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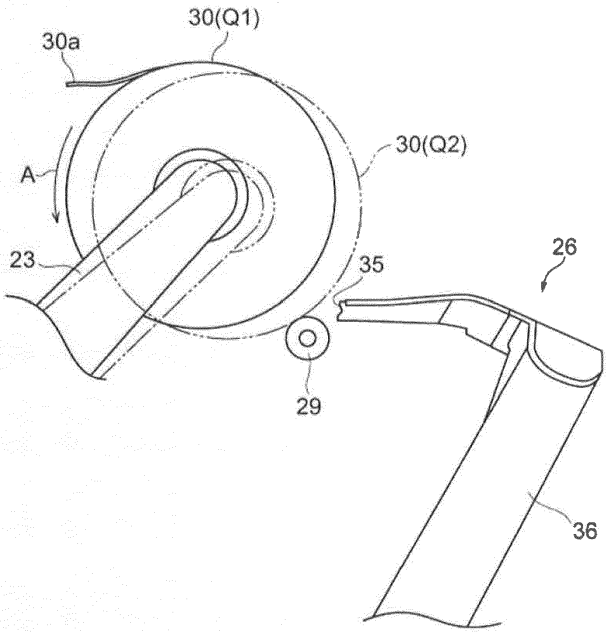
(54) Yarn winding apparatus and yarn withdrawal method

(57) A winder unit 10 includes a cradle 23, a contact roller 29, an upper-yarn suction opening 35, a drive mechanism 60, and a unit controller 50. The cradle 23 holds a package 30, and the contact roller 29 comes into contact with a surface of the package 30. The upper-yarn suction opening 35 performs a sucking and catching operation to catch a yarn end 30a trailing from the package 30. The drive mechanism 60 moves the cradle 23 such that the package 30 is held at a non-contact position Q1 where the package 30 is separated from the contact roller 29 and at a contact position Q2 where the package 30 comes into contact with the contact roller 29. The unit controller 50 controls the drive mechanism 60 and the upper-yarn suction opening 35 such that the upper-yarn suction opening 35 performs the sucking and catching operation when the package 30 is held at each of the non-contact position Q1 and the contact position Q2.

FIG.6



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a yarn winding apparatus and a yarn withdrawal method.

2. Description of the Related Art

[0002] A yarn winding apparatus disclosed in Japanese Patent Application Laid-open No. 2003-261265 is known in the art. The yarn winding apparatus includes a touch roller (support roller) that is generally in contact with a winding package (cross-wound bobbin), and a yarn-end catching section (suction nozzle) that performs a sucking operation. The sucking operation includes sucking and withdrawing a yarn end from the winding package when a yarn is cut. When the yarn is cut while a yarn winding operation is being performed, the winding package is uplifted and separated from the touch roller. Thereafter, the winding package is rotated in a direction opposite to a winding direction of the yarn (hereinafter, "unwinding direction") and the yarn-end catching section moves closer to the surface of the winding package and performs the sucking operation. Once the yarn end trailing from the winding package is sucked and caught by the yarn-end catching section, the caught yarn end is delivered to a splicer device (yarn twisting device), and joined to the yarn end from a yarn feeding bobbin. Consequently, the winding operation of the yarn is resumed.

[0003] Thus, in order to reliably perform catching of the yarn end in such a yarn winding apparatus, it is necessary to move the yarn-end catching section sufficiently close to the surface of the winding package. However, in the yarn winding apparatus disclosed in Japanese Patent Application Laid-open No. 2003-261265, because the winding package is separated from the touch roller when catching the yarn end, a position of the winding package varies due to fluctuation in the weight of the winding package and mechanical variation of a drive mechanism. As a result, a distance between the surface of the winding package and the yarn-end catching section is likely to vary and a success rate of catching the yarn end is also likely to reduce.

SUMMARY OF THE INVENTION

[0004] It is an object of the present invention to provide a yarn winding apparatus and a yarn withdrawal method by which a yarn end of a winding package can be reliably caught. This object is achieved by a yarn winding apparatus according to claim 1.

[0005] According to an embodiment of the present invention, a yarn winding apparatus includes a holding section, a touch roller, a yarn-end catching section, a moving section, and a control section. The holding section is adapted to rotatably hold a winding package. The touch roller is arranged to make contact with the winding package. The yarn-end catching section is adapted to catch a yarn end of a yarn trailing from the winding package. The moving section is adapted to move the holding section such that the winding package is held at a first position and a second position, each position being at a different distance from the touch roller. The control section is adapted to control the moving section and the yarn-end catching section such that the yarn-end catching section performs a catching operation when the winding package is held at each of the first position and the second position.

[0006] According to the yarn winding apparatus, the yarn-end catching section performs the catching operation while the winding package is held at each of the first position and the second position. Because the yarn-end catching section performs the catching operation in each state in which the position of the winding package is changed, the yarn end is reliably caught.

[0007] The distance between the first position and the touch roller is longer than the distance between the second position and the touch roller. The control section is adapted to control the moving section and the yarn-end catching section such that the catching operation when the winding package is held at the second position is performed after the catching operation when the winding package is held at the first position is performed.

[0008] With this configuration, the catching operation is performed when the winding package is held at the first position, and thereafter, the catching operation is performed when the winding package is held at the second position that is closer to the touch roller than the first position is from the touch roller. Thus, because the yarn-end catching section performs the catching operation at each position at which the distance between the winding package and the touch roller is different, the yarn end is more reliably caught.

[0009] The control section is adapted to control the moving section such that the winding package is separated from the touch roller at the first position, and is in contact with the touch roller at the second position.

[0010] With this configuration, the yarn-end catching section performs the catching operation at least in two states, that is, when the winding package is in a non-contact state with the touch roller, and when the winding package is in a contact state with the touch roller. Therefore, the yarn end is further reliably caught.

[0011] The yarn winding apparatus further includes a package driving section adapted to drive and rotate the winding package in a winding direction and an unwinding direction. The package driving section is adapted to drive and rotate the winding package in the winding direction and the unwinding direction when the winding package is separated from the touch roller.

[0012] With this configuration, when a situation where the yarn end needs to be caught arises, the winding package is separated from the touch roller, and thereafter,

the winding package is decelerated and stopped and rotated in the unwinding direction. That is, there is no need to wait for the winding package to decelerate and stop when the winding package is in the contact state with the touch roller. Therefore, the yarn end can be prevented from being pressed by the touch roller and entering into the inner layers of the winding package.

[0013] The yarn winding apparatus further includes a package driving section adapted to drive and rotate the winding package in a winding direction and an unwinding direction. The control section is adapted to control the package driving section such that the winding package is driven and rotated in the unwinding direction when the winding package is separated from the touch roller.

[0014] With this configuration, since the winding package is rotated in the non-contact state with the touch roller, the yarn end is prevented from being pressed between the winding package and the touch roller 29 and entering into the inner layers of the winding package. Consequently, the yarn end is caught easily. The catching operation of the yarn end is performed in a state in which the yarn end is easily caught. Because the winding package is driven and rotated in the unwinding direction, the yarn end is easily withdrawn from the winding package and caught. As a result, the yarn end is reliably caught.

[0015] The yarn winding apparatus further includes a setting section adapted to set number of rotations of the winding package held at the first position in the unwinding direction. The control section is adapted to control the package driving section based on the number of rotations set by the setting section.

[0016] With this configuration, the winding package is rotated a desired number of times at the first position. Therefore, the yarn-end catching section reliably catches the yarn end.

[0017] In the yarn winding apparatus, the package driving section can drive and rotate the winding package in the winding direction and the unwinding direction when the winding package is separated from the touch roller.

[0018] With this configuration, when a situation where the yarn end needs to be caught arises, the winding package is separated from the touch roller, and thereafter, the winding package is decelerated and stopped and rotated in the unwinding direction. That is, there is no need to wait for the winding package to decelerate and stop when the winding package is in the contact state with the touch roller. Therefore, the yarn end can be prevented from being pressed by the touch roller and entering into the inner layers of the winding package.

[0019] The control section is adapted to control the position of the yarn-end catching section such that a distance between the yarn-end catching section and the surface of the winding package is a predetermined distance set beforehand when the winding package is held at the second position.

[0020] In the catching operation, if the yarn-end catching section and the surface of the winding package are very close to each other, there is a possibility of occurrence of double picking. On the other hand, if the yarn-end catching section is very far from the surface of the winding package, the yarn end cannot be caught. However, with the configuration described above, control is exerted such that a distance between the yarn-end catching section and the surface of the winding package is a predetermined distance set beforehand when the winding package is held at the second position. Therefore, the yarn end is reliably caught.

[0021] The yarn winding apparatus further includes a traverse guide that is provided independently from the touch roller, and that is adapted to traverse the yarn to be wound on the winding package.

[0022] In the yarn winding apparatus that includes the traverse guide independent from the touch roller, because the touch roller does not require a traverse function, the touch roller does not include a traverse groove. In such a touch roller, almost the entire surface of the touch roller comes into contact with the winding package. Therefore, after the yarn is cut or broken, if the rotation is continued in a state in which the winding package is in contact with the touch roller, there is a greater likelihood of the yarn end being pressed against the surface of the winding package by the touch roller and entering into the inner layers of the winding package. Even in such a yarn winding apparatus, a configuration is adopted in which the yarn-end catching section performs the catching operation in each state in which the position of the winding package is changed, and therefore, the yarn end is reliably caught. That is, in the yarn winding apparatus that includes the traverse guide independent from the touch roller, the configuration in which the yarn-end catching section performs the catching operation in each state in which the position of the winding package is changed is especially effective.

[0023] According to an embodiment of the present invention, a yarn withdrawal method is a method by which a yarn end of a winding package is withdrawn in a yarn winding apparatus that includes a holding section that rotatably holds the winding package, a touch roller arranged to make contact with a surface of the winding package, and a yarn-end catching section that catches the yarn end of the winding package. The yarn withdrawal method includes a first step, a second step, a third step, and a fourth step. The first step includes controlling the holding section to hold the winding package at a first position. The second step includes controlling the yarn-end catching section to perform catching of the yarn end trailing from the winding package held at the first position. The third step includes controlling the holding section to hold the winding package at a second position that is closer to the touch roller than the first position is from the touch roller. The fourth step includes controlling the yarn-end catching section to perform catching of the yarn end trailing from the winding package held at the second position.

[0024] According to the yarn withdrawal method, the yarn-end catching section performs the catching opera-

tion when the winding package is held at each of the first position and the second position. Thus, because the catching operation is performed in each state in which the position of the winding package is changed, the yarn end is reliably caught.

[0025] The first position is a position of the winding package when not in contact with the touch roller. The second position is a position of the winding package when in contact with the touch roller.

[0026] With this configuration, the catching operation is performed in two different states, that is, when the winding package is in a non-contact state with the touch roller and when the winding package is in a contact state with the touch roller. Therefore, the yarn end is more reliably caught.

[0027] In the second step, the winding package is caused to perform approximately one rotation or less than or equal to one rotation in the unwinding direction.

[0028] If the yarn end of the winding package is in a state in which the yarn end is easily caught, there is a greater likelihood of the yarn end being caught successfully even if the winding package performs less than or equal to one rotations. On the other hand, the success rate of catching the yarn end remains almost the same even if the winding package performs more than one rotations. Therefore, causing the winding package to perform approximately one rotation or less than or equal to one rotation in the unwinding direction is especially effective when the winding package is in the non-contact state with the touch roller.

[0029] In the fourth step, the yarn-end catching section performs the catching operation at a position that is at a predetermined distance set beforehand from the winding package.

[0030] If the yarn-end catching section performs the catching operation at the position that is very close to the surface of the winding package, double picking of the yarn is likely to occur. If the catching operation is performed at the position that is very far from the winding package, the yarn end cannot be caught. However, with the configuration described above, in the fourth step, the yarn-end catching section performs the catching operation at a position that is at a predetermined distance set beforehand from the winding package. Therefore, the yarn end can be reliably caught.

[0031] According to a yarn winding apparatus and a yarn withdrawal method of the present invention, a yarn end of a winding package can be reliably caught.

[0032] 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

[0033]

FIG. 1 is a schematic diagram of an automatic winder that includes a winder unit according to an embodiment of the present invention;

FIG. 2 is a schematic diagram and a block diagram of the winder unit;

FIG. 3 is an enlarged left-side view of the vicinity of a traverse device of the winder unit;

FIG. 4 is an enlarged right-side view of the vicinity of a cradle of the winder unit;

FIG. 5 is a flowchart of a withdrawing operation of an upper yarn performed by the winder unit; and

FIG. 6 is a left-side view of a package moved to a non-contact position or a contact position.

DETAILED DESCRIPTION OF EMBODIMENTS

[0034] Exemplary embodiments of a yarn winding apparatus and a yarn withdrawal method according to the present invention are explained in detail below with reference to the accompanying drawings.

[0035] First, an overall configuration of an automatic winder 1 that includes a plurality of winder units (yarn winding apparatuses) 10 according to an embodiment of the present invention is explained with reference to FIG. 1. In the present specification, "upstream" and "downstream" signify an upstream side and a downstream side in a running direction of a yarn in winding the yarn.

[0036] As shown in FIG. 1, the automatic winder 1 includes a plurality of the winder units 10 arranged side-by-side, an automatic doffing device 80, and a machine setting device 90.

[0037] Each of the winder units 10 winds a yarn 20 while causing the yarn 20, which is unwound from a yarn feeding bobbin 21, to traverse to form a package (winding package) 30.

[0038] When the package 30 in a particular one of the winder units 10 is fully wound, the automatic doffing device 80 moves to the position of that winder unit 10, collects the fully wound package 30, and sets an empty bobbin in that winder unit 10.

[0039] The machine setting device 90 includes a setting section 91 and a display section 92. The setting section 91 performs setting of various parameters to each winder unit 10 when an operator performs operation of entering various values and selection of an appropriate control method. The display section 92 displays a yarn winding status of each winder unit 10 and details of a problem that has occurred.

[0040] A configuration of the winder unit 10 is concretely explained with reference to FIG. 2. FIG. 2 is a schematic diagram and a block diagram of the winder unit 10. Each winder unit 10 includes a winder-unit main body 16 and a unit controller (control section) 50.

[0041] Although not shown specifically, the unit controller 50, for example, includes a Central Processing Unit (CPU), a Random Access Memory (RAM), a Read Only Memory (ROM), an Input-and-Output (I/O) port, and a communication port. A computer program that controls

various components of the winder-unit main body 16 is recorded in the ROM. Various components (described in detail later) included in the pertinent winder-unit main body 16 and the machine setting device 90 are connected to the I/O port and the communication port. Consequently, control information, etc., can be communicated to those components from the unit controller 50. Thus, the unit controller 50 can control operations of the various components included in the winder-unit main body 16.

[0042] The winder-unit main body 16 includes a yarn unwinding assisting device 12, a tension applying device 13, a splicer device (yarn joining device) 14, and a clearer 15 sequentially arranged from the side of the yarn feeding bobbin 21 in a yarn running path between the yarn feeding bobbin 21 and a contact roller (touch roller) 29.

[0043] A yarn feeding section 11 is arranged at the bottom of the winder-unit main body 16 to feed the yarn 20 to a winding bobbin 22. The yarn feeding section 11 holds the yarn feeding bobbin 21 at a predetermined position. The yarn feeding bobbin 21 is conveyed by a not shown bobbin conveying system.

[0044] The yarn unwinding assisting device 12 includes a regulating member 40 arranged to cover a core tube of the yarn feeding bobbin 21. The yarn unwinding assisting device 12 lowers the regulating member 40 in conjunction with unwinding of the yarn 20 from the yarn feeding bobbin 21, thus assisting the unwinding of the yarn 20 from the yarn feeding bobbin 21. The regulating member 40 comes into contact with a balloon of the yarn 20, which is formed on an upper portion of the yarn feeding bobbin 21 due to swinging and centrifugal force of the yarn 20 unwound from the yarn feeding bobbin 21, and controls the balloon to an appropriate size. Consequently, the yarn unwinding assisting device 12 assists the unwinding of the yarn 20. A not shown sensor is arranged near the regulating member 40 to detect a chase portion of the yarn feeding bobbin 21. When the sensor detects the lowering of the chase portion, the regulating member 40 is lowered with, for example, a not shown air cylinder following the lowering of the chase portion.

[0045] The tension applying device 13 applies a predetermined tension to the running yarn 20. A gate-type tension applying device can be used as the tension applying device 13. Movable combs are arranged between fixed combs in the gate-type tension applying device. The movable combs can be swung by a rotary solenoid such that the movable combs are engaged with or released from the fixed combs. Apart from the gate-type tension applying device, for example, a disk-type tension applying device can be used as the tension applying device 13.

[0046] The splicer device 14 joins a lower yarn from the yarn feeding bobbin 21 and an upper yarn from the package 30 when the yarn is intentionally cut by the clearer 15 when the clearer 15 detects a yarn defect, or when the yarn is accidentally broken during unwinding of the yarn 20 from the yarn feeding bobbin 21. As a yarn joining device that joins the upper yarn and the lower yarn, a mechanical yarn joining device or a yarn joining device that uses fluid, such as, compressed air can be used.

[0047] The clearer 15 includes a clearer head 49 and an analyzer 52. The clearer head 49 includes a not shown yarn thickness sensor to detect a thickness of the yarn 20 and the analyzer 52 processes a yarn thickness signal output from the yarn thickness sensor. The clearer 15 monitors the yarn thickness signal output from the yarn thickness sensor to detect a yarn defect, such as, a slub. A cutter 39 is arranged near the clearer head 49 to immediately cut the yarn 20 when the clearer 15 detects the yarn defect.

[0048] A lower-yarn catching member 25 is arranged below the splicer device 14. The lower-yarn catching member 25 catches a yarn end from the yarn feeding bobbin 21 to guide the yarn end to the splicer device 14. An upper-yarn catching member 26 is arranged above the splicer device 14. The upper-yarn catching member 26 catches a yarn end from the package 30 to guide the yarn end to the splicer device 14. The lower-yarn catching member 25 includes a lower-yarn pipe arm 33 and a lower-yarn suction opening 32 formed at a tip of the lower-yarn pipe arm 33. The upper-yarn catching member 26 includes an upper-yarn pipe arm 36 and an upper-yarn suction opening (yarn-end catching section) 35 formed at a tip of the upper-yarn pipe arm 36.

[0049] The lower-yarn pipe arm 33 and the upper-yarn pipe arm 36 are, respectively, rotatable about shafts 34 and 37. A not shown appropriate negative pressure source is connected to each of the lower-yarn pipe arm 33 and the upper-yarn pipe arm 36. Consequently, suction flows can be generated in the lower-yarn suction opening 32 and the upper-yarn suction opening 35, and as a result, the yarn ends of the upper yarn and the lower yarn can be sucked and caught.

[0050] The winder-unit main body 16 includes a cradle (holding section) 23 and the contact roller (touch roller) 29. The cradle 23 detachably supports the winding bobbin 22. The contact roller 29 is rotatable while making contact with a peripheral surface of the winding bobbin 22 or a peripheral surface of the package 30. In the winder-unit main body 16, an arm-type traverse device 70 is arranged near the cradle 23 and traverses the yarn 20. The winder-unit main body 16 winds the yarn 20 onto the package 30 while traversing the yarn 20 by the traverse device 70. A guide plate 28 is arranged slightly upstream of a traverse position to guide the upstream yarn 20 to the traverse position. A ceramic traverse fulcrum 27 is provided further upstream of the guide plate 28. The traverse device 70 causes the yarn 20 to traverse in a direction indicated by a double-headed arrow shown in FIG. 2 with the traverse fulcrum 27 as a fulcrum.

[0051] The cradle 23 is rotatable about a rotating shaft 48. In the winder unit 10, an increase in a yarn layer diameter of the package 30 associated with the winding of the yarn 20 around the winding bobbin 22 is absorbed with swinging of the cradle 23.

[0052] A package driving motor (package driving section) 41 that is constituted by a servo motor is coupled

to the cradle 23. In the winder unit 10, the package driving motor 41 drives and rotates the winding bobbin 22 to wind the yarn 20. The package driving motor 41 is capable of driving and rotating the winding bobbin 22 (package 30) in the winding direction as well as in the unwinding direction. A motor shaft of the package driving motor 41 is coupled to the winding bobbin 22 so as not to be rotatable relative to the winding bobbin 22 when the winding bobbin 22 is supported by the cradle 23 (a so-called direct drive system). A package drive controller 42 controls an operation of the package driving motor 41. The package drive controller 42 receives an operation signal from the unit controller 50 and controls the package driving motor 41 to operate or not operate based on the content of the operation signal. Apart from the servo motor, various other types of motors, namely, a step motor, an induction motor, and the like can be used as the package driving motor 41.

[0053] An angle sensor 44 is attached to the rotating shaft 48 to detect an angle of the cradle 23. The angle sensor 44 includes, for example, a rotary encoder, and transmits an angle signal indicative of the detected angle of the cradle 23 to the unit controller 50. The angle of the cradle 23 changes as the wound diameter of the package 30 increases. Accordingly, the package diameter of the package 30 can be detected by detection of the rotation angle of the cradle 23 by the angle sensor 44. Any other configuration can be used to detect the package diameter. For example, a configuration that employs a Hall IC or an absolute encoder can be used to detect the package diameter.

[0054] A configuration of the traverse device 70 and a layout of a configuration near the traverse device 70 are explained with reference to FIG. 3. FIG. 3 is an enlarged left-side view of the vicinity of the traverse device 70. In the present embodiment, the contact roller 29 is arranged in such a manner that an axial direction thereof is oriented towards a lateral direction of the winder-unit main body 16. Therefore, FIG. 3 is a side view when the traverse device 70 is viewed from the axial direction of the contact roller 29. In FIG. 3, clockwise rotation corresponds to the winding direction and counter-clockwise rotation corresponds to the unwinding direction of the package 30.

[0055] As shown in FIG. 3, the traverse device 70 includes a traverse driving motor 76, an output shaft 77, and a traverse arm (traverse guide) 74.

[0056] The traverse driving motor 76 drives the traverse arm 74. The traverse driving motor 76 is, for example, a servo motor. As shown in FIG. 2, a traverse controller 78 controls an operation of the traverse driving motor 76. Other motors, such as, a step motor, a voice coil motor, and the like can be used as the traverse driving motor 76.

[0057] The traverse controller 78 is constituted by hardware having a dedicated microprocessor. The traverse controller 78 receives a control signal from the unit controller 50 and controls the traverse driving motor 76 to operate or not operate based on the contents of the control signal.

[0058] As shown in FIG. 3, a driving force of the traverse driving motor 76 is transmitted to a base end portion of the traverse arm 74 via the output shaft 77. A rotor of the traverse driving motor 76 rotates in forward and backward directions to perform a reciprocating pivoting movement of the traverse arm 74 in a direction perpendicular to a surface of the paper on which FIG. 3 (horizontal direction of FIG. 2) has been printed. In FIG. 3, the traverse arm 74 is positioned at a traverse end portion.

[0059] A hook-shaped yarn guiding member 73 is formed at a tip end of the traverse arm 74. The traverse arm 74 engages with and guides the yarn 20 by the action of the yarn guiding member 73. The yarn guiding member 73 performs a reciprocating pivoting movement while being engaged with the yarn 20 to traverse the yarn 20.

[0060] In FIG. 3, a reference symbol L1 denotes a rotational axis line of the traverse driving motor 76 (a rotational axis line of the traverse arm 74), and a reference symbol L2 denotes a virtual straight line drawn from the base end portion of the traverse arm 74 towards a longitudinal direction on a side surface of the traverse arm 74 (a center line on the side surface of the traverse arm 74). Accompanying the reciprocating pivoting movement of the traverse arm 74, the yarn guiding member 73 reciprocates while drawing an arc locus in a virtual plane perpendicular to the rotational axis line L1 of the traverse arm 74 (hereinafter, the virtual plane is referred to as "swing plane"). In the present embodiment, the traverse arm 74 is arranged substantially perpendicular to the rotational axis line L1. Therefore, the virtual line L2 is perpendicular to the rotational axis line L1. Accordingly, it can be said that the traverse arm 74 performs a reciprocating pivoting movement in the swing plane.

[0061] When a yarn path line L3 is defined as a straight line indicating a yarn path near the tip end of the traverse arm 74 (the yarn path from the end portion of the guide plate 28 to the contact roller 29), in the present embodiment, a layout is attained in which the yarn path line L3 is parallel to the rotational axis line L1 of the traverse arm 74. In other words, the yarn path line L3 is perpendicular to the swing plane (and the virtual line L2).

[0062] A system in which traversing is performed such that a longitudinal direction of the traverse arm 74 is substantially parallel to an installation surface of the winder unit (yarn winding apparatus) 10 is sometimes called "horizontal traverse system". In the winder unit 10 according to the present embodiment in which the horizontal traverse system is adopted, almost no force is applied to pull out or slacken the yarn 20 in a direction of the yarn path line L3 when traversing the yarn 20. Therefore, bending of the yarn 20 caused by the yarn guiding member 73, particularly, at a traverse end portion, can be reduced, and as a result, degradation of the quality of the package 30 can be suppressed.

[0063] A configuration of the cradle 23 is explained in greater detail with reference to FIG. 4. FIG. 4 is an en-

larged right-side view of the vicinity of the cradle 23.

[0064] The winder-unit main body 16 includes a rotating plate 17 that is rotatable about the rotating shaft 48. The cradle 23 rotates integrally with the rotating plate 17 about the rotating shaft 48. A spring 18 that is configured as a tension spring to gradually decrease the contact pressure and an air cylinder 60 are coupled to the rotating plate 17. A predetermined rotational torque is applied to the cradle 23 by the spring 18 and the air cylinder 60.

[0065] The air cylinder (moving section) 60 is a double-acting cylinder that internally includes a piston 601. In FIG. 4, compressed air having an air pressure P1 is supplied to a cylinder chamber that is on the right side of the piston 601 in FIG. 4, and compressed air having an air pressure P2 is supplied to a cylinder chamber that is on the left side of the piston 601 in FIG. 4.

[0066] An electro-pneumatic regulator 61 is arranged on a pipe that supplies the compressed air having the air pressure P2 to the air cylinder 60. The air pressure P2 can be adjusted steplessly with the electro-pneumatic regulator 61. The electro-pneumatic regulator 61 regulates the air pressure P2 based on control signals received from the unit controller 50.

[0067] In the configuration shown in FIG. 4, when the air pressure P2 is reduced, a force applied by the air cylinder 60 to pull the cradle 23 increases. Therefore, the torque that causes the cradle 23 to rotate toward the front side of the winder-unit main body 16 about the rotating shaft 48 increases. Because the contact roller 29 is arranged more towards the front side of the winder-unit main body 16 than towards the rotating shaft 48, contact pressure between the package 30 and the contact roller 29 can be increased by reducing the air pressure P2. In contrast, when the air pressure P2 is increased, the force applied by the air cylinder 60 to pull the cradle 23 becomes weak. Therefore, the torque that causes the cradle 23 to rotate toward the back side of the winder-unit main body 16 about the rotating shaft 48 increases. In this way, the contact pressure between the package 30 and the contact roller 29 can be decreased. The package 30 can be separated from the surface of the contact roller 29 by further increasing the air pressure P2.

[0068] The rotating shaft 48 has an elongated shape and is perpendicular to a surface of the paper on which FIG. 4 has been printed. The angle sensor 44 is coupled to an end of the rotating shaft 48 at the distal side from the surface of the paper on which FIG. 4 has been printed. The angle sensor 44 detects a rotation angle of the cradle 23. The angle sensor 44 is connected to the unit controller 50 and sends the detected rotation angle to the unit controller 50.

[0069] In the above-described configuration, the air cylinder 60 moves the package 30 by causing the cradle 23 to rotate. In this manner, the package 30 can be moved to a non-contact position at which the package 30 is separated from the contact roller 29 (a position at which the package 30 is not in contact with the contact roller 29), and to a contact position at which the package 30 is in contact with the contact roller 29.

[0070] In the winder unit 10 explained above, when the yarn is intentionally cut due to detection of a yarn defect by the clearer 15 or when the yarn is accidentally broken during unwinding of the yarn 20 from the yarn feeding bobbin 21 (hereinafter, referred to as "yarn cut"), it is necessary to join the lower yarn and the upper yarn with the splicer device 14. Therefore, it is necessary to catch and withdraw the lower yarn from the yarn feeding bobbin 21 by the lower-yarn suction opening 32, and the upper yarn from the package 30 by the upper-yarn suction opening 35.

[0071] Control of the withdrawing operation of the upper yarn and a withdrawing operation performed in the winder unit 10 when the yarn cut or the like occurs are explained in detail below with reference to FIG. 2 and FIGS. 4 to 6.

[0072] During the winding operation, before the yarn cut or the like occurs, the surface of the package 30 is in contact with the contact roller 29. In other words, the package 30 is in the contact position. The contact position is denoted by a reference symbol Q2.

[0073] Step 1: A drive signal is transmitted from the unit controller 50 to the electro-pneumatic regulator 61 immediately after the yarn cut or the like occurs during the winding operation. The electro-pneumatic regulator 61 is driven based on the drive signal resulting in a change in the air pressure P2 of the compressed air supplied to the air cylinder 60. As a result, as shown in FIG. 6, the cradle 23 is driven in a direction in which it is separated from the contact roller 29. Consequently, the package 30 is separated from the contact roller 29 to the non-contact position (Step S101 in FIG. 5). The non-contact position is denoted by a reference symbol Q1. Simultaneously, by transmitting an operation signal from the unit controller 50 to the package drive controller 42, the rotation of the package 30 is decelerated and stopped, and the package 30 is rotated in an unwinding direction (in an arrow direction A shown in FIG. 6) (Step S103 in FIG. 5).

[0074] Step 2: Furthermore, by transmitting a drive signal from the unit controller 50 to the upper-yarn catching member 26, the upper-yarn pipe arm 36 is pivoted. Consequently, as shown in FIG. 6, the upper-yarn suction opening 35 moves to a predetermined position near the contact roller 29. This position of the upper-yarn suction opening 35 is also close to the surface of the package 30. The upper-yarn suction opening 35 performs the suction operation when the package 30 held at the non-contact position Q1 is rotating in the unwinding direction A (Step S105 in FIG. 5). With the suction operation described above, there is a likelihood of a yarn end 30a of the upper yarn trailing from the package 30 being sucked and caught by the upper-yarn suction opening 35.

[0075] The sucking and catching operation performed while the package 30, which is held at the non-contact position (first position) Q1, is rotating in the unwinding direction A at a position located away from the contact

roller 29 is, hereinafter, referred to as "first sucking and catching operation".

[0076] The number of rotations of the package 30 during the first sucking and catching operation is controlled by the operation signal output from the unit controller 50 based on information set or input beforehand from the setting section 91 (see FIG. 1). That is, the information of the number of rotations input from the setting section 91 by key operations, etc., performed by an operator is transmitted to the unit controller 50 of each of the winder units 10 as control information. With this configuration, the operator can set a desired number of rotations of the package 30. It is preferable that the number of rotations be set to approximately one or less than or equal to one. It is more preferable that the number of rotations be set to one. When the yarn end 30a is in a state in which it can be easily caught, there is a greater likelihood of the yarn end 30a being caught successfully even if the number of rotations of the package 30 is less than or equal to one. On the other hand, the success rate for catching the yarn end 30a remains almost the same even if the package 30 performs more than one rotations, and there is a disadvantage that the operation time is wasted. It is preferable that the number of rotations be greater than or equal to 0.5. If the value is less than 0.5, there is a likelihood that the yarn end 30a cannot reach near the upper-yarn suction opening 35 to be sucked and caught. A typical example of the state in which the yarn end 30a can be easily caught is a state in which the yarn end 30a is floating above the surface of the package 30.

[0077] Step 3: Thereafter, the following operations are performed irrespective of the success or failure in catching of the yarn end 30a in the first sucking and catching operation. That is, after the first sucking and catching operation is performed, the cradle 23 is moved toward the contact roller 29 to return the package 30 to the contact position Q2 where the package 30 is in contact with the contact roller 29 (Step S107 in FIG. 5). Because the package 30 continues to rotate in the unwinding direction A even after it is returned to the contact position Q2, the package 30 rotates in the unwinding direction A while in contact with the contact roller 29 and the contact roller 29 rotates following the package 30.

[0078] Step 4: At this time, the upper-yarn suction opening 35 is held at the predetermined position described above and the suction operation performed by the upper-yarn suction opening 35 is also continued (Step S109 in FIG. 5). Consequently, the upper-yarn suction opening 35 performs the suction operation while the package 30 being held at the contact position Q2 is rotating in the unwinding direction A, and therefore, there is a likelihood of the yarn end 30a being sucked and caught successfully. The sucking and catching operation performed while the package 30, which is held at the contact position (second position) Q2, is rotating in a contact state with the contact roller 29 is, hereinafter, referred to as "second sucking and catching operation".

[0079] The upper-yarn pipe arm 36 pivots downward and guides the caught yarn end 30a to the splicer device 14 after completion of Step 4.

[0080] The advantages of both the winder unit 10 that controls the withdrawing operation described above and the withdrawing operation are explained below.

[0081] In the first sucking and catching operation, the package 30 is separated from the contact roller 29 immediately after the yarn cut or the like occurs, and the package 30 is decelerated and stopped. Then, the package 30 is rotated in the unwinding direction A. Therefore, the yarn end 30a of the cut yarn 20 is prevented from being pressed between the package 30 and the contact roller 29, and entering into inner layers of the package 30. Therefore, the yarn end 30a floats above the surface of the package 30, and is easily sucked by the suction flow of the upper-yarn suction opening 35. Even if the yarn end 30a is not floating above the surface of the package 30, the yarn end 30a is likely to float above the surface of the package 30 by the rotation of the package 30 in the unwinding direction A. Because the package 30 is rotating in the unwinding direction A, the yarn end 30a can be easily withdrawn from the package 30 and caught.

[0082] That is, in the first sucking and catching operation, the package 30 is separated from the contact roller 29 and rotated in the unwinding direction A immediately after the yarn cut or the like occurs; therefore, the upper-yarn suction opening 35 can easily suck and catch the yarn end 30a. Consequently, the yarn end 30a is caught successfully. The yarn end 30a easily floats above the surface of the package 30, and therefore, the upper-yarn suction opening 35 need not be arranged very close to the surface of the package 30. Thus, a likelihood of double picking of the yarn 20 is also reduced. Double picking is a phenomenon that the yarn 20 is caught from the middle of the package 30 and not from the yarn end trailing from the package 30.

[0083] In the second sucking and catching operation, the package 30 is accurately positioned with respect to the contact roller 29 when the package 30 comes into contact with the contact roller 29. On the other hand, because driving of the upper-yarn pipe arm 36 is almost not affected by an undefined element like the weight of the package 30, the position of the upper-yarn suction opening 35 relative to the contact roller 29 is substantially accurately controlled to a pre-set position. Therefore, by causing the package 30 to come into contact with the contact roller 29, a distance between the surface of the package 30 and the upper-yarn suction opening 35 can be accurately matched with a predetermined distance set beforehand. The predetermined distance set beforehand is a distance that is best suited for sucking and catching the yarn end 30a and, such a predetermined distance varies according to the type, etc., of the yarn 20. The predetermined distance, for example, is a distance that is regulated by a not shown stopper, and defined by the upper-yarn pipe arm 36 coming into contact with the stopper. The operator can set and input the predetermined distance beforehand from the setting section

91.

[0084] In the second sucking and catching operation, by causing the package 30 to come into contact with the contact roller 29, the distance between the surface of the package 30 and the upper-yarn suction opening 35 can be accurately controlled to the predetermined distance suitable for sucking and catching the yarn end 30a. The distance (degree of approximation) between the surface of the package 30 and the upper-yarn suction opening 35 is reliably secured; therefore, the yarn end 30a is sucked and caught by the upper-yarn suction opening 35 with high probability even in a situation where the yarn end 30a is pressed between the package 30 and the contact roller 29. Consequently, there is a greater likelihood of the yarn end 30a being caught successfully. Because a distance between the surface of the package 30 and the upper-yarn suction opening 35 that is suitable for sucking and catching the yarn end 30a is realized, a likelihood of double picking of the yarn 20 is reduced.

[0085] As described above, the first sucking and catching operation is performed in which the package 30 is rotated in the non-contact state with the contact roller 29, and the second sucking and catching operation is performed in which the package 30 is rotated in the contact state with the contact roller 29. Because the first and second sucking and catching operations with different conditions are consecutively performed, there is a very high likelihood of the yarn end 30a being caught successfully in at least one of the sucking and catching operations. That is, when the package 30 is moved to the non-contact position Q1 after the yarn cut or the like occurs, a case where the yarn end 30a is floating above the surface of the package 30 and a case where the yarn end 30a is not floating above the surface of the package 30 can occur. In the first case where the yarn end 30a is floating above the surface of the package 30, there is a greater likelihood of the yarn end 30a being caught successfully in the first sucking and catching operation. In the second case where the yarn end 30a is not floating above the surface of the package 30, there is a greater likelihood of the yarn end 30a being caught successfully in the second sucking and catching operation. Therefore, by controlling the withdrawing operation and the withdrawing operation described above, the yarn end 30a of the package 30 can be reliably caught.

[0086] Because the package 30 is in the non-contact state with the contact roller 29 in the first sucking and catching operation, the distance between the surface of the package 30 and the upper-yarn suction opening 35 is also likely to vary due to the weight of the package 30 and the mechanical variation, etc., of the winder unit 10. However, because the first and second sucking and catching operations are consecutively performed as described above, there is a greater likelihood of the yarn end 30a being caught successfully, and the necessity for precisely controlling a distance for moving the package 30 to the non-contact position Q1 and the distance between the surface of the package 30 and the upper-yarn suction opening 35 is relatively low. Therefore, by omitting such a control, a complexity of the configuration and an increase in the cost of the winder unit 10 can be avoided.

[0087] Because the second sucking and catching operation is performed irrespective of the success or failure in catching of the yarn end 30a in the first sucking and catching operation, there is no need to detect the success or failure in catching of the yarn end 30a. Therefore, a sensor that detects the yarn 20 sucked by the upper-yarn suction opening 35 can be omitted leading to a simpler configuration and lower cost of the winder unit 10.

[0088] In the winder unit 10, because the package driving motor 41 is attached to the cradle 23, the package 30 can be driven and rotated in the winding direction and the unwinding direction A even if the package 30 is in the non-contact state with the contact roller 29. With this configuration, when the yarn cut or the like occurs, the package 30 is separated from the contact roller 29, and thereafter, the package 30 is decelerated and stopped and rotated in the unwinding direction A. Therefore, when the package 30 is being decelerated and stopped, the yarn end 30a can be prevented from being pressed between the package 30 and the contact roller 29 and entering into the inner layers of the package 30.

[0089] In other yarn winding apparatuses, there is a system in which the yarn is guided through a traverse groove provided on the surface of the contact roller, and traversed (hereinafter, referred to as "traverse drum system"). On the other hand, in the winder unit 10, a system is adopted in which the yarn 20 is traversed by the traverse arm 74 that is an independent traverse guide from the contact roller 29 (hereinafter, referred to as "arm traverse system"); therefore, the traverse groove is not provided on the surface of the contact roller 29. The entire surface of such a contact roller 29 that does not include the traverse groove comes into contact with the package 30. Therefore, if the rotation of the package 30 is continued in a state in which the package 30 is in contact with the contact roller 29 even after occurrence of the yarn cut or the like, there is a greater likelihood of the yarn end 30a being pressed against the surface of the package 30 by the contact roller 29 and entering into the inner layers of the package 30.

[0090] In contrast, in the winder unit 10, the yarn end 30a can be reliably caught by consecutively performing the first and second sucking and catching operations. In a yarn winding apparatus that includes a traverse guide independent from the contact roller, it is more difficult to catch the yarn end. Therefore, the configuration of the winder unit 10 described above is especially effective. Apart from the arm traverse system described above, a so-called belt traverse system disclosed in Japanese Patent Application Laid-open No. 2001-299791, and a so-called rotary traverse system disclosed in Japanese Patent Application Laid-open No. 2002-104729 can be used as the system in which the traverse guide independent from the contact roller is used.

[0091] The horizontal traverse system adopted in the winder unit 10 as well as a so-called perpendicular traverse system can be used as the arm traverse system. The perpendicular traverse system is a system in which the traversing is performed by a traverse device in which a longitudinal direction of the traverse arm is substantially perpendicular to the installation surface of the yarn winding apparatus. The perpendicular traverse system is disclosed in Japanese Patent Application Laid-open No. 2010-13259.

[0092] The present invention is not limited to the embodiments described above. For example, in the above-explained embodiments, the non-contact position Q1 where the package 30 is separated from the contact roller 29 and the contact position Q2 where the package 30 comes into contact with the contact roller 29 are set as the positions of the package 30 for performing the first and second sucking and catching operations, respectively. However, the non-contact position Q1 and the contact position Q2 are merely examples of the first and second positions. That is, two positions, each being at a different distance from the contact roller 29, can be suitably set as the first and second positions. It is not necessary to select a position similar to the position where the winding package comes into contact with the contact roller. Furthermore, in the above-explained embodiments, the first sucking and catching operation is executed at the non-contact position Q1 before the second sucking and catching operation is executed at the contact position Q2. However, the sequence for execution of the first and second sucking and catching operations can be reversed.

[0093] The present invention is applicable to the winder unit 10 in which the horizontal traverse system is adopted; however, the present invention is also applicable to a yarn winding apparatus in which the perpendicular traverse system is adopted. Furthermore, the application of the present invention is not limited to a yarn winding apparatus in which the arm traverse system is adopted, but is also equally applicable to a yarn winding apparatus in which the belt traverse system or the rotary traverse system is adopted. The present invention is also applicable to a yarn winding apparatus in which the traverse drum system is adopted.

[0094] In the winder unit 10 according to the above-explained embodiments, the package driving motor (package driving section) 41 directly drives and rotates the package 30. Alternatively, a system can be used in which the contact roller is driven and rotated, and the package is caused to follow the rotation of the contact roller. In this case, the contact roller is decelerated and stopped and reverse rotated when the yarn cut or the like occurs, and the package following the contact roller is rotated in the unwinding direction. Thereafter, by causing the package to separate from the contact roller, the package can be rotated in the unwinding direction by virtue of inertia when the package is in the non-contact state with the contact roller.

[0095] Although the invention has been described 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 basic teaching herein set forth.

Claims

1. A yarn winding apparatus comprising:

a holding section (23) adapted to rotatably hold a winding package (30);
a touch roller (29) arranged to make contact with the winding package (30);
a yarn-end catching section (35) adapted to catch a yarn end (30a) of a yarn (20) trailing from the winding package (30);
a moving section (60) adapted to move the holding section (23) such that the winding package (30) is held at a first position (Q1) and a second position (Q2), each position being at a different distance from the touch roller (29); and
a control section (50) adapted to control the moving section (60) and the yarn-end catching section (35) such that the yarn-end catching section (35) performs a catching operation when the winding package (30) is held at each of the first position (Q1) and the second position (Q2).

2. The yarn winding apparatus according to Claim 1, wherein
a distance between the first position (Q1) and the touch roller (29) is longer than a distance between the second position (Q2) and the touch roller (29), and
the control section (50) is adapted to control the moving section (60) and the yarn-end catching section (35) such that the catching operation when the winding package (30) is held at the second position (Q2) is performed after the catching operation when the winding package (30) is held at the first position (Q1) is performed.

3. The yarn winding apparatus according to Claim 1 or 2, wherein the control section (50) is adapted to control the moving section (60) such that the winding package (30) is separated from the touch roller (29) at the first position (Q1), and is in contact with the touch roller (29) at the second position (Q2).

4. The yarn winding apparatus according to Claim 3, further comprising:

a package driving section (41) adapted to drive and rotate the winding package (30) in a winding direction and an unwinding direction,

wherein the package driving section (41) is adapted to drive and rotate the winding package (30) in the winding direction and the unwinding direction when the winding package (30) is separated from the touch roller (29).

5. The yarn winding apparatus according to Claim 3, further comprising:

a package driving section (41) adapted to drive and rotate the winding package (30) in a winding direction and an unwinding direction,
wherein the control section (50) is adapted to control the package driving section (41) such that the winding package (30) is driven and rotated in the unwinding direction when the winding package (30) is separated from the touch roller (29).

6. The yarn winding apparatus according to Claim 5, further comprising:

a setting section (91) adapted to set number of rotations in the unwinding direction of the winding package (30) held at the first position (Q1),
wherein the control section (50) is adapted to control the package driving section (41) based on the number of rotations set by the setting section (91).

7. The yarn winding apparatus according to Claim 5 or 6, wherein the package driving section (41) is adapted to drive and rotate the winding package (30) in the winding direction and the unwinding direction when the winding package (30) is separated from the touch roller (29).

8. The yarn winding apparatus according to any one of Claims 1 to 7, wherein the control section (50) is adapted to control a position of the yarn-end catching section (35) such that a predetermined distance set beforehand is provided between the yarn-end catching section (35) and a surface of the winding package (30) when the winding package (30) is held at the second position (Q2).

9. The yarn winding apparatus according to any one of Claims 1 to 8, further comprising a traverse guide (74) that is provided independently from the touch roller (29), and that is adapted to traverse the yarn (20) to be wound on the winding package (30).

10. A yarn withdrawal method by which a yarn end (30a) of a winding package (30) is withdrawn in a yarn winding apparatus (10) that includes
a holding section (23) that rotatably holds the winding package (30),
a touch roller (29) arranged to make contact with the winding package (30), and
a yarn-end catching section (35) that catches the yarn end (30a) of the winding package (30),
the yarn withdrawal method comprising:

a first step of controlling the holding section (23) to hold the winding package (30) at a first position (Q1);
a second step of controlling the yarn-end catching section (35) to perform catching of the yarn end (30a) trailing from the winding package (30) held at the first position (Q1);
a third step of controlling the holding section (23) to hold the winding package (30) at a second position (Q2) that is closer to the touch roller (29) than the first position (Q1) is from the touch roller (29); and
a fourth step of controlling the yarn-end catching section (35) to perform catching of the yarn end (30a) trailing from the winding package (30) held at the second position (Q2).

11. The yarn withdrawal method according to Claim 10, wherein
the first position (Q1) is a position of the winding package (30) when separated from the touch roller (29), and
the second position (Q2) is a position of the winding package (30) when in contact with the touch roller (29).

12. The yarn withdrawal method according to Claim 11, wherein at the second step, the winding package (30) is caused to perform approximately one rotation or less than or equal to one rotation in an unwinding direction.

13. The yarn withdrawal method according to any one of Claims 10 to 12, wherein at the fourth step, the yarn-end catching section (35) performs a catching operation while being positioned at a predetermined distance set beforehand from the winding package (30).

FIG.1

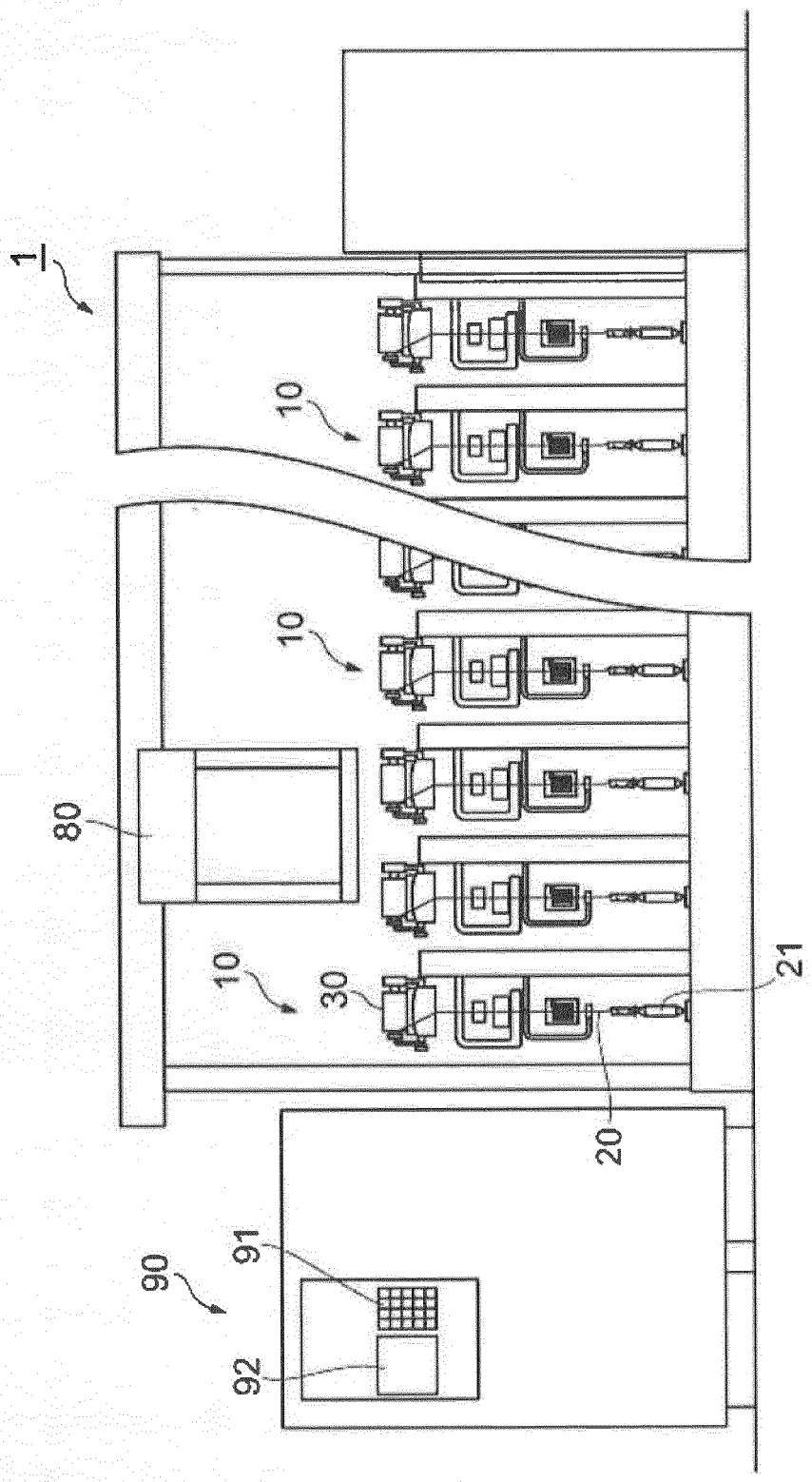
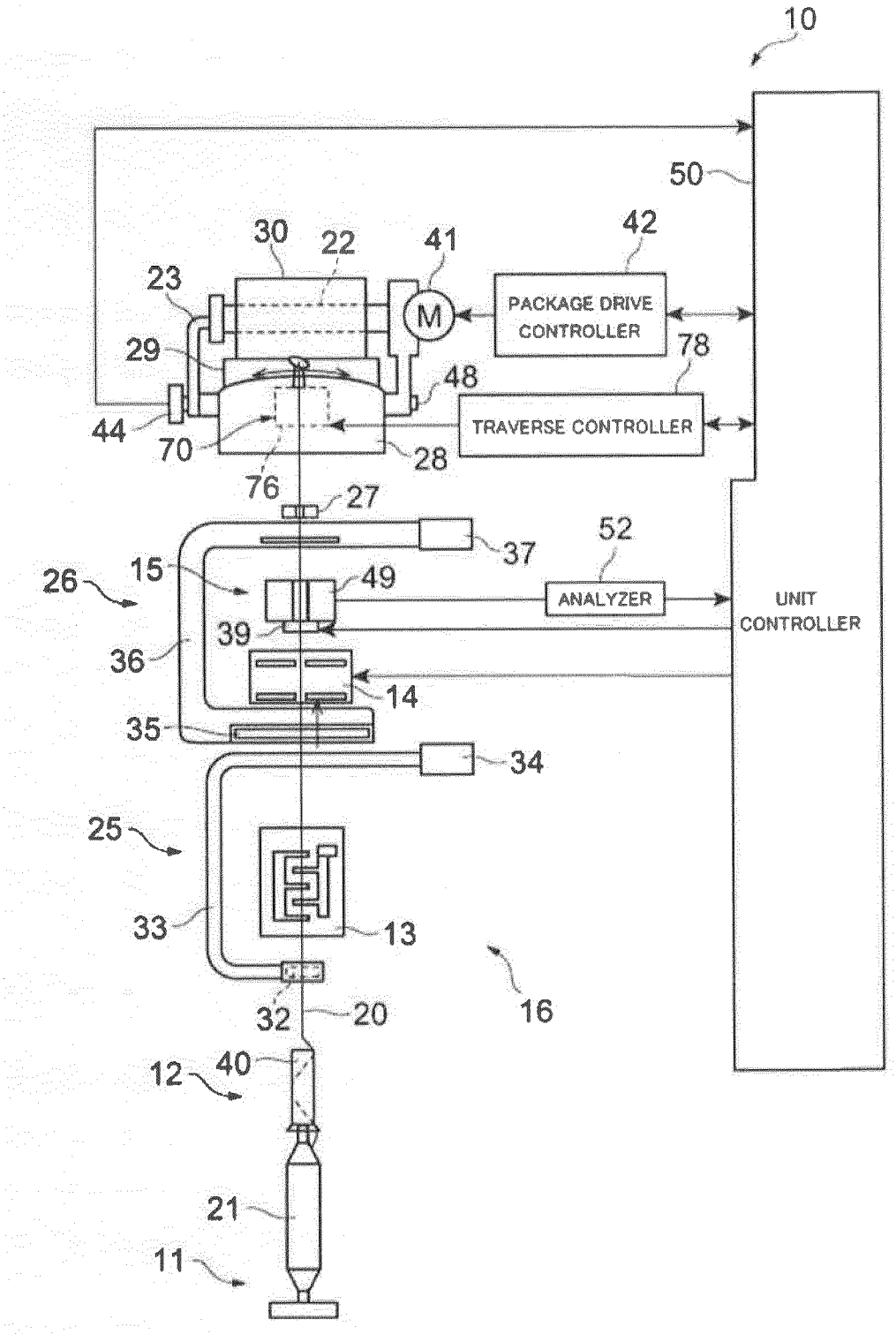


FIG.2


10
50
30
22
41
42
23
M
PACKAGE DRIVE CONTROLLER
29
78
48
44
70
TRAVERSE CONTROLLER
28
76
27
37
52
26
15
49
ANALYZER
UNIT CONTROLLER
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16
32
20
12
40
21
11

FIG.3

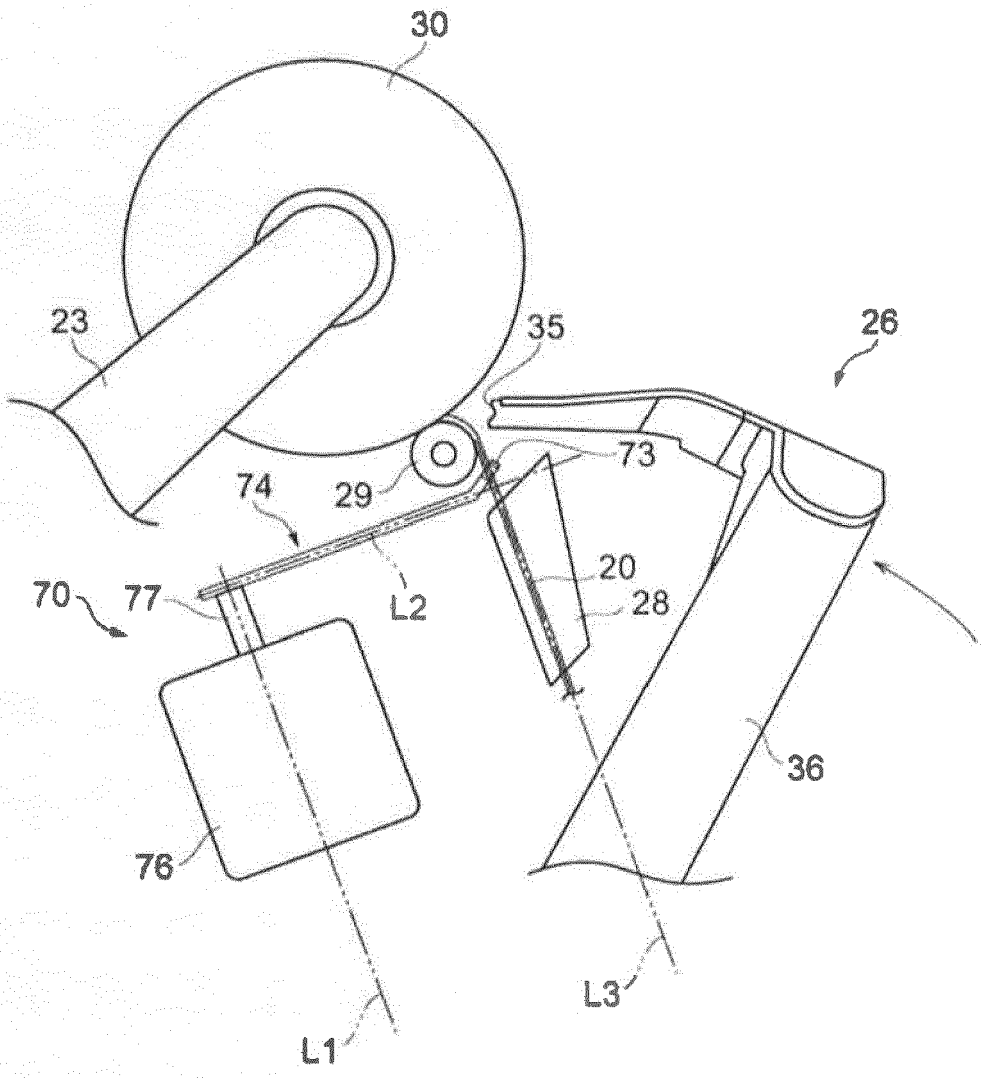


FIG.4

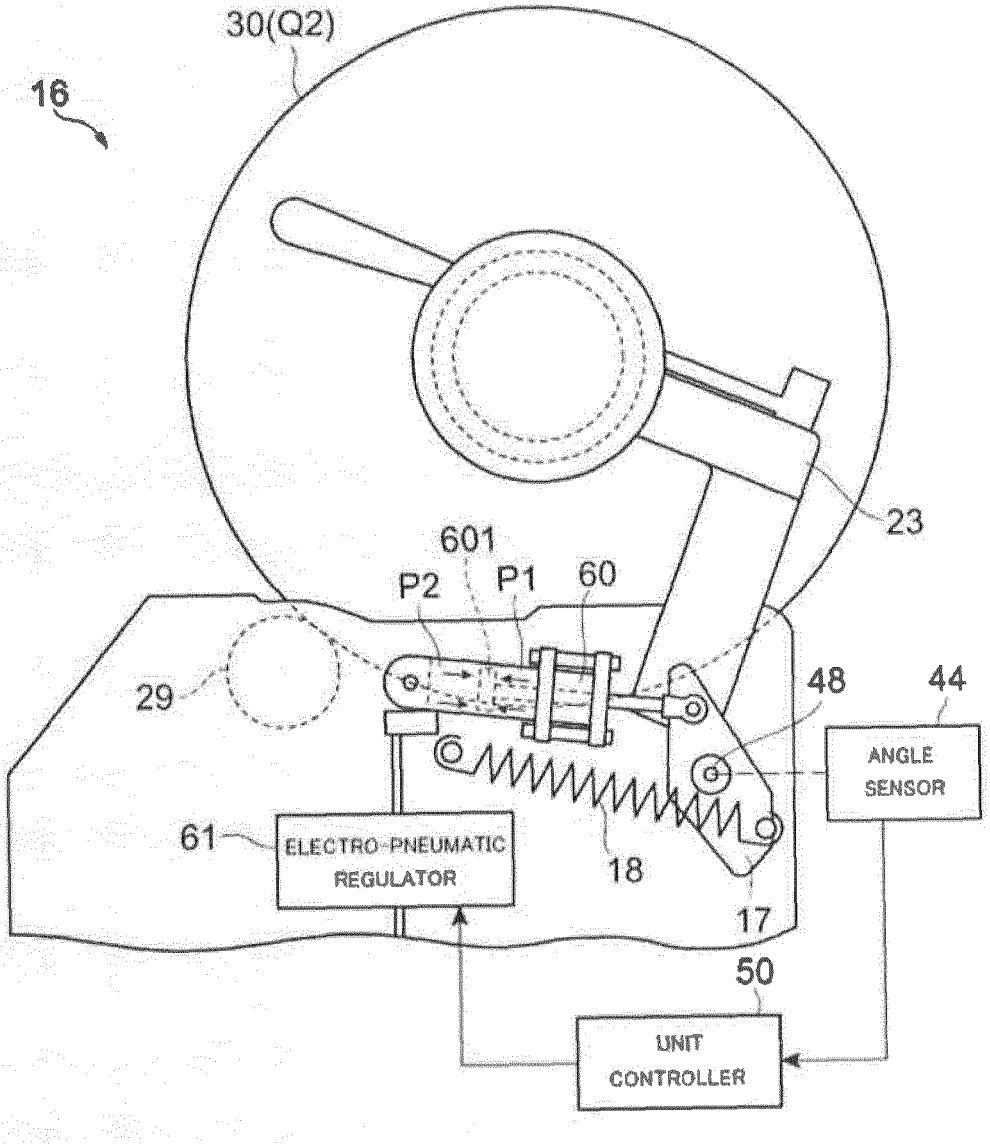

30(Q2)
16
23
601
P2
P1
60
29
48
44
ANGLE SENSOR
61
ELECTRO-PNEUMATIC REGULATOR
18
17
50
UNIT CONTROLLER

FIG.5

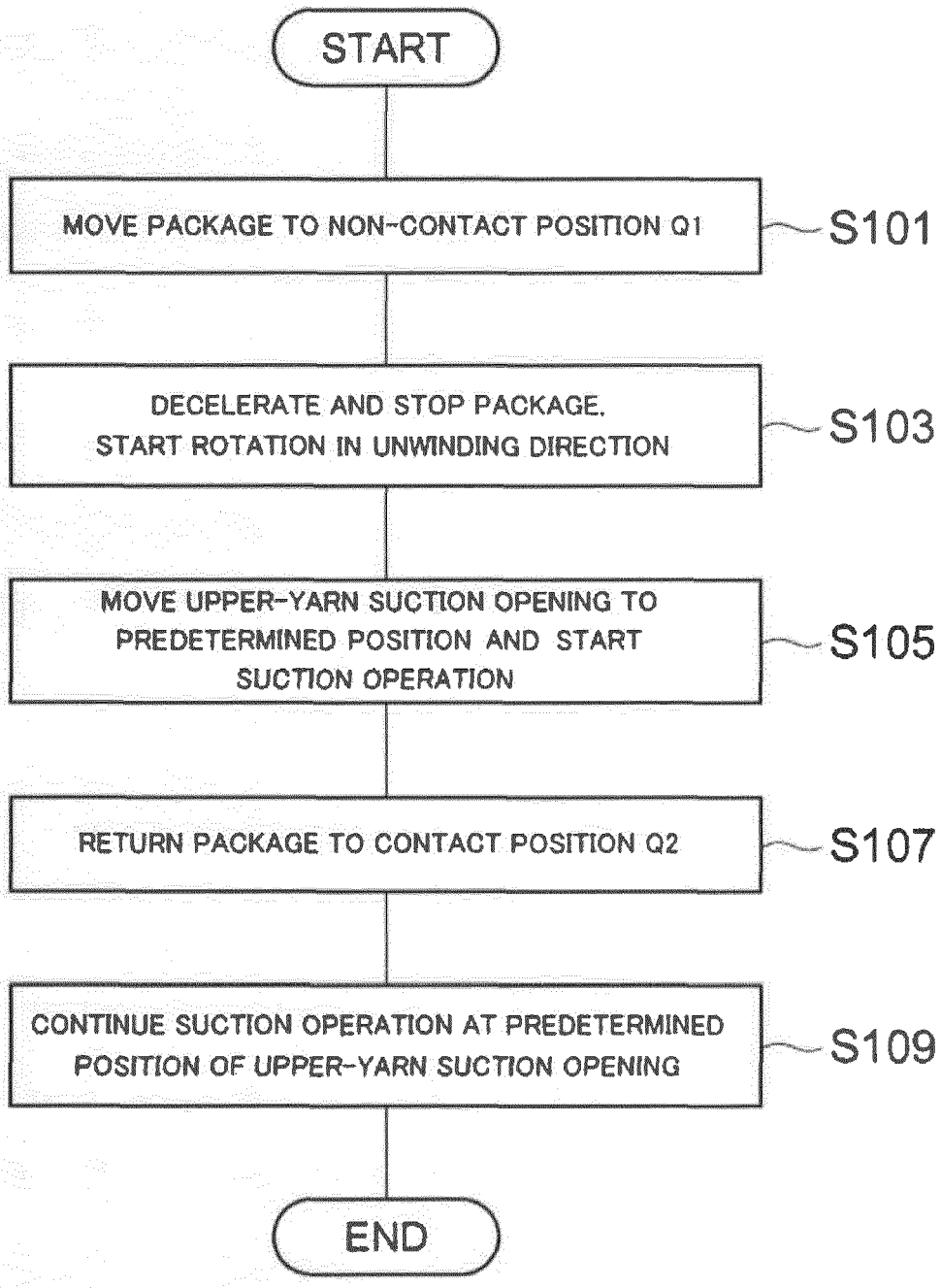
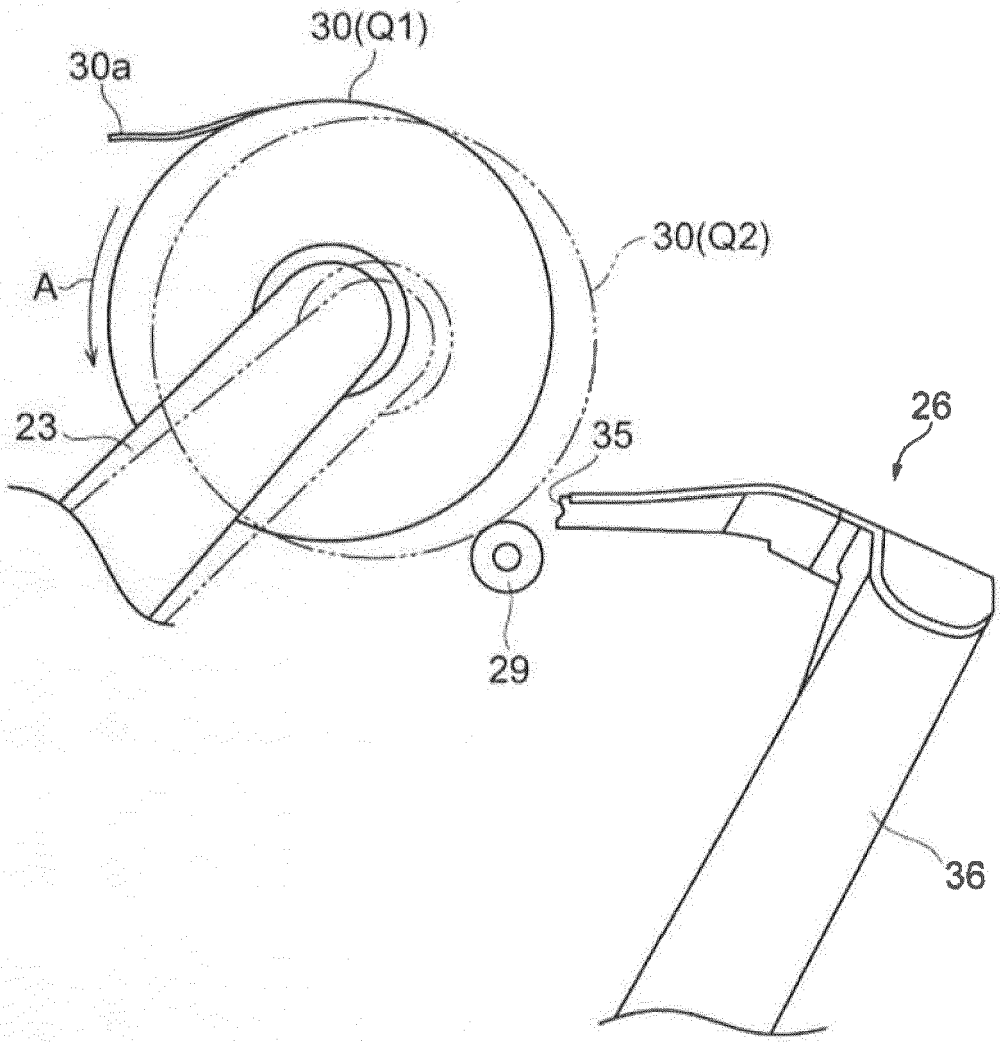

START
MOVE PACKAGE TO NON-CONTACT POSITION Q1
S101
DECELERATE AND STOP PACKAGE.
START ROTATION IN UNWINDING DIRECTION
S103
MOVE UPPER-YARN SUCTION OPENING TO
PREDETERMINED POSITION AND START
SUCTION OPERATION
S105
RETURN PACKAGE TO CONTACT POSITION Q2
S107
CONTINUE SUCTION OPERATION AT PREDETERMINED
POSITION OF UPPER-YARN SUCTION OPENING
S109
END

FIG.6



REFERENCES CITED IN THE DESCRIPTION

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- JP 2003261265 A **[0002] [0003]**
- JP 2001299791 A **[0090]**
- JP 2002104729 A **[0090]**
- JP 2010013259 A **[0091]**