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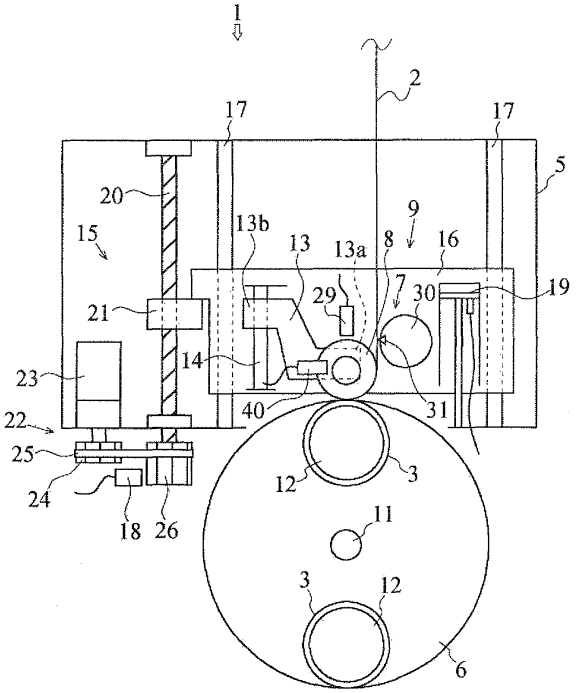
(54) Yarn winder

(57) An object of the present invention is to provide a device and method for a yarn winder which enables a package to be manufactured by taper winding. The present invention provides a yarn winder 1 that forms a package 4, the yarn winder including a contact roller 8 that contacts with the package 4 during formation of the package 4. a traverse device 7 located on an upstream side of the contact roller 8 in an advancing direction of a yarn 2, and a free length changing means 9 for enabling a change in free length FL of the yarn 2 between the contact roller 8 and the traverse device 7 during the formation of the package 4, and wherein during the formation of the package 4, the free length FL is substantially increased to allow winding to be performed such that the resulting package 4 includes a tapered end surface.

FIGURE 1



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Description

Field of the Invention

[0001] The present invention relates to a technique, for a yarn winder, of winding a yarn around a bobbin to form a package.

Background of the Invention

[0002] As a conventional technique, for a yarn winder, of winding a yarn around a bobbin to form a package, a yarn winder is known in which a spiral groove is formed in a surface of a cylindrical member (cylindrical grooved cam) so that rotation of the cylindrical member allows a traverse guide to reciprocate at a speed corresponding to a rotation speed of the cylindrical member and the inclination of the groove, thus traversing the yarn (for example, the Unexamined Japanese Patent Application Publication (Tokkai-Hei) No. 5-238645). In the yarn winder, the shape of the groove in the cylindrical member (cylindrical grooved cam) causes a traverse range to be fixed. This prevents a traverse width from being changed during winding.

[0003] As another technique of winding a yarn around a bobbin to form a package, a yarn winder is known which includes a traverse guide that engages with and traverses the yarn, and a traverse guide driving motor that moves the traverse guide (for example, the Unexamined Japanese Patent Application Publication (Tokkai) No. 2007-137615). The yarn winder is configured such that controlling driving of the traverse guide driving motor enables traversing movement to be controlled, thus allowing the traverse width to be changed during winding.

[0004] The yarn winder winds various types of yarns. However, in particular, where the yarn winder winds a yarn such as a monofilament which is composed of one filament, a phenomenon called a yarn stitching may occur in which the yarn slips down an end surface of the package during winding. This may form defective packages. Thus, where a yarn that is likely to undergo the yarn stitching is to be wound, then to prevent the possible the yarn stitching, taper winding in which the axial direction winding width of the package is gradually reduced may be used to form a package.

[0005] However, in the above-described yarn winder with the cylindrical grooved cam, the shape of the groove in the cylindrical member (cylindrical grooved cam) causes the traverse range to be fixed. This prevents the traverse width from being changed during winding. Thus, with the yarn winder with the cylindrical grooved cam, forming a package by taper winding is disadvantageously difficult.

[0006] Furthermore, with the yarn winder in which the traverse guide is moved by the driving of the traverse guide driving motor as described above, the traverse width can be easily changed during winding, allowing a package to be easily formed by taper winding. However, for example, the configuration of a device that moves the traverse guide is disadvantageously difficult.

[0007] The present invention has been made to solve the above-described problems. An object of the present invention is to provide a device and method for a yarn winder which enables a package to be manufactured by taper winding.

Summary of the Invention

[0008] The problems to be solved by the present invention have been described. Now, means for solving the problems will be described below.

[0009] A yarn winder according to a first invention is a yarn winder that forms a package, the yarn winder comprising:

a contact roller that contacts with the package during package formation;
a traverse device located on an upstream side of the contact roller in an advancing direction of a yarn; and
a free length changing means for enabling a change in free length of the yarn between the contact roller and the traverse device during the package formation,
wherein during the package formation, the free length is substantially increased to allow winding to be performed such that the resulting package includes a tapered end surface.

[0010] A yarn winder according to a second invention corresponds to the yarn winder according to the first invention wherein from beginning of winding of the package until end thereof, the free length is increased to allow taper winding to be performed.

[0011] A yarn winder according to a third invention corresponds to the yarn winder according to the first invention wherein the winding is performed with the free length partly increased and reduced so that the free length is entirely increased consistently with package diameter.

[0012] A yarn winder according to a fourth invention corresponds to the yarn winder according to any one of the first to third inventions wherein the free length changing means increases the free length by moving the traverse device toward the upstream side of the contact roller in the advancing direction of the yarn.

[0013] A yarn winder according to a fifth invention corresponds to the yarn winder according to any one of the first to fourth inventions wherein the free length changing means comprises a position sensor that senses an elevating position and a lowering position of the traverse device, and includes an elevating and lowering amount control means for sensing and controlling an elevating and lowering amount of the traverse device which is preset based on the package diameter and a free length amount.

[0014] A yarn winder according to a sixth invention corresponds to the yarn winder according to any one of the

first to fifth inventions wherein the free length changing means controls movement of the traverse device according to amount of change in winding diameter of the package and amount of increase in free length.

[0015] A yarn winding method according to a seventh invention is a yarn winding method of forming a package wherein during the package formation, from beginning of winding until end thereof, a free length is substantially increased to allow winding to be performed such that the resulting package includes a tapered end surface.

[0016] The present invention exerts the following effects.

[0017] In the first invention, during the package formation, the free length is substantially increased to allow the winding to be performed such that the resulting package includes the tapered end surface. Thus, the package can be formed by taper winding. Furthermore, even a yarn that is likely to undergo a yarn stitching can be wound without undergoing the yarn stitching.

[0018] In the second invention, from the beginning of winding of the package until the end thereof, the free length is increased to allow taper winding to be performed. Thus, the package can be formed by taper winding. Furthermore, even the yarn that is likely to undergo the yarn stitching can be wound without undergoing the yarn stitching.

[0019] In the third invention, the winding is performed with the free length partly increased and reduced so that the free length is entirely increased consistently with the package diameter. Thus, the package can be formed by taper winding. Furthermore, even the yarn that is likely to undergo the yarn stitching can be wound without undergoing the yarn stitching. This also enables prevention of a saddle bag shape phenomenon in which a yarn density concentrates at yarn turn portions to make opposite ends of the package higher than a central portion of the package.

[0020] In the fourth invention, the free length changing means increases the free length by moving the traverse device toward the upstream side of the contact roller in the advancing direction of the yarn. Thus, the free length can be increased with the contact roller always kept in contact with the package. Consequently, even with an increase in free length, the yarn traversed by the traverse device can be appropriately received and appropriately delivered to an outer periphery of the package. This enables prevention of possible formation of a defective package caused by improper winding or the like.

[0021] In the fifth invention, the free length changing means comprises the position sensor that senses the elevating position and lowering position of the traverse device, and includes the elevating and lowering amount control means for sensing and controlling the elevating and lowering amount of the traverse device which is preset based on the package diameter and the free length amount.

[0022] Thus, the position of the traverse device can be fed back to the control of the free length, thus enabling the free length to be accurately controlled to a desired value.

[0023] In the sixth invention, the free length changing means controls the movement of the traverse device according to the amount of change in the winding diameter of the package and the amount of increase in free length. Thus, the traverse device can be moved taking the shape of the package and the amount of increase in free length into account. Consequently, the shape of the package and the amount of increase in free length can be fed back to the control of the free length. Therefore, the free length can be accurately controlled to the desired value.

[0024] The seventh invention provides the yarn winding method of forming the package, wherein during the package formation, from the beginning of winding until the end thereof, the free length is substantially increased to allow the winding to be performed such that the resulting package includes the tapered end surface. Thus, the package can be formed by taper winding. Furthermore, even a yarn that is likely to undergo a yarn stitching can be wound without undergoing the yarn stitching.

[0025] Other features, elements, processes, steps, characteristics and advantages of the present invention will become more apparent from the following detailed description of preferred embodiments of the present invention with reference to the attached drawings.

Brief Description of the Drawings

[0026]

Figure 1 is a front view of a yarn winder 1 according to an embodiment of the present invention.

Figure 2 is a diagram of a system of the yarn winder 1.

Figure 3 is a diagram showing a relationship between a free length FL and traverse delay.

Figure 4 is a diagram showing a relationship between the amount of change in free length FL and the amount of decrease in the winding width of a package 4.

Figure 5 is a sectional view of the package 4 formed by winding with the free length FL maintained constant (4a) and by winding with the free length FL continuously varied (4b).

Figure 6 is a diagram showing control for maintaining the free length FL constant with respect to an increase in the diameter of the package 4 during the formation of the package 4.

Figure 7 is a diagram showing control for continuously increasing the free length FL consistently with the diameter of the package 4 during the formation of the package 4.

Figure 8 is a diagram showing a relationship between the free length FL and the winding diameter d of the package 4 which relationship is observed when the free length FL is continuously increased.

Figure 9 is a diagram showing a relationship between the free length FL and the winding diameter d of the

package 4 which relationship is observed when the free length FL is constant.

Figure 10 is a diagram showing a relationship between the duration of winding of the package 4 and the elevation amount of a slide box 16.

Figure 11 is a diagram showing a relationship between the duration of winding of the package 4 and the elevation amount of the slide box 16 which relationship is observed when the free length FL is substantially increased while repeatedly increased and reduced.

Detailed Description of the Preferred Embodiment

[0027] A winder 1 as a yarn winder according to an embodiment of the present invention will be described below with reference to the drawings. Figure 1 is a front view of the yarn winder 1 according to the embodiment of the present invention. Figure 2 is a diagram showing a system of the yarn winder 1.

[0028] The winder 1 is a yarn winder that winds synthetic fibers (synthetic fiber yarn) 2 as a yarn, around a bobbin 3 to form a package 4 (Figure 6). The yarn winder that winds the synthetic fibers (synthetic fiber yarn) 2 will be described below. However, the present invention is not limited to this aspect.

[0029] The yarn winder 1 may wind spun fiber yarn such as a cotton yarn. As shown in Figure 1, the yarn winder 1 includes a machine frame 5, a turret plate 6, a slide box 16, a traverse device 7, a contact roller 8, and a free length changing means 9. As shown in Figure 2, components of the yarn winder 1 are electrically connected to a control section 80. The control section 80 is configured as a well-known microcomputer, and includes a CPU as an arithmetic device, and storage means such as a ROM, a RAM, and an external storage device. The control section 80 controls driving of various driving motors based on signals generated by various sensors described below.

[0030] The turret plate 6 is provided on the machine frame 5 and can be pivotally moved around a rotating shaft 11 by a rotational driving device (not shown in the drawings). Two bobbin holders 12 on which bobbins 3 are installed are protrusively provided on the turret plate 6 at positions where the bobbin holders 12 are symmetric with respect to the rotating shaft 11. The turret plate 6 is rotated by the rotational driving device so that one of the bobbin holders 12 is placed at an upper, winding position, whereas the other is placed at a lower, standby position; the positions of the two bobbin holders 12 can be changed to each other. As shown in Figure 2, the two bobbin holders 12, provided on the turret plate 6, are connected to respective driving motors 27 and rotated by driving of the driving motors 27. The driving motors 27 are electrically connected to the control section 80 so that the driving of the driving motors 27 is controlled by the control section 80. A bobbin holder rotation sensor 35 is provided on the each of the bobbin holders 12 and electrically connected to the control section 80. The bobbin holder rotation sensor 35 senses the rotation speed of the bobbin holder 12 to transmit a sensing signal to the control section 80.

[0031] The slide box 16 is guided along rails 17, 17 provided at opposite ends of the slide box 16 so as to extend in a vertical direction in the machine frame 5.

[0032] The slide box 16 is thus movable in the vertical direction in the machine frame 5. The slide box 16 is elevated and lowered by the free length changing means 9, described below. The slide box 16 elevates to separate the traverse device 7, positionally fixed to the slide box 16, from the contact roller 8 (Figure 6). The slide box 16 lowers to approach the contact roller 8.

[0033] The traverse device 7 traverses the yarn 2 and is positionally fixed to the slide box 16. The traverse device 7 includes a traverse cam 30, a traverse guide 31, and a traverse motor 28. The traverse cam 30 is rotatably supported in the slide box 16 and includes a spiral traverse cam groove formed on a peripheral surface thereof. Rotationally driving the traverse cam 30 causes the traverse guide 31 to move along the traverse cam groove to reciprocate in an axial direction of the traverse cam 30. The traverse guide 31 guides the traveling yarn 2 to the contact roller 8 while traversing the yarn 2 in a lateral direction. The traverse motor 28 rotationally drives the traverse cam 30. The traverse motor 28 is electrically connected to the control section 80 so that driving of the traverse motor 28 is controlled by the control section 80. The control section 80 controls the rotation number of the traverse motor 28 so as to enable a change in traverse speed.

[0034] The contact roller 8 is located on a downstream side of the traverse device 7 in the advancing direction of the yarn 2. During formation of the package 4, the contact roller 8 rotates in conjunction with the package 4 to receive the yarn 2 traversed by the traverse device 7 to deliver the yarn 2 to an outer periphery of the package 4. The contact roller 8 is rotatably supported on a first end 13a side of an arm 13. A second end 13b of the arm 13 is inserted around a slide bar 14 supported in the slide box 16. The second end 13b can slide up and down with respect to the slide box 16. That is, the contact roller 8 is configured to be able to slide up and down with respect to the slide box 16 via the arm 13. A rotation sensor 40 is provided on the contact roller 8 to sense the rotation speed thereof. The contact roller 8 is connected to a motor 37. The contact roller 8 is rotationally driven by the motor 37 during a yarn hooking operation in which to start forming the package 4, an operator hooks the yarn 2 on the empty bobbin 3 and during a yarn switching operation in which when the formation of the package 4 is completed, the turret plate 6 rotates to automatically switch the yarn 2 to the standing-by empty bobbin 3.

[0035] The rotation sensor 40 senses the rotation speed of the contact roller 8 rotating in conjunction with the package 4. Based on the rotation speed, the rotation sensor 40 senses an outer peripheral speed of the pack-

age 4. The rotation sensor 40 is electrically connected to the control section 80. The control section 80 controls the driving of the driving motor 27 for the bobbin holder 12 so as to make the rotation speed sensed by the rotation sensor 40 constant. Specifically, when the value sensed by the rotation sensor 40 is smaller than a predetermined value corresponding to a winding speed, the control section 80 performs control such that the rotation speed of the driving motor 27 is increased. In contrast, when the sensed value is larger than the predetermined value, the control section 80 performs control such that the rotation speed of the driving motor 27 is reduced.

[0036] During the formation of the package 4, the free length changing means 9 elevates and lowers the slide box 16 to enable a change in the free length FL (Figure 6) of the yarn 2 between the contact roller 8 and the traverse device 7. The free length changing means 9 includes a ball screw mechanism 15, a position sensor 18, and a cylinder 19. Here, the free length FL refers to the free length of the yarn 2 over which the yarn 2 engaged with the traverse device 7 travels after being released from the traverse device 7 and before coming into contact with a peripheral surface of the contact roller 8.

[0037] The ball screw mechanism 15 is a section that elevates and lowers the slide box 16. The ball screw mechanism 15 includes a screw bar 20. a ball nut 21, and an elevating and lowering driving section 22. The screw bar 20 is located so as to extend in the vertical direction in the machine frame 5. The screw bar 20 is supported so as to be rotatable with respect to the machine frame 5. The ball nut 21 is threadably fitted around the screw bar 20 and engaged with the slide box 16 to elevate and lower the slide box 16.

[0038] The elevating and lowering driving section 22 rotationally drives the screw bar 20. The elevating and lowering driving section 22 rotates the screw bar 20 forward and backward to elevate and lower the slide box 16. The elevating and lowering driving section 22 is composed of a motor 23, a first gear 24, a belt 25, and a second gear 26. The motor 23 is connected to the first gear 24. The belt 25 is connected between the first gear 25 and the second gear 26. The screw bar 20 is connected to the second gear 26. When the motor 23 provides driving, a rotational driving force of the motor 23 is transmitted to the belt 25 via the first gear 24. Then, the belt 25 is driven to transmit a driving force of the belt 25 to the second gear 26 to rotationally drive the screw bar 20. Thus, the rotational driving force of the motor 23 is transmitted to the first gear 24, the belt 25, and the second gear 26 in this order to rotate the screw bar 20. As shown in Figure 2, the motor 23 is electrically connected to the control section 80 so that the driving of the motor 23 is controlled by the control section 80.

[0039] The cylinder 19 uses a cylinder pressure to carry most of the weight of the slide box 16 to allow the above-described elevating and lowering driving section 22 to elevate and lower the slide box 16 under a weak driving force. The cylinder pressure of the cylinder 19 is adjusted by an air supply section 36.

[0040] A sensor 29 is provided in the slide box 16 to sense the position of the contact roller 8 relative to the slide box 16 to sense an increase in the diameter of the package 4. The sensor 29 is provided opposite a direction in which the contact roller 8 moves. As described above, as the yarn 2 is wound around the bobbin to increase the diameter of the package 4, the contact roller 8 kept in contact with an outer peripheral surface of the package 4 moves upward in conjunction with the increase in the diameter of the package 4. The sensor 29 senses the contact roller 8 moving upward in conjunction with the increase in the diameter of the package 4 to sense the increase in the diameter of the package 4. Specifically, since the yarn 2 is wound around the bobbin 3 to increase the diameter of the package 4, the contact roller 8 kept in contact with the package 4 moves upward to reduce a distance between the contact roller 8 and the sensor 29. Then, when the distance decreases to a predetermined value, the sensor 29 is turned on. In contrast, when the contact roller 8 is separated from the sensor 29 by a distance that is equal to or greater than the predetermined value, the sensor 29 is turned off. As shown in Figure 2, the sensor 20 is electrically connected to the control section 80. When turned on, the sensor 29 transmits a sensing signal to the control section 80. Upon receiving the sensing signal from the sensor 29, the control section 80 determines that the slide box 16 is located below a steady-state position. The control section 80 thus transmits a control signal for elevation of the ball nut 21 to the ball screw mechanism 15 to allow the slide box 16 to be moved upward to the steady-state position. That is, control (thickening control) is performed so as to maintain the free length FL constant with respect to the increasing diameter of the package.

[0041] The position sensor 18 is provided opposite the second gear 26, which rotationally drives the screw bar 20 of the elevating and lowering driving section 22. The position sensor 18 senses rotation of the second gear 26 to sense the position of the slide box 16 and thus the position of the traverse device 7, supported in the slide box 16. As shown in Figure 2, the position sensor 18 is electrically connected to the control section 80. When turned on, the position sensor 18 transmits a sensing signal to the control section 80. Specifically, upon receiving the sensing signal from the sensor 29, the control section 80 transmits the control signal for elevation of the ball nut 21 to the ball screw mechanism 15. Then, the motor 23 of the elevating and lowering driving section 22 provides rotational driving. The rotational driving force of the motor 23 is transmitted to the second gear 26 to rotate the second gear 26.

[0042] When placed opposite a tooth tip of the rotating second gear 26, the position sensor 18 is turned on. When placed opposite a tooth root of the second gear 26, the position sensor 18 is turned off. The second gear 26 includes a predetermined number of teeth. Thus, counting the number of the teeth allows rotation angle of

the second gear 26 to be determined. The rotation angle of the screw bar 20 is determined from the rotation angle of the second gear 26. The movement distance of the ball nut 21 is determined from the rotation angle of the screw bar 20. Finally, the position of the slide box 16 supported by the ball nut 21 is sensed to sense the position of the traverse device 7.

[0043] Thus, the free length changing means 9 includes the position sensor 18, which senses the position of the traverse device 7. The control section 80 controls the elevation amount of the traverse device 7 which is preset based on the package diameter and a free length amount.

[0044] Now, a relationship between the free length FL and the taper winding will be described. Figure 3 is a diagram showing a relationship between the free length FL and the traverse delay. As described above, the free length FL refers to the free length of the yarn 2 over which the yarn 2 engaged with the traverse device 7 travels after being released from the traverse device 7 and before coming into contact with the peripheral surface of the contact roller 8.

[0045] The free length FL can be increased by separating the traverse device 7 (traverse guide 31) from the contact roller 8. With a constant angle (winding angle) between a straight line perpendicular to the axial direction of the bobbin 3 and the direction of the yarn 2 wound around the bobbin 3, the increased free length FL increases a difference (traverse delay) between an axial position (the position of the traverse guide 31) where the yarn 2 is actually traversed and an axial position where the yarn 2 is actually received by the contact roller 8.

[0046] This will be specifically described with reference to Figure 3. First, when the winding angle is Al and the free length FL = FL1, the yarn 2 is received by the controller 8 at an axial direction position N1. In this case, the traverse delay is D1. That is, even though the traverse guide 31 reaches an end of a traverse range, the yarn 2 is actually wound around the package 4 at a position closer to an axial direction center by a distance corresponding to the traverse delay D1. Then, when the winding angle is still Al but the free length FL = FL2, the yarn 2 is received by the contact roller 8 at an axial direction position N2. In this case, the traverse direction delay is D2. That is, even though the traverse guide 31 reaches the end of the traverse range, the yarn 2 is actually wound around the package 4 at a position closer to the axial direction center by a distance corresponding to the traverse delay D2. Namely, increasing the free length FL from FL1 to FL2 results in a difference (D2 - D1) in traverse delay. The yarn 2 is thus wound around the package 4 at the position closer to the axial direction center by the distance corresponding to the difference (D2 - D1) in traverse delay. Therefore, increasing the free length FL allows the position where the yarn 2 is wound around the package 4 to be gradually moved closer to the axial direction center.

[0047] Now, control for increasing the free length FL will be described. Figure 4 is a diagram showing a relationship between the amount of change in free length FL and the amount of decrease in the winding width of the package 4. Figure 5 is a sectional view of the package 4 resulting from winding with free length FL maintained constant (4a) and winding with the free length FL continuously varied (4b).

[0048] As described above, increasing the free length FL enables taper winding in which the yarn 2 is wound into the package 4 with the axial direction winding width of the package 4 gradually reduced. In the present embodiment, a continuous increase in free length FL will be described. As shown in Figure 4, a continuous increase in free length FL reduces the winding width of the package 4, while increasing the amount of decrease in the winding width of the package 4. Here, the amount of decrease in the winding width of the package 4 refers to the amount of decrease in winding width on one side of the package 4 (D1, D2 in Figure 5).

[0049] This will be specifically described with reference to Figures 4 and 5. When the yarn 2 is wound with the free length FL maintained constant at FL0, a package 4a with a constant winding width D is formed as shown by an alternate long and two short dashes line. On the other hand, as shown in Figure 4, increasing the free length FL from FL0 to FL1 changes the amount of decrease in the winding width of the package 4b to D1 and thus changes the winding width of the package 4b to (D - 2 x D1). Moreover, increasing the free length FL from FL1 to FL2 changes the amount of decrease in the winding width of the package 4b from D1 to D2 and thus changes the winding width of the package 4b to (D - 2 x D2). Thus, maintaining the free length FL constant allows the formation of the package 4a with the constant winding width (as shown by the alternate long and two short dashes line in Figure 5). Continuously varying the free length FL allows the package 4b to be formed by taper winding (as shown by a solid line in Figure 5).

[0050] As described above, continuously increasing the free length FL allows the package 4 to be formed by taper winding, in which the winding width of the package 4 is gradually reduced. That is, by performing control for continuously increasing the free length FL, the yarn winder 1 enables the package 4 to be formed by taper winding. The yarn winder 1 elevates and lowers the traverse device 7 to perform the control for continuously increasing the free length FL.

[0051] The traverse device 7 is elevated and lowered by elevating and lowering the slide box 16.

[0052] Now, the control for continuously increasing the free length FL will be described. Figure 6 is a diagram showing the control for maintaining the free length FL constant with respect to the increasing diameter of the package 4 during the formation of the package 4. Figure 7 is a diagram showing the control for continuously increasing the free length FL consistently with the diameter of the package 4 during the formation of the package 4.

[0053] First, as shown in Figures 6A, 6B, when the

yarn 2 is wound on the bobbin 3, the winding diameter of the package 4 increases. As shown in Figure 6B, it is assumed that the yarn 2 has been wound on the bobbin 3 to form the package 4 with a certain diameter and that the current radius of the package 4 is defined as (r). It is also assumed that the diameter of the package 4, that is, the radius of the package 4, further increase by a very small amount (dr) to (r + dr). At this time, the contact roller 8 kept in contact with the package 4 elevates relative to the slide box 16 by a distance corresponding to the increase (dr) in the radius of the package 4. The contact roller 8 thus moves upward relative to the slide box 16 so as to be located higher than in Figure 6B.

[0054] As the contact roller 8 elevates relative to the slide box 16, the sensor 29 transmits the sensing signal to the control section 80. Upon receiving the signal, the control section 80 drives the elevating and lowering driving section 22 of the ball screw mechanism 15 to elevate the slide box 16 by a distance corresponding to the increase dr in the diameter of the package 4. Control is performed such that the slide box 16 is elevated to lower the contact roller 8 relative to the slide box 16 so as to return the contact roller 8 to the original position thereof with respect to the slide box 16. Thus, the free length FL is maintained constant by performing control for elevating the slide box 16 by the distance corresponding to the increase in package diameter. Therefore, for a continuous increase in free length FL, the slide box 16 needs to be elevated by a distance greater than the increase in package diameter.

[0055] Thus, as shown in Figures 7A, 7B, to perform the control for continuously increasing the free length FL consistently with the diameter of the package 4 during the formation of the package 4. the yarn winder 1 elevates the slide box 16 by the distance corresponding to the increase in package diameter, and further drives the elevating and lowering driving section 20 of the ball screw mechanism 15 to continuously elevate the slide box 16 so as to achieve the desired free length FL. When the slide box 16 is elevated, the contact roller 8 lowers relative to the slide box 16 under the weight of the slide box 16, while keeping in contact with the package 4. On the other hand, the traverse device 7 is fixed to the slide box 16 and thus elevates together with the slide box 16. As a result, the free length FL of the yarn 2 between the traverse device 7 and the contact roller 8 is continuously increased (Figure 7B).

[0056] Now, control of the elevation amount of the slide box 16 will be described. Figure 8 is a diagram showing a relationship between the free length FL and the winding diameter d of the package 4 which relationship is observed when the free length FL is continuously increased. Figure 9 is a diagram showing a relationship between the free length FL and the winding diameter (d) of the package 4 which relationship is observed when the free length FL is constant.

[0057] As described above, the yarn winder 1 controls the free length FL by elevating the slide box 16. The slide box 16 is elevated by the free length changing means 9. The free length changing means 9 controls the elevation of the slide box 16 according to the amount of change (the amount of increase) in the winding diameter of the package 4 and the elevation amount of the slide box 16, which is derived from the increase amount of the free length FL.

[0058] The elevation amount of the slide box 16 is the sum of the "amount of increase in the diameter of the package 4 during the formation of the package 4" and the "amount of increase in free length FL".

[0059] The "amount of increase in free length FL" is calculated from a precalculated "package diameter calculated value" and a "set value" set by a combination of the winding diameter of the package 4 and the amount of increase in free length FL.

[0060] Here, the above-described "package diameter calculated value" is calculated from the "rotation number of the contact roller 8", the "diameter of the contact roller 8", and the "rotation number of the bobbin holder 12".

[0061] Furthermore, for the above-described "set value", the combination of the " winding diameter of the package 4" and the "amount of increase in free length FL" is preset. The "set value" is set so as to exhibit such a relationship as shown in Figure 8A.

[0062] Here, the elevation amount of the slide box 16 will be specifically described with reference to Figure 8. First, the free length FL with respect to the winding start diameter (d0) of the package 4 is set to FL0. Then, the free length FL with respect to the winding diameter (d1) of the package 4 is set to FL1. The elevation amount of the slide box 16 is then calculated. Moreover, the free length FL with respect to the winding diameter (d2) of the package 4 is set to FL2. The elevation amount of the slide box 16 is then calculated.

[0063] Thus, by elevating the slide box 16 while calculating the elevation amount of the slide box 16, the free length FL is continuously increased to gradually reduce the winding width of the package 4 as shown in Figure 8B. When the free length FL is maintained constant as shown in Figure 9A, the winding width of the package 4 remains constant as shown in Figure 9B.

[0064] Figure 10 is a diagram showing a relationship between time required to wind the yarn into the package 4 and the elevation amount of the slide box 16. A solid line in Figure 10 shows a variation in the elevation amount of the slide box 16 observed when the free length FL is continuously increased. An alternate long and two short dashes line in Figure 10 shows a variation in the elevation amount of the slide box 16 observed when the free length FL is constant.

[0065] As shown by the alternate long and two short dashes line in Figure 10, even with the free length FL maintained constant, the yarn winder 1 elevates the slide box 16 as the yarn 2 is wound around the bobbin 3 (as winding time elapses). That is, as described above, the control (thickening control) for maintaining the free length FL constant is performed with respect to the increasing

package diameter of the package 4 resulting from winding of the yarn 2 around the bobbin 3. Furthermore, as shown by the solid line in Figure 10, even with the free length FL continuously increased, the package diameter of the package 4 increases as described above. Thus, the yarn winder 1 elevates the slide box 16 with the increase in package diameter taken into account.

[0066] In a yarn winder such as the yarn winder 1 which traversely winds the yarn 2 around the bobbin 3 rotated in contact with the contact roller 8, to form the package 4, a yarn density may concentrate at portions of the package 4 in which the yarn 2 is turned and which correspond to the opposite ends of the package 4, to cause a saddle bag shape phenomenon in which the opposite ends of the package 4 are higher than a central portion thereof. To avoid the saddle bag shape phenomenon, an operation may be performed which, with the package 4 and the contact roller 8 kept in contact with each other, temporarily increases and then reduces the free length FL back to the original value during the formation of the package 4.

[0067] In the above description, the free length FL is continuously increased. However, even by repeatedly increasing and reducing the free length FL to gradually increase the free length FL instead of continuously increasing the free length FL, the yarn winder 1 according to the present invention can exert similar effects. That is, the free length FL may be controlled so as to, in spite of a temporary reduction, be gradually increased over the period during which the package 4 is formed. Therefore, the saddle bag shape phenomenon and yarn stitching can be prevented by repeating the operation of temporarily increasing and then reducing the free length FL back to the original value, that is, repeatedly increasing and reducing the free length FL to partly increase and reduce the free length FL. An operation of substantially increasing the free length FL while repeatedly increasing and reducing the free length FL will be described below.

[0068] Figure 11 is a diagram showing a relationship between the duration of winding of the package 4 and the elevation amount of the slide box 16 which relationship is observed when the free length FL is substantially increased while repeatedly increased and reduced. A solid line in Figure 11 indicates a variation in the elevation amount of the slide box 16 observed when the free length FL is substantially increased while repeatedly increased and reduced. An alternate long and two short dashes line in Figure 11 indicates a variation in the elevation amount of the slide box 16 observed when the free length FL is maintained constant.

[0069] As shown by the solid line in Figure 11, temporarily elevating the slide box 16 high results in a temporary sharp reduction in the winding width of the package 4. Thus, the yarn density can be prevented from concentrating at the opposite ends of the package 4, allowing the saddle bag shape phenomenon to be prevented. On the other hand, as shown by the solid line in Figure 11, the elevation amount of the slide box 16 substantially increases to allow the package 4 to be formed by taper winding.

[0070] According to the present embodiment, described above, during the formation of the package 4, the free length changing means 9 of the yarn winder 1 gradually increases the free length FL. This gradually increases the difference between the axial direction position where the yarn 2 is traversed and the axial direction position where the yarn 2 is received by the contact roller 8, that is, the traverse delay. Consequently, when the yarn 2 is wound, the axial direction winding width of the package is gradually reduced. As a result, the package 4 can be formed by taper winding, allowing even a yarn that is likely to undergo yarn stitching to be wound without undergoing the yarn stitching.

[0071] Furthermore, the free length changing means 9 of the yarn winder 1 gradually increases the free length FL by moving the traverse device 7 toward the upstream side of the contact roller 8 in the advancing direction of the yarn 2. Thus, the free length FL can be increased with the contact roller 8 always kept in contact with the package 4. Consequently, even with an increase in free length FL, the yarn 2 traversed by the traverse device 7 can be appropriately received and then appropriately delivered to the outer periphery of the package 4. This enables prevention of possible formation of a defective package caused by improper winding or the like.

[0072] Moreover, the free length changing means 9 of the yarn winder 1 includes the position sensor 18, which senses the position of the traverse device 7, to control movement of the traverse device 7 according to a sensing result provided by the position sensor 18. Thus, the position of the traverse device 7 can be fed back to the control of the free length FL, allowing the free length FL to be accurately controlled to the desired value. Furthermore, the position sensor 18 senses the position of the slide box 16 to determine whether or not the elevating position of the slide box 16 is correct. This enables prevention of possible formation of a defective package caused by improper winding or the like.

[0073] Moreover, the free length changing means 9 of the yarn winder 1 controls the movement of the traverse device 7 according to an increase in the winding diameter of the package 4 and the amount of increase in free length FL. Thus, the taper of the package 4 can be set to any shape.

[0074] While the present invention has been described with respect to preferred embodiments thereof, it will be apparent to those skilled in the art that the disclosed invention may be modified in numerous ways and may assume many embodiments other than those specifically set out and described above. Accordingly, it is intended by the appended claims to cover all modifications of the present invention that fall within the scope of the invention.

Claims

1. A yarn winder that forms a package, the yarn winder **characterized by** comprising:

   a contact roller that contacts with the package during package formation;
   a traverse device located on an upstream side of the contact roller in an advancing direction of a yarn; and
   a free length changing means for enabling a change in free length of the yarn between the contact roller and the traverse device during the package formation, and
   in that during the package formation, the free length is substantially increased to allow winding to be performed such that the resulting package includes a tapered end surface.

2. The yarn winder according to Claim 1. **characterized in that** from beginning of winding of the package until end thereof, the free length is increased to allow taper winding to be performed.

3. The yarn winder according to Claim 1, **characterized in that** the winding is performed with the free length partly increased and reduced so that the free length is entirely increased consistently with package diameter.

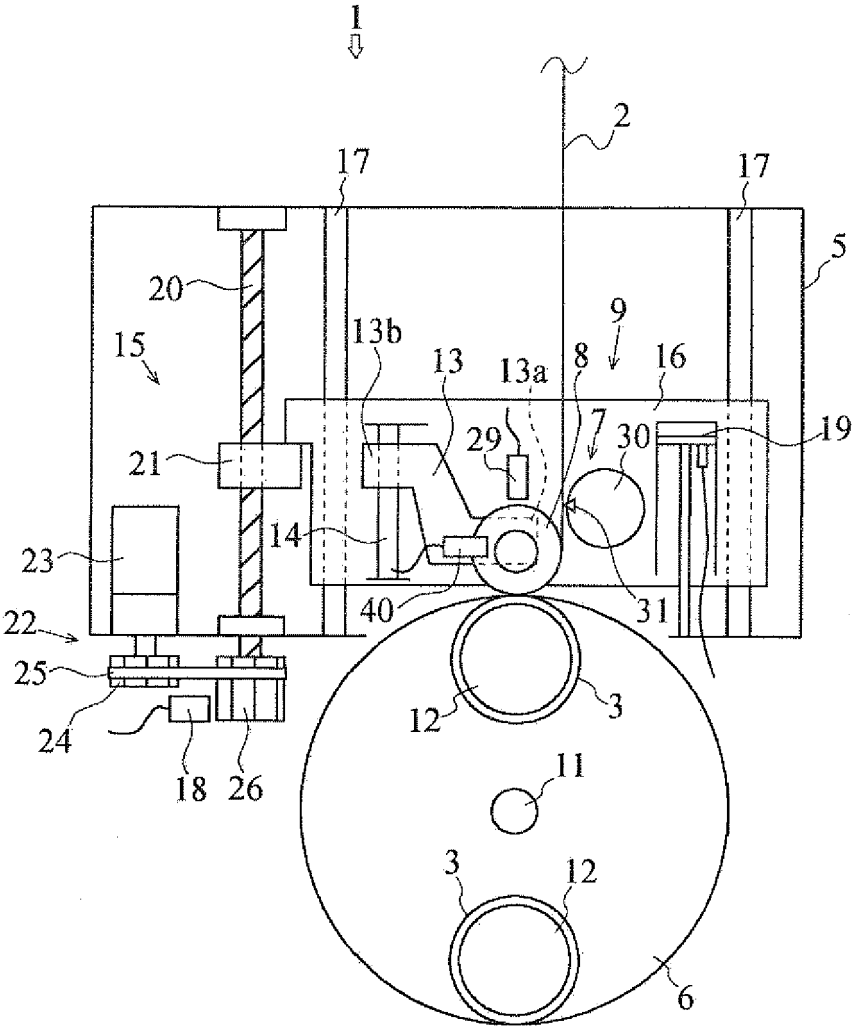
4. The yarn winder according to any one of Claims 1 to 3, **characterized in that** the free length changing means increases the free length by moving the traverse device toward the upstream side of the contact roller in the advancing direction of the yarn.

5. The yarn winder according to any one of Claims 1 to 4. **characterized in that** the free length changing means comprises a position sensor that senses an elevating position and a lowering position of the traverse device, and includes an elevating and lowering amount control means for sensing and controlling an elevating and lowering amount of the traverse device which is preset based on the package diameter and a free length amount.

6. The yarn winder according to any one of Claims 1 to 5, **characterized in that** the free length changing means controls movement of the traverse device according to amount of change in winding diameter of the package and amount of increase in free length.

7. A yarn winding method of forming a package, the method being **characterized in that** during the package formation, from beginning of winding until end thereof, a free length is substantially increased to allow winding to be performed such that the resulting package includes a tapered end surface.

FIGURE 1


1
2
17
17
5
20
9
13b
15
13
13a
8
16
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23
40
31
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25
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18
26
3
12
6

FIGURE 2

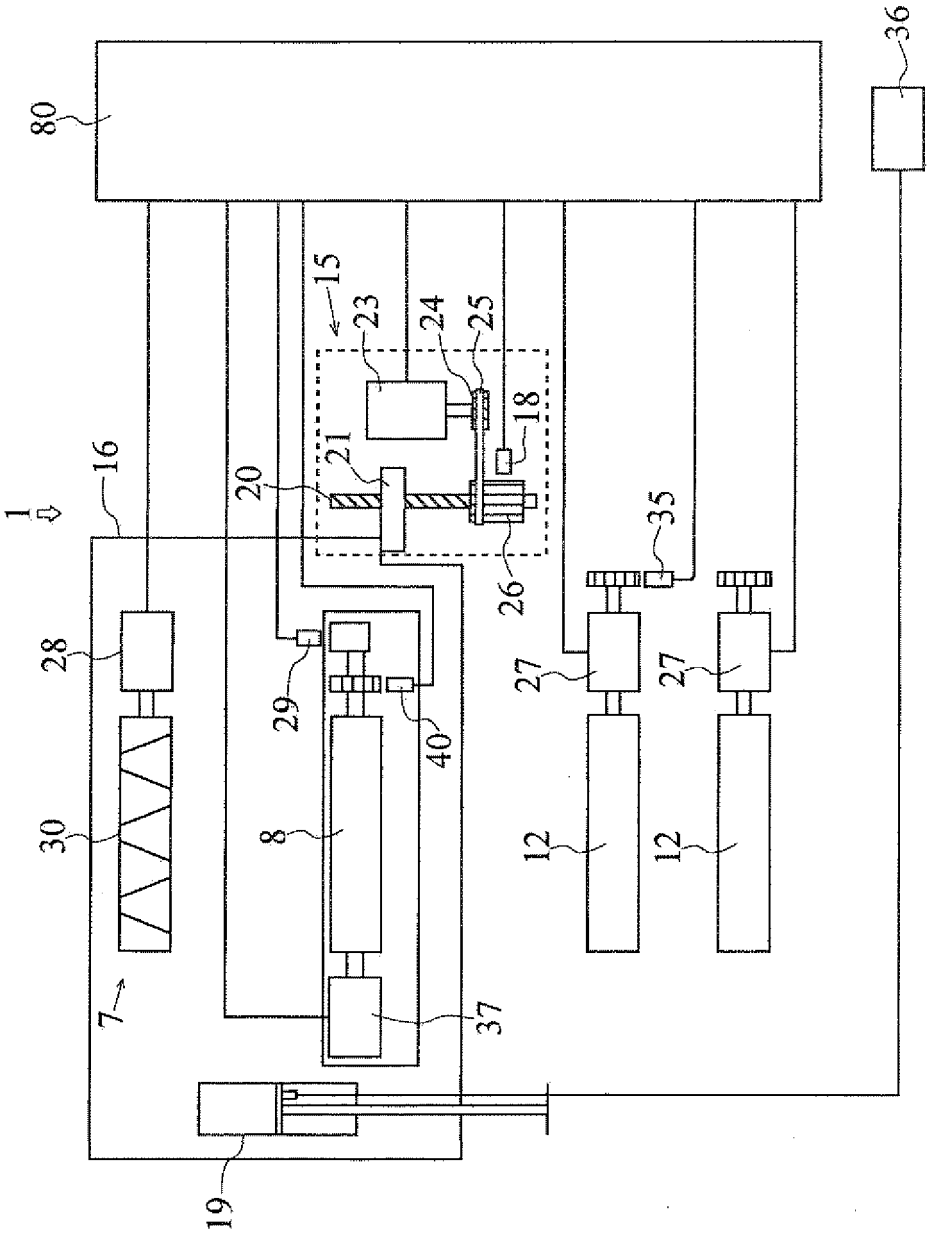


FIGURE 3

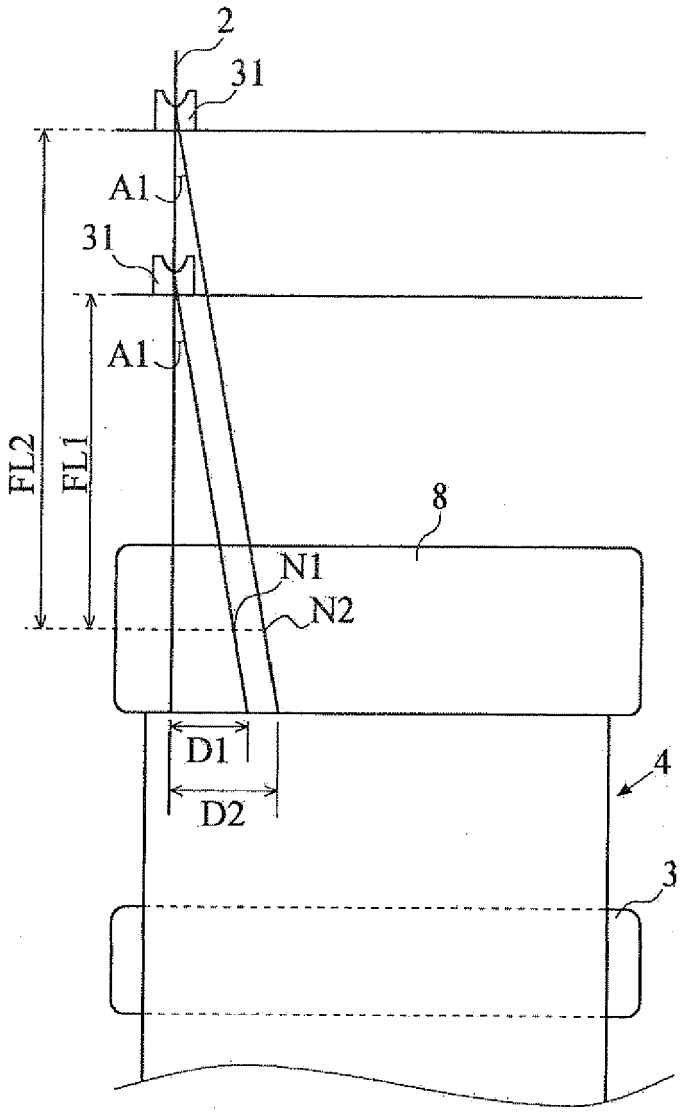


FIGURE 4

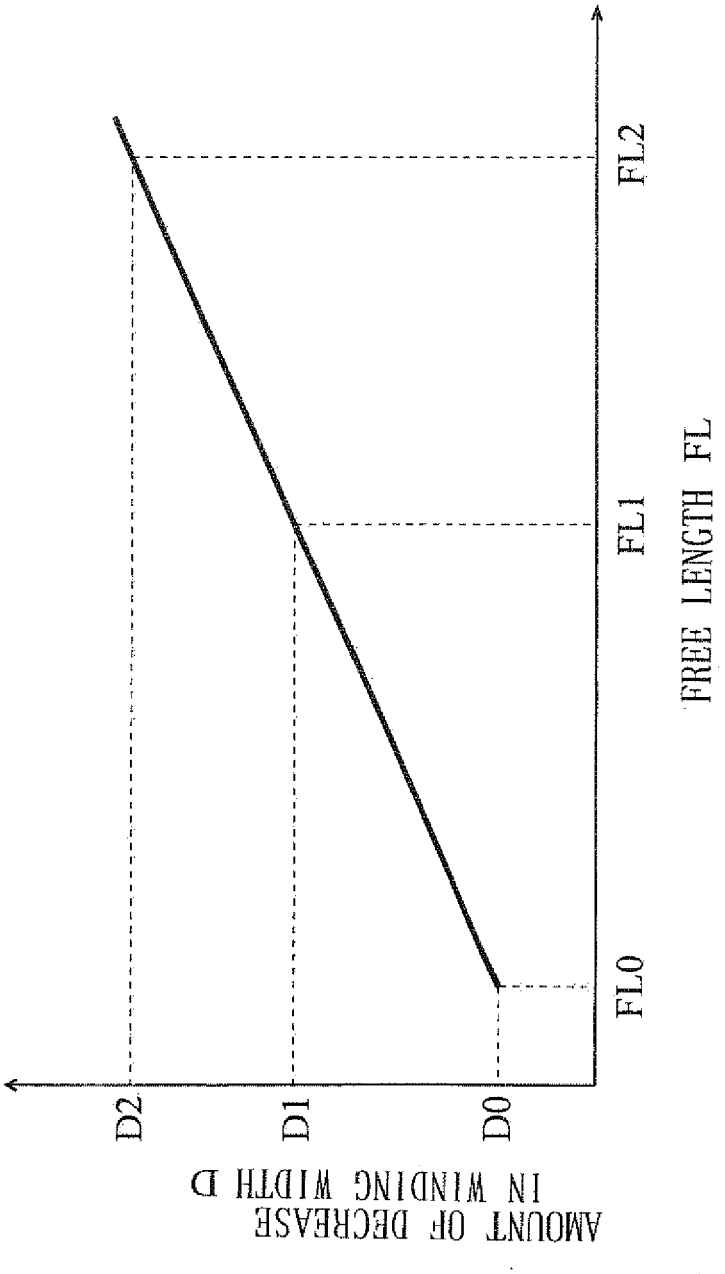

AMOUNT OF DECREASE IN WINDING WIDTH D
D2
D1
D0
FL0
FL1
FL2
FREE LENGTH FL

FIGURE 5

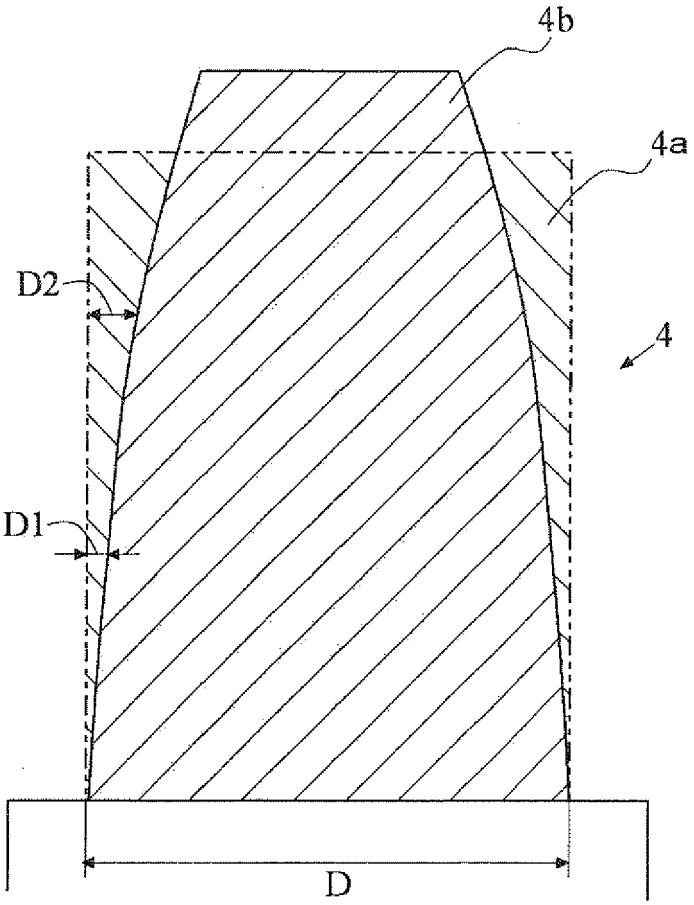


FIGURE 6B

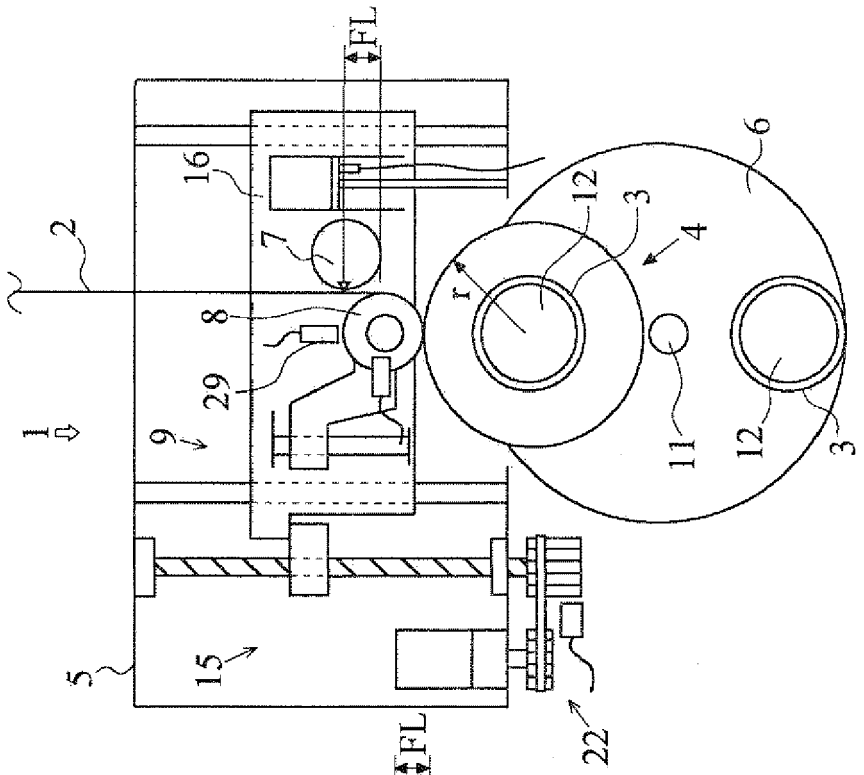


FIGURE 6A

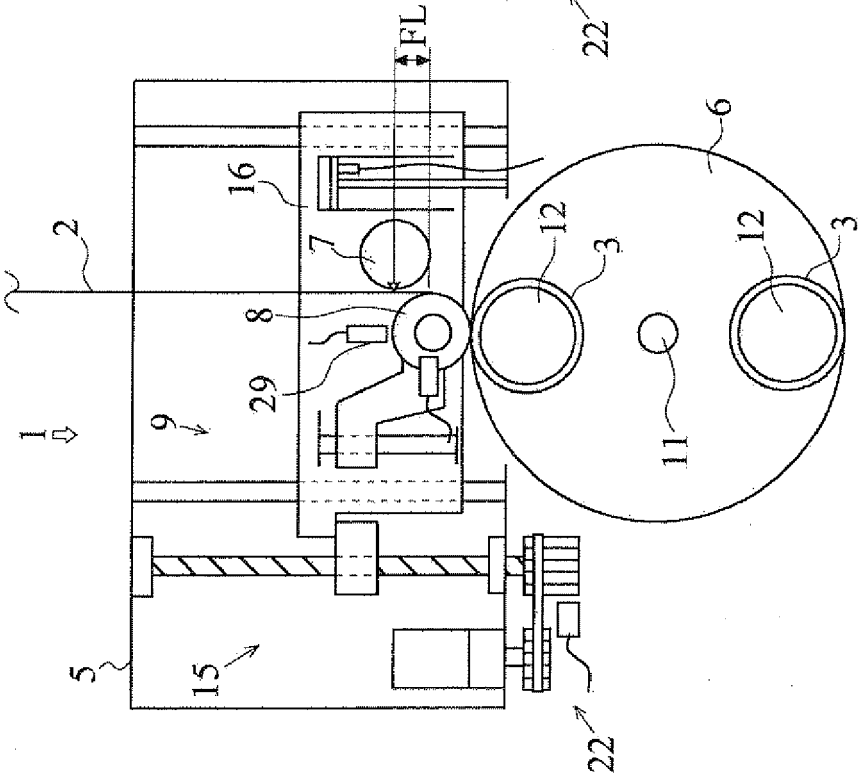


FIGURE 7B

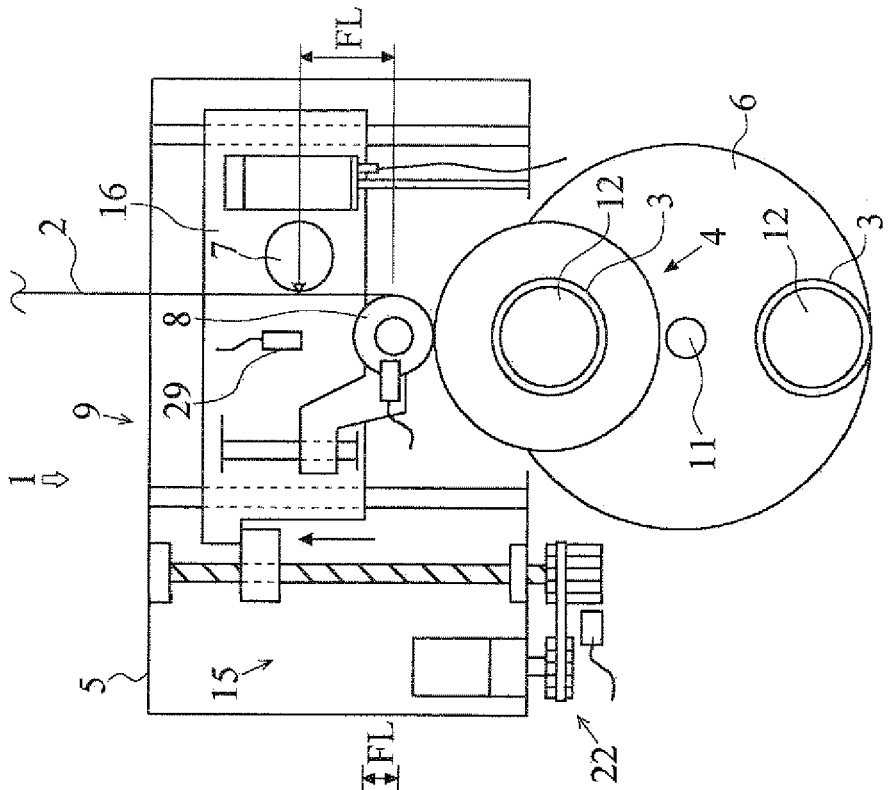
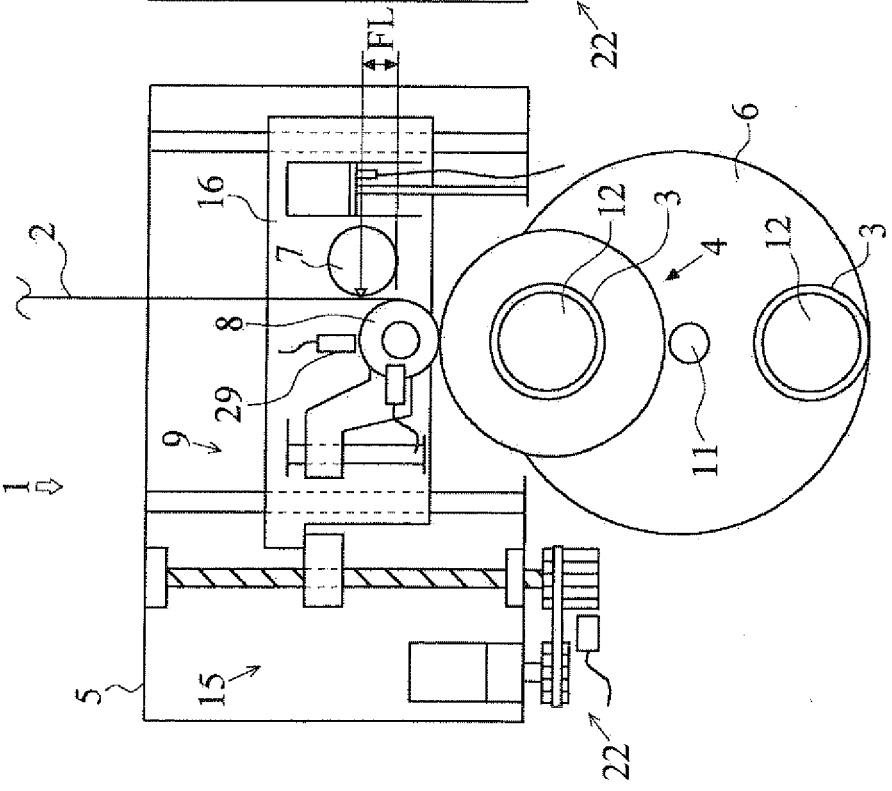


FIGURE 7A



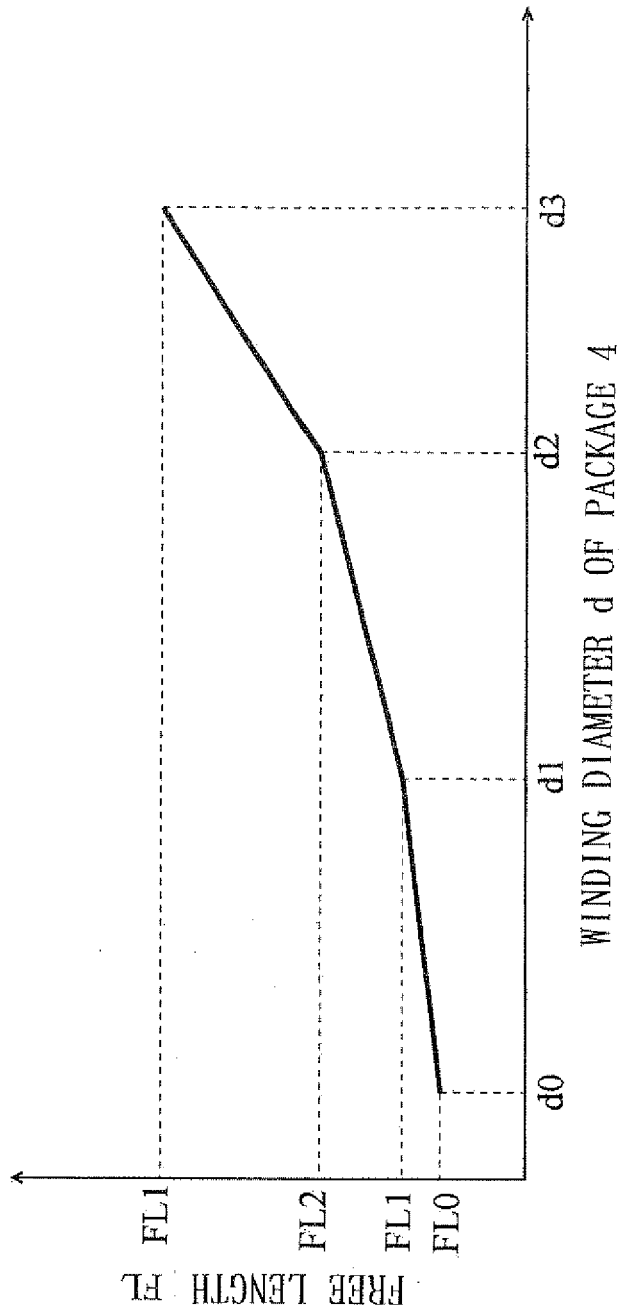


FIGURE 8A

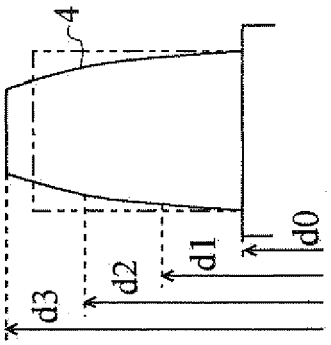


FIGURE 8B

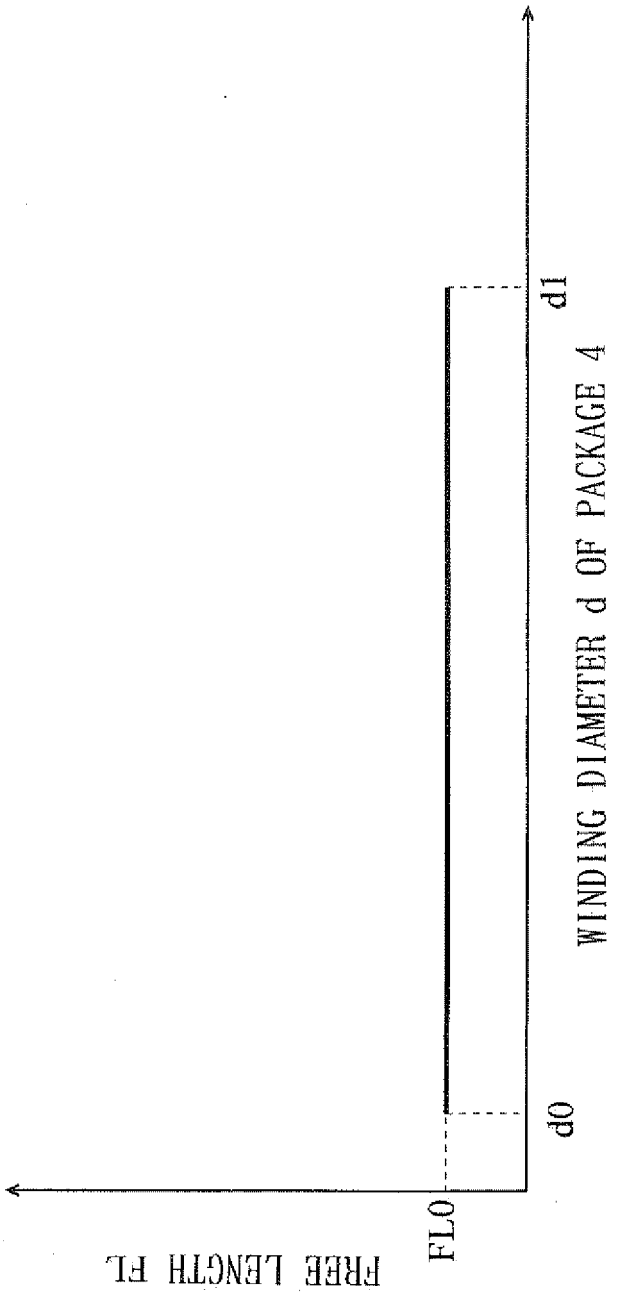


FIGURE 9A

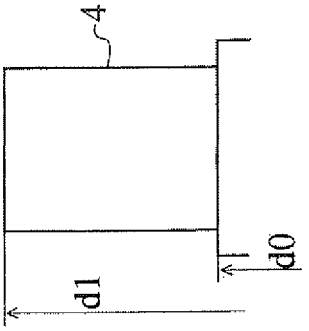


FIGURE 9B

FIGURE 10

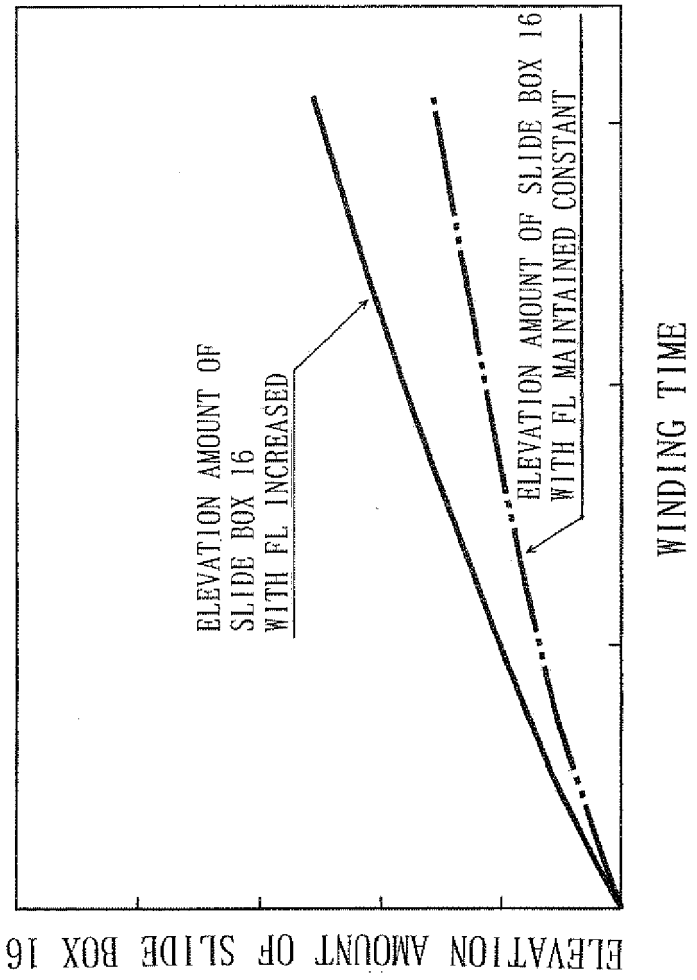
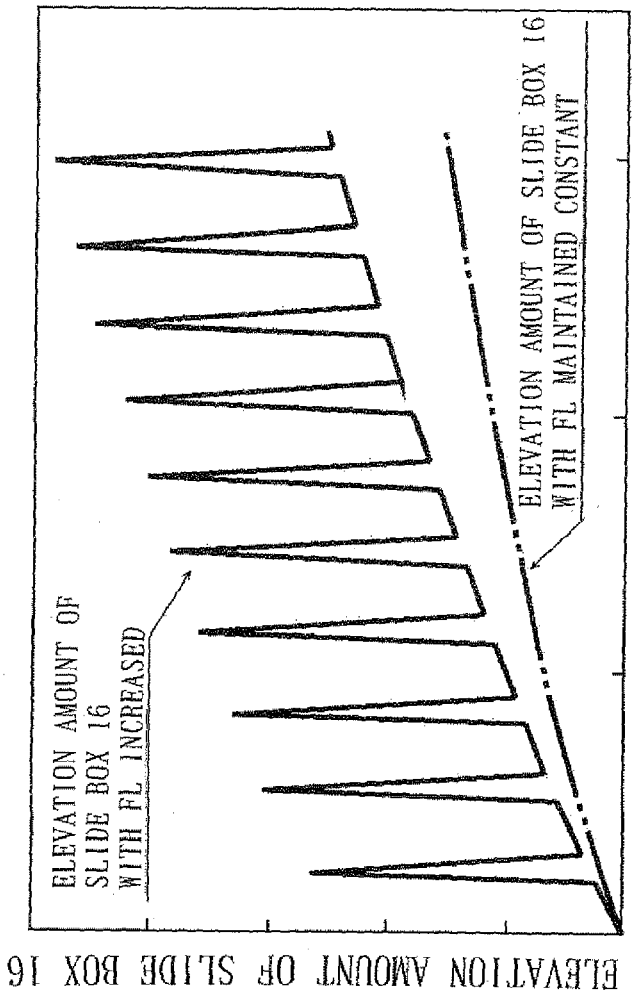

ELEVATION AMOUNT OF SLIDE BOX 16
WINDING TIME
ELEVATION AMOUNT OF SLIDE BOX 16 WITH FL INCREASED
ELEVATION AMOUNT OF SLIDE BOX 16 WITH FL MAINTAINED CONSTANT

FIGURE 11


ELEVATION AMOUNT OF SLIDE BOX 16
ELEVATION AMOUNT OF SLIDE BOX 16 WITH FL INCREASED
ELEVATION AMOUNT OF SLIDE BOX 16 WITH FL MAINTAINED CONSTANT
WINDING TIME

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EUROPEAN SEARCH REPORT

Application Number
EP 09 15 1499

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	DE 102 41 552 A1 (HEITMANN UWE [DE]) 18 March 2004 (2004-03-18) * paragraphs [0003], [0012], [0017], [0039] - [0045]; figure 1 *	1-4,6,7	INV. B65H54/10 B65H54/38 B65H67/048
X	DE 203 04 108 U1 (COMOLI FERMO S R L [IT]) 22 May 2003 (2003-05-22) * page 6, lines 5-13; figures 1,2 *	1,3,4	
X	JP 2005 225611 A (TMT MACHINERY INC) 25 August 2005 (2005-08-25) * abstract; figures 1-6 *	1,3-5	
			TECHNICAL FIELDS SEARCHED (IPC) B65H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	10 November 2009	Pussemier, Bart

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10-11-2009

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- JP 2007137615 A **[0003]**