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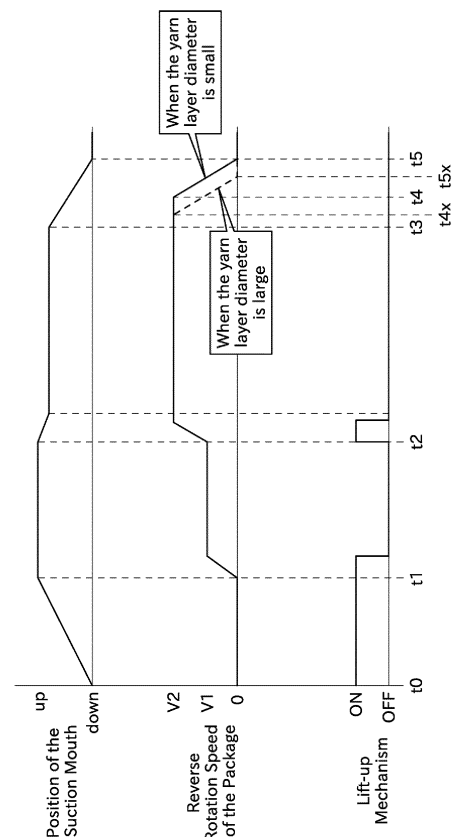
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(54) **YARN WINDING UNIT**

(57) A winder unit comprises a winding section, a package driving motor, an upper yarn catching pipe, and a unit controller. The winding section winds a yarn to form a package. The package driving motor rotates the package reversibly in the rotation direction. The upper yarn catching pipe catches a yarn from the package rotated by the driving section in a reverse direction opposite to a yarn winding direction. The unit controller controls a rotation direction of the package and starting/stopping of rotation of the package. The unit controller changes a timing of issuing at least either a reverse rotation stop command or a reverse rotation speed reduction command issued to the driving section in correspondence to rotational inertia of the package. The reverse rotation stop command is defined as a command issued to the driving section to stop a reverse rotation of the package which is the rotation of the package in the reverse direction, and the reverse rotation speed reduction command is defined as a command issued to the driving section to reduce the reverse rotation speed of the package for the purpose of stopping the reverse rotation of the package.

Fig.5



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Description

TECHNICAL FIELD

[0001] The present invention relates to a yarn winding apparatus. More specifically, the present invention relates to reverse rotation control of a package during a yarn joining operation performed by a yarn winding unit of the yarn winding apparatus.

BACKGROUND ART

[0002] There is a conventional well-known yarn winding apparatus having a winding section which winds a yarn fed from a yarn feeding section so as to form a package. Generally, this kind of yarn winding apparatus includes a winding unit which is provided with a yarn catching and guiding device and a yarn joining device. The yarn catching and guiding device catches a yarn end of one of divisional yarns into which a yarn is divided between the yarn feeding section and the winding section. The yarn joining device joins another yarn end to the yarn end guided by the yarn catching and guiding device. Patent Document 1 discloses a winding unit serving as a package forming unit of this kind of yarn winding apparatus.

[0003] The winding unit of Patent Document 1 includes a power source for driving an upper yarn guide pipe for catching yarn unwound from the reverse rotating package, and includes a controller for moving a mouth portion of the upper yarn guide pipe at a speed not more than the speed of yarn unwound from a yarn layer by the reverse rotation of the package. Patent Document 1 describes that after the upper yarn is caught, the movement speed of the mouth portion and the yarn unwinding speed of the reverse rotating package should be desirably controlled to become equal to each other.

CITATION LIST

Patent Literature

[0004] Patent Literature 1: Patent Application Laid Open Gazette No. 2009-155101

SUMMARY OF THE INVENTION

Problem to Be Solved by the Invention

[0005] Regarding the winding unit disclosed by Patent Literature 1, the upper yarn guide pipe continuously holds the upper yarn caught at its mouth portion after the upper yarn guide pipe catching the upper yarn finishes its movement for guiding the upper yarn to the yarn joining device. Therefore, when the mouth comes to rest, the package desirably stops its reverse rotation simultaneously. However, the rotation inertia varies in correspondence to weight, so that the period of time from the start of con-

trolling to stop the reverse rotation of the package until the actual stop of the package varies in correspondence to variation in the quantity of yarn wound to the package (variation in the wound yarn layer diameter). Therefore, the yarn unwound from the package may have an irregular length so that the upper yarn guided by the upper yarn guide pipe may be torn off or loosened, whereby the yarn joining operation may be wrongly performed.

[0006] The present invention is created in view of the above-mentioned situation. A main object of the invention is to provide a yarn winding unit which can control a timing of actually stopping the reverse rotation of the package.

Solution to the Problem and Effect

[0007] The foregoing description is given of the problem to be solved by the invention. Solution to the problem and effects of the solution will now be described.

[0008] In a first aspect of the invention, provided is a yarn winding unit configured as follows: A yarn winding unit comprises a winding section, a driving section, a yarn catching section and a unit controller. The winding section winds a yarn to form a package. The driving section rotates the package reversibly in the rotation direction. The yarn catching section catches a yarn from the package rotated by the driving section in a reverse direction opposite to a yarn winding direction. The unit controller controls a rotation direction of the package and starting/stopping of rotation of the package. The unit controller changes a timing of issuing at least either a reverse rotation stop command or a reverse rotation speed reduction command issued to the driving section in correspondence to rotational inertia of the package. The reverse rotation stop command is defined as a command issued to the driving section to stop a reverse rotation of the package which is the rotation of the package in the reverse direction, and the reverse rotation speed reduction command is defined as a command issued to the driving section to reduce the reverse rotation speed of the package for the purpose of stopping the reverse rotation of the package.

[0009] Therefore, the timing of actually stopping the reverse rotation of the package can be controlled in correspondence to the rotational inertia.

[0010] Preferably, in the yarn winding unit, when the rotational inertia of the package is large, the unit controller issues at least either the reverse rotation stop command or the reverse rotation speed reduction command issued to the driving section at a timing earlier than that when the rotational inertia of the package is small.

[0011] Therefore, the commands for speed-reducing and stopping the reverse rotation are issued to the driving section at the respective timings corresponding to variation of the rotational inertia so that the fluctuation of the timing of actually stopping the reverse rotation of the package is reduced appropriately.

[0012] Preferably, in the yarn winding unit, the unit controller issues at least either the reverse rotation stop com-

mand or the reverse rotation speed reduction command issued to the driving section so that the reverse rotation of the package is actually stopped at a constant timing regardless of variation in quantity of yarn wound into the package.

[0013] Therefore, the motion timing after the stopping of the reverse rotation of the package can be regulated, thereby simplifying the control.

[0014] Preferably, the yarn winding unit is configured as follows: The yarn winding unit comprises a yarn joining device for joining a yarn caught by the yarn catching section to another yarn. The unit controller matches the timing at which the reverse rotation of the package is actually stopped with a timing at which the yarn catching section holding the yarn from the package arrives at a guide position for guiding the yarn to the yarn joining device and comes to rest there.

[0015] Therefore, the timing at which the reverse rotation of the package can be matched with the timing at which the yarn catching section finishes guiding the yarn to the yarn joining device and comes to rest. Accordingly, the yarn is prevented from being torn off or loosened immediately before the yarn joining device is activated, whereby the yarn joining device stably performs the yarn joining operation.

[0016] Preferably, the yarn winding unit is configured as follows: The yarn winding unit comprises a yarn layer diameter obtaining section which obtains a yarn layer diameter of yarn wound in the package. When the yarn layer diameter obtained by the yarn layer diameter obtaining section is large, the unit controller changes the timing of issuing at least either the reverse rotation stop command or the reverse rotation speed reduction command so that the timing becomes different from that when the obtained diameter is small.

[0017] Therefore, the timing at which the reverse rotation of the package is actually stopped is appropriately controlled by using the influence of variation in the yarn layer diameter of the package to variation in the rotational inertia.

[0018] Preferably, the yarn winding unit is configured as follows: The yarn winding unit comprises a cradle which supports the package rotatably and rotates according to increase of the yarn layer diameter of the yarn wound in the package. The yarn layer diameter obtaining section is an angle sensor which detects a rotation angle of the cradle.

[0019] Therefore, such a simple configuration is enough to obtain the required yarn layer diameter of the package.

[0020] Alternatively, the yarn winding unit may be configured as follows: The yarn winding unit comprises a yarn feeding section and a yarn running speed detection device. The yarn feeding section unwinds a yarn from a yarn supplying bobbin and feeds the winding section with the yarn. The yarn running speed detection device is provided on a yarn running path between the yarn feeding section and the winding section to detect a running speed

of yarn. The yarn layer diameter obtaining section obtains the yarn layer diameter by calculation using the running speed of yarn detected by the yarn running speed detection device.

5 [0021] Therefore, such a simple configuration is enough to obtain the required yarn layer diameter of the package.

10 [0022] In a second aspect of the invention, a yarn winding apparatus comprising the yarn winding unit is configured as follows: The yarn winding apparatus comprises a setting section which can set the timing of issuing at least either the reverse rotation stop command or the reverse rotation speed reduction command issued to the driving section in correspondence to rotational inertia of the package.

15 [0023] Therefore, for example, if a kind of yarn to be formed into the package is changed, the set content can be changed to appropriately control the timing at which the reverse rotation of the package is actually stopped.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024]

25 [FIG. 1] A schematic front view of an automatic winder according to an embodiment of the present invention illustrating an entire configuration thereof.

[FIG. 2] A front view and a block diagram of a winder unit illustrating a general configuration thereof.

30 [FIG. 3] A side view of the winder unit illustrating a state that a yarn is divided into two divisional yarns and yarn ends of the respective divisional yarns are guided to a yarn joining device.

[FIG. 4] An enlarged right side view of the winder unit illustrating a cradle and its surroundings.

35 [FIG. 5] A timing chart illustrating an exemplary reverse rotation control of a package in the winder unit.

[FIG. 6] A diagram illustrating contents set in a base control device regarding a timing of issuing a reverse rotation speed reduction command to a package driving motor and a timing of issuing a reverse rotation stop command to the package driving motor.

40 [FIG. 7] A timing chart illustrating a reverse rotation control of the package according to a first modified embodiment.

45 [FIG. 8] A timing chart illustrating a reverse rotation control of the package according to a second modified embodiment.

DETAILED DESCRIPTION OF EMBODIMENTS

50 [0025] An embodiment of the present invention will now be described with reference to drawings. FIG. 1 is a schematic front view of an automatic winder 100 according to an embodiment of the present invention illustrating an entire configuration thereof.

[0026] The automatic winder (yarn winding apparatus) 100 mainly includes aligned winder units (yarn winding

units) 10, a blower box 70, a base controlling device (a setting section) 80 and a doffer 90.

[0027] An unillustrated blower is disposed in the blower box 70. The blower functions as a compressed air source for supplying compressed air to the respective winder units 10. The blower also functions as a negative pressure source for applying negative pressure to the respective winder units 10.

[0028] The base controlling device 80 includes an operation section 81 and a display section 82. The operation section 81 and the display section 82 are communicative with the respective winder units 10. An operator who operates the automatic winder 100 can operate the operation section 81 so as to input a prescribed set value or so as to select an optional controlling manner. Therefore, the plurality of winder units 10 can be collectively managed. The base control device 80 controls motion of the doffer 90. The display section 82 can display the quantity of yarn 12 wound by each winder unit 10, a content of trouble which occurs, and so on.

[0029] The doffer 90 is configured so that when one winder unit 10 comes to have a package 20 fully wound (the predetermined quantity of yarn 12 is wound), the doffer 90 runs to the position of the corresponding winder unit 10, removes the fully wound package 20, and sets an empty winding bobbin 22.

[0030] A configuration of the winder unit 10 will now be described with reference to FIGS. 2 to 4. FIG. 2 is a front view and a block diagram of a winder unit 10 illustrating a general configuration thereof. FIG. 3 is a side view of the winder unit 10 illustrating a state that a yarn 12 is divided into two divisional yarns and yarn ends of the divisional yarns are guided to a yarn joining device 3. FIG. 4 is an enlarged right side view of the winder unit 10 illustrating a cradle 21 and its surroundings.

[0031] As shown in FIG. 2, each winder unit 10 includes a main winder unit body 40 and a unit controller 50. The main winder unit body 40 includes a yarn feeding section 1 and a winding section 2. The winder unit 10 unwinds the yarn 12 from a yarn supplying bobbin 11 supplied in the yarn feeding section 1, traverses the unwound yarn 12 and winds it around the winding bobbin 22 so as to form the package 20. In the following description, with regard to the package 20, rotation in a direction to wind the yarn 12 may be referred to as "normal rotation", and rotation in another opposite direction may be referred to as "reverse rotation". Words "upstream" and "downstream" mean upstream and downstream in a running direction of the yarn 12 when it is wound.

[0032] The unit controller 50 includes a CPU and a ROM, for example. The ROM stores programs, control tables and so on for controlling respective configurations of the main winding unit body 40. The CPU executes the programs stored in the ROM.

[0033] The yarn feeding section 1 can support the yarn supplying bobbin 11 mounted on an unillustrated conveyance tray at a predetermined position therein, and can unwind the yarn 12 from the yarn supplying bobbin

11. The yarn feeding section 1 is configured so as to eject the yarn supplying bobbin 11 which becomes empty after complete unwinding of the yarn 12 therefrom, and so as to receive another new yarn supplying bobbin 11 supplied from an unillustrated yarn supplying bobbin supplying device. Incidentally, the yarn feeding section 1 is not limited to the above-mentioned one with the conveyance tray. For example, the yarn feeding section 1 may be a magazine type yarn feeding section configured so as to support the yarn supplying bobbin supplied from an unillustrated magazine, and so as to unwind the yarn 12 to feed the yarn 12.

[0034] The winding section 2 has a principal configuration including the cradle 21, a contact roller 26 and a traverse device 25. The cradle 21 is configured so that the winding bobbin 22 can be attached to the cradle 21.

[0035] The cradle 21 holds the winding bobbin 22 (the package 20) detachably attached thereto. Although a yarn layer diameter of the package 20 increases according to the winding of the yarn 12 onto the winding bobbin 22, the cradle 21 is swingable forward and rearward of the winder unit 10 so that the increase of yarn layer diameter of the package 20 can be absorbed by swinging the cradle 21.

[0036] In other words, even if the yarn layer diameter of the package 20 varies according to the winding of the yarn 12, a surface of the package 20 can appropriately contact the contact roller 26.

[0037] A package driving motor 61 is mounted on the cradle 21. For example, a servomotor serves as the package driving motor 61. The winding section 2 rotates the winding bobbin 22 by driving the package driving motor 61 so as to wind the yarn 12 onto a surface of the winding bobbin 22 (or the surface of the package 20).

[0038] A rotation shaft of the package driving motor 61 is joined to the winding bobbin 22 unrotatably relative to the winding bobbin 22 (in a direct drive manner) when the winding bobbin 22 is supported by the cradle 21. The package driving motor 61 is electrically connected to the unit controller 50 so that the unit controller 50 can control the rotation speed and direction of the package driving motor 61.

[0039] The contact roller 26 is rotatably supported and is configured so as to be upwardly contactable with the surface of the winding bobbin 22 or the surface of the package 20. The contact roller 26 can support at least a part of weight of the winding bobbin 22 or the package 20.

[0040] The traverse device 25 includes a traverse arm 35 and a traverse driving motor 36. The traverse arm 35 is swingably supported and is configured so as to be able to hold the yarn 12 at a tip thereof. The traverse driving motor 36 drives the traverse arm 35. The traverse driving motor 36 is electrically connected to the unit controller 50 so that the unit controller 50 can traverse the yarn 12 wound to the package 20 at a predetermined lead angle by driving the traverse driving motor 36 in cooperation with the package driving motor 61.

[0041] The cradle 21 includes a lift-up mechanism 60

as shown in FIG. 4. The lift-up mechanism 60 can separate the package 20 from the contact roller 26 by swinging the cradle 21 at need.

[0042] Referring to FIG. 4, the lift-up mechanism 60 includes a rotation plate 17, a spring 18 and an air cylinder 71.

[0043] The rotation plate 17 is rotatably centered on a rotation shaft 16 and is rotatably integral with the cradle 21. The rotation shaft 16 is provided with an angle sensor 63 (a yarn layer diameter obtaining section 63) for detecting a rotation angle of the cradle 21. For example, a potentiometer may serve as the angle sensor 63.

[0044] The spring 18 is configured as a tension spring connected to the rotation plate 17. The spring 18 is configured so as to pull the rotation plate 17 in a direction to raise the cradle 21. Therefore, while the package 20 is expanded by winding the yarn 12 onto the winding bobbin 22, a part of the weight of the package 20 is canceled by the spring force so as to prevent the contact pressure between the contact roller 26 and the package 20 from becoming excessive.

[0045] The air cylinder 71 is telescopically activated by compressed air supplied from an electromagnetic valve 64 and is connected to the rotation plate 17. When the package 20 has a bit of yarn 12 wound therein, the air cylinder 71 lowers the cradle 21 against the spring 18 so as to press the contact roller 26 against the package 20 with an appropriate contact pressure. When the package 20 becomes large by getting the yarn 12 wound therein, the air cylinder 71 operates so that the spring 18 raises the cradle 21 to reduce the increase of the contact pressure according to increase of the weight of the package 20.

[0046] Further, when the yarn 12 loses its continuity (hereinafter, this state may be referred to as "divided into two divisional yarns") between the yarn feeding section 1 and the winding section 2, the air cylinder 71 applies a force together with the spring 18 in the direction to raise the cradle 21 so as to raise the package 20 away from the contact roller 26 as illustrated in chained lines in FIG. 4. Therefore, the above-mentioned lift-up function is realized.

[0047] The winder unit 10 has a yarn running path between the yarn feeding section 1 and the winding section 2, and includes an unwinding assist device 13, a tension applying device 14, a lower yarn catching pipe 4, the yarn joining device 3, a yarn quality measurement device (yarn monitoring device) 19 and an upper yarn catching pipe (yarn catching section) 5, which are arranged on the yarn running path.

[0048] The unwinding assist device 13 includes a regulation member 13a coverable over a core tube of the yarn supplying bobbin 11. The regulation member 13a is substantially cylindrical and is disposed to abut against a balloon formed at an upper portion of the yarn layer on the yarn supplying bobbin 11. In this regard, the yarn 12 unwound from the yarn supplying bobbin 11 has a portion swung by a centrifugal force, and this portion is referred

to as the "balloon".

[0049] By bringing the regulation member 13a into contact with the balloon, a tension is applied to the balloon portion of the yarn 12 so as to prevent the yarn 12 from being excessively swung. Therefore, the yarn 12 can be appropriately unwound from the yarn supplying bobbin 11.

[0050] The tension applying device 14 applies a predetermined tension to the running yarn 12. In the present embodiment, the tension applying device 14 is configured as a gate type device including fixed comb teeth and movable comb teeth. The movable comb teeth are biased so as to mesh with the fixed comb teeth.

[0051] The mutually meshing movable and fixed comb teeth have spaces therebetween, and the yarn 12 is zig-zagged and passed through the spaces so as to receive an appropriate tension, thereby enhancing the quality of the package 20. The tension applying device 14 is not limited to the above-mentioned gate type device. For example, a disk type device may serve as the tension applying device 14.

[0052] The lower yarn catching pipe 4 is configured so that when the yarn 12 is divided into two divisional yarns between the yarn feeding section 1 and the winding section 2 for some reason, the lower yarn catching pipe 4 catches the yarn 12 (a yarn end) on the yarn supplying bobbin 11 side and guides it to the yarn joining device 3.

[0053] More specifically, the lower yarn catching pipe 4 is rotatable centered on a pipe shaft 41 and is formed at a tip thereof with a suction mouth 42. An appropriate negative pressure source is connected to the lower yarn catching pipe 4 so as to generate a suction flow at the suction mouth 42.

[0054] Due to this configuration, when the yarn is divided into two divisional yarns, the suction mouth 42 of the lower yarn catching pipe 4 catches the lower yarn at a position illustrated in chained lines in FIG. 3, and then, the lower yarn catching pipe 4 is rotated upward centered on the pipe shaft 41 so as to guide the lower yarn to the yarn joining device 3.

[0055] When the yarn 12 is divided into two divisional yarns, the yarn 12 (the yarn end) on the yarn feeding section 1 side and the yarn 12 (a yarn end) on the winding section 2 side are joined to each other by the yarn joining device 3. In the present embodiment, the yarn joining device 3 is configured as a splicer which twists the yarn ends together by swirling airflow generated from the compressed air. However, the yarn joining device 3 is not limited to the splicer. For example, a mechanical knotter may serve as the yarn joining device 3.

[0056] The yarn quality measurement device 19 monitors a thickness or so on of the running yarn 12 by an appropriate sensor so as to detect a yarn defect. A cutter 24 is provided close to the yarn quality measurement device 19 so as to cut the yarn 12 immediately after the yarn quality measurement device 19 detects a yarn defect.

[0057] The upper yarn catching pipe 5 is configured so

that when the yarn 12 is divided into two divisional yarns, the upper yarn catching pipe 5 catches the yarn 12 (the yarn end) on the winding section 2 side and guides it to the yarn joining device 3.

[0058] More specifically, the upper yarn catching pipe 5 is rotatable centered on a shaft 51, and is formed at a tip thereof with a suction mouth 52. The above-mentioned blower is connected to the upper yarn catching pipe 5 so as to be able to generate a suction flow in the suction mouth 52.

[0059] The suction mouth 52 is formed in a long narrow shape such as to include the roll width of the package 20. Therefore, the suction flow is applied to the outer peripheral surface of the package 20 thoroughly in the roll width direction.

[0060] An unillustrated shutter member is disposed between the upper yarn catching pipe 5 and the blower. By selectively opening or closing the shutter member, the suction flow into the suction mouth 52 is selectively generated or stopped.

[0061] An output shaft of a motor 62 is connected to the upper yarn catching pipe 5. The motor 62 is electrically connected to the unit controller 50 so that the unit controller 50 can control rotation/stop of the motor 62.

[0062] Due to the configuration, when the yarn feeding is terminated or when the yarn is divided into two divisional yarns, the suction mouth 52 of the upper yarn catching pipe 5 catches the upper yarn at an upper yarn catching position as drawn in chained lines in FIG. 3 and then rotates centered on the shaft 51 to a yarn joining position as drawn in solid lines in FIG. 3 so as to guide the upper yarn to the yarn joining device 3.

[0063] In this way, the winder unit 10 can form the package 20 by winding the yarn 12 onto the winding bobbin 22.

[0064] When the yarn 12 is divided into two divisional yarns between the yarn feeding section 1 and the winding section 2, a series of operations of the winder unit 10 are performed since the divisional yarns 12 are joined together until the joined yarn is wound again. The series of operations of the winder unit 10 will be described in detail with reference to FIGS. 2, 3 and 5. FIG. 5 is a timing chart illustrating an exemplary reverse rotation control of the package 20 in the winder unit 10.

[0065] In the winder unit 10, when the yarn 12 is divided into two divisional yarns, the yarn end of the divisional yarn 12 on the package 20 (the winding section 2) side is wound into the package 20 which is inertially rotating. Reasons why the yarn 12 is divided into two divisional yarns include that the yarn 12 is cut by the cutter 24 automatically because the yarn quality measurement device 19 detects a yarn defect, and that the yarn 12 is broken by an accidentally generated large tension. These reasons should not be considered to be restrictive. In the following description, the yarn end on the package 20 side may be referred to as the "upper yarn end".

[0066] The unit controller 50 transmits a drive signal to the motor 62 to rotate the upper yarn catching pipe 5 upward to an upper yarn catching position as drawn in

chained lines in FIG. 3 so as to make the suction mouth 52 approach the package 20. As a result, the suction mouth 52 of the upper yarn catching pipe 5 comes to the position where it substantially confronts the surface of the package 20.

[0067] When the suction mouth 52 reaches the upper yarn catching position, the unit controller 50 transmits a drive signal to the package driving motor 61 to rotate the package 20 in a yarn unwinding direction (reversely) opposite to the yarn winding direction, and to generate the suction airflow in the suction mouth 52. Therefore, the upper yarn end unwound from the package 20 by the reverse rotation of the package 20 is sucked into the upper yarn catching pipe 5 by the suction airflow when it runs through the position confronting the suction mouth 52.

[0068] On the other hand, the yarn end of the divisional yarn 12 on the yarn supplying bobbin 11 (the yarn feeding section 1) side is caught by a suction airflow generated at a tip of the lower yarn catching pipe 4. In this regard, in the following description, the yarn end on the yarn supplying bobbin 11 side may be referred to as the "lower yarn end".

[0069] After the upper yarn end and the lower yarn end are caught, the unit controller 50 transmits a drive signal to the motor 62 to rotate the upper yarn catching pipe 5 downward as directed by a bold arrow in FIG. 3. Also, the unit controller 50 rotates the lower yarn catching pipe 4 upward as directed by another bold arrow. Accordingly, the yarn end on the package 20 side caught by the upper yarn catching pipe 5 and the yarn end on the yarn supplying bobbin 11 side caught by the lower yarn catching pipe 4 are guided to the yarn joining device 3.

[0070] Subsequently, the yarn ends of divisional yarns are joined to each other by the yarn joining device 3. When the yarn 12 becomes continuous between the yarn feeding section 1 and the winding section 2, the unit controller 50 controls the package driving motor 61 so as to forwardly rotate the package 20 to restart the winding of the yarn 12.

[0071] The above-mentioned control processes will now be described in detail with reference to the timing chart of FIG. 5.

[0072] Immediately after the yarn 12 being wound is divided into two divisional yarns, the unit controller 50 controls the package driving motor 61 so as to stop the rotation of the package 20. Almost simultaneously, the lift-up mechanism 60 moves to raise the cradle 21 so as to separate the package 20 from the contact roller 26.

[0073] Afterward, at a timing t_0 as shown in FIG. 5, the unit controller 50 starts the upward rotation of the upper yarn catching pipe 5. As a result, at a timing t_1 , the suction mouth 52 reaches at the upper yarn catching position as drawn in chained lines in FIG. 3. The shutter member disposed on a connection path between the upper catching pipe 5 and the blower is opened at a time when the upper yarn catching pipe 5 starts its upward rotation. At the upper yarn catching position, the suction mouth 52

is adjacent to the surface of the package 20 so as to apply a strong suction flow to the surface of the package 20.

[0074] At the timing t1, the unit controller 50 transmits a signal to the package driving motor 61 so as to start reverse rotation of the package 20. At a timing when a predetermined time passes after the start of reverse rotation of the package 20, the lift-up mechanism 60 cancels the raising of the package 20. Afterward, the first speed V1 defined as the reverse rotation speed of the package 20 is kept constant.

[0075] According to the reverse rotation, the upper yarn end is unwound from the package 20 and is caught in the suction mouth 52. A yarn detection sensor 53 is disposed inside of the upper yarn catching pipe 5. When a considerable quantity of the upper yarn end is sucked into suction mouth 52, the yarn detection sensor 53 detects the upper yarn end. For example, an optical sensor may serve as the yarn detection sensor.

[0076] The reverse rotation of the package 20 at the first speed V1 is performed to a predetermined time since the start of reverse rotation and is further maintained until the elapse of a predetermined time. Then, at a timing t2, the unit controller 50 controls the lift-up mechanism 60 to raise the package 20 again and to increase the reverse rotation speed of the package 20 from the first speed V1 to a predetermined second speed V2 higher than the first speed V1. Further, the suction mouth 52 slightly moves away from the surface of the package 20. The raising of the package 20 by the lift-up mechanism 60 is canceled approximately at the timing at which the reverse rotation of the package 20 reaches the second speed V2.

[0077] According to the reverse rotation of the package 20, the upper yarn end is further unwound from the package 20 and is sucked into the suction mouth 52. In the state where the suction mouth 52 is moved a little away from the package 20, the reverse rotation of the package 20 at the second speed V2 is maintained for a time corresponding to the length of the detected yarn defect plus an appropriate margin time. Therefore, a portion including the whole yarn defect can be removed from the yarn wound in the package 20. At this time, the reverse rotation speed of the package 20 is the relatively high second speed V2 so that the yarn 12 can be promptly unwound.

[0078] Afterward, at a timing t3, the unit controller 50 transmits the drive signal to the upper yarn catching pipe 5 so as to rotate the upper yarn catching pipe 5 to move the suction mouth 52 downward (to the yarn joining position for guiding the upper yarn to the yarn joining device 3). At a timing t4 before the upper yarn catching pipe 5 reaches the yarn joining position, the unit controller 50 transmits the drive signal to the package driving motor 61 so as to start the reverse rotation speed reduction of the package 20.

[0079] In the present embodiment, since the timing t4 defined as the timing for starting the speed reduction, the unit controller 50 linearly reduces a command speed issued to the package driving motor 61 from the second

speed (as a reverse rotation speed reduction command), and finally zeroes the command speed at a timing t5 (as a reverse rotation stop command). However, if the yarn layer diameter of the package 20 is large, the reduction and zeroing of the command speed may insufficiently weaken the strong inertial rotation of the package 20, so that the reverse rotation of the package 20 may be actually stopped with a delay after the timing t5.

[0080] In this regard, according to the present embodiment, the unit controller 50 changes the timing of issuing the reverse rotation stop command and the timing of issuing the reverse rotation speed reduction command issued to the package driving motor 61 in correspondence to the yarn layer diameter of the package 20. The reverse rotation stop command is defined as a command issued to the package driving motor 61 to stop the reverse rotation of the package 20, and the reverse rotation speed reduction command is defined as a command issued to the package driving motor 61 to reduce the reverse rotation speed of the package 20 for the purpose of stopping the reverse rotation of the package 20. More specifically, when the yarn layer diameter of the package 20 is large, the unit controller 50 issues the reverse rotation stop command and the reverse rotation speed reduction command at respective timings earlier than those when the yarn layer diameter of the package 20 is small. Referring to the example of FIG. 5, if the yarn layer diameter of the package 20 is small, the reverse rotation speed reduction command is issued at the timing t4, and the reverse rotation stop command is issued at the timing t5. On the contrary, if the yarn layer diameter of the package 20 is large, the reverse rotation speed reduction command is issued at a timing t4x, and the reverse rotation stop command is issued at a timing t5x. Due to the change of the respective timings of issuing the reverse rotation speed reduction command and the reverse rotation stop command, the reverse rotation of the package 20 can be actually stopped at an expected timing (i.e., the timing t5 at which the upper yarn catching pipe 5 arrives at the yarn joining position and comes to rest there). As a result, the upper yarn is prevented from being torn off or loosened.

[0081] In this way, the divisional yarn 12 from the package 20 is guided to the yarn joining device 3 and the yarn joining operation by the yarn joining device 3 is started. Substantially simultaneously, the shutter member disposed on the connection path between the upper yarn catching pipe 5 and the blower is closed so as to stop the suction flow in the suction mouth 52.

[0082] An operator can set a relation between the yarn layer diameter and the timing at which the unit controller 50 issues the reverse rotation stop command or the reverse rotation speed reduction command. For example, referring to FIG. 6, the yarn layer diameter may be classified by size into three stages so that the timing of issuing the reverse rotation speed reduction command to the package driving motor 61 and the timing of issuing the reverse rotation stop command to the package driving

motor 61 may be set in correspondence to each of the three stages.

[0083] The operation section 81 of the base controlling device 80 can be operated by an operator so as to adjust the set contents in the base controlling device 80. Therefore, the automatic winder 100 can flexibly adapt to variation in weight density of the package 20 caused by variation in kind of the yarn 12, variation in lead angle for winding the yarn 12, or so on.

[0084] As mentioned above, the winder unit 10 according to the present embodiment comprises the winding section 2, the package winding motor 61, the upper yarn catching pipe 5 and the unit controller 50. The winding section 2 winds the yarn 12 to form the package 20. The package driving motor 61 rotates the package 20 reversibly in the rotation direction. The upper yarn catching pipe 5 catches the yarn 12 from the package 20 rotated by the package driving motor 61 in the reverse direction opposite to the yarn winding direction. The unit controller 50 controls the rotation direction of the package 20 and starting/stopping of rotation of the package 20. The unit controller 50 changes the timing of issuing at least either the reverse rotation stop command or the reverse rotation speed reduction command issued to the package driving motor 61 in correspondence to rotational inertia of the package 20. The reverse rotation stop command is defined as a command issued to the package driving motor 61 to stop the reverse rotation of the package 20, and the reverse rotation speed reduction command is defined as a command issued to the package driving motor 61 to reduce the reverse rotation speed of the package 20 for the purpose of stopping the reverse rotation of the package 20.

[0085] Therefore, the timing of actually stopping the reverse rotation of the package 20 can be controlled in correspondence to the rotational inertia.

[0086] In the winder unit 10 according to the present embodiment, when the rotational inertia of the package 20 is large, the unit controller 50 issues at least either the reverse rotation stop command or the reverse rotation speed reduction command at a timing earlier than that when the rotational inertia of the package 20 is small.

[0087] Therefore, the commands for speed-reducing and stopping the reverse rotation are issued to the package driving motor 61 at the respective timings corresponding to variation of the rotational inertia so that the fluctuation of the timing of actually stopping the reverse rotation of the package 20 is reduced appropriately.

[0088] In the winder unit 10 according to the present embodiment, the unit controller 50 issues at least either the reverse rotation stop command or the reverse rotation speed reduction command so that the reverse rotation of the package 20 is actually stopped at the constant timing (the timing t_5) regardless of variation in quantity of the yarn 12 wound into the package 20.

[0089] Therefore, the motion timing (for example, the timing of yarn joining operation by the yarn joining device 3) after the stopping of the reverse rotation of the package

20 can be regulated, thereby simplifying the control.

[0090] According to the present embodiment, the winder unit 10 comprises the yarn joining device 3 for joining the divisional yarn 12 caught by the upper yarn catching pipe 5 to the other divisional yarn 12. The unit controller 50 matches the timing at which the reverse rotation of the package 20 is actually stopped with the timing (the timing t_5) at which the upper yarn catching pipe 5 holding the divisional yarn 12 from the package 20 arrives and stops at the guide position for guiding the divisional yarn 12 to the yarn joining device 3.

[0091] Therefore, the timing at which the reverse rotation of the package 20 can be matched with the timing at which the upper yarn catching pipe 5 finishes guiding the divisional yarn 12 to the yarn joining device 3 and comes to rest. Accordingly, the divisional yarn 12 is prevented from being torn off or loosened immediately after the reverse rotation of the package 20 is actually stopped, whereby the yarn joining device 3 stably performs the yarn joining operation.

[0092] According to the present embodiment, the winder unit 10 comprises the angle sensor 63 which obtains the diameter of the yarn layer wound in the package 20. When the diameter of the yarn layer obtained by the angle sensor 63 is large, the unit controller 50 changes the timing of at least either the reverse rotation stop command or the reverse rotation speed reduction command in comparison with that when the obtained diameter is small.

[0093] Therefore, the timing at which the reverse rotation of the package 20 is actually stopped is appropriately controlled by using the influence of variation in the yarn layer diameter of the package 20 to variation in the rotational inertia.

[0094] According to the present embodiment, the winder unit 10 comprises the cradle 21 which supports the package 20 rotatably and rotates according to increase of the diameter of the yarn layer of the yarn 12 wound in the package 20. The angle sensor 63 obtains the yarn layer diameter by detecting the rotation angle of the cradle 21.

[0095] Therefore, such a simple configuration is enough to obtain the required diameter of the yarn layer in the package 20.

[0096] Alternatively, the winder unit 10 may obtain the yarn layer diameter of the package 20 in the following way: The winder unit 10 comprises an unillustrated yarn running speed detection device provided on the yarn running path between the yarn feeding section 1 and the winding section 2. The wound length of the yarn 12 is calculated by time-integrating the running speed of yarn detected by the yarn running speed detection device. The wound length is converted by a common formula into a yarn layer diameter. In this way, the yarn layer diameter of the package 20 can be obtained by calculation.

[0097] For example, the yarn running speed detection device includes two sensors (e.g., optical sensors) aligned along the yarn running path. The two sensors

detect unevenness of yarn respectively, and time changes of respective waveforms detected by the respective sensors are compared to calculate a time difference between a time at which a portion of the yarn passes one sensor and another time at which the portion of the yarn passes the other sensor. Therefore, the yarn running speed can be calculated based on the calculated time difference. Alternatively, the yarn quality measurement device 19 may have a function to detect the yarn running speed based on the above-mentioned principle.

[0098] Therefore, such a simple configuration is enough to obtain the required yarn layer diameter of the package 20.

[0099] According to the present embodiment, the automatic winder 100 comprises the winder unit 10, and comprises the base controlling device 80. The base controlling device 80 can set the timing of issuing at least either the reverse rotation stop command or the reverse rotation speed reduction command issued to the package driving motor 61 in correspondence to rotational inertia of the package 20. The reverse rotation stop command is defined as a command issued to the package driving motor 61 to stop the reverse rotation of the package 20, and the reverse rotation speed reduction command is defined as a command issued to the package driving motor 61 to reduce the reverse rotation speed of the package 20 for the purpose of stopping the reverse rotation of the package 20. The set contents in the base controlling device 80 can be adjusted by an operator's operation.

[0100] Therefore, for example, if a kind of yarn 12 to be formed into the package 20 is changed, the set content can be changed to appropriately control the reverse rotation of the package 20.

[0101] Two modified embodiments regarding the speed reduction and stop of the reverse rotation of the package will now be described. In the description of the two modified embodiments, members identical or similar to those in the above-mentioned embodiment may be designated by the same reference numerals and description of them may be omitted.

[0102] In a first modified embodiment as shown in FIG. 7, when the yarn layer diameter of the package 20 is large, the unit controller 50 issues the reverse rotation speed reduction command to the package driving motor 61 at a timing earlier than the timing when the yarn layer diameter is small. More specifically, when the yarn layer diameter of the package 20 is small, the reverse rotation speed reduction command is issued at the timing t4. When the yarn layer diameter of the package 20 is large, the reverse rotation reverse rotation speed reduction command is issued at the timing t4x.

[0103] However, in this modified embodiment, when the yarn layer diameter of the package 20 is large, the slope of reducing the command speed for reducing the reverse rotation speed of the package 20 is gentler than that when the yarn layer diameter is small. As a result, the reverse rotation stop command (i.e., the command for zeroing the reverse rotation speed) to the package

driving motor 61 is issued at a timing t5 constantly regardless of variation in the yarn layer diameter of the package 20.

[0104] In a second modified embodiment as shown in FIG. 8, the unit controller 50 issues the reverse rotation speed reduction command at the timing t4 constantly regardless of variation in the yarn layer diameter of the package 20.

[0105] However, in this modified embodiment, when the yarn layer diameter of the package 20 is large, the slope of reducing the command speed for reducing the reverse rotation speed of the package 20 is steeper than that when the yarn layer diameter of the package 20 is small. As a result, when the yarn layer diameter of the package 20 is large, the unit controller 50 issues the reverse rotation stop command (i.e., the command for zeroing the reverse rotation speed) at a timing t5x which is earlier than that (the timing t5) when the yarn layer diameter of the package 20 is small.

[0106] As understood from the above-mentioned two modified embodiments, the slope of reducing the command speed issued to the package driving motor 61 to reduce the reverse rotation speed of the package 20 may be changed in correspondence to variation in the yarn layer diameter of the package 20.

[0107] The foregoing description is given of a preferred embodiment of the present invention and modified embodiments. However, for example, the above-mentioned configurations may be modified as follows.

[0108] The control of the reverse rotation of the package 20 before the timing t3 shown in FIG. 5 may be altered from the above-mentioned control into another appropriate control.

[0109] The decline of the command speed outputted from the unit controller 50 to the package driving motor 61 to reduce the reverse rotation speed of the package 20 may be rated as illustrated in a smooth curve instead of the linear change as shown in FIG. 5 and so on.

[0110] The timings of issuing the reverse rotation speed reduction or stop command to the package driving motor may be set based on classification of the yarn layer diameter into two, four or more stages instead of the three stages as shown in FIG. 6. Further, function parameters may be set in a base controlling device 80 so as to enable stepless changing of these timings.

[0111] Instead of the control based on the yarn layer, a control operation may be performed based on another parameter expressing a magnitude of the rotational inertia (e.g., a package weight).

[0112] During the reverse rotation of the package 20, the unit controller 50 may issue the reverse rotation stop command (command for zeroing the speed) to the package driving motor 61 without the previous issue of the speed reduction command.

[0113] A brake mechanism may be provided on a portion of the package driving motor 61 so that the brake mechanism is operated for braking during the operation for the reverse rotation stopping or speed reduction.

[0114] The configuration of controlling reverse rotation of the package 20 according to the present invention is not limited to the winder unit 10 in which the package 20 is rotated directly by the package driving motor 61 and the yarn 12 is traversed by the arm-type traverse device 25. For example, a columnar drum contacting the outer peripheral surface of the package 20 may be driven by a motor so that the yarn can be traversed along a spiral traversing groove formed on the drum. In this case, the motor for driving the drum serves as the driving section.

DESCRIPTION OF THE REFERENCE NUMERALS

[0115]

- 2 a winding section
- 5 an upper yarn catching pipe (a yarn catching section)
- 10 a winder unit (a yarn winding unit)
- 12 a yarn
- 20 a package
- 50 a unit controller
- 61 a package driving motor (a driving section)

Claims

1. A yarn winding unit comprising:

a winding section which winds a yarn to form a package;
 a driving section which rotates the package reversibly in the rotation direction;
 a yarn catching section which catches a yarn from the package rotated by the driving section in a reverse direction opposite to a yarn winding direction; and
 a unit controller which controls a rotation direction of the package and starting/stopping of rotation of the package,
 wherein the unit controller changes a timing of issuing at least either a reverse rotation stop command or a reverse rotation speed reduction command issued to the driving section in correspondence to rotational inertia of the package, the reverse rotation stop command being defined as a command issued to the driving section to stop a reverse rotation of the package which is the rotation of the package in the reverse direction, and the reverse rotation speed reduction command being defined as a command issued to the driving section to reduce the reverse

rotation speed of the package for the purpose of stopping the reverse rotation of the package.

2. The yarn winding unit according to claim 1, wherein when the rotational inertia of the package is large, the unit controller issues at least either the reverse rotation stop command or the reverse rotation speed reduction command to the driving section at a timing earlier than that when the rotational inertia of the package is small.

3. The yarn winding unit according to claim 1 or 2, wherein the unit controller issues at least either the reverse rotation stop command or the reverse rotation speed reduction command to the driving section so that the reverse rotation of the package is actually stopped at a constant timing regardless of variation in quantity of yarn wound into the package.

4. The yarn winding unit according to claim 3, further comprising:

a yarn joining device for joining a yarn caught by the yarn catching section to another yarn, wherein the unit controller matches the timing at which the reverse rotation of the package is actually stopped with a timing at which the yarn catching section holding the yarn from the package arrives at a guide position for guiding the yarn to the yarn joining device and comes to rest there.

5. The yarn winding unit according to any one of claims 1 to 4, further comprising:

a yarn layer diameter obtaining section which obtains a yarn layer diameter of yarn wound in the package, wherein when the yarn layer diameter obtained by the yarn layer diameter obtaining section is large, the unit controller changes the timing of issuing at least either the reverse rotation stop command or the reverse rotation speed reduction command so that the timing becomes different from that when the obtained diameter is small.

6. The yarn winding unit according to claim 5, further comprising:

a cradle which supports the package rotatably and rotates according to increase of the yarn layer diameter of the yarn wound in the package, wherein the yarn layer diameter obtaining section is an angle sensor which detects a rotation angle of the cradle.

7. The yarn winding unit according to claim 5, further

comprising:

a yarn feeding section which unwinds a yarn from a yarn supplying bobbin and feeds the winding section with the yarn; and 5
a yarn running speed detection device provided on a yarn running path between the yarn feeding section and the winding section to detect a running speed of the yarn, 10
wherein the yarn layer diameter obtaining section obtains the yarn layer diameter by calculation using the running speed of the yarn detected by the yarn running speed detection device.

8. A yarn winding apparatus comprising: 15

the yarn winding unit according to any one of claims 1 to 7; and
a setting section which can set the timing of issuing at least either the reverse rotation stop 20
command or the reverse rotation speed reduction command to the driving section in correspondence to rotational inertia of the package.

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Fig.1

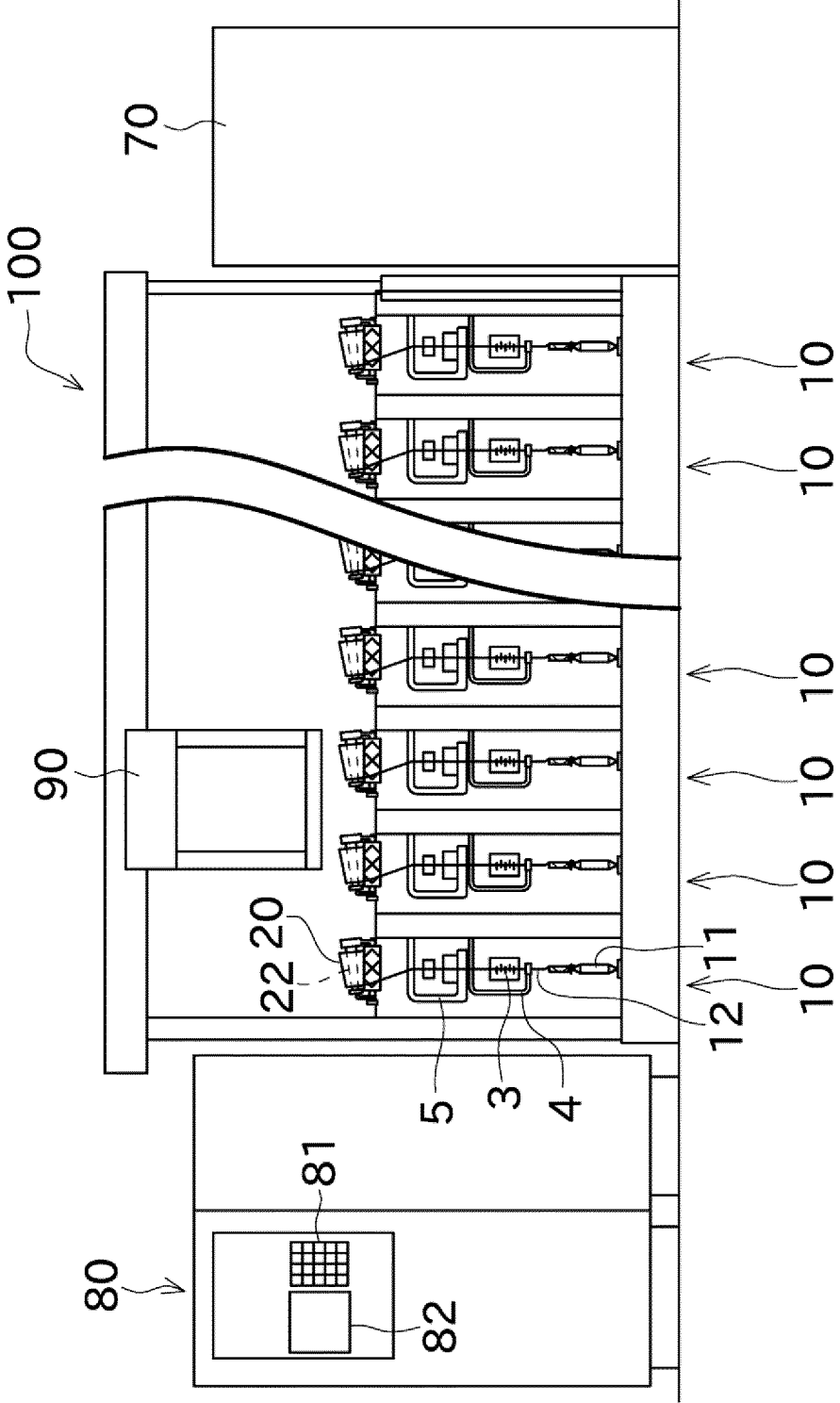


Fig.2

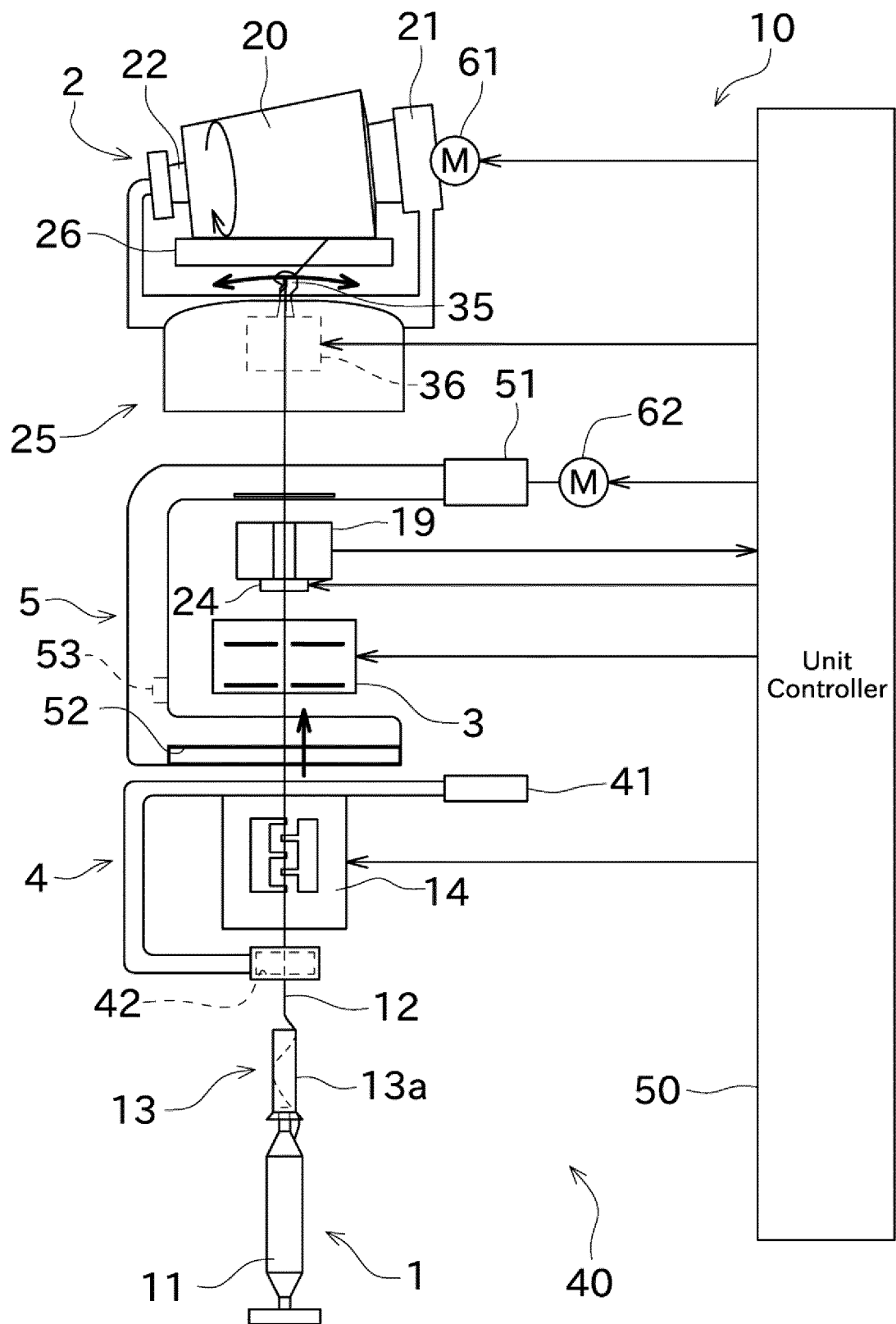


Fig.3

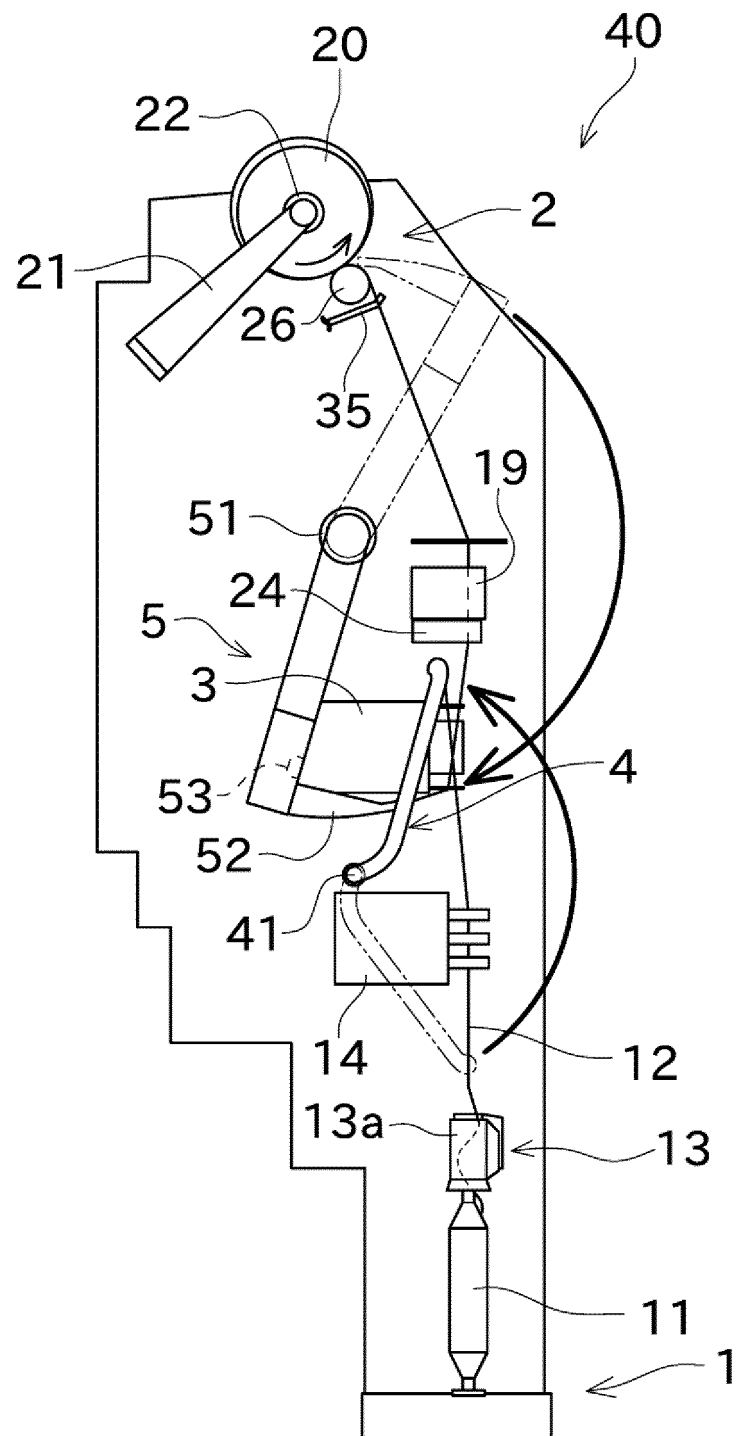


Fig.4

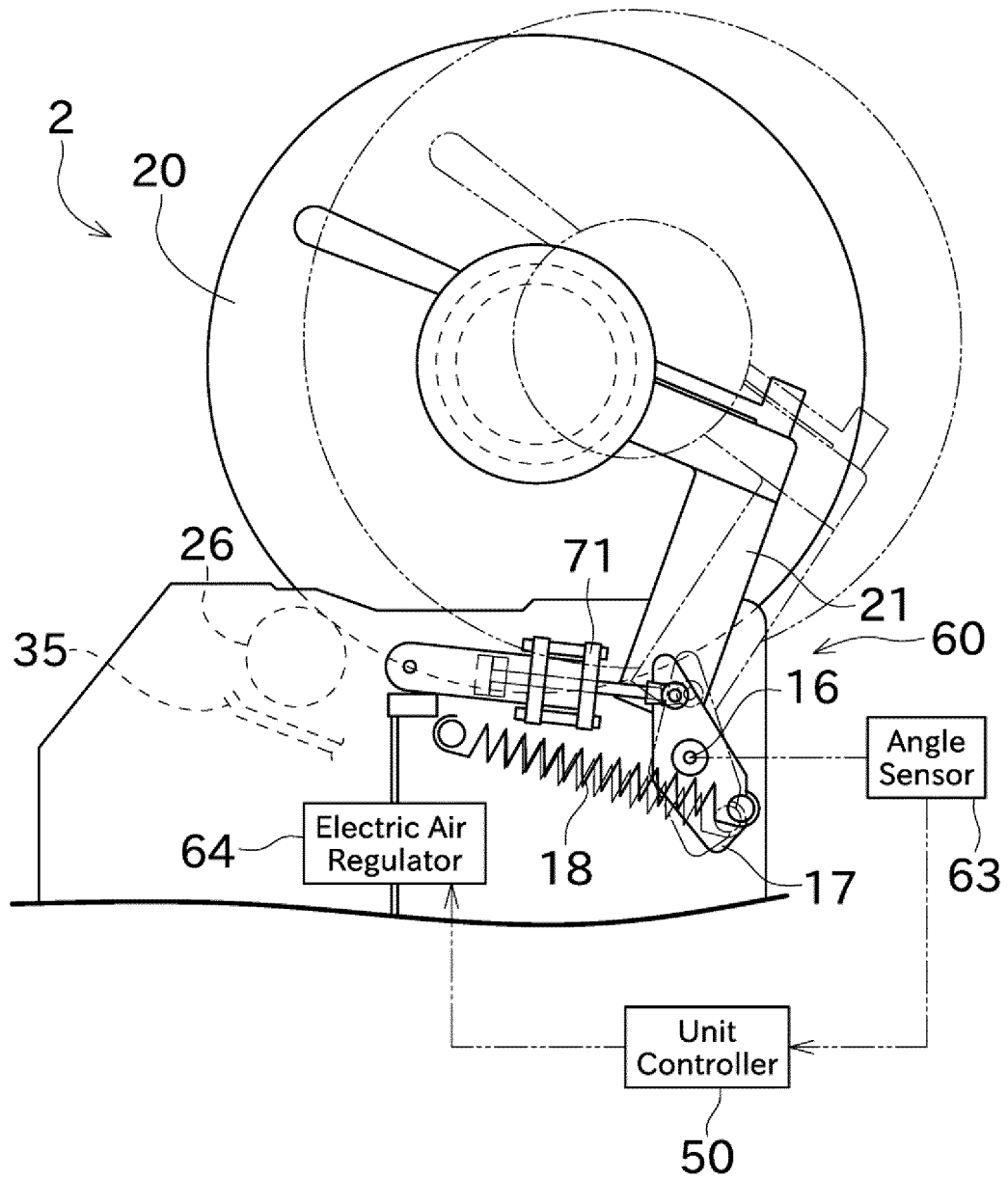


Fig.5

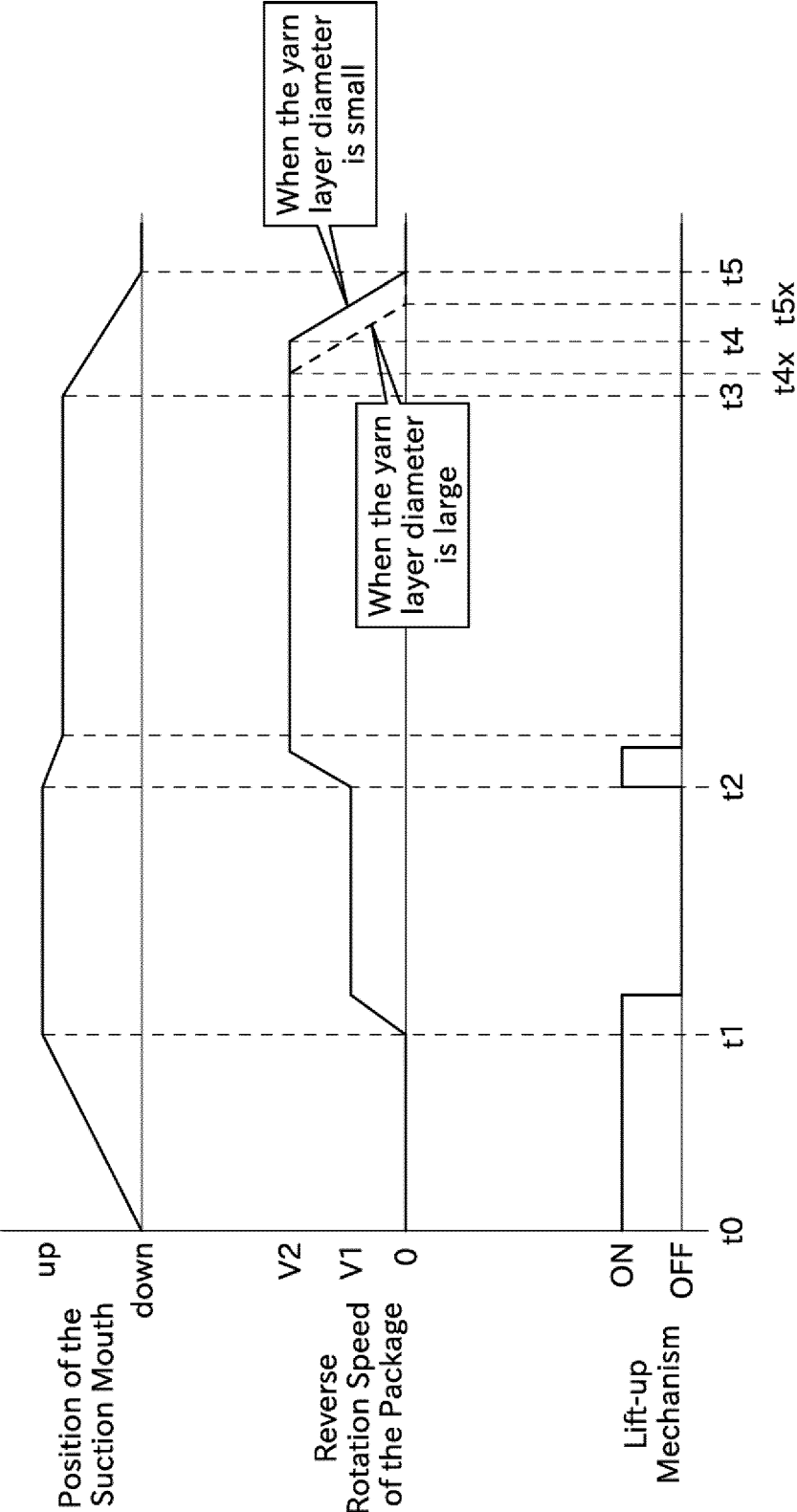


Fig.6

Yarn Layer Diameter	Timing of issuing a command after the suction mouth starts to move downward	
	Reverse Rotation Speed Reduction	Reverse Rotation Stop
Larger than D2	A3 Seconds After	B3 Seconds After
Larger than D1 but not larger than D2	A2 Seconds After	B2 Seconds After
Not larger than D1	A1 Seconds After	B1 Seconds After

(D1<D2)

(A1>A2>A3, B1>B2>B3)

Fig.7

First Modified Embodiment

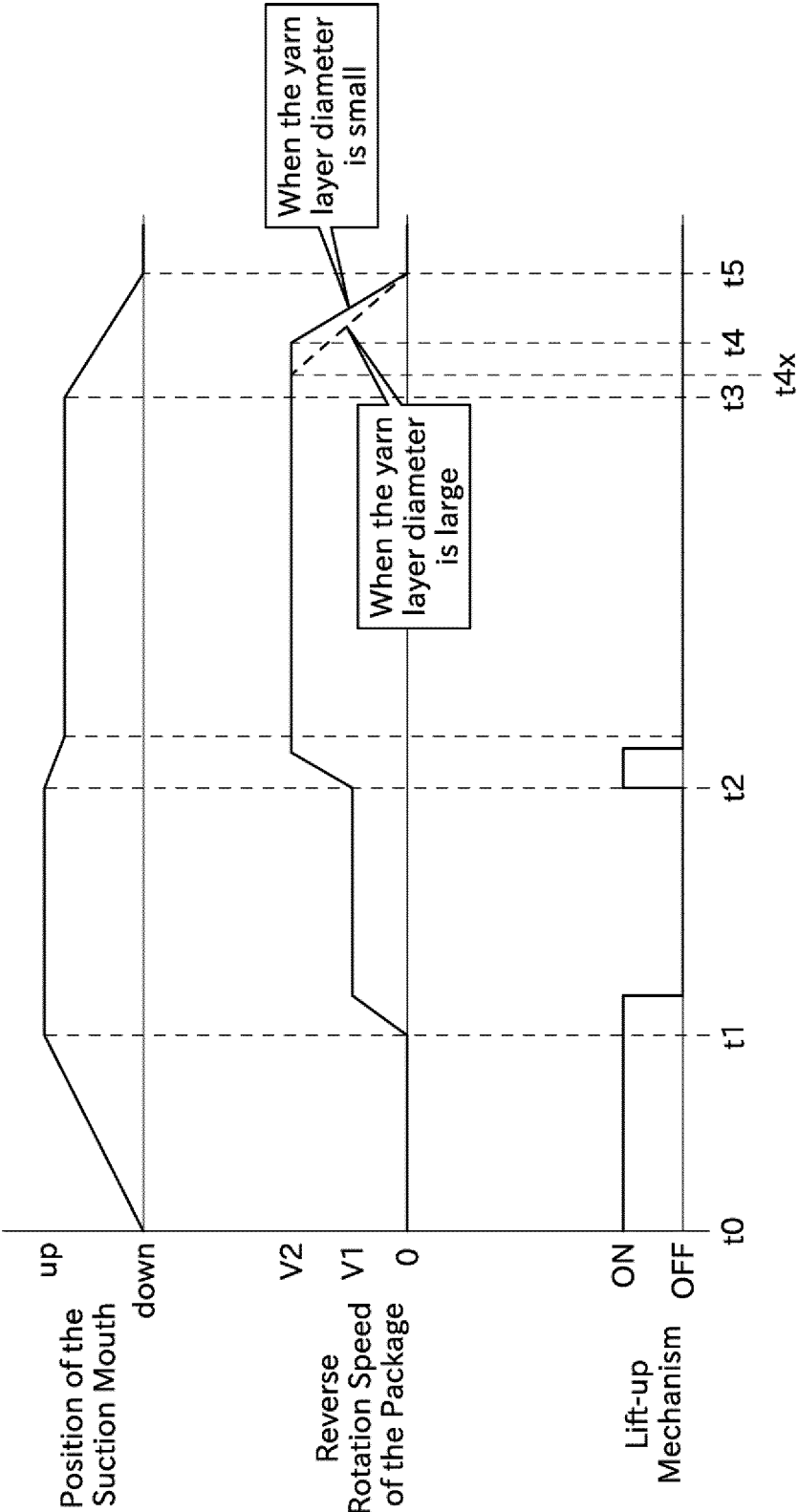
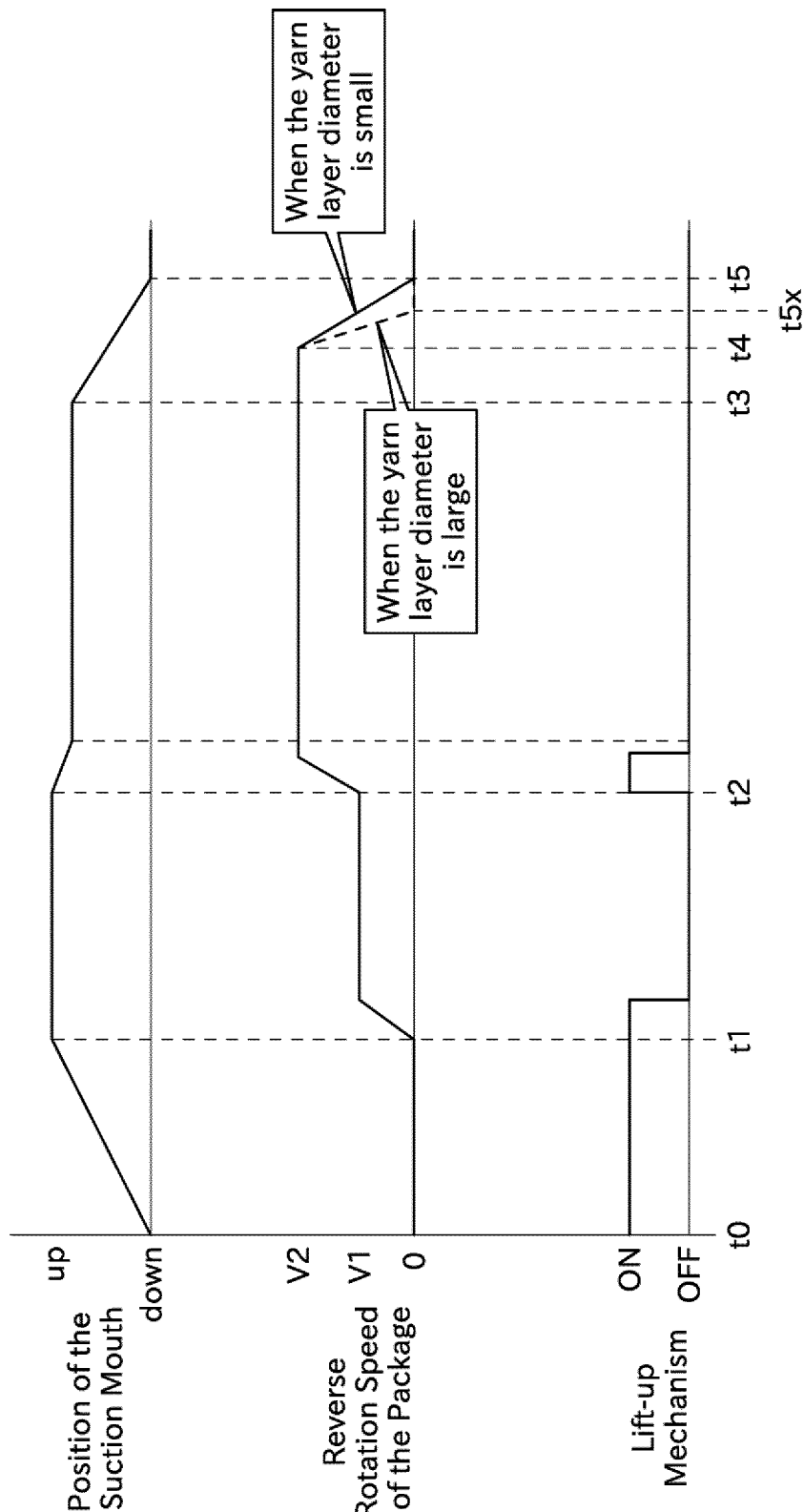


Fig.8

Second Modified Embodiment



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2018/026208

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl. B65H67/08 (2006.01) i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int. Cl. B65H67/00-67/08

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

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2018
Registered utility model specifications of Japan 1996-2018
Published registered utility model applications of Japan 1994-2018

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2014-088638 A (MURATA MACHINERY LTD.) 15 May	1, 5, 7-8
Y	2014, paragraphs [0031]-[0039], fig. 5-7 & EP	6, 8
A	2727870 A2, paragraphs [0029]-[0038], fig. 5-7 & CN 103787150 A	2-4
Y	JP 2015-209305 A (MURATA MACHINERY LTD.) 24 November 2015, paragraph [0075] (Family: none)	6, 8
A	JP 05-246626 A (MURATA MACHINERY LTD.) 24 September 1993 (Family: none)	1-8
A	WO 2015/029292 A1 (MURATA MACHINERY LTD.) 05 March 2015 & JP 2015-048155 A	1-8



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search
07.09.2018

Date of mailing of the international search report
18.09.2018

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International application No.
PCT/JP2018/026208

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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REFERENCES CITED IN THE DESCRIPTION

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