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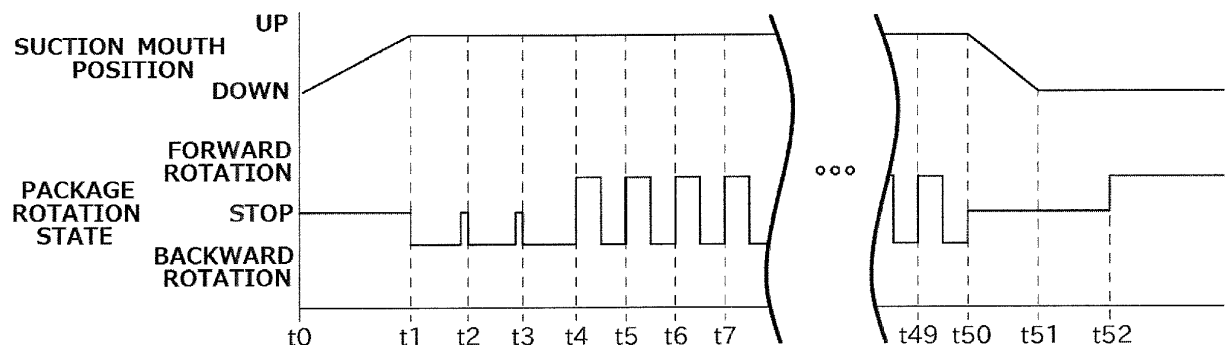
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(54) **YARN WINDING DEVICE AND YARN CATCHING METHOD**

(57) When a yarn (12) that is being wound by a winding section (2) is disconnected, an upper-yarn catching pipe (5) of an automatic winder (100) sucks and catches the yarn (12) from a package (20). A unit controller (50) controls a package driving motor. After the upper-yarn catching pipe (5) starts to suck an upper yarn, the unit controller (50) causes a driving section to perform a for-

ward-backward reciprocal driving that starts from a forward driving in which the package (20) is rotated forward in a winding direction of the yarn (12) and a backward driving in which the package (20) is rotated in a direction opposite to the winding direction for a rotation amount that is larger than the rotation amount in the forward driving.

FIG.6



Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

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

2. Description of the Related Art

[0002] A yarn winding device that forms a package by winding a yarn is known in the art. Japanese Patent No. 4277227 discloses an automatic winder that is a type of yarn winding device.

[0003] In the automatic winder disclosed in Japanese Patent No. 4277227, a winding unit forms a winding package by unwinding a spun yarn from a yarn supplying bobbin and rewinding a predetermined amount of the yarn on the winding package. When forming a package, if the yarn supplied from the yarn supplying bobbin breaks midway, in the winding unit, at the winding package side, the cut yarn is sucked and caught by a suction mouth and guided to a yarn joining device, and yarn joining is performed by a yarn joining device. In this process, the suction mouth sucks and catches the yarn on the package side and pulls the yarn end from the winding package (so-called end finding).

[0004] When the suction mouth sucks and catches the yarn on the winding package side, the winding package is rotated in a forward direction (winding direction) for a predetermined number of rotations (or a predetermined time), and then the winding package is rotated in a backward direction of the forward direction. Japanese Patent No. 4277227 does not particularly explain a relationship between a rotation amount of the winding package in the forward direction when the suction mouth is near the winding package and the rotation amount of the winding package in the backward direction in the same state.

[0005] When the yarn breakage occurs between a yarn supplying bobbin side and a winding package during yarn rewinding, the technique (automatic winder) disclosed in Japanese Patent No. 4277227 assumes that, when a winding package is caused to rotate in the forward direction while the suction mouth is near the winding package and then caused to rotate in the backward direction, the suction mouth can suck and catch the yarn by the end part of the yarn instead of the middle part. However, some yarns have a large amount of fluff, and in such yarns, the yarn on the winding package may firmly stick to the surface of the package due to the heavy fluff. In such a case, for example, when the winding package is simply caused to rotate in the forward and the backward directions and the suction is applied to the end of the yarn, sticking of the yarn on the winding package could not be eliminated, and thus the yarn could not be caught. When this happens, because an unwinding operation to manually unwind the yarn on the winding package side by an operator

becomes necessary, efforts of the operator increase. Moreover, because the forming of the winding package by the winding unit must be stopped until the operator performs the unwinding operation, the operating efficiency is lowered.

SUMMARY OF THE INVENTION

[0006] The present invention has been made in view of the above circumstances. It is an object of the present invention to provide a technique that can perform catching of a yarn of a package efficiently.

[0007] An object of the present invention is as mentioned above, and the means to achieve the object and the advantageous effect thereof will be explained below.

[0008] According to one aspect of the present invention, a yarn winding device includes a winding section that forms a package by winding a yarn; a driving section that causes the package to drive rotatably and is capable of switching a rotation direction of the package between a forward rotation direction in which the package is rotated in a winding direction of the yarn and a backward rotation direction in which the package is rotated in an opposite direction of the winding direction of the yarn; a yarn catching section that sucks and catches the yarn from the package when the yarn that is being wound by the winding section is disconnected; and a control section that controls the driving section, wherein when the yarn catching section starts sucking the yarn on the package side, the control section causes the driving section to perform a forward-backward reciprocal driving that includes a forward driving in which the package is rotated at a first angle in the forward rotation direction and a backward driving in which the package is rotated at a second angle that is larger than a rotation angle amount in the forward driving.

[0009] According to another aspect of the present invention, a yarn catching method includes winding a yarn to form a package, and catching by drawing the yarn from the package to perform yarn joining when the yarn is disconnected during winding, wherein in the catching, a forward-backward reciprocal driving that includes a forward driving in which the package is rotated in a yarn winding direction and a backward driving in which the package is rotated in an opposite direction of the yarn winding direction for a rotation amount larger than that in the forward driving is performed multiple times.

[0010] The above and other objects, features, advantages and technical and industrial significance of this invention will be better understood by reading the following detailed description of presently preferred embodiments of the invention, when considered in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011]

FIG. 1 is a schematic front view showing an overall configuration of an automatic winder according to a first embodiment of the present invention.

FIG. 2 is a front view and a block diagram showing a schematic configuration of a winder unit.

FIG. 3 is a side view showing a state in which a yarn end on a package side is guided to a yarn joining device when the yarn in the winder unit is disconnected.

FIG. 4 is a flowchart showing processes performed by the winder unit when forming a package.

FIGS. 5A to 5C are enlarged side views for explaining an effect of a forward-backward reciprocal driving of the package.

FIG. 6 is a timing chart showing an example of a rotation control of the package executed in the winder unit.

FIG. 7 is a front view and a block diagram showing a schematic configuration of an automatic winder according to a second embodiment of the present invention.

DETAILED DESCRIPTION

[0012] Exemplary embodiments of the present invention are explained below with reference to the accompanying drawings. FIG. 1 is a schematic front view showing an overall configuration of an automatic winder 100 according to a first embodiment of the present invention.

[0013] The automatic winder (yarn winding device) 100 shown in FIG. 1 includes a plurality of winder units 10 that is arranged side by side, a blower box 70, a main control device 80, and a doffing device 90.

[0014] A not-shown blower is arranged inside the blower box 70. The blower functions as a negative pressure source to supply negative pressure via a not-shown blower duct to each winder unit 10.

[0015] The main control device 80 includes one or more operation keys (operation section) 81 and a display (alarm unit, notification section) 82. The main control device 80 can communicate with each of the winder units 10. An operator of the automatic winder 100 can input a predetermined setting value or select an appropriate control method by operating the operation keys 81. Accordingly, the plurality of the winder units 10 can be centrally controlled. The main control device 80 also controls operation of the doffing device 90. The display 82 can display information such as the winding status of a yarn 12 in each winder unit 10 and details of an error that may have occurred.

[0016] When the package 20 in the winder unit 10 is fully wound (a state in which a specific amount of the yarn 12 is wound), the doffing device 90 travels to the position of such a winder unit 10, removes the fully wound package 20 from the winder unit 10, and sets an empty winding bobbin 22 in the winder unit 10.

[0017] Next, a configuration of the winder unit 10 will be explained with reference to FIGS. 2 and 3. FIG. 2 is

a front view and a block diagram showing a schematic configuration of the winder unit 10. FIG. 3 is a side view of a state in which a yarn end is guided to a yarn joining device 3 when the yarn 12 in the winder unit 10 is disconnected.

[0018] As shown in FIG. 2, each winder unit 10 includes a winding unit main body 40, which includes a yarn supplying section 1 and a winding section 2, and a unit controller (control section) 50. The winder unit 10 unwinds the yarn 12 from a yarn supplying bobbin 11, which is supplied to the yarn supplying section 1, and winds the yarn 12 onto the winding bobbin 22, while traversing the yarn 12, to form the package 20. In the following explanation, rotation of the package 20 in a winding direction, a direction in which the package 20 is rotated when winding the yarn 12 on the package 20, is referred to as "forward driving", and rotation of the package 20 in a direction opposite to the forward direction (backward direction) is referred to as "backward driving".

[0019] The unit controller 50 includes, for example, a CPU and a ROM. A computer program, a control table, and the like to control various components of the winding unit main body 40 are stored in the ROM. The CPU executes the computer program stored in the ROM.

[0020] The yarn supplying section 1 supports the yarn supplying bobbin 11 placed on a not-shown transport tray at a predetermined position and unwinds the yarn 12 from the yarn supplying bobbin 11. When all the yarn 12 is unwound from the yarn supplying bobbin 11, the yarn supplying section 1 discharges the empty yarn supplying bobbin 11 and receives a new yarn supplying bobbin 11 from a not-shown yarn supplying bobbin supplying device. The yarn supplying section 1 is not limited to the transport tray type as explained above, and can be, for example, a magazine type yarn supplying section that supplies the yarn 12 by supporting a yarn supplying bobbin supplied from a magazine at a predetermined position and unwinds the yarn 12.

[0021] The winding section 2 is provided in an upper part of the winding unit main body 40. The winding section 2 includes a cradle 21 that is capable of holding the winding bobbin 22, a winding drum (traverse drum) 23 that traverses the yarn 12 and rotates the winding bobbin 22, and a first motor (driving section) 29 that rotationally drives the winding drum 23. A helical-shaped traverse groove 27 is formed on the outer peripheral surface of the winding drum 23. When the first motor 29 rotates the winding drum 23, the yarn 12 unwound from the yarn supplying bobbin 11 in the yarn supplying section 1 is wound around the winding bobbin 22 at a fixed width while being traversed via the traverse groove 27. Accordingly, the package 20 having a fixed winding width and a predetermined length (or a predetermined weight) can be formed. In this configuration, the first motor 29 is operative to rotate the package 20 and to switch the rotation directions of the package 20.

[0022] In the winder unit 10, an unwinding assisting device 13, a tension applying device 14, a lower-yarn

catching pipe 4, the yarn joining device 3, a yarn monitoring device 19, and an upper-yarn catching pipe (yarn catching section) 5 are arranged on a yarn running path between the yarn supplying section 1 and the winding section 2.

[0023] The unwinding assisting device 13 includes a regulating member 13a capable of coving a core tube of the yarn supplying bobbin 11. The regulating member 13a is substantially cylindrical in shape and is arranged so as to come into contact with a balloon formed on an upper portion of a yarn layer of the yarn supplying bobbin 11. The balloon is a portion formed when the yarn 12 unwound from the yarn supplying bobbin 11 is swayed by a centrifugal force.

[0024] By causing the regulating member 13a to contact the balloon, tension is applied to the yarn 12 in the balloon portion to prevent the yarn 12 from being swayed excessively. Accordingly, the yarn 12 can be caused to unwind appropriately from the yarn supplying bobbin 11.

[0025] The tension applying device 14 applies a predetermined tension to the traveling yarn 12. In the present embodiment, the tension applying device 14 has a gate-type structure in which movable comb teeth are arranged with respect to fixed comb teeth. The movable comb teeth are biased such that the comb teeth engage with each other.

[0026] By causing the yarn 12 to bend and pass between the comb teeth in the engaged state, an appropriate tension is applied to the yarn 12 and the quality of the package 20 can be improved. However, the tension applying device 14 is not limited to the gate-type structure explained above and can have, for example, a disc-type structure.

[0027] When the yarn 12 positioned between the yarn supplying section 1 and the winding section 2 is disconnected due to some reason (such as yarn breakage or yarn disconnection), the lower-yarn catching pipe 4 can suck and catch the yarn 12 (yarn end) on the yarn supplying bobbin side and guide the yarn 12 to the yarn joining device 3.

[0028] Specifically, the lower-yarn catching pipe 4 is rotatable around a pipe shaft 41. A suction port 42 is formed at a tip end of the lower-yarn catching pipe 4. An appropriate negative pressure source is connected to the lower-yarn catching pipe 4 to generate a suction current at the suction port 42.

[0029] In this configuration, when the yarn 12 is disconnected, the suction port 42 of the lower-yarn catching pipe 4 catches a lower yarn of the yarn 12 that is on the yarn supplying section side at a position shown by a double-dashed line in FIG. 3. Subsequently, the lower-yarn catching pipe 4 rotates upward around the pipe shaft 41 to guide the lower yarn to the yarn joining device 3.

[0030] When the yarn 12 is disconnected as explained above, the yarn joining device 3 joins the yarn 12 (yarn end) on the yarn supplying section side and the yarn 12 (yarn end) on the winding section side. In the present embodiment, the yarn joining device 3 is configured as

a splicer device that twists yarn ends together by a swirling airflow generated by compressed air. However, the yarn joining device 3 is not limited to the splicer device, and for example, a disc-type splicer or a mechanical yarn knotting device such as a knoter can be used as a yarn joining device.

[0031] The yarn monitoring device 19 detects a yarn defect by monitoring the thickness and the like of the traveling yarn 12 with an appropriate sensor. Moreover, the yarn monitoring device 19 also detects yarn breakage, that is, detects presence of the yarn 12 on the yarn running path. A cutter 24 that allows immediate cutting of the yarn 12 when the yarn monitoring device 19 detects the yarn defect is provided near the yarn monitoring device 19.

[0032] When the yarn 12 is disconnected as explained above, the upper-yarn catching pipe 5 sucks and catches the yarn 12 (yarn end) on the winding section side, and guides the caught yarn 12 to the yarn joining device 3.

[0033] Specifically, the upper-yarn catching pipe 5 is rotatable around a shaft 51. A suction mouth 52 is formed at a tip end of the upper-yarn catching pipe 5. The blower duct explained above is connected to the upper-yarn catching pipe 5, and a suction current can be generated at the suction mouth 52.

[0034] The suction mouth 52 is formed in an elongated shape so as to include a winding width of the package 20. With such a configuration, the suction current can be applied to the outer peripheral surface of the package 20 across the entire winding width direction.

[0035] A not-shown shutter member is arranged between the suction mouth 52 of the upper-yarn catching pipe 5 and the blower duct. The opening / closing of the shutter member is controlled by the unit controller 50. By causing the shutter member to open / close, the operation of the shutter member can be switched between generation / stopping of the suction current in the suction mouth 52.

[0036] An output shaft of a second motor 62 is connected to the upper-yarn catching pipe 5. The second motor 62 is electrically connected to the unit controller 50. By controlling the second motor 62, the unit controller 50 can start / stop the rotation of the second motor 62, or can change the rotation direction thereof.

[0037] Accordingly, when the yarn 12 is disconnected, the suction mouth 52 of the upper-yarn catching pipe 5 catches the upper yarn of the yarn 12 that is on the winding section side at an upper-yarn catching position shown by the double-dashed line in FIG. 3. Subsequently, the upper-yarn catching pipe 5 rotates around the shaft 51 to the yarn joining position shown by a solid line in FIG. 3 to guide the upper yarn to the yarn joining device 3.

[0038] A yarn detecting sensor (detecting section) 53 is provided in the winder unit 10. The yarn detecting sensor 53 detects whether the upper-yarn catching pipe 5 has caught the yarn. Specifically, the yarn detecting sensor 53 detects whether the yarn (yarn end) is present inside the upper-yarn catching pipe 5. The yarn detecting

sensor 53 is electrically connected to the unit controller 50. The yarn detecting sensor 53 can be configured as, for example, an optical sensor. The yarn detecting sensor 53 is arranged near the winding section 2. The yarn detecting sensor 53 is configured as the optical sensor that is known in the art, and includes a not-shown light emitting unit and a not-shown light receiving unit. A part of the upper-yarn catching pipe 5 is formed as a transparent member through which the light can be pass. When the upper-yarn catching pipe 5 is in the upper-yarn catching position, the light emitting unit of the yarn detecting sensor 53 can irradiate light into the upper-yarn catching pipe 5 through the transparent member. When the yarn 12 is present inside the upper-yarn catching pipe 5, the light receiving unit of the yarn detecting sensor 53 can receive the light reflected from the yarn 12. It is possible to omit the yarn detecting sensor 53. In that case, the suction mouth 52 is lowered once to cause the yarn monitoring device 19 to detect whether the upper-yarn catching pipe 5 has caught the yarn. In such a configuration, the yarn monitoring device 19 functions as the detecting section that detects whether the yarn is present inside the yarn catching section of the upper-yarn catching pipe 5.

[0039] According to the configuration explained above, the winder unit 10 can form the package 20 by winding the yarn 12 around the winding bobbin 22.

[0040] Next, while referring to FIGS. 2 and 3, an operation performed by the winder unit 10 when the yarn 12 between the yarn supplying section 1 and the winding section 2 is disconnected will be explained up to a step in which the disconnected yarn 12 is joined and the winding is resumed.

[0041] In the winder unit 10, when the yarn 12 is disconnected, a yarn end of the disconnected yarn 12 that is on the package side (winding section side) is wound on the package 20 that is rotating by inertia. The reasons for such a disconnection of the yarn 12 include the yarn 12 being automatically cut by the cutter 24 when the yarn monitoring device 19 detects a yarn defect, the yarn 12 is cut due to incidentally generated significant tension, and the like. However, the reasons are not limited thereto. In the following explanation, the yarn end on the package side is referred to as an upper yarn end.

[0042] The unit controller 50 sends a drive signal to the second motor 62 and causes the upper-yarn catching pipe 5 to rotate upward such that the suction mouth 52 approaches the package 20, thereby causing the upper-yarn catching pipe 5 to move up to the upper-yarn catching position shown by the double-dashed line in FIG. 3. As a result, the suction mouth 52 of the upper-yarn catching pipe 5 moves to a position in which the upper-yarn catching pipe 5 is substantially facing the surface of the package 20 but separated therefrom by a predetermined distance.

[0043] When the suction mouth 52 reaches the upper-yarn catching position, the unit controller 50 sends a drive signal to the first motor 29 to cause the package 20 to rotate in a backward direction of the yarn winding direc-

tion, that is, in the yarn unwinding direction (backward driving). Moreover, the unit controller 50 causes the upper-yarn catching pipe 5 to generate the suction air current in the suction mouth 52. Accordingly, the upper yarn end can be unwound from the package 20 by the sucking action of the suction mouth 52 and the backward driving of the package 20. When the upper yarn end on the surface of the package 20 crosses a portion of the package 20 that faces the suction mouth 52, the upper yarn is sucked into the upper-yarn catching pipe 5 by the action of the suction air current. On the one hand, when the upper yarn end is not unwound from the package 20 even after performing the catching operation in which the package 20 is caused to perform the backward driving and the upper yarn end is sucked and caught, the backward driving of the package 20 is stop temporarily. The backward driving is then performed again and the catching operation by the upper-yarn catching pipe 5 is performed in the same manner as explained above. When the upper yarn end is not unwound from the package 20 even after the package 20 is caused to perform the backward driving and the catching operation by the upper-yarn catching pipe 5 is performed for a predetermined number of times, the unit controller 50 causes the package 20 to perform reciprocal rotation movement at least one time and the catching operation by the upper-yarn catching pipe 5 is performed in the same manner as explained above. Details of the reciprocal rotation movement will be explained later.

[0044] On the other hand, the yarn end of the disconnected yarn 12 on the yarn supplying bobbin side (the yarn supplying section side) is caught by the suction air current generated at the tip end of the lower-yarn catching pipe 4. In the following explanation, the yarn end on the yarn supplying bobbin side is referred to as a lower yarn end.

[0045] After the upper yarn end and the lower yarn end are caught, the unit controller 50 sends a drive signal to the second motor 62 to cause the upper-yarn catching pipe 5 to pivot downward as shown by an upper thick arrow in FIG. 3. Furthermore, the unit controller 50 causes the lower-yarn catching pipe 4 to pivot upward as shown by a lower thick arrow in FIG. 3. Accordingly, the upper yarn end caught by the upper-yarn catching pipe 5 and the lower yarn end caught by the lower-yarn catching pipe 4 are guided to the yarn joining device 3.

[0046] Then, the yarn joining device 3 performs yarn joining of the upper yarn end and the lower yarn end. Once the yarn 12 becomes continuous between the yarn supplying section 1 and the winding section 2, the unit controller 50 controls the first motor 29 so as to cause the package 20 to drive forward and resumes the winding of the yarn 12.

[0047] Next, the operation performed by the winder unit 10 during the winding process will be explained in detail while referring to FIG. 4. FIG. 4 is a flowchart showing processes performed by the winder unit 10 when forming the package 20.

[0048] When the winding process in which the yarn 12 is wound on the package 20 is performed, the unit controller 50 determines whether the yarn 12 on the yarn running path between the yarn supplying section 1 and the winding section 2 is disconnected (Step S101). In the present embodiment, the unit controller 50 determines whether the yarn 12 is disconnected depending on whether a signal that indicates that the yarn 12 is present on the yarn running path is received from the yarn monitoring device 19. Moreover, when the yarn monitoring device 19 detects the yarn defect and the yarn 12 is cut by the cutter 24, the unit controller 50 determines that the yarn 12 is disconnected upon receiving a cut signal from the cutter 24.

[0049] When it is determined that the yarn 12 is not disconnected (No at Step S101), the unit controller 50 causes the package 20 to drive forward at a predetermined winding speed (rotation speed of the package 20 when winding the yarn) (Step S108). In other words, winding of the yarn 12 is performed so as to form the package 20.

[0050] On the other hand, when it is determined that the yarn 12 is disconnected (Yes at Step S101), the unit controller 50 starts a process in which the upper-yarn catching pipe 5 catches the upper yarn end (catching process) (Step S102).

[0051] Specifically, the operation performed to catch the yarn is explained below. The unit controller 50 controls the first motor 29 so as to immediately stop the rotation of the package 20. Subsequently, the unit controller 50 causes the upper-yarn catching pipe 5 to start pivoting upward. As a result, the suction mouth 52 reaches the upper-yarn catching position shown by the double-dashed line in FIG. 3. Furthermore, the unit controller 50 opens the shutter member arranged on a path that connects the upper-yarn catching pipe 5 and the blower duct when the upper-yarn catching pipe 5 starts to pivot upward. The suction mouth 52 of the upper-yarn catching pipe 5 can apply the suction current to the surface of the package 20 at the upper-yarn catching position in which the suction mouth 52 is near the surface of the package 20.

[0052] Furthermore, the unit controller 50 sends a signal to the first motor 29 to cause the package 20 to start the backward driving. The unit controller 50 causes the package 20 to perform the backward driving for a predetermined rotation amount when the upper-yarn catching pipe 5 is rotated upward. The package 20 is caused to perform the backward driving in a state in which the suction mouth 52 is caused to apply the suction current on the surface of the package 20, thereby prompting the unwinding of the upper yarn and the suction of the upper yarn end by the suction mouth 52.

[0053] There could be a case in which even when the package 20 is caused to perform the backward driving for a predetermined rotation amount, the upper yarn end is not caught by the upper-yarn catching pipe 5. In such a case, after temporarily stopping the backward driving

of the package 20, the unit controller 50 causes the package 20 to perform the backward driving again and attempts catching of the upper yarn end by the upper-yarn catching pipe 5. The unit controller 50 repeats the attempts of catching of the upper yarn end by causing the package 20 to perform the backward driving until the number of attempts reaches a predetermined upper limit value. The upper limit value can be appropriately determined, and the value can be one attempt or more than one attempt.

[0054] The unit controller 50 monitors at an appropriate timing a signal received from the yarn detecting sensor 53 each time an attempt to catch the upper yarn end is performed. When a signal that indicates the presence of the yarn inside the upper-yarn catching pipe 5 is received from the yarn detecting sensor 53, the unit controller 50 immediately terminates the process performed at Step S102 even if the process is midway because it is not necessary to attempt to catch the upper yarn end anymore.

[0055] Subsequently, the unit controller 50 determines whether the upper yarn end is successfully caught by the upper-yarn catching pipe 5 (Step S103). Such a determination can be performed based on a yarn detection signal that is received from the yarn detecting sensor 53.

[0056] When it is determined that the upper yarn end is successfully caught by the upper-yarn catching pipe 5 (Yes at Step S103), the unit controller 50 causes the yarn joining device 3 to perform yarn joining (Step S104). Specifically, the unit controller 50 rotates the upper-yarn catching pipe 5 in a downward direction while continuing the backward rotation of the package 20 and guides the upper yarn end to the yarn joining device 3. Moreover, the unit controller 50 guides the lower yarn to the yarn joining device 3 by rotating the lower-yarn catching pipe 4 upward around the pipe shaft 41. In such a state, the upper yarn and the lower yarn are joined by the yarn joining device 3. Almost at the same time as that of the yarn joining, the unit controller 50 closes the shutter member arranged on a path that connects the upper-yarn catching pipe 5 and the blower duct so as to stop the suction current in the suction mouth 52.

[0057] When it is determined that the upper-yarn catching pipe 5 has failed to catch the upper yarn end even after a predetermined number of attempts are performed (No at Step S103), the unit controller 50 sends a signal to the first motor 29 so as to terminate the backward driving of the package 20 and start a forward-backward reciprocal driving of the package 20 (Step S105). As a cause of the failure in catching the yarn, for example, the upper yarn end is being firmly stuck to the surface of the package 20 because of a lot of fluff on the yarn and the like can be considered; however, the cause is not limited thereto.

[0058] First, the unit controller 50 causes the package 20 to perform the forward driving. After causing the package 20 to rotate for a predetermined first rotation amount, the unit controller 50 switches the rotation direction of

the package 20 and causes the package 20 to perform the backward driving for a predetermined second rotation amount.

[0059] At this step, when performing the forward-backward reciprocal driving, the unit controller 50 controls rotation time, rotation speed, and the like of the package 20, and sets the second rotation amount (the rotation amount of the package 20 in the backward driving) larger than the first rotation amount (the rotation amount of the package 20 in the forward driving). As long as the rotation amount in the backward driving is larger than the rotation amount in the forward driving, the specific rotation time, specific rotation speed, and the like can be set as desired.

[0060] In such a manner, in the present embodiment, during one forward-backward reciprocal driving, the rotation amount in the backward driving is larger than the rotation amount in the forward driving. Consequently, the upper yarn is shaken with a larger stroke when the package 20 is rotated backward than that when it is rotated forward, thereby generating a change in stimulus for the upper yarn. Moreover, in addition to the suction current applied by the suction mouth 52 to the upper yarn from various positions within the scope of the forward-backward reciprocal driving, the suction mouth 52 can be caused to apply the suction current to the upper yarn in an asymmetrical form that is biased toward the backward driving side (that is, the side that prompts unwinding of the upper yarn). As a result, it is possible to obtain an untangling effect by applying a unique stimulus to the upper yarn. Accordingly, sticking of the yarn can be eliminated at a high probability even when the upper yarn is firmly stuck to the surface of the package 20, and the upper yarn end can be caught by the upper-yarn catching pipe 5.

[0061] An example shown in FIG. 5A will be explained below. In FIG. 5A, fluff occurs in the middle portion of the upper yarn, and such a fluff portion gets stuck to the surface of the package 20. For convenience of explanation, the fluff portion is indicated with a small square mark in FIGS. 5A to 5C. In a state shown in FIG. 5A, a part of the upper yarn that is on the tip end side than the fluff portion attached to the surface of the package 20 is sucked by the suction mouth 52 that is in the upper-yarn catching position. However, because the fluff portion is firmly stuck, the fluff portion cannot be peeled from the surface of the package 20 even by the suction current applied by the suction mouth 52. In FIG. 5A, the upper yarn is bent around the position of the fluff portion that is above the suction mouth 52.

[0062] When the package 20 is caused to perform the backward driving from such a state, the fluff portion moves toward the suction mouth 52. In FIG. 5B, a state in which the forward driving is completed and the fluff portion is substantially facing the suction mouth 52 is shown. The bending occurred in the upper yarn extends during the movement of the fluff portion. Consequently, because most of the upper yarn on the tip end side than the position of the fluff on the upper yarn is sucked by

the suction mouth 52, the suction current can pull the upper yarn with a stronger force.

[0063] When the package 20 is caused to perform the backward driving from the state shown in FIG. 5B, the fluff portion moves again in a direction away from the suction mouth 52. The upper yarn attempts to bend again around the fluff portion; however, because the suction mouth 52 has already sucked the upper yarn up to near the fluff portion, the upper yarn is strongly pulled by the action of the suction current. Therefore, by moving the fluff portion, a strong force is applied to the fluff portion via the upper yarn from the surface of the package 20 in a direction in which the yarn is peeled from the package 20 (that is, the direction in which the upper yarn is unwound). Moreover, because the rotation amount in the backward driving is larger than the rotation amount in the forward driving of the package 20, the strong peeling force is applied to the fluff portion over a long moving stroke of the fluff portion. As a result, as shown in FIG. 5C, the fluff portion can be peeled from the package 20 with a high probability and sucked into the upper-yarn catching pipe 5.

[0064] In the present embodiment, the first rotation amount is set to a rotation amount that is equal to or less than the amount of one rotation of the package 20. In other words, the rotation amount of the package 20 in the forward driving during the forward-backward reciprocal driving is equal to or less than 360 degrees. The second rotation amount can be equal to or less than the amount of one rotation of the package 20 or can be higher than the amount of one rotation of the package 20.

[0065] Moreover, in the forward-backward reciprocal driving, the unit controller 50 controls the rotation speed of the package 20 so as to be slower than the winding speed of the yarn 12 when forming the package 20. The rotation speed of the package 20 in the forward-backward reciprocal driving can be the same for the forward driving and the backward driving, or can be different for the forward driving and the backward driving.

[0066] A scenario in which the upper yarn end is not caught by the upper-yarn catching pipe 5 even when the package 20 is caused to perform the forward-backward reciprocal driving as explained above can be thought. In such a case, the unit controller 50 causes the package 20 to perform the forward-backward reciprocal driving again and attempts to perform the catching of the upper yarn end by the upper-yarn catching pipe 5. The unit controller 50 repeats the attempt to catch the upper yarn end by performing the forward-backward reciprocal driving of the package 20 till the number of attempts reaches a predetermined upper limit value. The upper limit value can be stipulated appropriately.

[0067] The unit controller 50 monitors a signal that is input from the yarn detecting sensor 53 at an appropriate timing each time an attempt to catch the upper yarn end is performed. When a signal that indicates the presence of the yarn inside the upper-yarn catching pipe 5 is received from the yarn detecting sensor 53, the unit con-

troller 50 immediately terminates the process performed at Step S105 even when the process is midway because it is not necessary to attempt to catch the upper yarn end anymore.

[0068] When the upper limit value for the number of attempts of catching the upper yarn end is set to two or more and the yarn detecting sensor 53 does not detect the upper yarn end in one forward-backward reciprocal driving, the package 20 is caused to perform the forward-backward reciprocal driving (repetitive reciprocal driving) at least twice.

[0069] As explained above, in one round of the forward-backward reciprocal driving, the rotation amount in the backward driving is larger than that in the forward driving of the package 20. Therefore, each time the forward-backward reciprocal driving is performed, the package 20 is caused to perform the backward driving for a differential amount between the rotation amounts in driving in both directions as a result. In other words, when the repetitive reciprocal driving of the package 20 is performed, the position of the upper yarn against the suction mouth 52 shifts to the backward rotation side each time one round of the forward-backward reciprocal driving is performed. Consequently, because the stimulus that the upper yarn receives from the suction current of the suction mouth 52 becomes diverse, sticking of the upper yarn to the surface of the package 20 can be eliminated more effectively. Furthermore, even when the difference in the amount of rotations in both directions during one round of the forward-backward reciprocal driving is small, the package 20 can be effectively caused to perform the backward driving by a significant rotation amount (for example, amount of 10 rotations) by causing the backward driving to accumulate by repeating the forward-backward reciprocal driving multiple times. In such a manner, the suction current from the suction mouth 52 can be applied to the entire package 20 by simply repeating the forward-backward reciprocal driving of the package 20 till the upper yarn is successfully caught, and the untangling action on the upper yarn can be iteratively obtained with variations. As a result, because the upper yarn that was firmly stuck and had to be removed manually by an operator in the conventional configuration can be automatically eliminated and the upper yarn can be caught with the present configuration, labor-saving efforts can be realized.

[0070] The upper limit value of the number of attempts for catching the upper yarn end (that is, the limit value relating to the number of the forward-backward reciprocal driving attempts) can be appropriately stipulated and can be set to, for example, 100 attempts. It is desirable that the upper limit value is set so that the backward driving amount of the package 20 accumulated because of the forward-backward reciprocal driving is equal to at least one round. Accordingly, because the suction mouth 52 can be caused to act on the entire outer periphery of the package 20, probability of catching the upper yarn end can be improved.

[0071] Subsequently, the unit controller 50 determines

whether the upper yarn end is successfully caught by the upper-yarn catching pipe 5 (Step S106). The process performed at Step S106 is the same as the process performed at Step S103. When it is determined that the upper yarn end is successfully caught by the upper-yarn catching pipe 5 (Yes at Step S106), the unit controller 50 causes the yarn joining device 3 to perform yarn joining (Step S104).

[0072] When it is determined that the upper-yarn catching pipe 5 has failed to catch the upper yarn end (No at Step S106) after performing the predetermined number of attempts, the unit controller 50 causes the display 82 of the main control device 80 to display an alarm and then stops the operation (Step S107). By stopping the forward-backward reciprocal driving when the upper-yarn catching pipe 5 fails to catch the upper yarn successively for a certain number of times, unnecessary rotation of the package 20 can be avoided and energy saving can be realized. Moreover, by displaying the alarm on the display 82, the operator can be prompted to manually peel off the upper yarn end that is firmly attached to the surface of the package 20.

[0073] After the yarn is joined by the yarn joining device 3, the unit controller 50 sends a drive signal to the first motor 29 and causes the package 20 to drive forward. Consequently, the yarn 12 is wound around the package 20 (Step S108).

[0074] Subsequently, for example, when another abnormality occurs in the winder unit 10 which requires winding of the yarn 12 to be stopped, or when an instruction to stop the winder unit 10 is given by the operator (Yes at Step S109), the unit controller 50 terminates the process. When such a state does not occur (No at Step S109), the unit controller 50 repeatedly executes Steps S101 to S108 explained above.

[0075] Next, operation of the winder unit 10 in the winding process will be explained with reference to the timing chart shown in FIG. 6. FIG. 6 shows a timing chart showing an example of a rotation control of the package 20 in the winder unit 10.

[0076] When the yarn 12 is disconnected, the unit controller 50 controls the first motor 29 so as to immediately stop the rotation of the package 20.

[0077] At time t0 shown in FIG. 6, the unit controller 50 causes the upper-yarn catching pipe 5 to pivot upward. As a result, at time t1, the suction mouth 52 reaches the upper-yarn catching position.

[0078] At time t1, the unit controller 50 sends a signal to the first motor 29 to start the backward driving of the package 20. The backward driving of the package 20 is performed till a predetermined time has elapsed from time t1. In FIG. 6, an example in which catching of the upper yarn end by performing the backward driving of the package 20 is attempted at each of times t1, t2, and t3, and the yarn catching fails in all attempts is shown.

[0079] In the example shown in FIG. 6, the upper limit value for the attempts of catching of the upper yarn end by performing the backward driving of the package 20 is

set to 3. Because the number of attempts has reached the upper limit, at time t4, the unit controller 50 sends a signal to the first motor 29 to start the forward-backward reciprocal driving of the package 20. The forward-backward reciprocal driving of the package 20 is performed repeatedly as shown at times t4, t5, t6, ... till the upper yarn end is successfully caught.

[0080] The unit controller 50 monitors whether the yarn is successfully caught from time t4 onwards. In the example shown in FIG. 6, a case in which it is determined for the first time that the upper yarn end is successfully caught at time t50 as a result of repeated forward-backward reciprocal driving of the package 20 for 40 times or more is shown. After continuing the backward rotation of the package 20 till an appropriate time that is after time t50, the unit controller 50 sends a signal to the first motor 29 to stop the driving of the package 20. Moreover, at time t50, the unit controller 50 causes the upper-yarn catching pipe 5 to pivot downward. As a result, the suction mouth 52 reaches the yarn joining position at time t51. Then, yarn joining is performed in the yarn joining device 3.

[0081] At time t52 at which the yarn joining is completed, the unit controller 50 sends a signal to the first motor 29 to start the forward driving of the package 20. Accordingly, the yarn winding is performed.

[0082] A speed at which the package 20 is caused to perform the forward-backward reciprocal driving can be constant from the beginning to the end of the repetitive reciprocal driving, or can be changed midway. For example, after time t7 at which an attempt to catch the yarn by performing the forward-backward reciprocal driving of the package 20 fails three consecutive times, the unit controller 50 can once again perform the forward-backward reciprocal driving so as to cause the package 20 to perform the forward driving and the backward driving at a rotation speed lower than that of the package 20 at the time of the initial forward-backward reciprocal driving (from time t4 to time t7). As a result, the forward-backward reciprocal driving speed of the package 20 reduces gradually. When catching of the upper yarn fails, it is suspected that the upper yarn is firmly stuck on the surface of the package 20, and the action of the suction current of the suction mouth 52 on the upper yarn can be strengthened by reducing the rotation speed at which the forward-backward reciprocal driving is performed and the probability of successfully catching the upper yarn can be improved.

[0083] In the present embodiment, when such forward-backward reciprocal driving of the package 20 is performed, the unit controller 50 notifies, by using the display 82 of the main control device 80, that the package 20 is caused to perform the forward-backward reciprocal driving. Such notification can be realized by, for example, displaying an appropriate message on the display 82; however, the mode of notification is not limited to such method. The operator can find out about a change in the status (yarn disconnection and countermeasures there-

of) at an early stage based on the contents displayed on the display 82.

[0084] As explained above, the automatic winder 100 according to the present embodiment includes the winding section 2, the first motor 29, the upper-yarn catching pipe 5, and the unit controller 50. The winding section 2 forms the package 20 by winding the yarn 12. The first motor 29 drives the package 20 to rotate and allows switching of the rotation direction of the package 20 between the forward rotation direction in which the package 20 is rotated in the winding direction of the yarn and the backward rotation direction in which the package 20 is rotated in the opposite direction of the winding direction. When the yarn 12 that is being wound by the winding section 2 is disconnected, the upper-yarn catching pipe 5 sucks and catches the yarn end from the package 20. The unit controller 50 controls the first motor 29. Once the upper-yarn catching pipe 5 starts the suction of the upper yarn, the unit controller 50 causes the package 20 to perform the forward-backward reciprocal driving that starts from the forward driving that includes the forward driving in which the package 20 is rotated in the winding direction of the yarn 12 and the backward driving in which the package 20 is rotated in the opposite direction of the winding direction of the yarn 12 for a rotation amount that is larger than that in the forward driving till the yarn end is successfully caught by upper yarn end catching operation.

[0085] Accordingly, by causing the package 20 to perform the forward-backward reciprocal driving, a satisfactory stimulus can be applied to the upper yarn by the catching action of the upper-yarn catching pipe 5 and the like. Moreover, because the package 20 is caused to perform the backward driving for the rotation amount that is larger than that in the forward driving in the forward-backward reciprocal driving, an asymmetrical stimulus can be applied to the upper yarn by the upper-yarn catching pipe 5 and prompting of yarn unwinding can be expected. Therefore, even when the upper yarn is firmly stuck to the surface of the package 20, sticking of the upper yarn can be easily eliminated and the upper yarn can be caught efficiently.

[0086] In the winder unit 10 according to the present embodiment, the unit controller 50 causes the package 20 to perform the repetitive reciprocal driving in which the forward-backward reciprocal driving is repeated multiple times as and when needed.

[0087] Accordingly, because an opportunity to eliminate sticking of the yarn can be secured multiple times, catching of the upper yarn can be facilitated. Moreover, because the package 20 is caused to perform the backward driving gradually each time one round of the forward-backward reciprocal driving is completed, a more diverse stimulus can be applied to the upper yarn by the upper-yarn catching pipe 5 (suction mouth 52) and the upper-yarn catching pipe 5 can be caused to act on a wider area of the outer periphery of the package 20.

[0088] Moreover, in the winder unit 10 according to the

present embodiment, by the cumulation of the forward-backward reciprocal driving, the unit controller 50 can cause the package 20 to perform the forward-backward reciprocal driving for two times or more till the backward driving completes at least one round from a starting point of the first forward-backward reciprocal driving of the package 20.

[0089] Accordingly, by performing the repetitive reciprocal driving, the upper-yarn catching pipe 5 can be caused to act on an entire outer periphery of the package 20.

[0090] Moreover, in the automatic winder 100 according to the present embodiment, the unit controller 50 can be configured so as to perform the forward-backward reciprocal driving of the package 20 again by lowering the rotation speed of the package 20 in the forward and the backward directions after the package 20 is caused to perform the repetitive reciprocal driving at least once and the upper-yarn catching pipe 5 fails to catch the upper yarn.

[0091] In such a case, because the rotation speed in the forward-backward reciprocal driving in the repetitive reciprocal driving lowers automatically under a state in which catching of the upper yarn seems difficult, the probability of catching the upper yarn can be improved on a subsequent operation.

[0092] Moreover in the automatic winder 100 according to the present embodiment, the unit controller 50 can be configured so as to perform the forward-backward reciprocal driving of the package 20 again by lowering the rotation speed of the package 20 in the forward and the backward directions after the forward-backward reciprocal driving is performed at least once during the repetitive reciprocal driving and the upper-yarn catching pipe 5 fails to catch the upper yarn.

[0093] In such a case, because the rotation speed in the forward-backward reciprocal driving lowers automatically under a state in which catching of the upper yarn seems difficult, the probability of catching the upper yarn can be improved on a subsequent operation.

[0094] In the automatic winder 100 according to the present embodiment, the rotation speed at which the package 20 is driven forward and backward when the unit controller 50 performs the repetitive reciprocal driving of the package 20 (Step S105) is slower than the rotation speed of the package 20 when the yarn 12 is wound to form the package 20 (Step S108).

[0095] Accordingly, the upper-yarn catching pipe 5 can be caused to act effectively on the package 20 to catch the upper yarn.

[0096] In the automatic winder 100 according to the present embodiment, the rotation amount of the package 20 in the forward driving included in one round of the forward-backward reciprocal driving in the repetitive reciprocal driving is equal to or less than the amount of one rotation.

[0097] Accordingly, because the rotation amount of the forward-backward reciprocal driving of the package 20

is comparatively small, vibration and the like occurring from the automatic winder 100 can be reduced.

[0098] Moreover, the automatic winder 100 according to the present embodiment includes the yarn detecting sensor 53 that detects whether the yarn is present inside the upper-yarn catching pipe 5. The unit controller 50 causes the yarn detecting sensor 53 to detect whether the yarn is present inside the upper-yarn catching pipe 5 at the same as when the upper-yarn catching pipe 5 is caused to perform the repetitive reciprocal driving, and when it is determined that the yarn is successfully caught by the upper-yarn catching pipe 5 based on a detection result of the yarn detecting sensor 53, the repetitive reciprocal driving is caused to terminate. Moreover, even when it is determined that the yarn is not caught by the upper-yarn catching pipe 5 based on the detection result of the yarn detecting sensor 53, the unit controller 50 determines that the upper-yarn catching pipe 5 has failed to catch the yarn when the limiting value for the number of the forward-backward reciprocal driving attempts stipulated beforehand is reached and causes the repetitive reciprocal driving to terminate.

[0099] Accordingly, after the upper yarn is successfully caught by the upper-yarn catching pipe 5, a subsequent operation can be started smoothly. Moreover, when the possibility of the upper-yarn catching pipe 5 successfully catching the upper yarn is low, unnecessary forward-backward reciprocal driving of the package 20 can be prevented.

[0100] The automatic winder 100 according to the present embodiment includes the display 82. When the repetitive reciprocal driving is terminated because the limiting value for the number of the forward-backward reciprocal driving attempts is reached, the display 82 starts an alarm.

[0101] Accordingly, the operator and the like can be immediately notified that the repetitive reciprocal driving is terminated because the possibility of the upper-yarn catching pipe 5 successfully catching the yarn in a subsequent operation is low.

[0102] Moreover, the automatic winder 100 according to the present embodiment includes the display 82. The display 82 notifies that the repetitive reciprocal driving of the package 20 is being performed.

[0103] Accordingly, the operator and the like in the vicinity can easily comprehend that the repetitive reciprocal driving of the package 20 is being performed to catch the upper yarn.

[0104] A yarn catching method using the automatic winder 100 (winder unit 10) according to the present embodiment includes a winding process and a catching process. In the winding process, the package 20 is formed by winding the yarn 12. In the catching process, when the yarn 12 is disconnected during the winding process, the yarn 12 is caught by drawing thereof from the package 20 to perform yarn joining. In the catching process, the forward-backward reciprocal driving of the package 20, which includes the forward driving of the

package 20 in the winding direction of the yarn 12 and the backward driving of the package 20 in the opposite direction of the winding direction of the yarn 12 for the rotation amount that is larger than that in the forward driving, is performed multiple times.

[0105] Accordingly, even when the upper yarn is firmly stuck to the surface of the package 20, such sticking can be easily eliminated, and the upper yarn can be caught efficiently.

[0106] Next, an automatic winder 100 according to the second embodiment will be explained by referring to FIG. 7. FIG. 7 is a front view and a block diagram showing a schematic configuration of a winder unit 10 of an automatic winder 100 according to the second embodiment. However, in the explanation of the second embodiment, portions that are identical or correspond to the embodiment explained above are indicated by the same reference symbols in the drawings and explanation thereof is omitted.

[0107] The automatic winder 100 of the present embodiment differs in that, instead of the winding section 2 in which the winding drum 23 includes the traverse groove 27, each of the winder units 10 according to the present embodiment includes a winding section 2x that includes a traversing device 123. In other words, the winding section 2x includes a cradle 121 on which the winding bobbin 22 can be mounted, a contact roller 122, and the traversing device 123.

[0108] The cradle 121 removably holds the winding bobbin 22 (package 20). The cradle 121 is capable of rotating (pivoting) on the front side and the back side of the winder unit 10. An increase in a yarn layer diameter of the package 20 because of the winding of the yarn 12 around the winding bobbin 22 can be absorbed by the rotation of the cradle 121. In other words, even when the yarn layer diameter of the package 20 changes because of the winding of the yarn 12, the surface of the package 20 can be caused to appropriately come into contact with the contact roller 122.

[0109] The cradle 121 includes a package driving motor (driving section) 125 that is constituted by, for example, a servo motor. The winding section 2x causes the winding bobbin 22 to drive rotationally by using the package driving motor 125 and winds the yarn 12 onto the surface of the winding bobbin 22 (or the surface of the package 20).

[0110] When the winding bobbin 22 is supported in the cradle 121, a rotating shaft of the package driving motor 125 is linked to the winding bobbin 22 so as to prevent the relative rotation (so called direct drive type). The package driving motor 125 is electrically connected to the unit controller 50. By controlling the package driving motor 125, the unit controller 50 can cause the rotation of the package driving motor 125 to start / stop, and can change the rotation direction and the rotation speed.

[0111] The contact roller 122 is rotatable and capable of coming into contact with the surface of the winding bobbin 22 or the surface of the package 20 from below.

The contact roller 122 can support at least a part of the weight of the winding bobbin 22 or the package 20.

[0112] The traversing device 123 includes a traverse arm 131 and a traverse driving motor 132. The traverse arm 131 is rotatable and can hold the yarn 12 at the tip thereof. The traverse driving motor 132 drives the traverse arm 131. The traverse driving motor 132 is electrically connected to the unit controller 50. By linking the unit controller 50 to the package driving motor 125 and causing the traverse driving motor 132 to drive reciprocally, the yarn 12 that is wound onto the package 20 can be traversed at a predetermined traverse angle.

[0113] Exemplary embodiments of the present invention are explained above. The configurations explained above can, however, be modified as explained below.

[0114] In the embodiments explained above, after the yarn 12 is disconnected, the package 20 is driven backward before the package 20 is caused to perform the reciprocal movement; however, such backward driving of the package 20 can be omitted. In other words, after the yarn 12 is disconnected, the package 20 can be immediately caused to perform the reciprocal movement.

[0115] Whether to perform the forward driving first or whether to perform the backward driving first in the reciprocal movement of the package 20 can be selected as desired.

[0116] An attempt to catch the upper yarn end by the upper-yarn catching pipe 5 while causing the package 20 to rotate for an appropriate rotation amount in an appropriate direction can be performed once or multiple times between the backward driving of the package 20 shown from time t1 to t4 in FIG. 6 and the repetitive reciprocal driving of the package 20 shown from time t4 onwards in FIG. 6. For example, the forward driving and the backward driving of the package 20 as disclosed in Japanese Patent No. 4277227 can be performed before time t4. When causing the upper-yarn catching pipe 5 to act on the surface of the package 20, instead of the upper yarn, a state in which only the middle part of the slackened upper yarn is sucked by the suction mouth 52 may occur. Such state can be eliminated by performing rotation of the package 20 as disclosed in Japanese Patent No. 4277227. Attempting to catch the upper yarn end by the repetitive reciprocal driving from time t4 onwards in FIG. 6 may take a long time to successfully catch the upper yarn end and reduce the operating efficiency of the winder unit 10. Consequently, attempting to catch the upper yarn end by causing the package 20 to rotate in various manners before shifting to the repetitive reciprocal driving of the package 20 is beneficial.

[0117] Instead of the number of times the reciprocal movement is performed, a limit value of the repetitive reciprocal driving of the package 20 can be defined based on the time elapsed from the start of the repetitive reciprocal driving.

[0118] Instead of the display 82, the state in which reciprocal movement of the package 20 is being performed can be notified via, for example, a lamp that is separately

provided on the main control device 80. Such a notification can be configured so as to cause lamps, buzzers, and the like of each winder unit 10 to operate. Similarly, the alarm explained at Step S107 of FIG. 4 can be realized by any appropriate method other than the display 82.

[0119] In the second embodiment, a lift-up mechanism that can cause the cradle 21 to rotate and cause the package 20 to separate from the contact roller 122 can be provided in the winding section 2x, and it can be configured such that, when the lift-up mechanism causes the package 20 to lift-up so as to separate from the contact roller 122, the unit controller 50 causes the package 20 to perform the reciprocal movement.

[0120] In the embodiments explained above, the upper limit value of the number of attempts for catching the upper yarn end (limiting value relating to the number of times reciprocal movement) is explained as, for example, 100; however, the upper limit value is not limited to such a value. For example, the upper limit value of the number of attempts for catching the upper yarn end can be set to 50 and the same operation can be repeated in two sets. Because the continuous attempts to catch the upper yarn end are interrupted when the upper limit value is divided in sets, a stimulus can be applied in a subsequent set by using a reciprocal movement that is different than that used in the previous set. Accordingly, increase in the success rate of catching the upper yarn can be expected.

[0121] Considering the explanation provided above, it is obvious that the present invention is capable of many modifications and variations. Therefore, it is to be understood that the present invention can be implemented in other ways and manners than those explained in the present specification within the scope of the patent claims.

[0122] According to one aspect of the present invention, a yarn winding device having the below configuration is provided. That is, the yarn winding device includes a winding section, a driving section, a yarn catching section, and a control section. The winding section forms a package by winding a yarn. The driving section causes the package to drive rotatably and is capable of switching a rotation direction of the package between a forward rotation direction in which the package is rotated in a winding direction of the yarn and a backward rotation direction in which the package is rotated in an opposite direction of the winding direction of the yarn. The yarn catching section sucks and catches the yarn from the package when the yarn that is being wound by the winding section is disconnected. The control section controls the driving section. When the yarn catching section starts sucking the yarn on the package side, the control section causes the driving section to perform a forward-backward reciprocal driving that includes a forward driving in which the package is rotated at a first angle in the forward rotation direction and a backward driving in which the package is rotated at a second angle that is larger than a rotation angle amount in the forward driving.

[0123] With this configuration, by causing the package to perform a forward-backward reciprocal driving, a satisfactory stimulus to the yarn on the package side can be applied by the catching action of the yarn catching section and the like. Moreover, in the forward-backward reciprocal driving, because the package is caused to perform the backward driving for a rotation amount that is larger than that in the forward driving, an asymmetrical stimulus can be applied to the yarn on the package side by the yarn catching section and the like, and it can be expected that the yarn unwinding is prompted. Therefore, even when the yarn is firmly stuck to the surface of the package, such sticking of yarn can be easily eliminated and the yarn on the package side can be caught efficiently.

[0124] In the above yarn winding device, it is preferable that the control section causes the driving section to perform a repetitive reciprocal driving in which the forward-backward reciprocal driving is repeated multiple times.

[0125] With this configuration, because an opportunity to eliminate the sticking of the yarn can be secured multiple times, catching of the yarn on the package side can be facilitated. Moreover, because the package is caused to perform the backward driving gradually each time the forward-backward reciprocal driving completes one round, more diverse stimuli can be applied to the yarn on the package side by the yarn catching section and the yarn catching section can act on a wider area of the outer periphery of the package.

[0126] In the above yarn winding device, it is preferable that the control section causes the driving section to perform the repetitive reciprocal driving by repeating the forward-backward reciprocal driving of the package for at least one round of the backward rotation from the time the forward-backward reciprocal driving starts.

[0127] With this configuration, because the repetitive reciprocal driving is performed, the yarn catching section can be caused to act on the entire outer periphery of the package.

[0128] In the above yarn winding device, it is preferable that, after causing the package to perform the repetitive reciprocal driving at least for one round and the yarn catching section has failed to catch the yarn, the control section causes the package to perform the repetitive reciprocal driving again by lowering the speed at which the package is caused to perform the forward driving and the backward driving.

[0129] With this configuration, because the rotation speed in the forward-backward reciprocal driving in the repetitive reciprocal driving lowers automatically under a state in which catching of the yarn seems difficult, the probability of the yarn being caught in a subsequent operation can be improved.

[0130] In the above yarn winding device, it is preferable that, after causing the package to perform the repetitive reciprocal driving at least for one round in the repetitive reciprocal driving and the yarn catching section has failed to catch the yarn, the control section causes the package

to perform the forward-backward reciprocal driving again by lowering the speed at which the package is caused to perform the forward driving and the backward driving.

[0131] With this configuration, because the rotation speed in the forward-backward reciprocal driving lowers automatically under a state in which catching of the yarn seems difficult, the probability of the yarn being caught in a subsequent operation can be improved.

[0132] In the above yarn winding device, it is preferable that, the speed at which the package is caused to perform the forward driving and the backward driving when the control section causes the driving section to perform the repetitive reciprocal driving is slower than a rotation speed of the package when the package is formed by winding the yarn.

[0133] With this configuration, the yarn catching section can be caused to act effectively on the package to catch the yarn on the package side.

[0134] In the above yarn winding device, it is preferable that, the rotation angle amount of the package in the forward driving included in one round of the forward-backward reciprocal driving in the repetitive reciprocal driving is equal to or less than one rotation.

[0135] With this configuration, because the rotation angle amount of the forward-backward reciprocal driving of the package is relatively small, vibration and the like generated from the yarn winding device can be reduced.

[0136] It is preferable that the above yarn winding device has following configuration. That is, the yarn winding device includes a detecting section that detects whether the yarn is present inside the yarn catching section. The control section causes the detecting section to implement a detection operation to detect whether the yarn is present inside the yarn catching section alongside with implementation of the repetitive reciprocal driving, and causes the repetitive reciprocal driving to terminate when it is determined that the yarn is successfully caught by the yarn catching section based on a detection result of the detecting section. Even when it is determined that the yarn is not caught by the yarn catching section based on a detection result of the detecting section, the control section determines that the yarn catching section has failed to catch the yarn when the number of times the forward-backward reciprocal driving can be performed or the time elapsed from the start of the repetitive reciprocal driving reaches a limit value set beforehand, and causes the repetitive reciprocal driving to terminate.

[0137] With this configuration, once the yarn on the package side is successfully caught by the yarn catching section, a subsequent operation can be started smoothly. Moreover, when the possibility of the yarn catching section successfully catching the yarn is low, unnecessary forward-backward reciprocal driving of the package can be prevented.

[0138] It is preferable that the above yarn winding device has following configuration. That is, the yarn winding device includes an alarm unit. The alarm unit generates an alarm when the repetitive reciprocal driving is termi-

nated because the number of times the forward-backward reciprocal driving can be performed, or the time elapsed from the start of the repetitive reciprocal driving reaches the limit value.

[0139] With this configuration, the operator and the like can be promptly notified that the repetitive reciprocal driving is terminated because the possibility of the yarn catching section successfully catching the yarn hereafter is low.

[0140] It is preferable that the above yarn winding device includes a notification section that notifies that the repetitive reciprocal driving of the package is being performed.

[0141] With this configuration, it can be easily comprehended that the repetitive reciprocal driving is being performed to catch the yarn on the package side.

[0142] In the above yarn winding device, it is preferable that the winding section includes a winding drum on which a helical-shaped traverse groove is formed on the outer peripheral surface that causes the package to rotate by coming into contact with the outer periphery of the package, and the driving section causes the package to rotate by causing the winding drum to drive.

[0143] Because the package is caused to rotate by the winding drum on which a helical-shaped traverse groove is formed on the outer circumferential surface, misalignment between the rotation of the package and the traversing does not occur even when the driving section is caused to perform the forward-backward reciprocal driving.

[0144] According to another aspect of the present invention, a yarn catching method is provided. The yarn catching method includes winding and catching. The winding includes winding a yarn to form a package. The catching includes catching by drawing the yarn from the package to perform yarn joining when the yarn is disconnected during winding. In the catching, a forward-backward reciprocal driving that includes a forward driving in which the package is rotated in a yarn winding direction and a backward driving in which the package is rotated in an opposite direction of the yarn winding direction for a rotation amount larger than that in the forward driving is performed multiple times.

[0145] With this configuration, by causing the package to perform a forward-backward reciprocal driving, a satisfactory stimulus to the yarn on the package side can be applied by the yarn catching section and like. Moreover, in the forward-backward reciprocal driving, because the package is caused to perform the backward driving for the rotation amount that is larger than that in the forward driving, an asymmetrical stimulus can be applied to the yarn on the package side by the yarn catching section and the like, and it can be expected that the yarn unwinding is prompted. Furthermore, multiple opportunities to eliminate the sticking of the yarn by performing the forward-backward reciprocal driving can be secured. Therefore, even when the yarn is firmly stuck to the surface of the package, such sticking of the yarn can be

easily eliminated and the yarn on the package side can be caught efficiently.

[0146] In the above explanation, the meaning of "a plurality of" also includes "a predetermined number of".

[0147] Although the invention has been explained with respect to specific embodiments for a complete and clear disclosure, the appended claims are not to be thus limited but are to be construed as embodying all modifications and alternative constructions that may occur to one skilled in the art that fairly fall within the scope of the claims.

Claims

1. A yarn winding device (100) comprising:

a winding section (2; 2x) configured to form a package (20) by winding a yarn;

a driving section (29; 125) configured to cause the package (20) to drive rotatably and being capable of switching a rotation direction of the package (20) between a forward rotation direction in which the package (20) is rotated in a winding direction of the yarn and a backward rotation direction in which the package (20) is rotated in an opposite direction of the winding direction of the yarn;

a yarn catching section (5) configured to suck and catch the yarn from the package (20) when the yarn that is being wound by the winding section (2; 2x) is disconnected; and

a control section (50) configured to control the driving section (29; 125), wherein when the yarn catching section (5) starts sucking the yarn on the package side, the control section (50) is configured to cause the driving section (29; 125) to perform a forward-backward reciprocal driving that includes a forward driving in which the package (20) is rotated at a first angle in the forward rotation direction and a backward driving in which the package (20) is rotated at a second angle that is larger than a rotation angle amount in the forward driving.

2. The yarn winding device (100) as claimed in Claim 1, wherein the control section (50) is configured to cause the driving section (29; 125) to perform a repetitive reciprocal driving in which the forward-backward reciprocal driving is repeated multiple times.

3. The yarn winding device (100) as claimed in Claim 2, wherein the control section (50) is configured to cause the driving section (29; 125) to perform the repetitive reciprocal driving by repeating the forward-backward reciprocal driving of the package (20) for at least one round of the backward rotation from the time the forward-backward reciprocal driving starts.

4. The yarn winding device (100) as claimed in Claim 3, wherein, after causing the package (20) to perform the repetitive reciprocal driving at least for one round and the yarn catching section (5) has failed to catch the yarn, the control section (50) is configured to cause the package (20) to perform the repetitive reciprocal driving again by lowering the speed at which the package (20) is caused to perform the forward driving and the backward driving.

5. The yarn winding device (100) as claimed in Claim 3, wherein, after causing the package (20) to perform the repetitive reciprocal driving at least for one round in the repetitive reciprocal driving and the yarn catching section (5) has failed to catch the yarn, the control section (50) is configured to cause the package (20) to perform the forward-backward reciprocal driving again by lowering the speed at which the package (20) is caused to perform the forward driving and the backward driving.

6. The yarn winding device (100) as claimed in any one of Claims 2 to 5, wherein the speed at which the package (20) is caused to perform the forward driving and the backward driving when the control section (50) causes the driving section (29; 125) to perform the repetitive reciprocal driving is slower than a rotation speed of the package (20) when the package (20) is formed by winding the yarn.

7. The yarn winding device (100) as claimed in any one of Claims 2 to 6, wherein the rotation angle amount of the package (20) in the forward driving included in one round of the forward-backward reciprocal driving in the repetitive reciprocal driving is equal to or less than one rotation.

8. The yarn winding device (100) as claimed in any one of Claims 2 to 7, comprising a detecting section (53) configured to detect whether the yarn is present inside the yarn catching section (5), wherein the control section (50) is configured to cause the detecting section (53) to implement a detection operation to detect whether the yarn is present inside the yarn catching section (5) alongside with the implementation of the repetitive reciprocal driving, and to cause the repetitive reciprocal driving to terminate when it is determined that the yarn is successfully caught by the yarn catching section (5) based on a detection result of the detecting section (53), and even when it is determined that the yarn is not caught by the yarn catching section (5) based on a detection result of the detecting section (53), the control section (50) is configured to determine that the yarn catching section (5) has failed to catch the yarn when the number of times the forward-backward reciprocal driving is performed or the time that elapses from the start of the repetitive reciprocal driving reaches

a limit value set beforehand, and to cause the repetitive reciprocal driving to terminate.

9. The yarn winding device (100) as claimed in Claim 8, comprising an alarm unit (82) configured to generate an alarm when the repetitive reciprocal driving is terminated because the number of times the forward-backward reciprocal driving is performed, or the time that elapses from the start of the repetitive reciprocal driving reaches the limit value. 5
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10. The yarn winding device (100) as claimed in any one of Claims 2 to 9, comprising a notification section (82) configured to notify that the repetitive reciprocal driving of the package (20) is being performed. 15
11. The yarn winding device (100) as claimed in any one of Claims 1 to 9, wherein the winding section (2) includes a winding drum (23) on which a helical-shaped traverse groove is formed on the outer peripheral surface that causes the package (20) to rotate by coming into contact with the outer periphery of the package (20), and the driving section (29) is configured to cause the package (20) to rotate by causing the winding drum (23) to drive. 20
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12. A yarn catching method comprising:
 - winding a yarn to form a package (20), and
 - catching the yarn from the package (20) to perform yarn joining when the yarn is disconnected during the winding, wherein 30
 - during the catching, a forward-backward reciprocal driving that includes a forward driving in which the package (20) is rotated in a yarn winding direction and a backward driving in which the package (20) is rotated in an opposite direction of the yarn winding direction for a rotation amount larger than that in the forward driving is performed multiple times. 35
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FIG.1

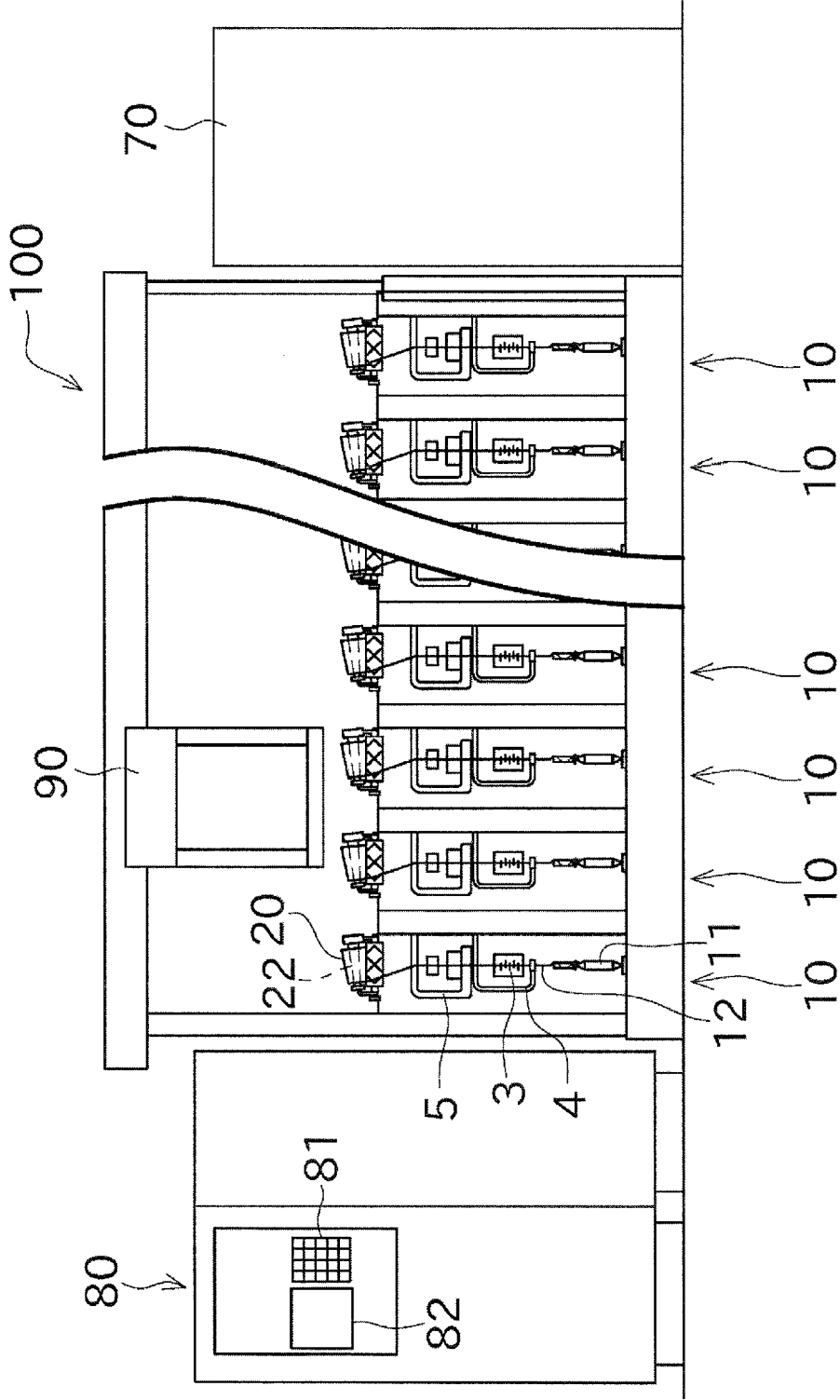


FIG.2

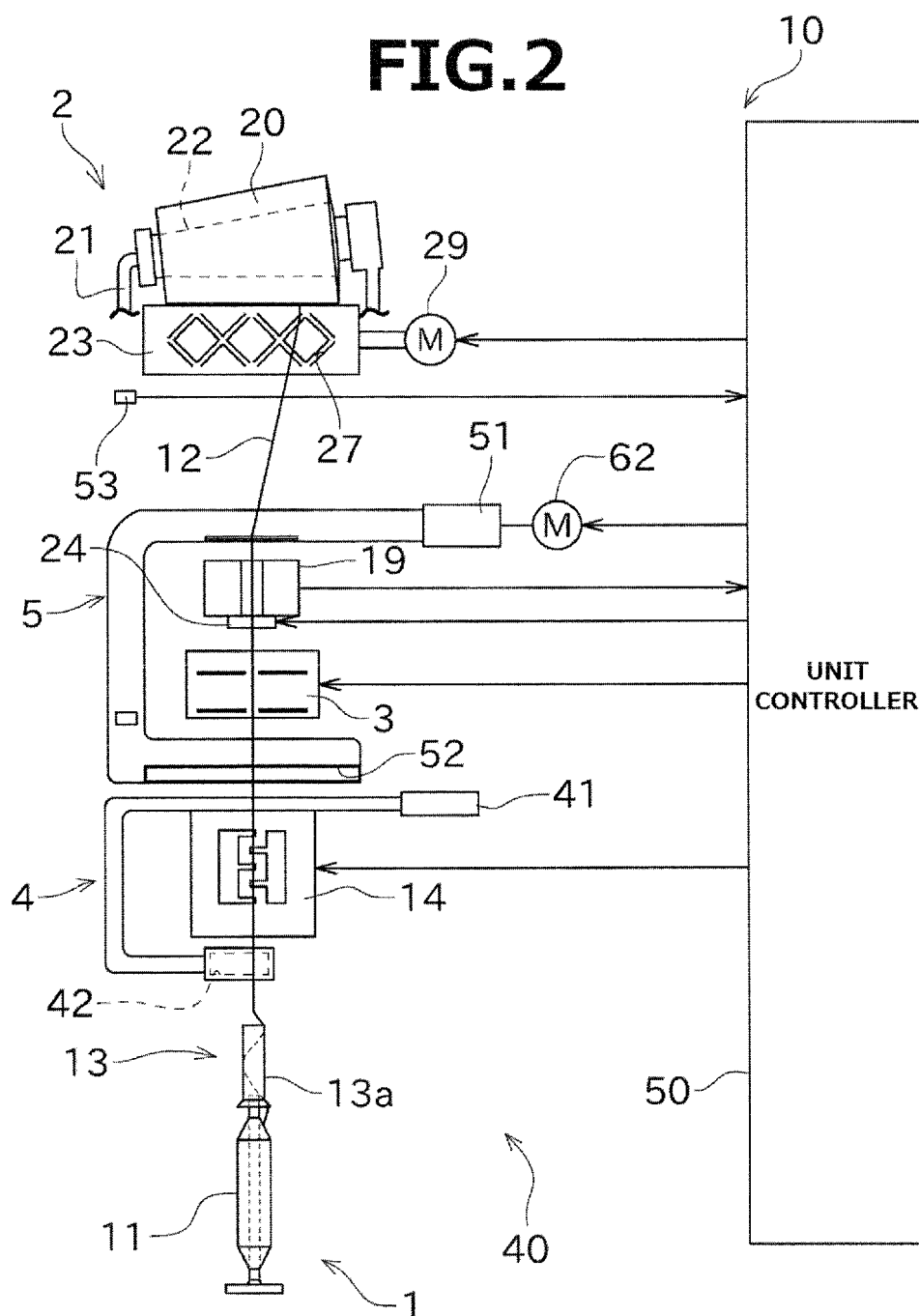


FIG.3

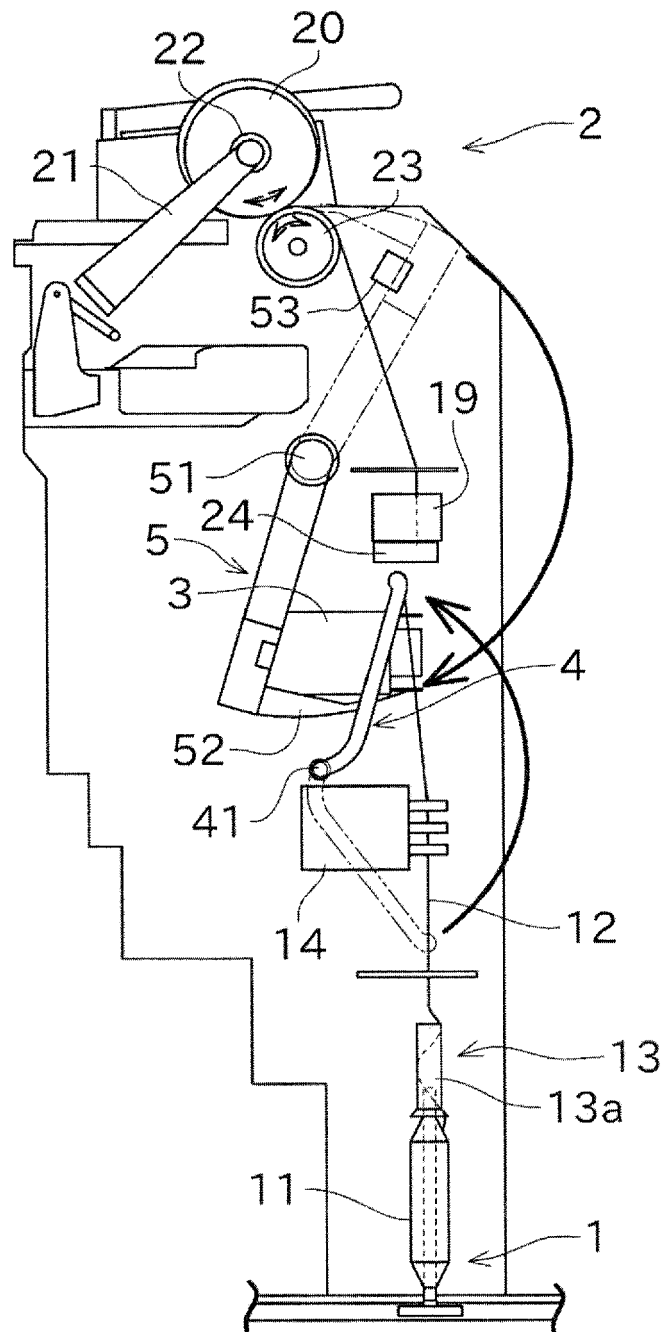


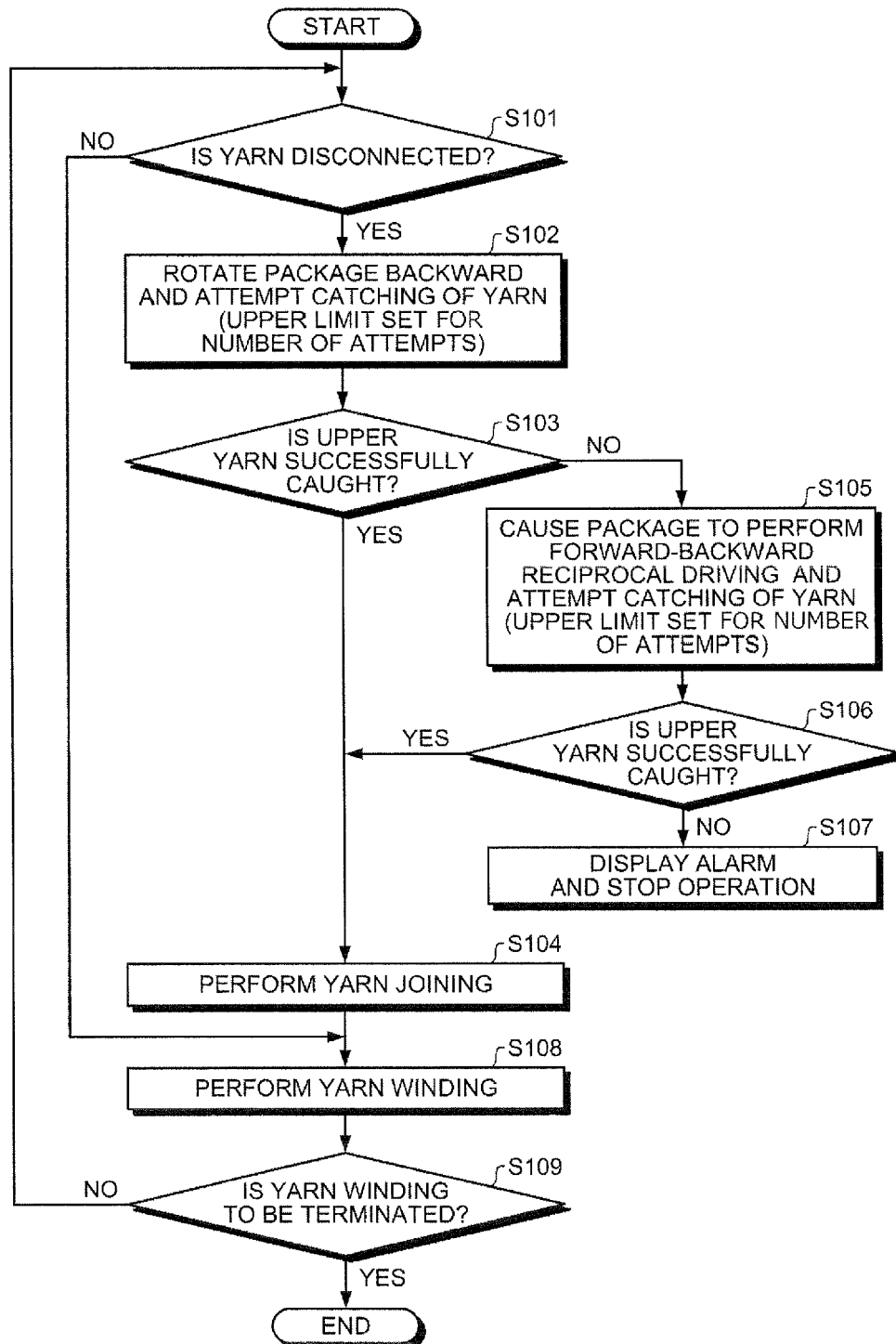
FIG.4

FIG.5A

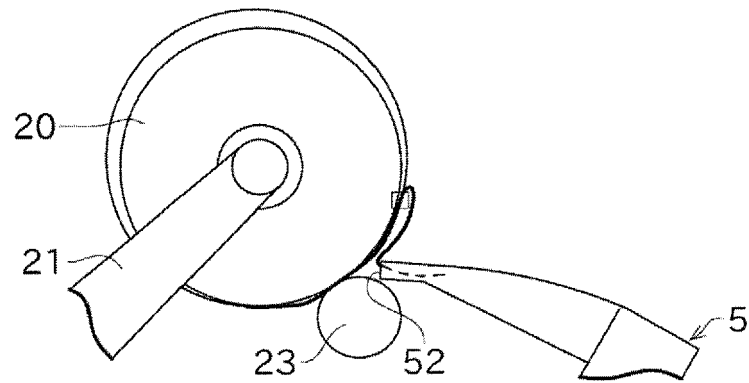


FIG.5B

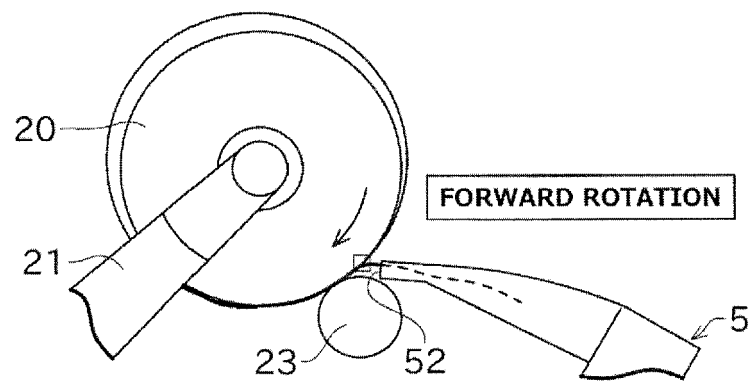


FIG.5C

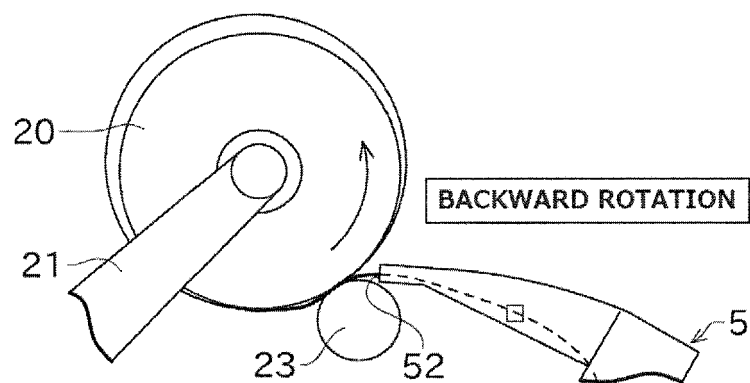


FIG.6

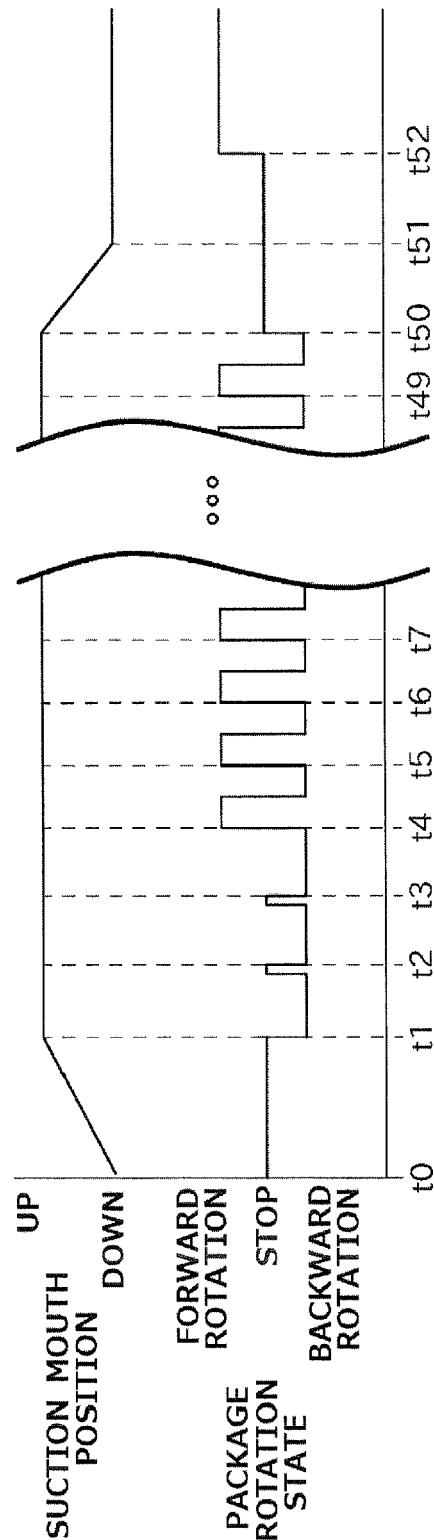
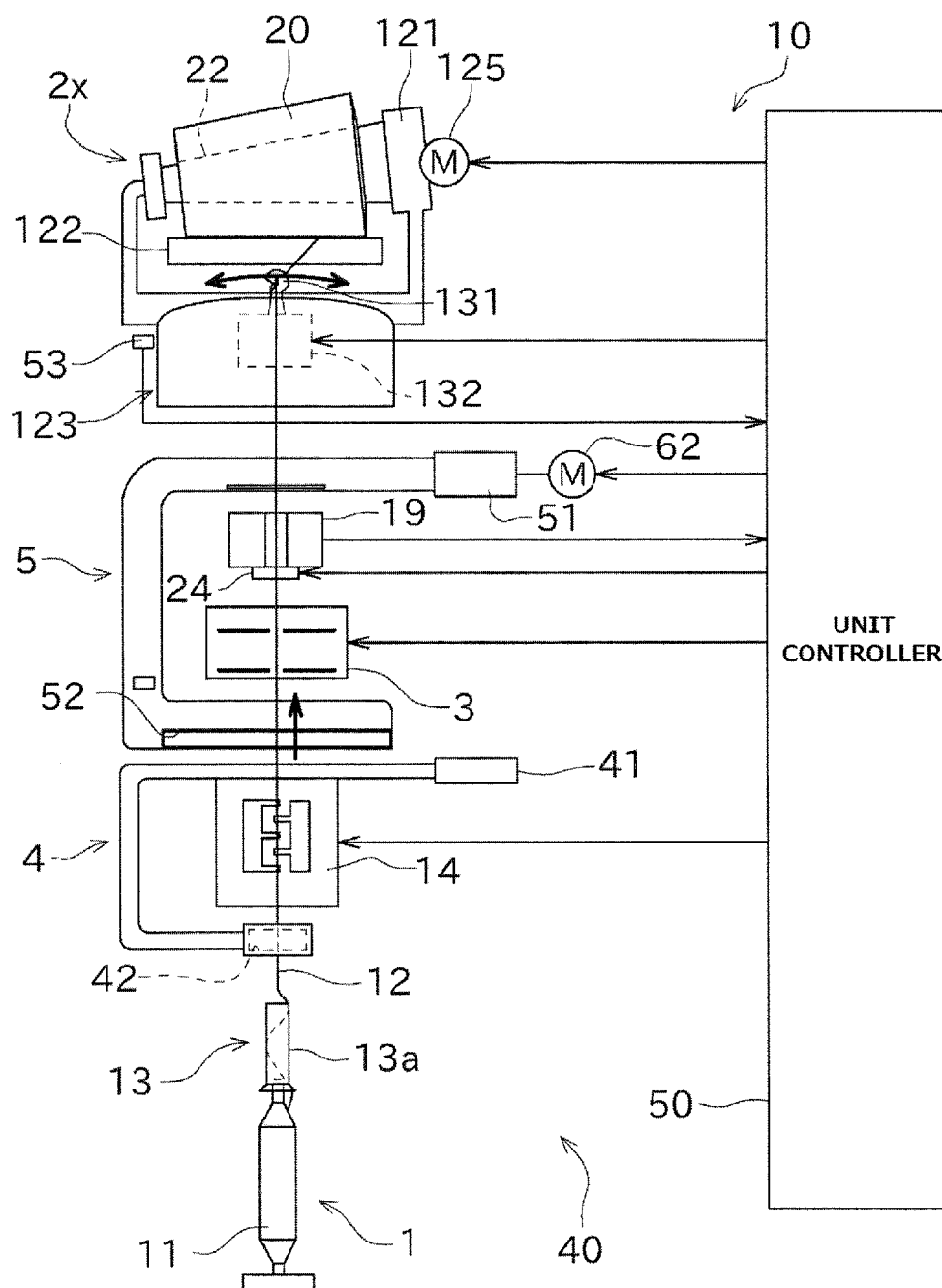


FIG.7





EUROPEAN SEARCH REPORT

Application Number
EP 20 20 0349

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			B65H
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 26 February 2021	Examiner Lemmen, René
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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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26-02-2021

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