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(54) **YARN WINDING MACHINE**

(57) A winding unit 10 includes a yarn supplying section (15), a yarn winding section (17, 17'), a yarn joining device (38), a first catching / guiding device (30), and a unit controlling section (100). When guiding a yarn end to the yarn joining device (38), if the first catching / guiding device (30) fails in catching the yarn end from a package (22, 22'), the unit controlling section (100) causes the package (22, 22') to rotate in a winding direction of the yarn at a second rotational speed (V2) at which the yarn is wound at a speed of 800 m/min or more. Otherwise the package (22, 22') is rotated at a first rotational speed (V1).

FIG.2

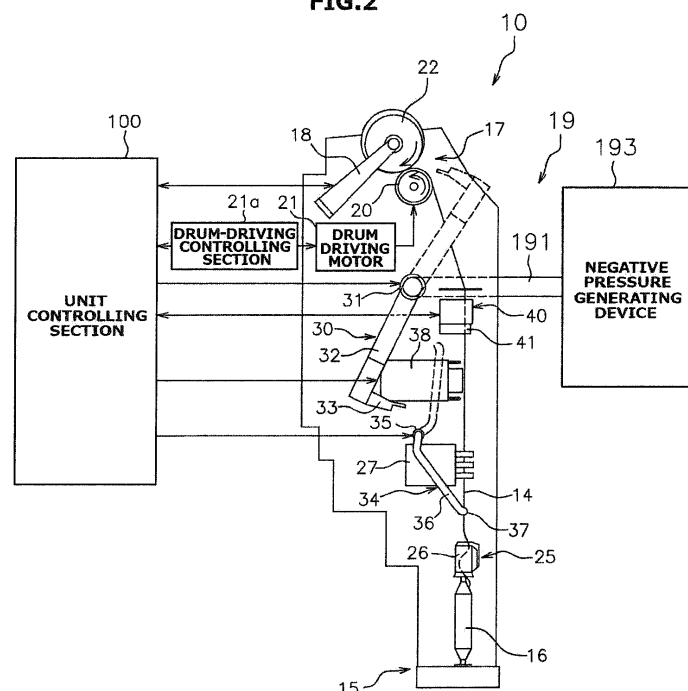
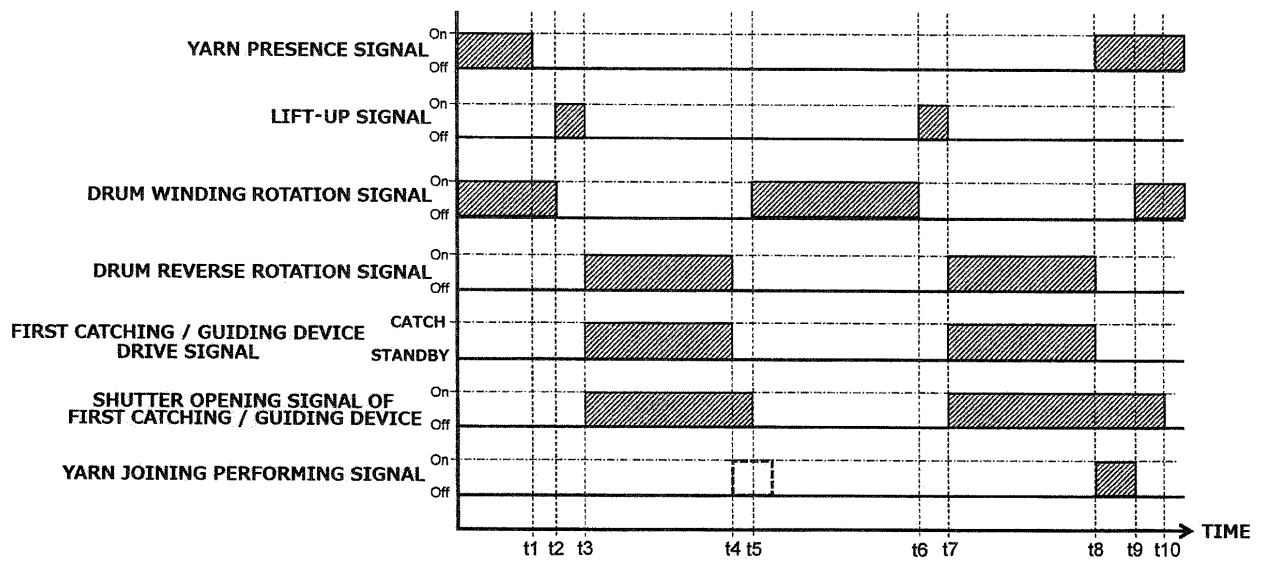


FIG.6



Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a yarn winding machine that produces a package by winding a supplied yarn.

2. Description of the Related Art

[0002] Yarn winding machines that produce a package of a yarn by winding the yarn supplied from a yarn supplying bobbin are known in the art. In such yarn winding machines, there are instances where the yarn supplied from the yarn supplying bobbin breaks in between during the production of the package. When the yarn breaks during the production of the package, the yarn winding machine resumes the production of the package after yarn joining is performed by a yarn joining device.

[0003] When the yarn joining device performs the yarn joining, the yarn winding machine catches a yarn end of the broken yarn and guides the yarn end to the yarn joining device. However, the device that catches the yarn end may fail to catch the yarn end for various reasons such as the yarn end is stuck and / or attached to the package due to fluff of the yarn wound on the package and / or static electricity, and the like.

[0004] To catch the yarn end more reliably, for example, Japanese Patent Application Laid-open No. 2016-11176 discloses a configuration in which, when a yarn breakage occurs, the package is caused to rotate in a winding direction of the yarn and the yarn end is caught by the action of centrifugal force, thereby eliminating sticking and attaching of the yarn end.

[0005] In the conventional yarn winding machine, even in a state in which the yarn end is stuck, the yarn end catching process is performed by applying a comparatively stronger negative pressure so that the yarn end of the broken yarn can be sucked and caught surely.

[0006] Because the yarn end catching process is performed by applying the comparatively stronger negative pressure even when the yarn end can be easily sucked and caught, the energy consumed to apply the negative pressure becomes a problem.

SUMMARY OF THE INVENTION

[0007] One object of the present invention is to improve energy efficiency of a yarn winding machine that produces a package of a yarn.

[0008] A yarn winding machine according to one aspect of the present invention includes a yarn supplying section, a yarn winding section, a yarn joining device, a yarn catching / guiding device, and a controlling section. The yarn supplying section supplies a yarn. The yarn winding section forms a package by winding the yarn

supplied by the yarn supplying section while rotating the package in a winding direction of the yarn at a first rotational speed. The yarn joining device joins a yarn end from the yarn supplying section and a yarn end from the package. The yarn catching / guiding device uses a negative pressure suction inside a tube member to catch the yarn end from the package and guides the caught yarn end to the yarn joining device. The controlling section controls the yarn winding section to rotate the package in the winding direction at a second rotational speed at which the yarn is wound in the package at a speed of 800 m/min or more when the yarn catching / guiding device fails in catching the yarn end from the package.

[0009] 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

[0010]

FIG. 1 is a diagram showing a configuration of an automatic winder.

FIG. 2 is a diagram showing a configuration of a winding unit according to a first embodiment of the present invention.

FIG. 3 is a diagram showing a configuration of a cradle that includes a lift-up mechanism.

FIG. 4 is a diagram showing a contact state and a separated state of a package with respect to a winding drum.

FIG. 5 is a flowchart for explaining a forming operation of the package.

FIG. 6 is a timing chart for explaining operations of various structural components of the winding unit in the forming operation of the package according to the first embodiment.

FIG. 7 is a diagram showing comparison of yarn end catching failure probability and the power consumption of the conventional winding unit with that of the winding unit according to the first embodiment.

FIG. 8 is a diagram showing a configuration of an upper yarn sensor.

FIG. 9 is a diagram showing a configuration of a transparent cover.

FIG. 10 is a cross-sectional view of a pipe member.

FIG. 11 is a timing chart for explaining operations of various structural components of the winding unit in a forming operation of the package according to a second embodiment.

FIG. 12 is a diagram showing a configuration of a winding unit according to a third embodiment.

DETAILED DESCRIPTION

1. First Embodiment

(1) Configuration of Automatic Winder

[0011] A first embodiment of the present invention will be explained in detail below. First, a configuration of an automatic winder 1 according to the first embodiment will be explained with reference to FIG. 1. FIG. 1 is a diagram showing the configuration of the automatic winder 1. The automatic winder 1 includes a plurality of winding units 10 (an example of a yarn winding machine) arranged side by side. Each of the winding units 10 unwinds a yarn 14 from a yarn supplying bobbin 16 and forms a package 22 while traversing the yarn 14. The configuration and operation of the winding unit 10 will be explained later.

[0012] The automatic winder 1 includes a main control device 12. The main control device 12 is capable of communicating with each of the winding units 10. An operator of the automatic winder 1 can collectively manage the winding units 10 by appropriately operating the main control device 12. A display section 12a and an input interface 12b are arranged in the main control device 12. The display section 12a displays information about setting contents and / or a state of the winding unit 10 and the like. By performing appropriate operations by using the input interface 12b, the operator can perform settings operation for the winding unit 10.

[0013] The display section 12a is, for example, a display device such as a liquid crystal display (LCD). The input interface 12b is an input device such as one or more physical input keys and / or a touch panel. However, the display section 12a and the touch panel, which functions as the input interface 12b, can be integrally arranged as one unit.

[0014] The automatic winder 1 includes a doffing device 13. When the package 22 is fully wound (a state where a predetermined amount of the yarn 14 is wound) in a certain winding unit 10, the doffing device 13 moves to a position of this winding unit 10, removes the fully wound package 22, and sets an empty winding bobbin in its place.

(2) Configuration of Winding Unit

[0015] A configuration of the winding unit 10 according to the first embodiment will be explained in detail below with reference to FIG. 2. FIG. 2 is a diagram showing the configuration of the winding unit 10 according to the first embodiment. The winding unit 10 according to the first embodiment is a traversing drum-type winding unit. The winding unit 10 includes in a lower part thereof a yarn supplying section 15. The yarn supplying section 15 supplies to a later-explained yarn winding section 17 the yarn 14 to produce the package 22. Specifically, the yarn supplying section 15 is a conveying tray-type supplying mechanism that supports the yarn supplying bobbin 16

set on a not-shown conveying tray at a predetermined position and supplies the yarn supplying bobbin 16 to the predetermined position. The yarn supplying section 15 is, however, not limited to the conveying tray-type supplying mechanism and can be, for example, a magazine type supplying mechanism.

[0016] The yarn winding section 17 pulls the yarn 14 from the yarn supplying bobbin 16 supported in the yarn supplying section 15. The yarn winding section 17 winds the pulled yarn 14 to form the package 22.

[0017] The winding unit 10 includes in an upper part thereof the yarn winding section 17. The yarn winding section 17 mainly includes a cradle 18 and a winding drum 20. The cradle 18 holds the package 22 from both ends in a length direction between a not-shown pair of rotation supporting members to rotatably support the package 22 around a predetermined axis. The cradle 18 includes a lift-up mechanism 50 (see FIG. 3) that can switch states between a contact state in which the supported package 22 is in contact with the winding drum 20 and a separated state in which the package 22 is separated from the winding drum 20. The lift-up mechanism 50 will be explained in detail later.

[0018] The winding drum 20 (an example of a contact roller) is a cylindrical member that is driven rotationally around an axis by a drum driving motor 21. By rotationally driving the winding drum 20 while the winding drum 20 is in contact with an outer periphery of the package 22, a driving force is applied to the package 22 and the package 22 is rotated following the rotation of the winding drum 20.

[0019] Moreover, a spiral traversing groove (traversing mechanism) is formed on a peripheral surface of the winding drum 20. While the winding drum 20 is being driven rotationally, when the package 22 is rotating following the rotation of the winding drum 20, the yarn 14 unwound from the yarn supplying bobbin 16 is traversed for a certain width on a surface of the package 22 by the traversing groove. Accordingly, the yarn 14 unwound from the yarn supplying bobbin 16 is wound while being traversed on the surface of the package 22. As a result, the package 22 of a certain width is formed.

[0020] The winding unit 10 includes an unwinding assisting device 25 immediately next to (above) the yarn supplying section 15 on a yarn traveling path that travels from the yarn supplying section 15 to the yarn winding section 17. The unwinding assisting device 25 includes a regulating member 26 that can cover a core tube of the yarn supplying bobbin 16. The regulating member 26 is substantially cylindrical in shape and is arranged so as to touch a balloon formed in a yarn layer upper part of the yarn supplying bobbin 16. The balloon is the part of the yarn 14, which is unwound from the yarn supplying bobbin 16, that swings around because of the centrifugal force. By causing the regulating member 26 to touch the balloon, the regulating member 26 touches the balloon part of the yarn 14, and prevents the yarn 14 from swinging around excessively. Accordingly, the yarn 14 can be

appropriately unwound from the yarn supplying bobbin 16.

[0021] The winding unit 10 includes a tension applying device 27 immediately next to (above) the unwinding assisting device 25 on the yarn traveling path. The tension applying device 27 applies a predetermined tension on the traveling yarn 14. For example, the tension applying device 27 can be a gate-type member having movable comb teeth and fixed comb teeth. The movable comb teeth are biased so as to engage with the fixed comb teeth. By passing the yarn 14 in a meandering state between the movable comb teeth and the fixed comb teeth that are in the engaged state, an appropriate tension can be applied to the yarn 14, and the quality of the package 22 can be improved.

[0022] The winding unit 10 includes a yarn joining device 38 immediately next to (above) the tension applying device 27 on the yarn traveling path. When the yarn 14 breaks between the yarn supplying section 15 and the yarn winding section 17 due to some reason, the yarn joining device 38 joins an end of the yarn 14 (yarn end) from the yarn supplying section 15 and a yarn end from the yarn winding section 17 (package 22). The yarn joining device 38 is, for example, a splicer device that twists together the yarn ends by using a swirling air current generated by compressed air.

[0023] The winding unit 10 includes a yarn monitoring device 40 immediately next to (above) the yarn joining device 38 on the yarn traveling path. The yarn monitoring device 40 monitors a state of the yarn 14 traveling on a yarn path and detects the presence / absence of a yarn defect based on information obtained in the monitoring. The yarn monitoring device 40 detects, as the yarn defect, for example, a thickness abnormality of the yarn 14 and / or a foreign substance contained in the yarn 14.

[0024] The yarn monitoring device 40 also detects a yarn breakage, that is, the presence / absence of the yarn 14 in the yarn traveling path and the like. Specifically, the yarn monitoring device 40 has a slit for passing the yarn 14 traveling on the yarn traveling path of the yarn 14, and monitors the yarn 14 passing through the slit with a not-shown optical sensor. Upon detecting that the light amount detected by the optical sensor is normal and within a predetermined range, the yarn monitoring device 40 outputs to a unit controlling section 100 a yarn presence signal. On the other hand, upon detecting that the light amount detected by the optical sensor is excessive than the predetermined range (the yarn 14 is too thin or yarn breakage has occurred) or less than the predetermined range (the yarn 14 is too thick), the yarn monitoring device 40 outputs to the unit controlling section 100 a yarn defect detection signal.

[0025] A cutter 41 that cuts the yarn 14 is arranged near the yarn monitoring device 40. The cutter 41 is operated by the yarn monitoring device 40.

[0026] The winding unit 10 includes above the yarn monitoring device 40 on the yarn traveling path a first catching / guiding device 30 (an example of a yarn catch-

ing / guiding device). When the yarn 14 breaks, the first catching / guiding device 30 catches the yarn end from the yarn winding section 17 by the action of the negative pressure suction. The first catching / guiding device 30 includes a shaft 31, a pipe member (tube member) 32, and a sucking / catching member 33. The pipe member 32 and the sucking / catching member 33 are pivotable (movable) about the shaft 31 as a center from a standby position (solid line in FIG. 2) on the yarn supplying section 15 side to a catching position (broken line in FIG. 2) on the yarn winding section 17 side.

[0027] Moreover, a negative pressure source 19 is connected to the first catching / guiding device 30 from the shaft 31 side of the pipe member 32, and a suction current can be generated in the sucking / catching member 33 (specifically, a suction port arranged at the tip end) by the action of negative pressure. As the negative pressure source 19, a system that includes a duct 191 that extends in an installation direction of the winding units 10 on the back side of the winding units 10 and one end thereof is connected to the shaft 31, and a negative pressure generating device 193 that is connected to the other end of the duct 191 and sets the duct 191 to a predetermined pressure (a negative pressure that is lower than the atmospheric pressure). The negative pressure generating device 193 is, for example, a blower device, and the duct 191 is set to a negative pressure of 3.0 kilopascal (kPa).

[0028] In the present embodiment, the negative pressure of the duct 191 is set lower than that set in the conventional yarn winding machines. Accordingly, it is possible to improve the energy efficiency of the winding unit 10 (negative pressure generating device 193). On the other hand, as explained later, when the first catching / guiding device 30 fails to catch the yarn end by the action of only the negative pressure suction, by causing the package 22 to rotate in a winding direction of the yarn 14 at a second rotational speed V2 and causing the yarn end to separate from the package 22, the first catching / guiding device 30 can reliably catch the yarn end. In other words, causing the package 22 to rotate in the winding direction at the second rotational speed V2 to cause the yarn end to separate from the package 22 constitutes compensating the decrease in the yarn end sucking and catching performance of the first catching / guiding device 30 according to the decrease in the negative pressure.

[0029] Accordingly, in the winding unit 10 according to the present embodiment, because the negative pressure generated by the negative pressure generating device 193 can be lowered at any desired time, the power consumption of the negative pressure generating device 193 can be lowered. As a result, the energy efficiency of the winding unit 10 (automatic winder 1) can be improved.

[0030] With the configuration explained above, in the catching position, the first catching / guiding device 30 can suck the yarn end from the yarn winding section 17 inside the pipe member 32 by the action of the suction current generated in the sucking / catching member 33

to catch the yarn end. Moreover, by returning to the standby position, the first catching / guiding device 30 can guide the caught yarn end to the yarn joining device 38.

[0031] In the present embodiment, the first catching / guiding device 30 includes a not-shown shutter arranged at a connecting portion between the pipe member 32 and the duct 191. The shutter opens / closes a gas flowing path that travels from the pipe member 32 to the duct 191. Specifically, when the shutter closes the gas flowing path, the suction current cannot be generated in the sucking / catching member 33. On the other hand, when the shutter opens the gas flowing path, the suction current is generated in the sucking / catching member 33.

[0032] Moreover, the winding unit 10 includes between the tension applying device 27 and the yarn joining device 38 a second catching / guiding device 34. Similar to the first catching / guiding device 30, the second catching / guiding device 34 includes a shaft 35, a pipe member 36, and a sucking / catching member 37. Similar to the sucking / catching member 33 of the first catching / guiding device 30, the sucking / catching member 37 is pivotable about the shaft 35 as a center and is capable of generating a suction current by the negative pressure suction. With this configuration, the second catching / guiding device 34 can catch the yarn end from the yarn supplying section 15 by the action of the suction current and guide the yarn end to the yarn joining device 38.

[0033] However, similar to the first catching / guiding device 30, to control whether to generate the suction current explained above, the second catching / guiding device 34 can include, for example, a shutter arranged at a connecting portion between the pipe member 36 and the duct 191.

[0034] The winding unit 10 includes the unit controlling section 100 (an example of a controlling section). The unit controlling section 100 is, for example, a computer system that includes a CPU, a storing device such as a ROM and / or a RAM, and various interfaces. The unit controlling section 100 controls the winding unit 10. However, the control of the winding unit 10 that includes various controls explained below can be realized by executing a computer program, which is stored in the storing device of the unit controlling section 100, by the unit controlling section 100 (CPU thereof). Alternatively, the unit controlling section 100 can be configured as a custom IC such as an SoC (System on Chip), and a part or the entire control of the winding unit 10 that includes the various controls explained below can be realized by using hardware.

[0035] Specifically, the unit controlling section 100 transmits a drive signal to a drum-driving controlling section 21a to control rotational driving of the drum driving motor 21. Accordingly, by controlling the rotation of the winding drum 20 via the unit controlling section 100, the winding unit 10 can form the package 22 of a certain winding width by winding the yarn 14 onto the package 22 while traversing the yarn 14.

[0036] Furthermore, the unit controlling section 100

can adjust a rotational speed of the winding drum 20 so that a winding speed of the yarn 14 wound onto the package 22 stays constant. However, to rotate the package 22 at a desired speed, the rotational speed of the winding drum 20 can be adjusted according to the current diameter of the package 22.

[0037] When no more yarn presence signal is received from the yarn monitoring device 40, the unit controlling section 100 causes the first catching / guiding device 30 to catch the yarn end from the yarn winding section 17 and guide the caught yarn end to the yarn joining device 38. On the other hand, the unit controlling section 100 causes the second catching / guiding device 34 to catch the yarn end from the yarn supplying section 15 and guide the caught yarn to the yarn joining device 38. Then, the unit controlling section 100 instructs the yarn joining device 38 to join the guided yarns (splicing operation). Accordingly, the yarn ends are joined and the breakage of the yarn 14 is repaired.

[0038] As explained above, even when the yarn 14 supplied from the yarn supplying bobbin 16 breaks while producing (forming) the package 22, the winding unit 10 can perform the yarn joining operation to join the yarn ends to repair the yarn breakage, and the production of the package 22 can be continued.

[0039] Furthermore, in the present embodiment, at the time of performing the yarn joining operation explained above, if catching of the yarn end from the package 22 fails, the unit controlling section 100 causes the winding drum 20 to rotate in the same direction as a winding direction of the yarn 14 (winding rotation). In other words, the package 22 supported in the yarn winding section 17 is rotated in the winding direction at a rotational speed at which the yarn can be wound onto the package 22 at a speed of 1000 meters/minute (m/min) or more (referred to as the second rotational speed V2).

[0040] Accordingly, when the yarn end from the package 22 could not be caught by the action of the suction current generated in the sucking / catching member 33 of the first catching / guiding device 30 (that is, when the yarn end from the package 22 could not be caught in the normal yarn catching operation), by reliably separating the yarn end from the package 22 from the package 22 by the centrifugal force, the success probability of the yarn end catching performed by the first catching / guiding device 30 in which a weak suction force (negative pressure) is used can be improved.

[0041] Detailed operation of the winding unit 10 according to the present embodiment will be explained in detail later.

(3) Lift-up Mechanism

[0042] Next, a configuration of the lift-up mechanism capable of switching between the contact state and the separated state of the outer periphery of the package 22 with respect to the winding drum 20 will be explained with reference to FIGS. 3 and 4. FIG. 3 is a diagram

showing a configuration of the cradle 18 that includes the lift-up mechanism 50. FIG. 4 is a diagram showing the contact state and the separated state of the package 22 with respect to the winding drum 20. However, the lift-up mechanism 50 explained below is just an example, and can have other configuration that causes the cradle 18 to move.

[0043] The lift-up mechanism 50 includes a rotating plate 501, a spring 502, and an air cylinder 503. The rotating plate 501 is arranged rotatably around a pivoting shaft 501a in the main body of the winding unit 10. A tip portion of the rotating plate 501 is pivotably supported by the cradle 18, and when the rotating plate 501 pivots around the pivoting shaft 501a, the cradle 18 pivots following the pivoting action.

[0044] The spring 502 is a tension spring in which one end thereof is fixed to the rotating plate 501, and the other end is attached to the main body of the winding unit 10. The spring 502 applies a predetermined rotation torque to the cradle 18 along with the later-explained air cylinder 503.

[0045] The air cylinder 503 internally includes a piston 503a. In FIG. 3, a compressed air of an air pressure P2 can be supplied to a cylinder chamber located on the left side of the piston 503a (a side away from the rotating plate 501). Moreover, the air cylinder 503 includes a shaft 503b in which one end thereof is fixed to the piston 503a and the other end thereof is pivotably supported by the rotating plate 501.

[0046] A solenoid valve 503c is connected to a pipe arranged to supply to the air cylinder 503 the compressed air of the air pressure P2. The compressed air of the air pressure P2 can be supplied to the air cylinder 503 by the action of the solenoid valve 503c. Open / close control of the solenoid valve 503c is performed based on a control signal received from the unit controlling section 100. Particularly, the control signal of the solenoid valve 503c to move the package 22 to a separated position Q1 is referred to as "lift-up signal".

[0047] The compressed air of the air pressure P2 supplied from the solenoid valve 503c is also supplied to a not-shown package brake. The package brake is a mechanism that uses the compressed air of the air pressure P2 to apply resistance to one of the pair of the rotation supporting members that support the package 22 and stops the rotation of the rotation supporting members. In other words, when the solenoid valve 503c is open and the compressed air of the air pressure P2 is supplied, the lift-up mechanism 50 causes the cradle 18 to move, and at the same time, rotation of the package 22 is stopped by the package brake.

[0048] Moreover, by detaching the air cylinder 503 from the solenoid valve 503c and connecting it to a separate valve capable of adjusting the air pressure, for example, a separate solenoid valve, a contact pressure between the package 22 and the winding drum 20 can be adjusted.

[0049] Based on the configuration explained above,

the lift-up mechanism 50 can move the package 22 by causing the cradle 18 to move. Accordingly, as shown in FIG. 4, the position of the package 22 can be switched between a position in which the package 22 is separated from the winding drum 20 (separated position Q1) and a position in which the package 22 is in contact with the winding drum 20 (contact position Q2).

(4) Package Forming Operation according to First Embodiment

(4-1) Outline of Package Forming Operation

[0050] Next, operation performed in the winding unit 10 according to the first embodiment to form the package 22 will be explained below with reference to FIGS. 5 and 6. FIG. 5 is a flowchart for explaining a forming operation of the package 22. FIG. 6 is a timing chart for explaining operations of various structural components of the winding unit 10 in the forming operation of the package 22 according to the first embodiment. First, an outline of the forming operation of the package 22 in the winding unit 10 according to the first embodiment will be explained below with reference to FIG. 5. When the forming of the package 22 starts in the winding unit 10, in a state in which an outer periphery of the winding drum 20 is in contact with the outer periphery of the package 22, the unit controlling section 100 outputs to the drum-driving controlling section 21a the drive signal to rotate the package 22 in the winding direction of the yarn 14 at a first rotational speed V1 (winding rotation).

[0051] Accordingly, the yarn 14 supplied from the yarn supplying section 15 is wound onto the package 22 while being traversed by the winding drum 20. Note that, to wind the yarn 14 onto the package 22 at a constant winding speed, the first rotational speed V1 explained above and the rotational speed of the winding drum 20 are adjusted according to the current diameter of the package 22.

[0052] At the time of winding the yarn 14 onto the package 22, the unit controlling section 100 determines whether the breakage of the yarn 14 has occurred on the yarn traveling path that travels from the yarn supplying section 15 to the yarn winding section 17 (Step S1). In the present embodiment, the unit controlling section 100 determines whether the yarn breakage has occurred based on whether the yarn presence signal is received from the yarn monitoring device 40.

[0053] When the yarn presence signal is received from the yarn monitoring device 40 and it is determined that the yarn breakage has not occurred ("No" at Step S1), the unit controlling section 100 continues the winding rotation of the package 22 at the first rotational speed V1. In other words, the forming of the package 22 continues (Step S6).

[0054] On the other hand, when the yarn presence signal is not received from the yarn monitoring device 40 and it is determined that the yarn breakage has occurred

("Yes" at Step S1), the unit controlling section 100 performs catching of the yarn end from the yarn winding section 17 (package 22) by using the first catching / guiding device 30 (Step S2).

[0055] Once the yarn end catching is performed at Step S2, the unit controlling section 100 determines whether the yarn end from the yarn winding section 17 (package 22) is successfully caught by the first catching / guiding device 30 (Step S3). Specifically, after the yarn end catching is performed at Step S2, the unit controlling section 100 determines whether the yarn end is successfully caught based on whether the yarn presence signal is received from the yarn monitoring device 40.

[0056] When the yarn presence signal is not received from the yarn monitoring device 40 and it is determined that the first catching / guiding device 30 has failed to catch the yarn end ("No" at Step S3), the unit controlling section 100 outputs to the drum-driving controlling section 21a the drive signal to rotate the package 22 in the winding direction at the second rotational speed V2 (Step S4). Therefore, by rotating the package 22 at the second rotational speed V2 that is faster, when the yarn end could not be separated from the package 22 by the suction of the sucking / catching member 33, the yarn end can be separated from the surface of the package 22 by the centrifugal force acting on the yarn end from the package 22.

[0057] After performing the process at Step S4 explained above, the control of the forming operation of the package 22 returns to the process at Step S2. In other words, after the yarn end is separated from the surface of the package 22 by rotating the package 22 at the second rotational speed V2, the catching of the yarn end by the sucking / catching member 33 of the first catching / guiding device 30 is performed again.

[0058] When the yarn presence signal is received after the yarn end catching explained above is performed ("Yes" at Step S3), the unit controlling section 100 instructs the yarn joining device 38 to join the yarn end caught by the first catching / guiding device 30 and the yarn end from the yarn supplying section 15 caught by the second catching / guiding device 34 (Step S5). After performing the yarn joining explained above, the unit controlling section 100 outputs to the drum-driving controlling section 21a the drive signal to rotate the package 22 in the winding direction at the first rotational speed V1. Accordingly, the winding of the yarn 14 onto the package 22 is resumed (Step S6).

[0059] Then, for example, unless any other error that requires stopping of the winding of the yarn 14 in the winding unit 10 occurs, or unless a user instructs stopping of the winding unit 10 ("No" at Step S7), the processes at Steps S1 to S6 are repeatedly performed. In the present embodiment, when the yarn end catching explained above fails for the number of attempts set beforehand by the user (for example, three attempts), the winding unit 10 stops with sounding an alarm.

[0060] In this manner, when the catching of the yarn end from the yarn winding section 17 (package 22) per-

formed based on the common method fails, by rotating the package 22 at the second rotational speed V2 at which the yarn can be wound onto the package 22 at a speed of 800 m/min or more, the yarn end can be reliably separated from the package 22 by the centrifugal force and the yarn end from the package 22 can be reliably caught by the sucking / catching member 33 even when the suction force of the sucking / catching member 33 is weak. As a result, operation efficiency of the winding unit 10 can be improved.

[0061] On the other hand, as shown in FIG. 5, when the yarn end from the yarn winding section 17 is successfully caught by performing the process at Step S2 only once after detecting the yarn breakage, in other words, when the yarn end from the yarn winding section 17 is caught only by the suction of the sucking / catching member 33, the unit controlling section 100 causes the yarn joining device 38 to perform the yarn joining without outputting the drive signal to rotate the package 22 at the second rotational speed V2 (without performing the process at Step S4).

[0062] In this manner, when the yarn end from the yarn winding section 17 (package 22) could be caught by only using the ordinary method, the yarn end catching can be completed in a minimum required time without performing any additional operation such as rotating the package 22 in the winding direction at high speed. As a result, stopping of the winding operation of the yarn 14 in the winding unit 10 for a long time every time the yarn breakage occurs can be avoided, and the operation efficiency of the winding unit 10 can be improved.

(4-2) Detailed Explanation of Package Forming Operation

[0063] The forming operation of the package 22 according to the present embodiment is explained below in further detail with reference to the timing chart shown in FIG. 6. An example in which the reception of the yarn presence signal is stopped at a time point t1 (FIG. 6) during the forming of the package 22 is explained below. At a time point t2 that is a time point after a predetermined time period has elapsed from the time point t1 at which the reception of the yarn presence signal is stopped (from the time point when the yarn presence signal changes from "On" to "Off"), the unit controlling section 100 stops the output of the drive signal to rotate the package 22 in the winding direction (drum winding rotation signal) to the drum-driving controlling section 21a. Accordingly, the driving of the winding drum 20 by the drum driving motor 21 is stopped.

[0064] At the time point t2 at which the output of the drive signal for the drum driving motor 21 is stopped, the unit controlling section 100 outputs to the solenoid valve 503c the lift-up signal. Accordingly, the package 22 moves to the separated position Q1, thereby releasing the contact state in which the outer periphery of the package 22 is in contact with the outer periphery of the winding

drum 20. At the same time, the package brake is operated. As a result, from the time point t2 onwards, the driven rotation of the package 22 is stopped.

[0065] Next, at a time point t3 at which the output of the lift-up signal is stopped, the unit controlling section 100 outputs to the first catching / guiding device 30 the drive signal to move the sucking / catching member 33 of the first catching / guiding device 30 to the catching position on the yarn winding section 17 side (first catching / guiding device drive signal). At the same time, the unit controlling section 100 outputs to the first catching / guiding device 30 a signal to open the shutter of the first catching / guiding device 30 (shutter opening signal of the first catching / guiding device 30). Accordingly, the first catching / guiding device 30 is set to a state in which the sucking / catching member 33 can suck and catch the yarn end from the yarn winding section 17.

[0066] Furthermore, when outputting the first catching / guiding drive signal and the shutter opening signal of the first catching / guiding device 30, the unit controlling section 100 also outputs to the drum-driving controlling section 21a a drive signal to rotate the package 22 in a direction opposite to that of the winding rotation (drum reverse rotation signal). The drum reverse rotation signal is a signal that is polar opposite to the drum winding rotation signal and / or is a signal in which the direction in which the phase advances is opposite to that of the drum winding rotation signal.

[0067] When the sucking / catching member 33 positioned at the catching position is generating the suction current, sucking of the yarn end from the package 22 by the sucking / catching member 33 can be made easier by causing the package 22 to rotate in the direction opposite to the winding direction of the yarn 14. It is because the yarn end can be sent from the package 22 toward the direction of the sucking / catching member 33 (the direction same as that of the suction current) by causing the package 22 to rotate in the direction opposite to the winding direction of the yarn 14. As shown in FIG. 6, the sucking performed by the sucking / catching member 33 and feeding of the yarn end away from the package 22 explained above continues between the time point t3 and a time point t4.

[0068] Moreover, although not shown in the figure, at the same time as the time point t3 explained above, or in the time period between the time point t3 and the time point t4, the unit controlling section 100 causes the sucking / catching member 37 of the second catching / guiding device 34 to move till a catching position (solid line in FIG. 2) for the yarn end from the yarn supplying section 15 and generate the suction current therein. Accordingly, the yarn end from the yarn supplying section 15 can be caught in the sucking / catching member 37 of the second catching / guiding device 34.

[0069] At the time point t4 at which the yarn end catching performed by the first catching / guiding device 30 and the second catching / guiding device 34 are completed, the unit controlling section 100 stops the output

of the first catching / guiding device drive signal and the drum reverse rotation signal. Accordingly, the sucking / catching member 33 is moved to the standby position (a position in which the yarn end is guided to the yarn joining device 38) and the reverse rotation of the package 22 is stopped. Moreover, the unit controlling section 100 moves the second catching / guiding device 34 till a position in which the yarn end is guided to the yarn joining device 38 (broken line in FIG. 2).

[0070] In the timing chart shown in FIG. 6, the operation performed up to the time point t4 corresponds to the operation performed at Steps S1 and S2 of the flowchart shown in FIG. 5.

[0071] At the time point t4 at which the catching of the yarn end by the catching / guiding devices is completed and the sucking / catching member 33 is moved to the standby position, the unit controlling section 100 determines whether the yarn presence signal is received from the yarn monitoring device 40, and then determines whether the yarn end is successfully caught by the first catching / guiding device 30. As shown in FIG. 6, when the yarn presence signal is "Off" at the time point t4, the unit controlling section 100 determines that the yarn presence signal is not received, and then determines that the first catching / guiding device 30 has failed to catch the yarn end.

[0072] As shown in FIG. 6, even when the yarn presence signal is "Off" at the time point t4, the unit controlling section 100 outputs to the yarn joining device 38 a yarn joining performing signal that causes the yarn joining device 38 to perform the yarn joining. As a result, even when the sucking / catching member 33 of the first catching / guiding device 30 fails to catch the yarn end, a part of the yarn joining device 38 (in particular, a mechanical part) performs the yarn joining. However, because the yarn end from the yarn winding section 17 (package 22) is not guided to the yarn joining device 38, even when the yarn joining device 38 operates from the time point t4 onwards, at this stage, the yarn breakage does not get repaired, and the yarn presence signal does not change to "On" (the yarn presence signal is not received).

[0073] When the yarn presence signal is "Off" at the time point t4 and it is determined that the first catching / guiding device 30 has failed to catch the yarn end, the unit controlling section 100 stops the output of the shutter opening signal of the first catching / guiding device 30 after a predetermined time has elapsed from the time point t4.

[0074] At a time point t5 at which the output of the shutter opening signal is stopped, the unit controlling section 100 outputs to the drum-driving controlling section 21a the drum winding rotation signal that causes the package 22 to rotate at the second rotational speed V2. Such a drum winding rotation signal is, for example, a signal that causes the drum-driving controlling section 21a to output a driving power required to rotate the package 22 at the second rotational speed V2. Alternatively, the drum winding rotation signal explained above can be a signal that

causes the drum-driving controlling section 21a to output a driving voltage and / or current having a frequency that is closer to a frequency of the driving voltage and / or current that is output to the drum driving motor 21 when the package 22 is caused to rotate at the first rotational speed V1.

[0075] The drum-driving controlling section 21a, which received the drum winding rotation signal that rotates the package 22 at the second rotational speed V2, outputs the driving power that rotates the winding drum 20 at a rotational speed at which the yarn 14 can be wound onto the package 22 at a speed of 800 m/min or more. In other words, it is preferable that the second rotational speed V2 of the package 22 is a speed at which the yarn 14 can be wound at a speed of 800 m/min or more. The second rotational speed V2 can be changed by using the input interface 12b explained above. The second rotational speed V2 can be changed according to the type of the yarn, or according to the change in the diameter of the package 22 that is being wound. It is more preferable that the second rotational speed V2 is a speed at which the yarn 14 can be wound onto the package 22 at a speed of 1000 m/min or more, and it is most preferable that the second rotational speed V2 is a speed at which the yarn 14 can be wound onto the package 22 at a speed of 1300 m/min or more but less than 1500 m/min. In the present embodiment, the second rotational speed V2 is set to a speed at which the yarn 14 can be wound at a speed of 1400 m/min. Accordingly, the centrifugal force that is enough to separate the yarn end from the yarn winding section 17 (package 22) from the package 22 can be generated. As a result, the probability of the yarn end getting caught by the sucking / catching member 33 of the first catching / guiding device 30 can be increased.

[0076] Moreover, as a duration during which the package 22 is rotated in the winding direction at the second rotational speed V2, a duration of one to ten seconds is preferable, two to five seconds is more preferable, and three seconds is most preferable. Accordingly, the yarn end from the yarn winding section 17 can be caught reliably and the time required to perform the yarn end catching process that includes a process of rotating the package 22 at high speed can also be shortened as much as possible. A time required to accelerate the rotation of the package 22 and a time required to decelerate the rotation of the package 22 are included in the duration discussed above.

[0077] Furthermore, the unit controlling section 100 sets the acceleration performed at the time of rotating the package 22 in the winding direction at the second rotational speed V2 to larger value than the acceleration performed at the time of rotating the package 22 in the winding direction at the first rotational speed V1. Accordingly, the rotational speed of the package 22 can attain the second rotational speed V2 more quickly, and the yarn end catching process that includes the process of rotating the package 22 at high speed can be completed earlier.

[0078] In the present embodiment, to set the acceleration performed at the time of rotating the package 22 in the winding direction at the second rotational speed V2 to a larger value than the acceleration performed at the time of rotating the package 22 in the winding direction at the first rotational speed V1, the contact pressure between the outer periphery of the package 22 and the winding drum 20 when the package 22 is rotated in the winding direction at the second rotational speed V2 is set to a larger value than the contact pressure set when the package 22 is rotated in the winding direction at the first rotational speed V1. Accordingly, "slippage" between the outer peripheries of the package 22 and the winding drum 20 can be reduced, and the rotational speed of the package 22 can attain the second rotational speed V2 at a higher rotation acceleration. As a result, the yarn end catching process that includes the process of rotating the package 22 at high speed can be completed earlier.

[0079] At a time point t6 that is a time point after the package 22 is rotated at the second rotational speed V2 for only a predetermined time (a duration between one to ten seconds), the unit controlling section 100 stops the winding rotation of the package 22 at the second rotational speed V2. Specifically, the unit controlling section 100 outputs to the solenoid valve 503c the lift-up signal in the period between the time point t6 and a time point t7. Accordingly, in the period from the time point t6 to the time point t7, the package 22 is moved to the separated position Q1, the contact between the outer periphery of the package 22 and the winding drum 20 is released, and the brake is applied to the package 22. As a result, the winding rotation of the package 22 at the second rotational speed V2 is stopped.

[0080] By releasing the contact between the outer periphery of the package 22 and the winding drum 20 at the time of stopping the winding rotation of the package 22 at the second rotational speed V2, damage to the package 22 due to a friction that occurs between the package 22 and the winding drum 20 at the time of stopping the winding rotation of the package 22 at the second rotational speed V2 can be avoided. Specifically, simultaneously with applying the brake to stop the winding rotation of the package 22, the contact between the outer periphery of the package 22 and the winding drum 20 is released.

[0081] In the timing chart shown in FIG. 6, the operation performed from the time point t4 to the time point t7 corresponds to performing the operation at Step S4 after "No" is obtained as the determination result at Step S3 of the flowchart shown in FIG. 5.

[0082] As explained above, after the package 22 is rotated in the winding direction at the second rotational speed V2 and the centrifugal force is applied to the yarn end from the package 22 during the period from the time point t5 to the time point t6, the yarn end catching by the first catching / guiding device 30 explained earlier is performed again during the period from the time point t7 to a time point t8. In other words, during the period from the

time point t7 to the time point t8 shown in FIG. 6, the winding unit 10 operates in the same manner as that during the period from the time point t3 to the time point t4.

[0083] Note that, till the time point t8, the second catching / guiding device 34 waits at a position in which the yarn end is guided to the yarn joining device 38 in a state in which the second catching / guiding device 34 holds the yarn end from the yarn supplying section 15 caught in the yarn end catching operation performed during the period from the time point t3 to the time point t4 (when the first catching / guiding device 30 fails to catch the yarn end).

[0084] At the time point t8 till which a second attempt to catch the yarn end performed by the first catching / guiding device 30 is successfully completed and the sucking / catching member 33 is moved to the standby position, the unit controlling section 100 determines whether the yarn presence signal is received from the yarn monitoring device 40. As shown in FIG. 6, because the yarn presence signal is "On" at the time point t8, the unit controlling section 100 determines that the yarn presence signal is received, and then determines that the first catching / guiding device 30 has successfully caught the yarn end.

[0085] The unit controlling section 100 that receives the yarn presence signal outputs, at the time point t8, the yarn joining performing signal to the yarn joining device 38. The yarn joining device 38 that receives the yarn joining performing signal joins the two yarn ends (the yarn end from the yarn supplying section 15 and the yarn end from the yarn winding section 17 (package 22)) guided to the yarn joining device 38, and repairs the yarn breakage that had occurred at the time point t1.

[0086] At a time point t9 till which the yarn joining (repairing of the yarn breakage) is completed by the yarn joining device 38, and the package 22 is moved to the contact position Q2, the unit controlling section 100 outputs to the drum-driving controlling section 21a the drive signal to cause the package 22 to rotate in the winding direction at the first rotational speed V1. Accordingly, from the time point t9 onwards, the winding operation in which the yarn 14 is wound onto the package 22 (the forming operation of the package 22) is performed again.

[0087] Furthermore, as shown in FIG. 6, at a time point t10 after the time point t9 at which the formation of the package 22 is resumed, the output of the shutter opening signal of the first catching / guiding device 30 is stopped. In other words, even if the formation of the package 22 is resumed after the yarn breakage is repaired, for a while, the joined yarn 14 remains caught by the first catching / guiding device 30.

[0088] In the timing chart shown in FIG. 6, the operation performed from the time point t7 to the time point t8 corresponds to performing the process at Step S2 again after performing the process at Step S4 of the flowchart shown in FIG. 5. Moreover, the operation performed from the time point t8 and onwards corresponds to performing the processes at Steps S5 and S6 after the process of

Step S2 is performed again and the determination result obtained at Step S3 changes to "Yes" in the flowchart shown in FIG. 5.

[0089] In the present embodiment, as shown in FIG. 6, after the yarn breakage occurs, the yarn end catching is attempted only by the suction of the sucking / catching member 33 of the first catching / guiding device 30. As a result, as shown in FIG. 6, when the sucking / catching member 33 successfully catches the yarn end by the suction in the second attempt, the process of rotating the package 22 at high speed is performed only once.

[0090] In this manner, in the present embodiment, the time taken till the resuming of the formation of the package 22 after the yarn breakage occurs can be shortened compared to the conventional configuration in which the package 22 is unconditionally rotated at high speed before the yarn end is caught by the suction.

[0091] Moreover, if the yarn end from the yarn winding section 17 is caught in the first attempt, the process of rotating the package 22 at high speed is omitted. In this manner, when the yarn end from the yarn winding section 17 is caught in the first attempt, a quicker yarn joining operation can be performed by not performing an additional operation of rotating the package 22 at the second rotational speed V2. As a result, stopping of the winding operation of the yarn 14 in the winding unit 10 for a long time each time the yarn breakage occurs can be avoided, and the operation efficiency of the winding unit 10 can be improved.

[0092] FIG. 7 shows a comparison result of yarn end catching failure probability and the power consumption of the winding unit 10 (automatic winder 1) according to the first embodiment (referred to as "present embodiment" in FIG. 7), the yarn end catching failure probability and the power consumption when the negative pressure in the duct is same as that in the conventional configuration (referred to as "Comparative Example 1" in FIG. 7), and the yarn end catching failure probability and the power consumption when the negative pressure in the duct is lowered (substantially the same as in that of the present embodiment) but the package is not rotated at the second rotational speed discussed above (referred to as "Comparative Example 2" in FIG. 7). In FIG. 7, bar graphs indicate the yarn end catching failure probability (left scale) and a solid line indicates the power consumption (right scale).

[0093] As shown in FIG. 7, in the winding unit 10 according to the present embodiment, the yarn end catching failure probability of the first catching / guiding device 30 is as low as that when the negative pressure in the duct 191 is set to a large value, and the power consumption is as low as that when the negative pressure in the duct 191 is set to low (about 15% lower than the power consumed when the negative pressure is set to a large value). In other words, in the winding unit 10 explained above, the yarn end from the package 22 can be reliably caught and the energy efficiency of the winding unit 10 (automatic winder 1) can be improved. Note that, the

magnitude of the negative pressure discussed above is the result of comparing magnitudes of the absolute values.

2. Second Embodiment

(1) Outline of Winding Unit according to Second Embodiment

[0094] In the winding unit 10 according to the first embodiment, whether the first catching / guiding device 30 has successfully caught the yarn end from the yarn winding section 17 (package 22) is determined based on whether the yarn presence signal is received after the sucking / catching member 33 of the first catching / guiding device 30 moves to the standby position. However, the present invention is not limited to such configuration, and whether the yarn end is successfully caught can be determined by using another sensor capable of detecting the presence / absence of the yarn (yarn end). A winding unit 10' according to a second embodiment includes a sensor (upper yarn sensor 60 (an example of a detecting unit)) that detects whether a yarn (yarn end) is present inside the first catching / guiding device 30 (inside the pipe member 32). In the second embodiment, whether the first catching / guiding device 30 has successfully caught the yarn end is determined based on whether the yarn end is detected by the upper yarn sensor 60.

[0095] Apart from including the upper yarn sensor 60 and determining whether the first catching / guiding device 30 has successfully caught the yarn end based on the output from the upper yarn sensor 60, the winding unit 10' according to the second embodiment has substantially the same configuration and functions as that of the winding unit 10 according to the first embodiment. Therefore, only the configuration of the upper yarn sensor 60 and the method of determining whether the yarn end is successfully caught by the first catching / guiding device 30 based on the output from the upper yarn sensor 60 will be explained below, and explanation of remaining configurations and operations of the winding unit 10' is omitted.

(2) Configuration of Upper Yarn Sensor

[0096] The configuration of the upper yarn sensor 60 will be explained below with reference to FIGS. 8 to 10. FIG. 8 is a diagram showing the configuration of the upper yarn sensor 60. FIG. 9 is a diagram showing a configuration of a transparent cover. FIG. 10 is a cross-sectional view of the pipe member 32. As shown in FIG. 8, the upper yarn sensor 60 includes a case 601, a light emitting section 602, and a light receiving section 603.

[0097] The case 601 is supported by a supporting member 604 in the yarn winding section 17. The case 601 supports the light emitting section 602 and the light receiving section 603. The light emitting section 602 is constituted by a light emitting element such as a light

emitting diode. The light emitting section 602 emits light on a transparent cover 605 (see FIG. 9) arranged on a side of the pipe member 32 that is facing the light emitting section 602 and the light receiving section 603. When the yarn 14 (yarn end) is present inside the pipe member 32, the light emitted by the light emitting section 602 is reflected from the yarn 14 (yarn end).

[0098] The light receiving section 603 is constituted by a light receiving element such as a photodiode. The light receiving section 603 receives the light reflected from the yarn 14 (yarn end) and outputs an electrical signal in the form of electric current or electric voltage according to the received light amount. A not-shown arithmetic section is provided inside the case 601. The arithmetic section is, for example, a system or a circuit configured in a custom IC such as an SoC, and determines based on a detection result of the light receiving section 603 whether the yarn 14 (yarn end) from the yarn winding section 17 is successfully caught by the first catching / guiding device 30. Specifically, the arithmetic section analyzes the electrical signal output from the light receiving section 603 and determines the presence / absence of the yarn 14 (yarn end) inside the pipe member 32.

[0099] The arithmetic section outputs to the unit controlling section 100, as a yarn catching signal, a detection signal that indicates the determination result (detection result) of the presence / absence of the yarn 14 inside the pipe member 32. Specifically, when it is determined that the yarn 14 (yarn end) is present inside the pipe member 32, the arithmetic section outputs the yarn catching signal. On the other hand, if it is determined that the yarn 14 (yarn end) is not present inside the pipe member 32, the arithmetic section does not output the yarn catching signal.

[0100] As explained above, as shown in FIG. 9, the pipe member 32 is provided with the transparent cover 605. The transparent cover 605 is formed by a transparent member (for example, acryl, polycarbonate, and the like). The transparent cover 605 is a member that closes an opening O arranged on the pipe member 32. The opening O is a hole that passes through a wall of the pipe member 32 and is arranged on a tip end part side (sucking / catching member 33 side) of the pipe member 32. In other words, the upper yarn sensor 60 detects the yarn 14 (yarn end) positioned on the tip end part side of the pipe member 32. The transparent cover 605 is pivotably arranged on the pipe member 32 and is capable of opening / closing the opening O.

[0101] As shown in FIG. 10, the light emitting section 602 and the light receiving section 603 of the upper yarn sensor 60 are arranged on one side of a center (virtual line L1 in FIG. 10) of a package width direction of the pipe member 32. Specifically, the light emitting section 602 and the light receiving section 603 are arranged such that an optical axis line L2 that indicates an optical axis of the light emitted from the light emitting section 602 does not intersect a center C of the pipe member 32.

[0102] By configuring the upper yarn sensor 60 to in-

clude the configuration explained above, it can be reliably detected that the first catching / guiding device 30 has caught the yarn end in the winding unit 10' according to the second embodiment.

(3) Package Forming Operation according to Second Embodiment

[0103] A forming operation of the package 22 in the winding unit 10' that includes the upper yarn sensor 60 according to the second embodiment 60 will be explained below with reference to FIG. 11. FIG. 11 is a timing chart for explaining operations of various parts of the winding unit 10' performed during the package forming operation according to the second embodiment. Similar to the explanation of the first embodiment, a situation in which the yarn presence signal could not be detected and the yarn breakage is detected at the time point t1 is explained as an example.

[0104] After the yarn breakage is detected at the time point t1, similar to the first embodiment, at the time point t3, the first catching / guiding device 30 and the second catching / guiding device 34 start the yarn end catching operation (a first attempt of the yarn end catching). At the time point t4 till which a predetermined time period from the time point t3 has elapsed as the duration of the first attempt of the yarn end catching, the unit controlling section 100 determines whether the yarn catching signal is received from the arithmetic section of the upper yarn sensor 60. As shown in FIG. 11, when the yarn catching signal is not received at the time point t4, the unit controlling section 100 determines that the first catching / guiding device 30 has failed to catch the yarn end.

[0105] Subsequently, similar to the first embodiment, the unit controlling section 100 causes the package 22 to rotate at the second rotational speed V2 for a predetermined duration (for example, within the range of one to ten seconds).

[0106] In the second embodiment, while the package 22 rotates in the winding direction at the second rotational speed V2, the unit controlling section 100 holds the sucking / catching member 33 of the first catching / guiding device 30 in the catching position. Moreover, the unit controlling section 100 continues to output the shutter opening signal of the first catching / guiding device 30, and generates the suction flow in the sucking / catching member 33. In other words, even when the package 22 is rotating at the second rotational speed V2, the first catching / guiding device 30 is capable of catching the yarn end from the yarn winding section 17 (package 22).

[0107] From the time point t7 that is a time point after the package 22 is rotated in the winding direction at the second rotational speed V2 and onwards, while the sucking / catching member 33 is held in the catching position and the suction current is being generated in the sucking / catching member 33, the unit controlling section 100 monitors the input of the yarn catching signal. At the time point t7, the package 22 is caused to rotate in a direction

opposite to the winding direction of the yarn 14. For example, as shown in FIG. 11, when the input of the yarn catching signal is detected at a time point t8' during the monitoring of the input of the yarn catching signal, the unit controlling section 100 stops the reverse rotation of the package 22 and causes the sucking / catching member 33 to move to the standby position.

[0108] At a time point t9' after the sucking / catching member 33 has attained the standby position, the yarn presence signal is output and the yarn joining is performed by the yarn joining device 38. Similar to the first embodiment, the winding of the yarn 14 is resumed at a time point t10' after the yarn joining is completed.

[0109] As explained above, by using the upper yarn sensor 60 to detect whether the yarn end has been caught in the first catching / guiding device 30, the catching of the yarn end by the first catching / guiding device 30 can be reliably detected without moving the sucking / catching member 33 to the standby position to pass the yarn 14 through the yarn monitoring device 40.

[0110] Moreover, by using the upper yarn sensor 60 to detect whether the yarn end has been caught in the first catching / guiding device 30, the time required to catch the yarn end in the second and subsequent attempts can be shortened. For example, as shown in FIG. 11, if the second attempt to catch the yarn end is successfully completed in a shorter time than the time from the time point t3 to the time point t4 (the time required for the first attempt to catch the yarn end), the time point t8' discussed above is a time point earlier than the time point t8 of the first embodiment. Consequently, when the sucking / catching member 33 is moved to the standby position at the time point t8' that is earlier than the time point t8, the second attempt (and subsequent attempts) to catch the yarn end can be completed in a shorter time than that in the first embodiment (in the first embodiment, the time required to catch the yarn end in the second and subsequent attempts remains constant to the time equivalent to the period between the time point t3 and the time point t4 (the time required for catching the yarn end in the first attempt)).

[0111] Furthermore, the winding unit 10' according to the second embodiment that includes the upper yarn sensor 60 can operate according to the timing chart shown in FIG. 6 explained in the first embodiment. In other words, in the winding unit 10' according to the second embodiment, while the package 22 is being rotated in the winding direction at the second rotational speed V2, the sucking / catching member 33 can be caused to move to the standby position and / or the generation of the suction current in the sucking / catching member 33 can be stopped.

3. Third Embodiment

(1) Outline of Winding Unit according to Third Embodiment

[0112] The winding unit 10 according to the first embodiment and the winding unit 10' according to the second embodiment are capable of traversing the yarn 14 and winding the same onto the package 22 by rotating the winding drum 20 while the outer periphery of the winding drum 20 on which the traversing groove is arranged and the outer periphery of the package 22 are in contact with each other. However, the winding unit operations explained in the first and the second embodiments can also be applied to an arm traversing-type winding unit 10" according to a third embodiment shown in FIG. 11. Apart from a different configuration of a yarn winding section 17' than that of the yarn winding section 17 according to the first and the second embodiments, the winding unit 10" according to the third embodiment has the same configuration and functions as that of the winding units 10 and 10' of the first and the second embodiments, respectively. Therefore, the configuration of the yarn winding section 17' will be briefly explained below and the explanation of other configurations is omitted.

(2) Configuration of Yarn Winding Section

[0113] The configuration of the winding unit 10" according to the third embodiment will be explained below with reference to FIG. 12. FIG. 12 is a diagram showing the configuration of the winding unit 10" according to the third embodiment. In particular, the configuration of the yarn winding section 17' will be explained below. The yarn winding section 17' includes a cradle 18', a driven roller (contact roller) 20', and a traversing device 70'. The cradle 18' is a member that removably supports a package 22'. The cradle 18' is pivotable around a pivoting shaft A2. The cradle 18' rotates and absorbs an increase in the diameter of the yarn layer of the package 22' because of the winding of the yarn 14 on the package 22'.

[0114] A package driving motor 21' is attached to the cradle 18'. The package driving motor 21' rotationally drives the package 22' and winds the yarn 14 onto the package 22'. The operation of the package driving motor 21' is controlled by a package-driving controlling section 21a'. The package-driving controlling section 21a' receives an operation signal from the unit controlling section 100 and controls the operation and stopping of the package driving motor 21'.

[0115] The driven roller 20' contacts the surface of an outer periphery of the package 22' and rotates following the rotation of the package 22'.

[0116] The traversing device 70' is arranged near the cradle 18' and traverses the yarn 14 that is hooked on a tip of a traverse arm 70a'. Specifically, by causing the tip of the traverse arm 70a' to perform a reciprocating move-

ment in the horizontal direction along a longitudinal direction of the driven roller 20', the traversing device 70' can traverse the yarn 14 along the longitudinal direction of the driven roller 20'.

[0117] By traversing the yarn 14 that is hooked on the tip of the traverse arm 70a' by using the traversing device 70' while rotating the package 22' by bringing the outer periphery of the package 22' in contact with the driven roller 20', the package 22' can be formed.

[0118] In the winding unit 10" according to the third embodiment, to rotate the package 22' at the second rotational speed V2 that is faster, the unit controlling section 100 instructs the lift-up mechanism 50 (the solenoid valve 503c thereof) to move the package 22' to the separated position Q1. Accordingly, in the winding unit 10" according to the third embodiment, the package 22' rotates at high speed at the second rotational speed V2 without contacting the driven roller 20'.

4. Fourth Embodiment

[0119] In the winding unit 10" according to the third embodiment explained above, the package 22' is caused to rotate by the package driving motor 21', and then the yarn 14 is wound onto the package 22'. However, the present invention is not limited to such configuration, and a package driving motor can be installed to the driven roller 20', instead of installing the package driving motor 21' to the cradle 18'. In such a configuration, in a state in which the driven roller 20' is in contact with the outer periphery of the package 22', the yarn 14 can be wound onto the package 22' by traversing the yarn 14 along the driven roller 20' while rotating the package driving motor and thereby rotationally driving the driven roller 20'. The operations explained in the first to third embodiments can also be applied to a winding unit 10"" that rotationally drives the driven roller 20' according to a fourth embodiment.

5. Commonalities of Embodiments

[0120] The first to fourth embodiments include the following common configurations and functions. The winding unit 10, 10', 10", 10"" (an example of the yarn winding machine) according to the first to fourth embodiments respectively includes the yarn supplying section 15 (an example of the yarn supplying section); the yarn winding section 17, 17' (an example of the yarn winding section); the yarn joining device 38 (an example of the yarn joining device); the first catching / guiding device 30 (an example of the yarn catching / guiding device); and the unit controlling section 100 (an example of the controlling section). The yarn supplying section 15 supplies the yarn 14 (an example of yarn). The yarn winding section 17, 17' rotates in the winding direction at the first rotational speed V1 (an example of the first rotational speed) and winds the yarn 14 that is pulled from the yarn supplying section 15 to form the package 22, 22' (an example of the pack-

age). The yarn joining device 38 joins the yarn end from the yarn supplying section 15 and the yarn end from the package 22, 22'. The first catching / guiding device 30 catches the yarn end from the package 22, 22' by the action of the negative pressure suction inside the pipe member 32 (an example of the pipe member), and guides the caught yarn end to the yarn joining device 38. When guiding the yarn ends to the yarn joining device 38, if the catching of the yarn end from the package 22, 22' fails, the unit controlling section 100 rotates the package 22, 22' supported by the yarn winding section 17, 17' in the winding direction at the second rotational speed V2 at which the yarn 14 can be wound onto the package 22, 22' at a speed of 800 m/min or more (an example of the second rotational speed).

[0121] In the winding unit 10, 10', 10", 10"', if the first catching / guiding device 30 fails to catch the yarn end from the package 22, 22', the package 22, 22' supported in the yarn winding section 17, 17' is caused to rotate at the second rotational speed V2 at which the yarn 14 can be wound onto the package 22, 22' at a speed of 800 m/min or more. Accordingly, even when the negative pressure required for catching the yarn end by the first catching / guiding device 30 is a weak negative pressure that reduces the energy consumption, the yarn end from the package 22, 22' can be reliably caught. As a result, the energy efficiency of the winding unit 10, 10', 10", 10"' can be improved.

[0122] Moreover, when the yarn end from the package 22, 22' is caught by the action of a weak negative pressure that reduces the energy consumption, the catching of the yarn end can be completed in a short time period without performing an additional operation of rotating the package 22, 22' in the winding direction at high speed. As a result, stopping of the winding operation of the winding unit 10, 10', 10", 10"' for a long time every time the yarn breakage occurs can be avoided, thus improving the operation efficiency and energy efficiency.

6. Other Embodiments

[0123] The embodiments of the present invention are explained above. The present invention, however, is not limited to the above embodiments, and can be modified in various manners without departing from the gist of the present invention. Particularly, the embodiments and modifications explained in this specification can be arbitrarily combined as required. For example, the first to fourth embodiments explained above can be appropriately combined without departing from the gist of the present invention. Moreover, the sequence of each process and / or the contents of the processes of the winding unit 10, 10', 10", 10"' (automatic winder 1), which are explained with reference to the flow chart shown in FIG. 5 and the like, can be appropriately modified without departing from the gist of the present invention.

[0124] In the above embodiments, a configuration in which the state of the yarn 14 is monitored by an optical

sensor arranged in the yarn monitoring device 40 is cited as an example. However, the sensor arranged in the yarn monitoring device 40 can be, for example, an electrostatic capacitance sensor. In such a configuration, in the yarn monitoring device 40, a yarn defect is detected based on a change in the electrostatic capacitance.

[0125] In the above embodiments, a configuration in which the tension applying device 27 is a gate type member is cited as an example. However, the tension applying device 27 can be, for example, a disk type member.

[0126] In the above embodiments, a configuration in which the yarn joining device 38 is a splicer device is cited as an example. However, the yarn joining device 38 can be, for example, a mechanical knotter and the like.

[0127] In the above embodiments, a configuration in which the detecting unit that detects the yarn 14 that travels in the yarn path is the yarn monitoring device 40 (clearer) is cited as an example. However, the detecting unit that detects the yarn 14 that is traveling on the yarn path is not limited to such configuration. The detecting unit can be arranged separately from the yarn monitoring device 40.

[0128] In the above embodiments, a configuration in which the transparent cover 605 is arranged pivotably on the pipe member 32 of the first catching / guiding device 30 is cited as an example. However, as long as the opening O is closed, the transparent cover 605 can be arranged so as to be not pivotable (not capable of opening / closing the opening O).

[0129] A plurality of aspects will be explained below as the means to solve the problem. Any of these aspects can be arbitrarily combined as required. A yarn winding machine according to one aspect of the present invention includes a yarn supplying section, a yarn winding section, a yarn joining device, a yarn catching / guiding device, and a controlling section. The yarn supplying section supplies a yarn. The yarn winding section forms a package by winding the yarn supplied by the yarn supplying section while rotating the package in a winding direction of the yarn at a first rotational speed. The yarn joining device joins a yarn end from the yarn supplying section and a yarn end from the package. The yarn catching / guiding device uses a negative pressure suction inside a tube member to catch the yarn end from the package and guides the caught yarn end to the yarn joining device. The controlling section controls the yarn winding section to rotate the package in the winding direction at a second rotational speed at which the yarn is wound in the package at a speed of 800 m/min or more when the yarn catching / guiding device fails in catching the yarn end from the package.

[0130] In the yarn winding machine explained above, when the yarn catching / guiding device fails to catch the yarn end from the package, the package supported in the yarn winding section is caused to rotate at the second rotational speed at which the yarn can be wound in the package at the speed of 800 m/min or more. With this configuration, even if the negative pressure required for

catching the yarn end by the yarn catching / guiding device is a weak negative pressure that reduces the energy consumption, the yarn end from the package can be reliably caught. As a result, energy efficiency of the yarn winding machine can be improved. Moreover, when the yarn end from the package can be caught by the action of a weak negative pressure that reduces the energy consumption, the catching of the yarn end can be completed by the action of the weak negative pressure that reduces the energy consumption without performing an additional operation to rotate the package in the winding direction at high speed. As a result, stopping of the winding operation of the yarn winding machine for a long time every time the yarn breakage occurs can be avoided, and thus operation efficiency and energy efficiency of the yarn winding machine can be improved.

[0131] The above yarn winding machine can further include a contact roller. The contact roller is capable of contacting an outer periphery of the package and applying a driving force to the package to cause the package to rotate. When stopping the winding rotation of the package at the second rotational speed, the controlling section releases the contact between the outer peripheries of the package and the contact roller. With this configuration, damage to the package due to a friction that occurs between the package and the contact roller at the time of stopping the winding rotation of the package at the second rotational speed can be avoided.

[0132] In the above yarn winding machine, the contact roller can include a traversing groove. The traversing groove traverses the yarn supplied from the yarn supplying section at a certain width on a surface of the package while the package is being rotated. Accordingly, the package of the certain width can be formed.

[0133] In the above yarn winding machine, the second rotational speed can be a speed at which the yarn can be wound at a speed of 1000 m/min or more. With this configuration, the centrifugal force that separates the yarn end from the package from the package can be strengthened. As a result, the catching probability of the yarn end can be increased.

[0134] In the above yarn winding machine, the second rotational speed can be 1300 m/min or more but less than 1500 m/min. Accordingly, the centrifugal force that separates the yarn end from the package from the package can be further strengthened. As a result, the catching probability of the yarn end can be increased.

[0135] In the above yarn winding machine, a duration of the winding rotation at the second rotational speed can be one to ten seconds. Thus, the time required for the yarn end catching process that includes a process in which the package is rotated at high speed can be shortened.

[0136] The above yarn winding machine can further include a duct, and a negative pressure generating device. The duct is connected to the tube member of the yarn catching / guiding device. The negative pressure generating device maintains a pressure inside the duct

to a predetermined pressure. With this configuration, the negative pressure by the action of which the yarn end is caught can be generated efficiently in the yarn catching / guiding device.

[0137] In the above yarn winding machine, the negative pressure generating device can be a blower device. With this configuration, the negative pressure can be generated efficiently in the duct.

[0138] The above yarn winding machine can further include a detecting unit that detects whether the yarn end is sucked inside the tube member of the yarn catching / guiding device. Accordingly, catching of the yarn end by the yarn catching / guiding device can be detected more reliably.

[0139] In the above yarn winding machine, acceleration that occurs when the package is to be rotated in the winding direction at the second rotational speed can be greater than acceleration that occurs when the package is to be rotated in the winding direction at the first rotational speed. With this configuration, the rotational speed of the package can attain the second rotational speed more quickly, and the yarn end catching process that includes a process of rotating the package at high speed can be completed earlier.

[0140] The above yarn winding machine can further include a contact roller capable of contacting an outer periphery of the package and applying a driving force to the package to cause the package to rotate. At the time of causing the package to rotate in the winding direction at the second rotational speed, the controlling section can increase a contact pressure between the outer peripheries of the package and the contact roller compared to a contact pressure applied at the time of causing the package to rotate in the winding direction at the first rotational speed. With this configuration, "slippage" that occurs between the outer peripheries of the package and the contact roller can be reduced, and the package can attain the second rotational speed at a higher rotation acceleration. As a result, the yarn end catching process that includes the process of rotating the package at high speed can be completed earlier.

[0141] The yarn winding machine explained above can operate with a higher energy efficiency.

[0142] The present invention can be widely applied to a yarn winding machine that produces a package by winding a supplied yarn.

[0143] In the above explanation, the meaning of "a plurality of" also includes "a predetermined number of".

[0144] 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 machine (10, 10', 10", 10''') comprising:

a yarn supplying section (15) that supplies a yarn (14);

a yarn winding section (17, 17') that forms a package (22, 22') by winding the yarn (14) supplied from the yarn supplying section (15) while rotating the package (22, 22') in a winding direction of the yarn (14) at a first rotational speed (V1);

a yarn joining device (38) that joins a yarn end from the yarn supplying section (15) and a yarn end from the package (22, 22');

a yarn catching / guiding device (30) that uses a negative pressure suction inside a tube member to catch the yarn end from the package (22, 22') and guides the caught yarn end to the yarn joining device (38); and

a controlling section (100) that controls the yarn winding section (17, 17') to rotate the package (22, 22') in the winding direction at a second rotational speed (V2) at which the yarn (14) is wound in the package (22, 22') at a speed of 800 m/min or more when the yarn catching / guiding device (30) fails in catching the yarn end from the package (22, 22').

2. The yarn winding machine (10, 10') as claimed in Claim 1 further comprising:

a contact roller (20, 20') capable of contacting an outer periphery of the package (22) and applying a driving force to the package (22) to cause the package (22) to rotate, wherein when stopping the winding rotation of the package (22) at the second rotational speed (V2), the controlling section (100) releases the contact between the outer peripheries of the package (22) and the contact roller (20, 20').

3. The yarn winding machine (10, 10') as claimed in Claim 2, wherein the contact roller (20) includes a traversing groove to traverse the yarn (14) supplied from the yarn supplying section (15) at a certain width on a surface of the package (22) while the package (22) is being rotated.

4. The yarn winding machine (10, 10', 10", 10''') as claimed in any one of Claims 1 to 3, wherein the second rotational speed (V2) is a speed at which the yarn (14) can be wound at a speed of 1000 m/min or more.

5. The yarn winding machine (10, 10', 10", 10''') as claimed in any one of Claims 1 to 4, wherein the

second rotational speed (V2) is 1300 m/min or more but less than 1500 m/min.

6. The yarn winding machine (10, 10', 10", 10''') as claimed in any one of Claims 1 to 5, wherein a duration of the winding rotation at the second rotational speed (V2) is one to ten seconds.

7. The yarn winding machine (10, 10', 10", 10''') as claimed in any one of Claims 1 to 6 further comprising:

a duct (191) connected to the tube member of the yarn catching / guiding device (30); and a negative pressure generating device (193) that maintains a pressure inside the duct (191) to a predetermined pressure.

8. The yarn winding machine (10, 10', 10", 10''') as claimed in Claim 7, wherein the negative pressure generating device (193) is a blower device.

9. The yarn winding machine (10, 10', 10", 10''') as claimed in Claim 7 or 8, further comprising a detecting unit (40) that detects whether the yarn end is sucked inside the tube member of the yarn catching / guiding device (30).

10. The yarn winding machine (10, 10', 10", 10''') as claimed in any one of Claims 1 to 9, wherein acceleration that occurs when the package (22, 22') is to be rotated in the winding direction at the second rotational speed (V2) is greater than acceleration that occurs when the package (22, 22') is to be rotated in the winding direction at the first rotational speed (V1).

11. The yarn winding machine (10, 10') as claimed in Claim 1, further comprising:

a contact roller (20) capable of contacting an outer periphery of the package (22) and applying a driving force to the package (22) to cause the package (22) to rotate, wherein at the time of causing the package (22) to rotate in the winding direction at the second rotational speed (V2), the controlling section (100) increases a contact pressure between the outer peripheries of the package (22) and the contact roller (20, 20') compared to a contact pressure applied at the time of causing the package (22) to rotate in the winding direction at the first rotational speed (V1).

12. The yarn winding machine (10, 10') as claimed in Claim 11, wherein the contact roller (20) includes a traversing groove to traverse the yarn (14) supplied from the yarn supplying section (15) at a certain width

on a surface of the package (22) while the package (22, 22') is being rotated.

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FIG.1

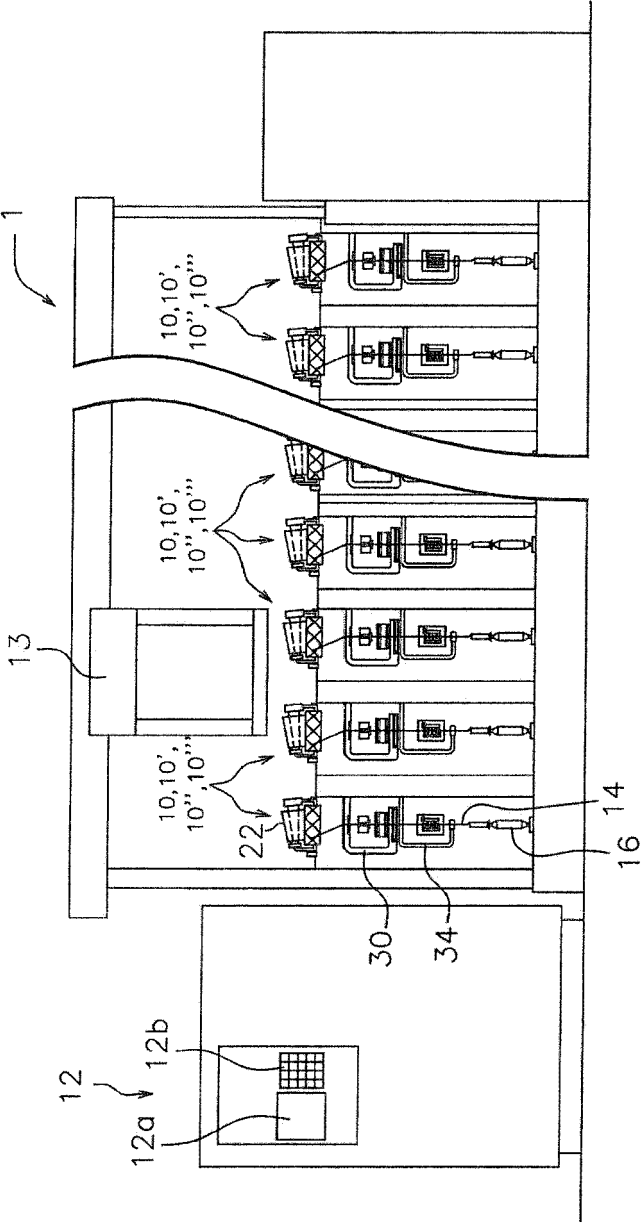


FIG.2

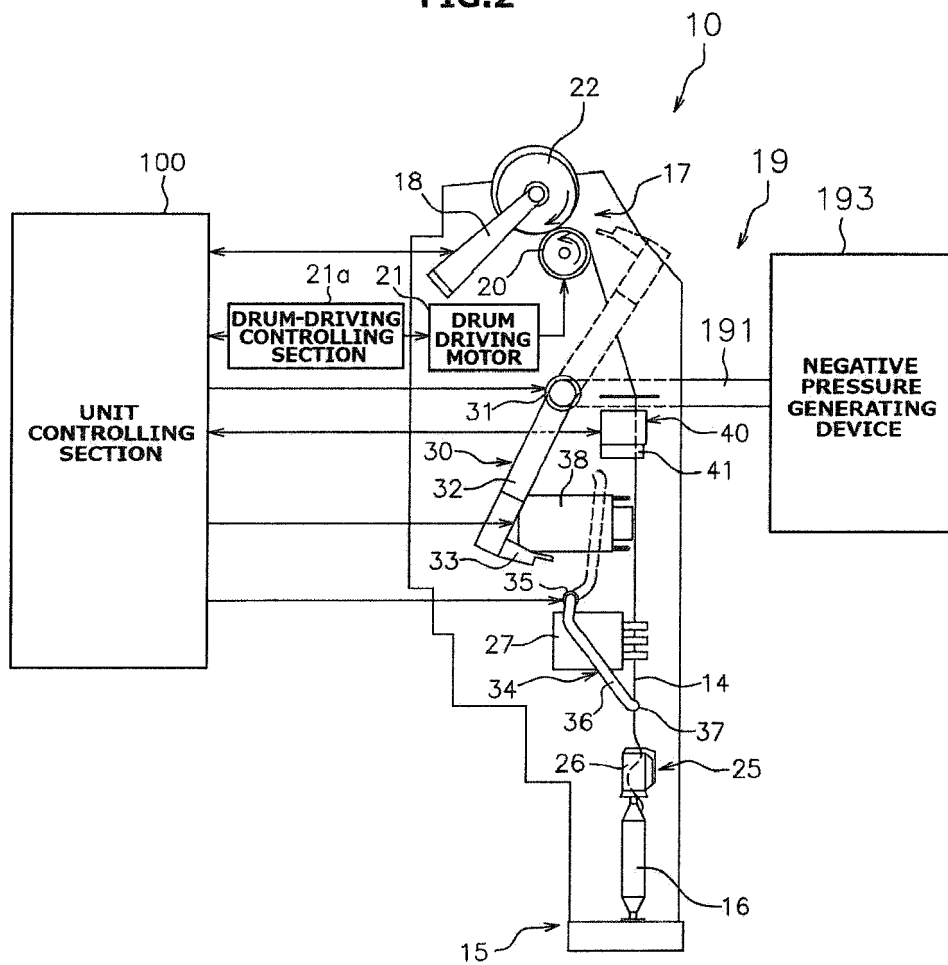


FIG.3

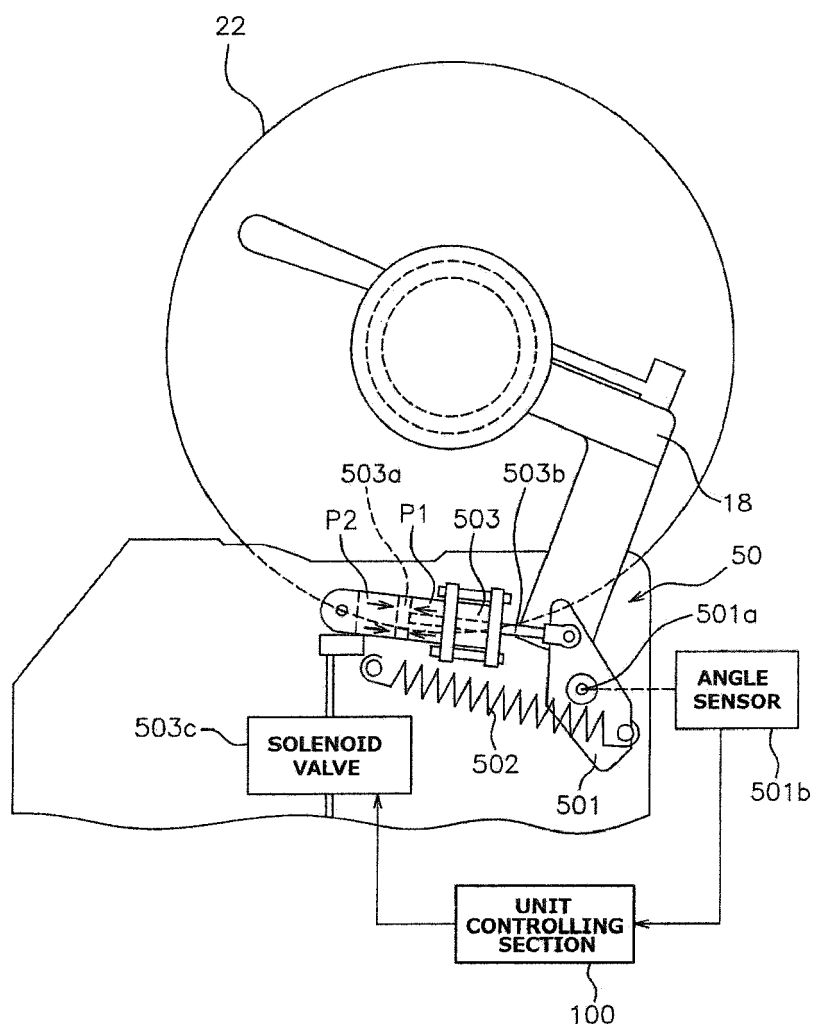


FIG.4

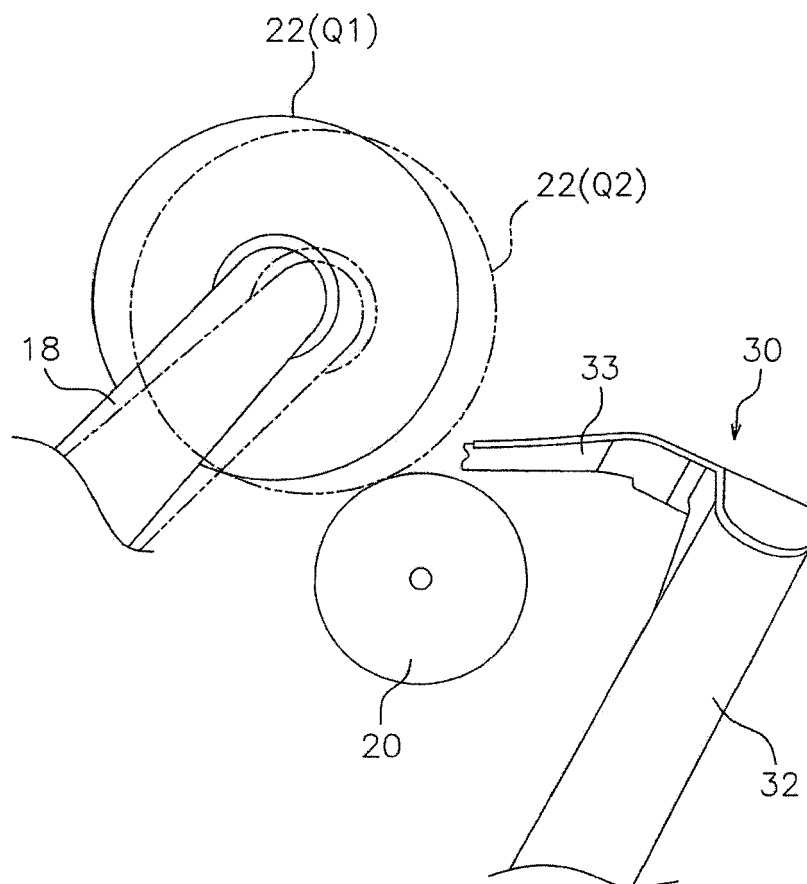


FIG.5

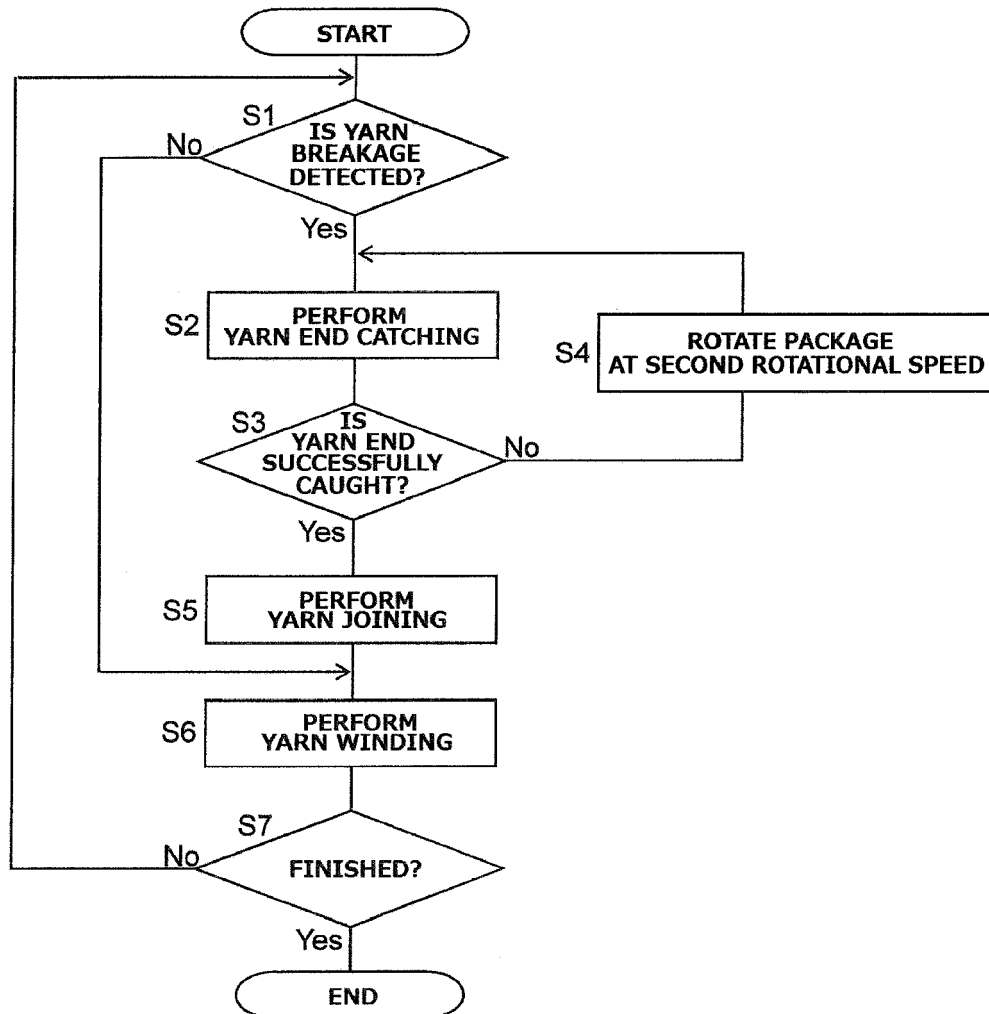


FIG.6

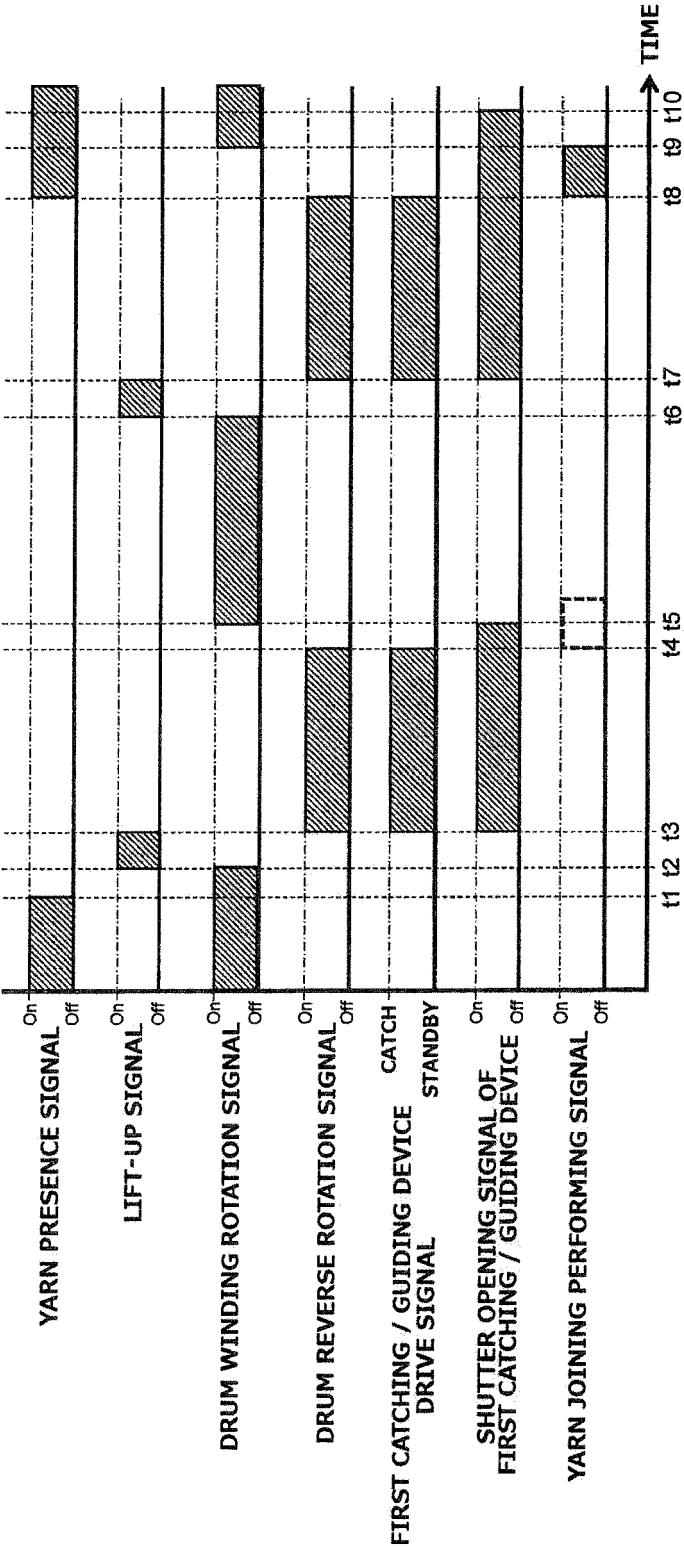


FIG.7

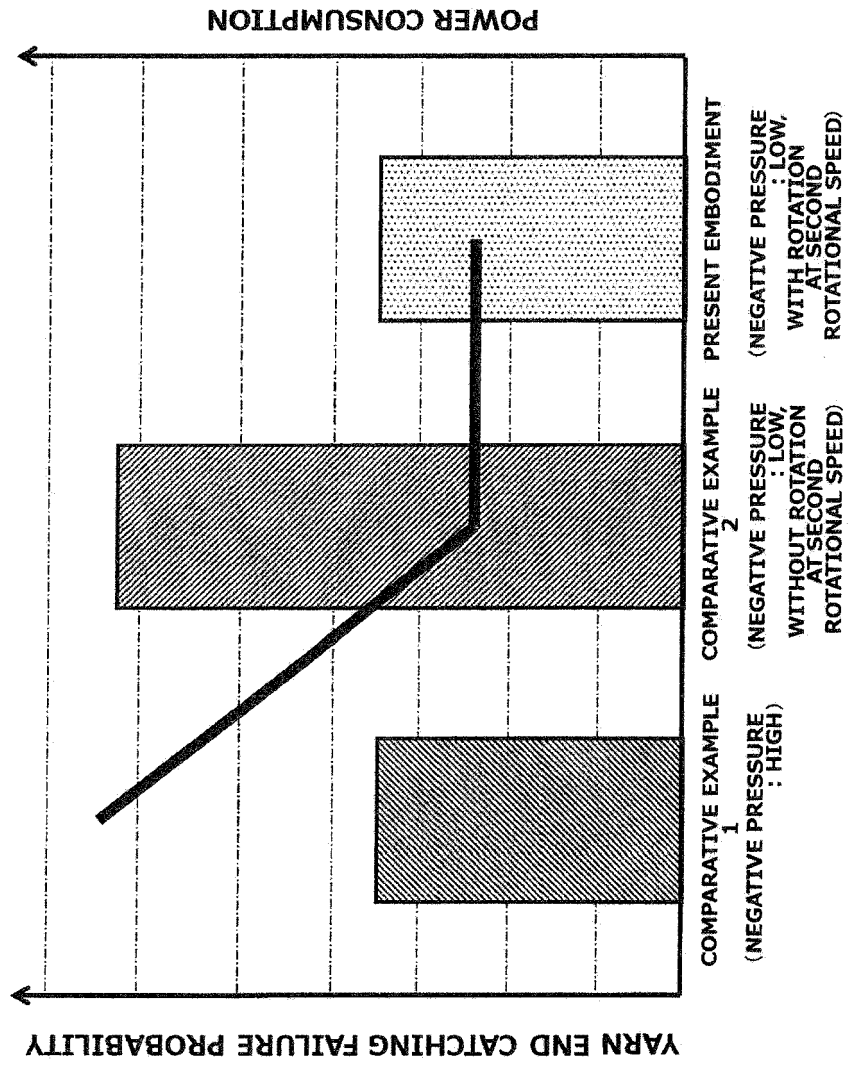


FIG.8

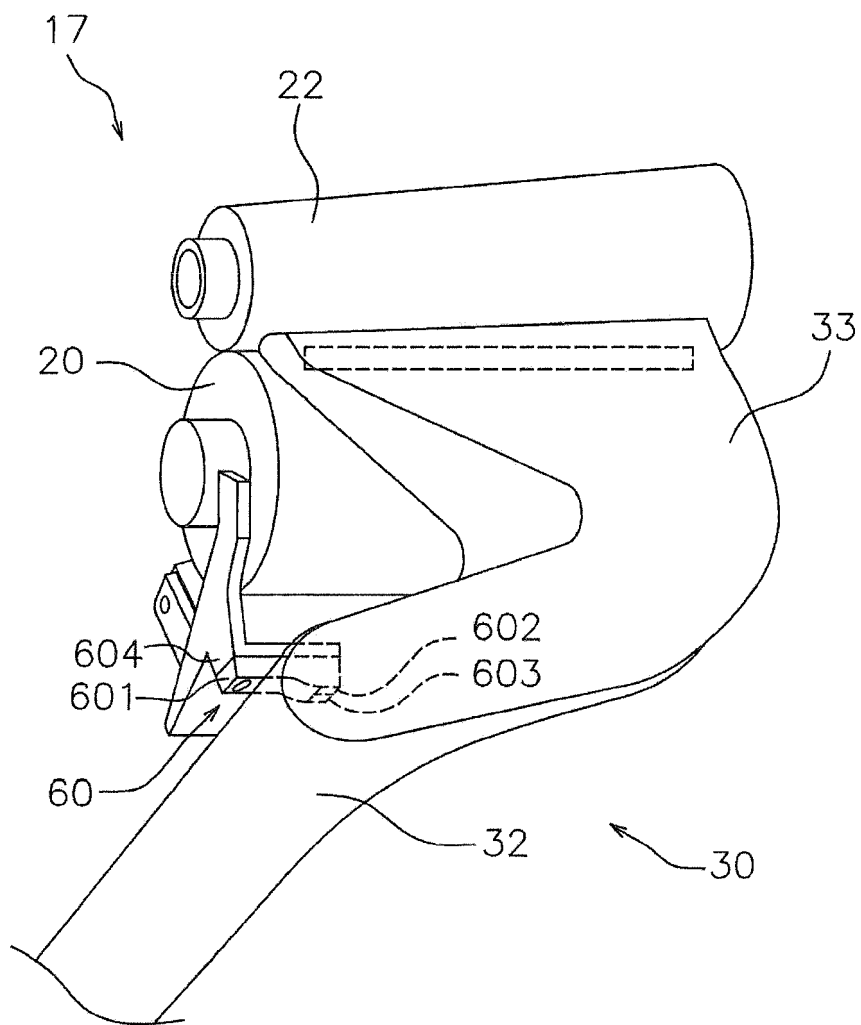


FIG.9

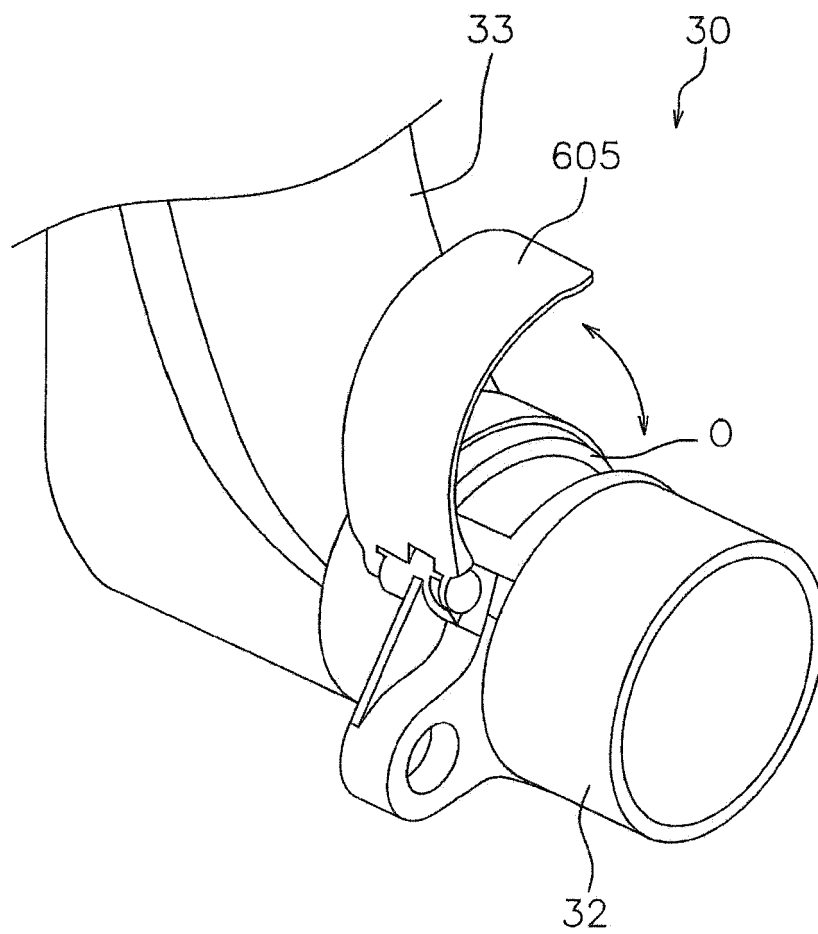


FIG.10

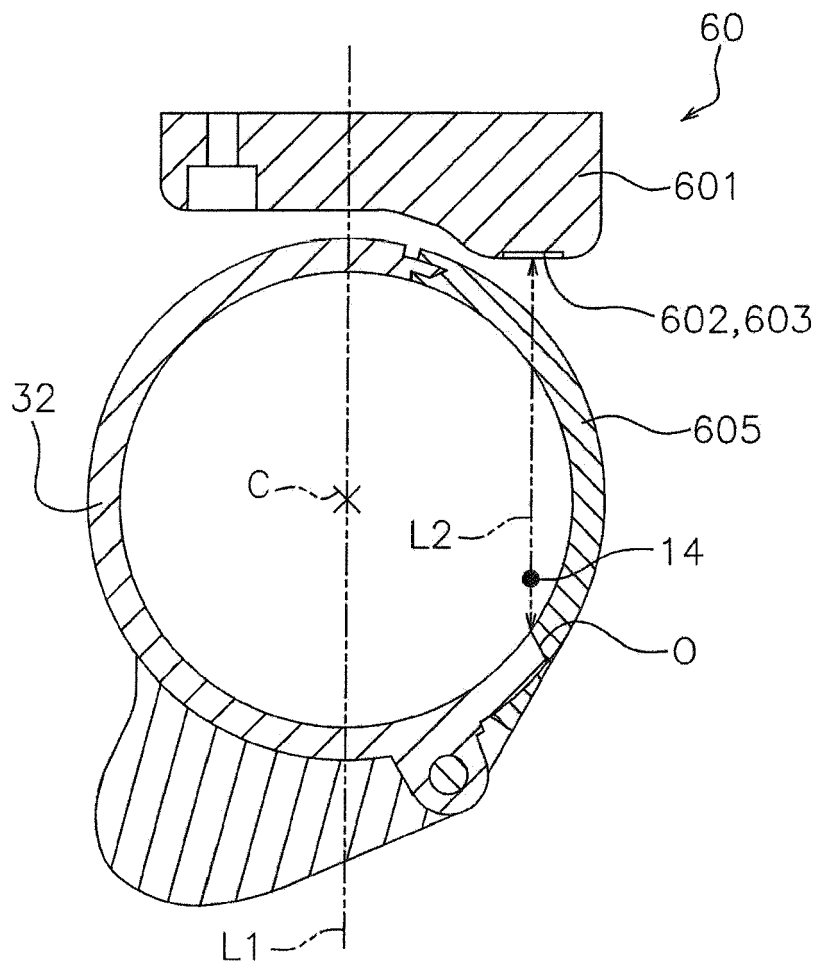


FIG.11

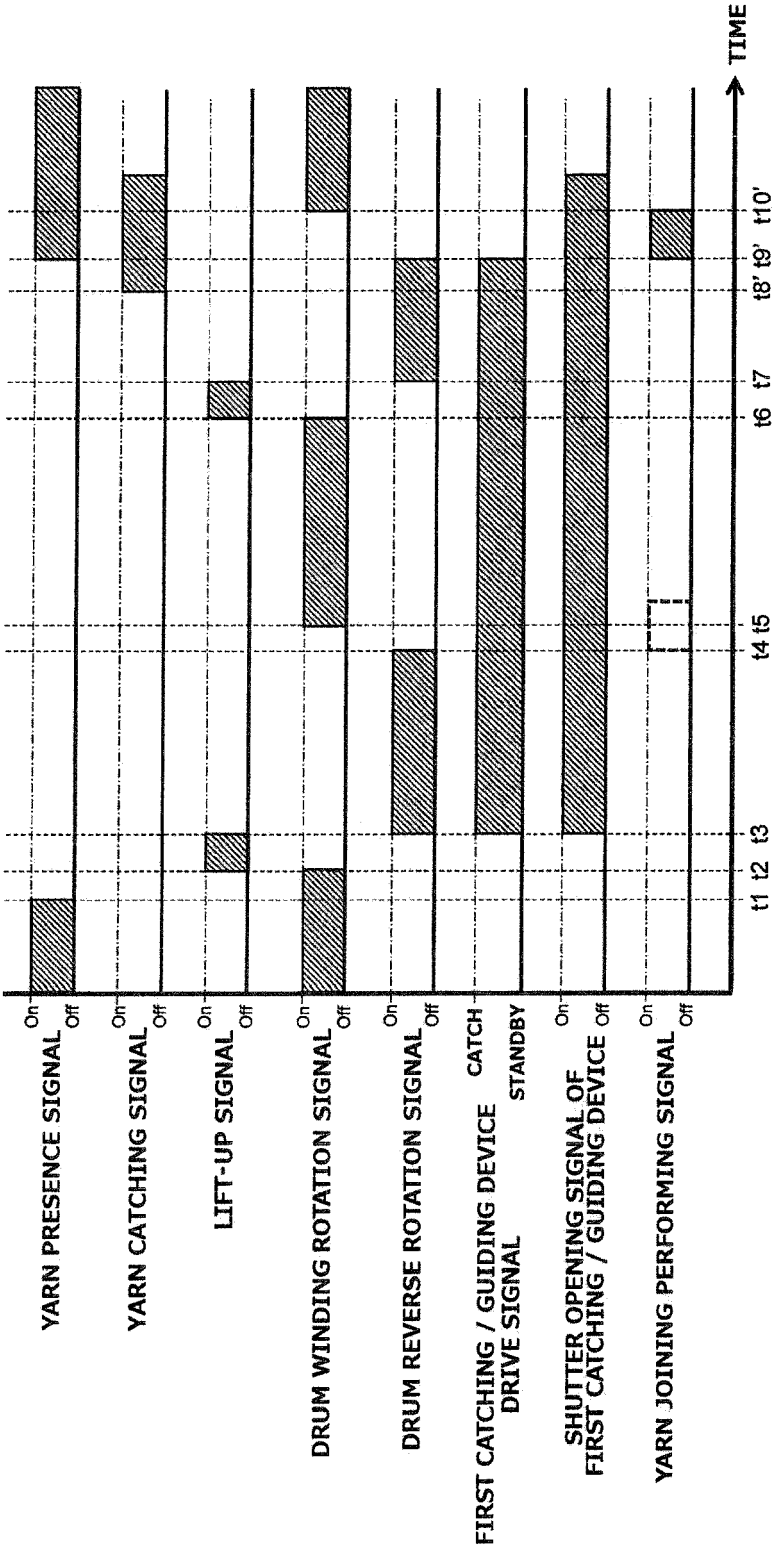
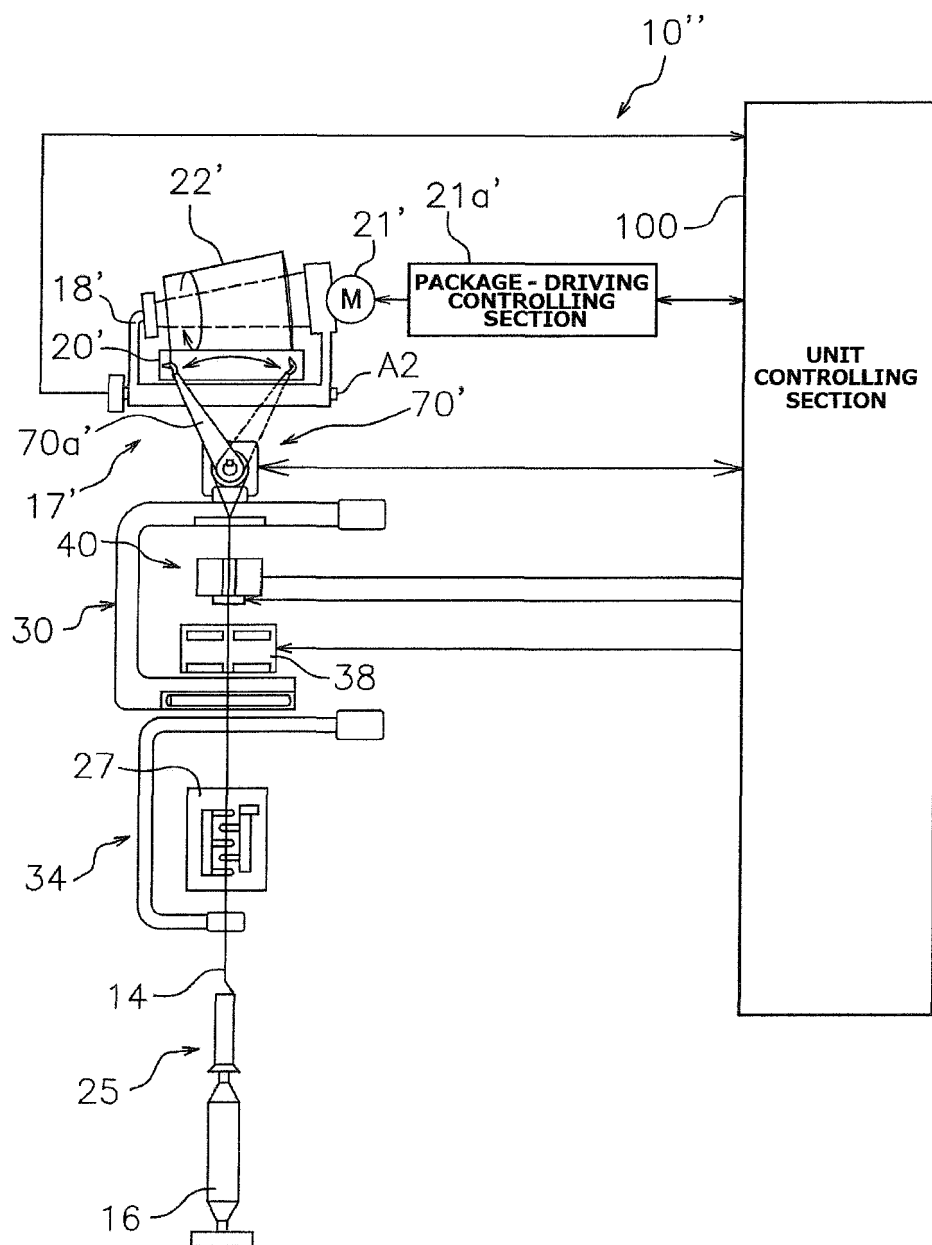


FIG.12





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Application Number
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Place of search The Hague		Date of completion of the search 15 August 2018	Examiner Pussemier, Bart
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