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## (54) Yarn winding machine and yarn withdrawal method

(57) A winder unit 10 includes a package driving motor 41, an upper-yarn catching member, and a unit control section 50. The unit control section 50 is adapted to control the package driving motor 41 to rotationally drive the package 30 at a yarn-end catching speed when the upper-yarn catching member 26 is located at a catching region R1 where the upper-yarn catching member 26 catches a yarn end of the package 30. The unit control section 50 is adapted to control the package driving motor 41 to rotationally drive the package 30 at a yarn guiding speed, which is faster than the yarn-end catching speed, when the upper-yarn catching member 26 moves from the catching region R1 to a guiding target 14.

FIG. 5

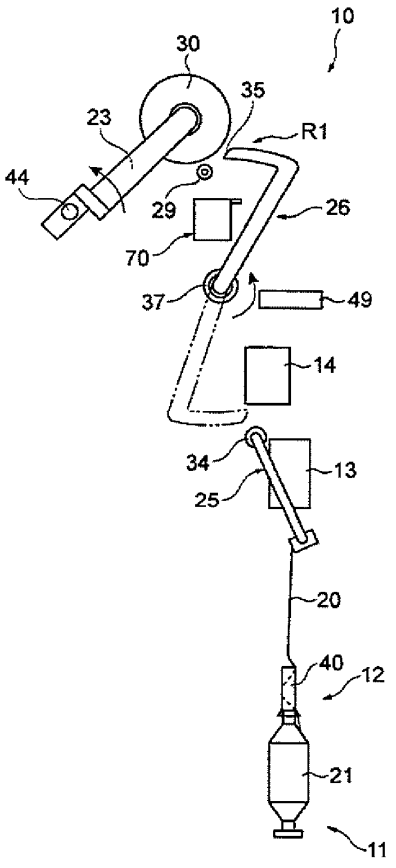


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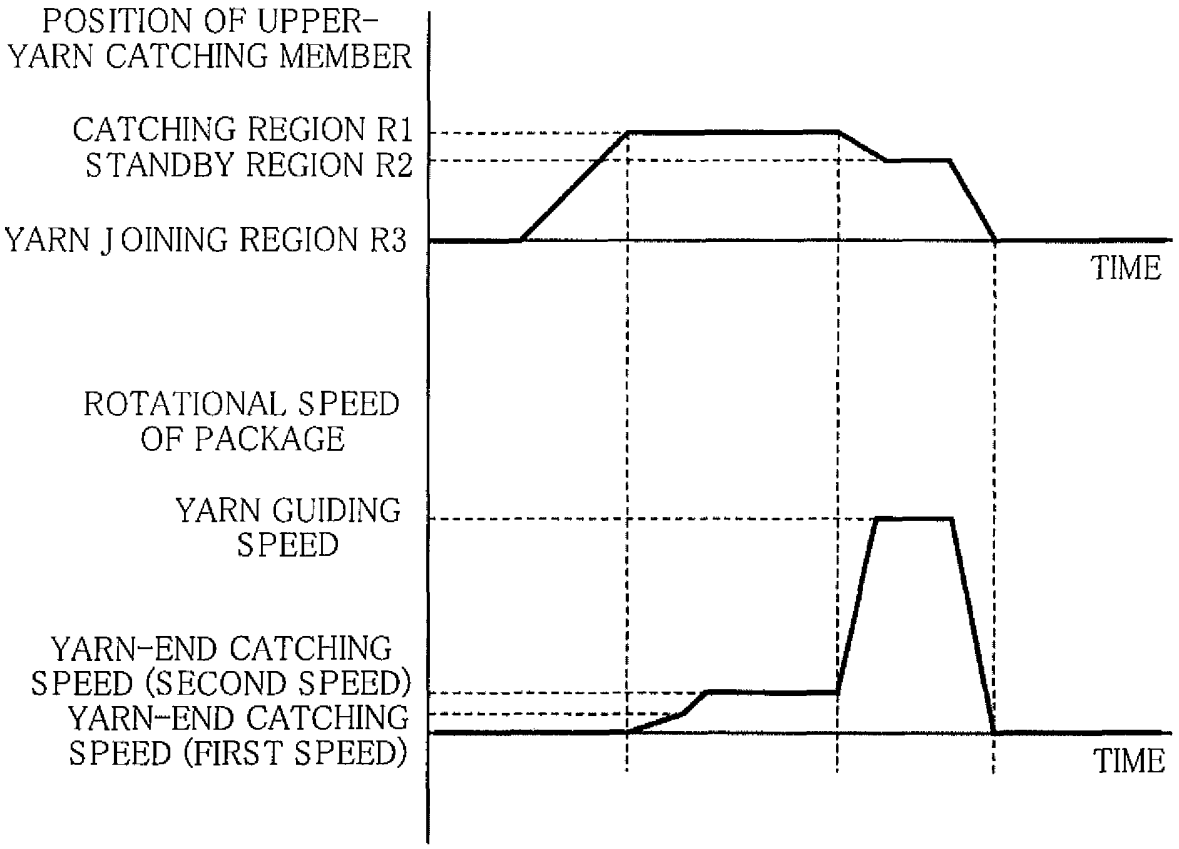
FIG. 10


POSITION OF UPPER-YARN CATCHING MEMBER
CATCHING REGION R1
STANDBY REGION R2
YARN JOINING REGION R3
TIME
ROTATIONAL SPEED OF PACKAGE
YARN GUIDING SPEED
YARN-END CATCHING SPEED (SECOND SPEED)
YARN-END CATCHING SPEED (FIRST SPEED)
TIME

## Description

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

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

#### 2. Description of the Related Art

**[0002]** Conventionally, as an art in this field, there has been known a yarn withdrawal method of a winding package that is disclosed in Japanese Examined Patent Publication No. 2-75674. In the yarn withdrawal method of the winding package, when a suction mouth adapted to suck a yarn end of the package is adjacent to the package, an initial driving to reversely rotate a winding drum at a low speed is started and, after the rotation is performed a set number of times, the winding drum is switched to a normal reverse rotation, which is faster.

### SUMMARY OF THE INVENTION

**[0003]** In a yarn winding machine, when a yarn wound around the package is cut, the yarn end of the package is caught by the suction mouth in the above-described manner and then the caught yarn is guided to a yarn joining device. In the yarn winding machine, since there is a room for further improvement in movement time in which the suction mouth guides the yarn to the yarn joining device, improvement in operation efficiency has been demanded.

**[0004]** An object of the present invention is to provide a yarn winding machine and a yarn withdrawal method that allow for improvement in operation efficiency.

**[0005]** A yarn winding machine includes a driving section adapted to rotationally drive a package around which a yarn is wound, a first catching and guiding device adapted to catch and guide a yarn end of the package and a control section adapted to control movements of the driving section and the first catching and guiding device. When the first catching and guiding device is located at a catching region where the first catching and guiding device catches the yarn end of the package, the control section controls the driving section to rotationally drive the package at a yarn-end catching speed. When the first catching and guiding device moves from the catching region to a guiding target, the control section controls the driving section to rotationally drive the package at a yarn guiding speed that is faster than the yarn-end catching speed. The yarn-end catching speed includes a first speed, at which the first catching and guiding device starts catching the yarn end of the package, and a second speed that is faster than the first speed. The control section may control the driving section to rotate the package at the second speed after rotationally driving the package at the first speed.

**[0006]** Consequently, the yarn can be guided to the guiding target at a high speed by the first catching and guiding device, thereby allowing reduction in the time for guiding the yarn to the guiding target by the first catching and guiding device. In the yarn winding machine, operation efficiency thus can be improved.

**[0007]** In one embodiment, the yarn winding machine may further include a setting section adapted to set a number of rotations , which is a number of times the package is rotated at the yarn-end catching speeds. The control section may control the driving section to rotationally drive the package at the yarn-end catching speeds while the package is being rotated the number of rotations set by the setting section, and after the package is rotated the number of rotations, the control section controls the driving section to rotationally drive the package at the yarn guiding speed. When the package has rotated the number of rotations at the yarn-end catching speed, the yarn winding machine assumes that the yarn end of the package has been caught by the catching and guiding device, and proceeds to a control in which the package is rotationally driven at the yarn guiding speed. By assuming without using a sensor or the like that the first catching and guiding device has caught the yarn end of the package, switching from the yarn-end catching speed to the yarn guiding speed can be performed with a simple configuration and control.

**[0008]** In one embodiment, the yarn winding machine may further include a yarn supplying section adapted to supply the yarn to be wound around the package, a second catching and guiding device adapted to catch and guide a yarn end from the yarn supplying section, and a yarn joining device adapted to join the yarn of the package guided by the first catching and guiding device and the yarn from the yarn supplying section guided by the second catching and guiding device when continuation of the yarn between the yarn supplying section and the package is disconnected. When guiding the yarn of the package by the first catching and guiding device to the yarn joining device, the control section may control the driving section to rotationally drive the package at the yarn guiding speed. This allows reduction in the time for yarn joining operation when continuation of the yarn is disconnected.

**[0009]** In one embodiment, the yarn winding machine may further include a yarn defect detecting device adapted to detect a presence or an absence of a yarn defect included in the yarn wound around the package, and a cutting device adapted to cut the yarn upon detection of the presence of the yarn defect by the yarn defect detecting device. When the cutting device cuts the yarn, the control section may control the first catching and guiding device to catch the yarn end of the package while rotationally driving the package at the yarn-end catching speeds, and then to control the first catching and guiding device to guide the yarn of the package while rotationally driving the package at the yarn guiding speed. The yarn defect can be removed in a short time when the presence

of the yarn defect is detected.

**[0010]** In one embodiment, the first catching and guiding device may include a suction mouth adapted to suck the yarn end of the package. The first catching and guiding device may be arranged such that the suction mouth is movable to a catching region, a standby region located farther away from the package than the catching region and a yarn joining region where the yarn of the package is guided to the yarn joining device. When the suction mouth is located at the standby region, the control section may control the driving section to rotationally drive the package at the yarn guiding speed. Consequently, the suction mouth of the first catching and guiding device can be reliably moved to the catching region, the standby region and the yarn joining region. Furthermore, in the yarn winding machine, since the package is rotationally driven at the yarn guiding speed at the standby region even in a case of a long yarn defect, the yarn defect can be collected in a short time.

**[0011]** In one embodiment, the driving section may directly drive the package. The package can be reliably rotated at the yarn-end catching speeds and the yarn guiding speed.

**[0012]** In one embodiment, the yarn winding machine may further include a contact roller adapted to be rotated in contact with the package, and a traverse guide. The traverse guide is arranged independently from the contact roller and is adapted to traverse the yarn to be wound around the package. When continuation of the yarn is disconnected, the control section may control the traverse guide to standby at one end in a traverse direction of the traverse guide. When performing the yarn joining operation or the like upon disconnection of the yarn, the yarn can be restrained from being caught in the traverse guide.

**[0013]** In one embodiment, the yarn winding machine may further include a contact roller adapted to be rotated in contact with the package, and a switching device. The switching device switches the package and the contact roller between a contacting state and a non-contacting state. When the first catching and guiding device catches the yarn end of the package, the switching device may switch the package and the contact roller to the non-contacting state. When catching the yarn end of the package, the yarn end can be prevented from being sandwiched between the package and the contact roller and from sticking to a surface of the package. In the yarn winding machine, the yarn end of the package thus can be reliably caught.

**[0014]** Further, a yarn withdrawal method for withdrawing a yarn end of a package in a winding machine including a driving section adapted to rotationally drive the package around which the yarn is wound, and a catching and guiding device adapted to catch and guide the yarn end of the package is enclosed. The yarn withdrawal method includes rotationally driving the package at a first speed, which is one of the yarn-end catching speeds, when the catching and guiding device is located at a catching region where the catching and guiding device catches the yarn end of the package, and starts catching the yarn end of the package. The yarn withdrawal method further includes, after the package is rotationally driven at the first speed, maintaining the catching and guiding device at the catching region and rotationally driving the package at a second speed, which is one of the yarn-end catching speeds and is faster than the first speed. The withdrawal method further includes, when moving the catching and guiding device from the catching region to a guiding target, rotationally driving the package at a yarn guiding speed, which is faster than the yarn-end catching speeds.

**[0015]** In the yarn withdrawal method, when the catching and guiding device moves to the guiding target after catching the yarn end of the package at the yarn-end catching speed at the catching region, the package is rotationally driven at the yarn guiding speed, which is faster than the yarn-end catching speeds. Consequently, in the yarn withdrawal method, the yarn can be guided to the guiding target at a high speed by the catching and guiding device, thereby allowing reduction in the time for guiding the yarn to the guiding target. In the yarn withdrawal method, operation efficiency thus can be improved.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0016]**

FIG. 1 is a schematic front view illustrating an automatic winder including a winder unit according to one embodiment;

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

FIG. 3 is an enlarged left-side view illustrating a portion in proximity to a traverse device of the winder unit;

FIG. 4 is an enlarged right-side view of a portion in proximity to a cradle of the winder unit;

FIG. 5 is a left-side view of the winder unit;

FIG. 6 is a left-side view of the winder unit;

FIG. 7 is a left-side view of the winder unit;

FIG. 8 is a left-side view illustrating a package moving to a non-contact position or a contact position;

FIG. 9 is a diagram illustrating a relation between rotational speeds of the package and movements of an upper-yarn catching member;

FIG. 10 is a diagram illustrating a relation between the rotational speeds of the package and the movements of the upper-yarn catching member according to an alternative embodiment; and

FIG. 11 is a diagram illustrating a relation between the rotational speeds of the package and the movements of the upper-yarn catching member according to a still further alternative embodiment.

## DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

**[0017]** A preferred embodiment of the present invention will be hereinafter described in detail with reference to the attached drawings. The same reference numerals are denoted on the same or corresponding portions throughout the drawings, and redundant description will be omitted.

**[0018]** An overall configuration of an automatic winder 1 including a winder unit (yarn winding machine) 10 of the present embodiment will be described with reference to FIG. 1. "Upstream" and "downstream" in the present specification respectively indicate upstream and downstream in a traveling direction of a yarn 20 at the time of yarn winding.

**[0019]** As illustrated in FIG. 1, the automatic winder 1 includes as main components, a plurality of the winder units 10 arranged next to each other, an automatic doffing device 80 and a machine setting device 90.

**[0020]** Each of the winder units 10 is capable of forming a package 30 by winding the yarn 20 unwound from a yarn supplying bobbin 21 while traversing the yarn 20.

**[0021]** When the package 30 is fully wound in each winder unit 10, the automatic doffing device 80 travels to a position of the relevant winder unit 10 and removes the fully-wound package 30 from the winder unit 10. The automatic doffing device 80 may supply an empty bobbin to the winder unit 10 after removing the package 30.

**[0022]** The machine setting device 90 includes as main components, a setting section 91 and a display section 92. The setting section 91 is capable of performing setting to each winder unit 10 when an operator inputs a predetermined set value or selects an appropriate control method. The display section 92 is capable of displaying a winding status of the yarn 20 of each winder unit 10, contents of an occurred trouble, or the like.

**[0023]** Next, a configuration of the winder unit 10 will be specifically described with reference to FIGS. 2 to 8. As illustrated in FIG. 2, each winder unit 10 includes a winding unit main body 16 and a unit control section (control section) 50.

**[0024]** The winding unit main body 16 includes a yarn unwinding assisting device 12, a tension applying device 13, a splicer device (yarn joining device, guiding target) 14 and a clearer (yarn defect detecting device) 15 sequentially arranged from a side of the yarn supplying bobbin 21 in a yarn traveling path between the yarn supplying bobbin 21 and a contact roller 29.

**[0025]** A yarn supplying section 11 adapted to supply the yarn 20 to the winding bobbin 22 is provided in a lower part of the winding unit main body 16 in a direction of machine height. The yarn supplying section 11 is capable of holding at a predetermined position, the yarn supplying bobbin 21 transported by a bobbin transporting system, which is not illustrated.

**[0026]** By lowering a regulating member 40 adapted to cover a core tube of the yarn supplying bobbin 21 in conjunction with unwinding of the yarn 20 from the yarn supplying bobbin 21, the yarn unwinding assisting device 12 assists the unwinding of the yarn 20 from the yarn supplying bobbin 21. The regulating member 40 makes contact with a balloon of the yarn 20, which is formed in an upper portion of the yarn supplying bobbin 21 with swinging and centrifugal force of the yarn 20 unwound from the yarn supplying bobbin 21, and controls the balloon to an appropriate size to assist unwinding of the yarn 20. A sensor (not illustrated) adapted to detect a chase section of the yarn supplying bobbin 21 is provided in proximity to the regulating member 40. When the sensor detects lowering of the chase section, the yarn unwinding assisting device 12 can lower the regulating member 40 with an air cylinder (not illustrated), e.g., following the chase section.

**[0027]** The tension applying device 13 applies a predetermined tension on the travelling yarn 20. The tension applying device 13 may be, e.g., a gate type in which movable comb teeth are arranged with respect to fixed comb teeth. The movable comb teeth can be swung by a rotary solenoid such that the movable comb teeth and the fixed comb teeth are engaged with each other or released from each other. The tension applying device 13 may be, e.g., a disc type other than the above-described gate type.

**[0028]** The splicer device 14 joins a lower yarn from the yarn supplying bobbin 21 and an upper yarn from the package 30 at the time of a yarn cut performed by the clearer 15 upon detection of a presence a yarn defect, at the time of a yarn breakage during unwinding of the yarn 20 from the yarn supplying bobbin 21, or the like. As a yarn joining device adapted to join the upper yarn and the lower yarn in such a manner, a mechanic type, a type that uses fluid such as compressed air, or the like may be employed.

**[0029]** The clearer 15 includes a clearer head 49 in which a sensor (not illustrated) adapted to detect a thickness of the yarn 20 is arranged, and an analyzer 52 adapted to process a yarn thickness signal from the sensor. The clearer 15 detects the yarn defect such as a slub by monitoring the yarn thickness signal from the sensor. A cutter (cutting device) 39 is provided in proximity to the clearer head 49 to immediately cut the yarn 20 when the clearer 15 detects the yarn defect. The clearer 15 may detect a presence or an absence of a foreign substance included in the yarn 20 as a presence or an absence of the yarn defect.

**[0030]** Above and below the splicer device 14, there are respectively provided a lower-yarn catching member (second catching and guiding device) 25 adapted to catch a yarn end from the yarn supplying bobbin 21 and guide the yarn end to the splicer device 14 and an upper-yarn catching member (first catching and guiding device, catching and guiding device) 26 adapted to catch a yarn end from the package 30 and 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 suc-

tion mouth 32 that is formed at a tip end 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 mouth (suction mouth) 35 that is formed at a tip end of the upper-yarn pipe arm 36.

**[0031]** The lower-yarn pipe arm 33 and the upper-yarn pipe arm 36 are respectively swingable with shafts 34 and 37 as a center. An appropriate negative pressure source is connected to each of the lower-yarn pipe arm 33 and the upper-yarn pipe arm 36. In this manner, suction flow is generated in the lower-yarn suction mouth 32 and the upper-yarn suction mouth 35, and thereby the yarn ends of the upper yarn and the lower yarn can be sucked and caught.

**[0032]** As illustrated in FIGS. 5 to 7, the upper-yarn catching member 26 is arranged in a movable manner such that the upper-yarn suction mouth 35 is positioned at a catching region R1, a standby region R2 and a yarn joining region R3. The catching region R1 is located in proximity to the package 30 and is a region where a yarn end 30a of the package 30 can be caught. The standby region R2 is a region where the upper-yarn suction mouth 35 is located farther away from the package 30 than the catching region R1 by the upper-yarn pipe arm 36 of the upper-yarn catching member 26 being swung in a direction to be farther away from the package 30 than the catching region R1. The yarn joining region R3 is a region where the yarn end 30a, which has been caught in the catching region R1, is guided to the splicer device 14 and can be joined by the splicer device 14. The standby region R2 and the yarn joining region R3 are regions where the upper-yarn catching member 26 is positioned when moving from the catching region R1 to the splicer device 14.

**[0033]** As illustrated in FIG. 2, the winding unit main body 16 includes a cradle 23 adapted to support the winding bobbin 22 in a removable manner and the contact roller 29 capable of rotating while making contact with a peripheral surface of the winding bobbin 22 or a peripheral surface of the package 30. The winding unit main body 16 includes in proximity to the cradle 23, an arm-type traverse device 70 adapted to traverse the yarn 20, and is capable of winding the yarn 20 around the package 30 while traversing the yarn 20 with the traverse device 70.

**[0034]** A guide plate 28 is arranged slightly upstream of a traverse position. The guide plate 28 guides the upstream yarn 20 to the traverse position. A ceramic traverse fulcrum 27 is arranged further upstream of the guide plate 28. The traverse device 70 traverses the yarn 20 in a winding width direction of the package 30 (a direction indicated by an arrow in FIG. 2) with the ceramic traverse fulcrum 27 as a fulcrum.

**[0035]** The cradle 23 is capable of swinging with a swinging shaft 48 as a center. An increase in a yarn layer diameter of the package 30 associated with winding the yarn 20 around the winding bobbin 22 can be absorbed with swinging the cradle 23.

**[0036]** A package driving motor (driving section) 41 formed of a servomotor, e.g., is mounted to the cradle 23. The winder unit 10 winds the yarn 20 by rotationally driving the winding bobbin 22 with the package driving motor 41. The package driving motor 41 is capable of rotationally driving the winding bobbin 22 (package 30) in a winding direction as well as in an unwinding direction A.

**[0037]** A motor shaft of the package driving motor 41 is coupled to the winding bobbin 22 so as not to be relatively rotatable with respect to the winding bobbin 22 when the winding bobbin 22 is supported by the cradle 23 (a so-called direct drive system). Movements of the package driving motor 41 are controlled by a package driving control section (control section) 42. The package driving control section 42 controls the package driving motor 41 to operate or stop in response to a drive signal from the unit control section 50. As the package driving motor 41, various motors such as a step motor, an induction motor, and the like may be employed without being limited to the servomotor.

**[0038]** An angle sensor 44 adapted to detect an angle of the cradle 23 is mounted to the swinging shaft 48. The angle sensor 44 is formed of a rotary encoder, e.g., and transmits an angle signal, which corresponds to the angle of the cradle 23, to the unit control section 50. Since the angle of the cradle 23 changes as a wound diameter of the package 30 increases, the diameter of the package 30 can be detected by detecting a swing angle of the cradle 23 with the angle sensor 44. Any appropriate configuration may be employed to detect the diameter of the package 30 other than the angle sensor 44. For example, a configuration that uses a Hall IC or an absolute type encoder may be employed to detect the diameter of the package 30.

**[0039]** Next, a layout of a configuration of the traverse device 70 and a configuration in proximity to the traverse device 70 will be described with reference to FIG. 3. In the present embodiment, since the contact roller 29 is arranged such that an axial direction thereof corresponds to a lateral direction of the winding unit main body 16, side views such as FIG. 3, e.g., can be a view in the axial direction of the contact roller 29. In FIG. 3, rotation of the package 30 in the winding direction is clockwise and rotation of the package 30 in the unwinding direction is counterclockwise.

**[0040]** As illustrated in FIG. 3, the traverse device 70 includes a traverse driving motor 76, an output shaft 77 and a traverse arm (traverse guide) 74.

**[0041]** The traverse driving motor 76 is adapted to drive the traverse arm 74 and is formed of a servomotor or the like. As illustrated in FIG. 2, operations of the traverse driving motor 76 are controlled by a traverse control section 78. The traverse driving motor 76 may be another motor such as a step motor, a voice coil motor, or the like.

**[0042]** The traverse control section 78 is formed of hardware such as a dedicated microprocessor or the like and is adapted to control the traverse driving motor 76 to operate or stop in response to a signal from the unit

control section 50.

**[0043]** Power of the traverse driving motor 76 is transmitted to a base-end portion of the traverse arm 74 via the output shaft 77 illustrated in FIG. 3. Since a rotor of the traverse driving motor 76 forwardly and reversely rotates, the traverse arm 74 swings into and/or out of the page of FIG. 3 (in a left-right direction (traverse direction) of FIG. 2). The traverse arm 74 in FIG. 3 indicates a position at a traverse end portion.

**[0044]** A hook-shaped yarn guiding section 73 is formed at a tip-end portion of the traverse arm 74. The yarn guiding section 73 can hold and guide the yarn 20. The yarn guiding section 73 reciprocates in a state of holding the yarn 20, thereby allowing traverse of the yarn 20.

**[0045]** Next, a configuration of the cradle 23 will be described in further detail with reference to FIG. 4. As illustrated in FIG. 4, the winding unit main body 16 includes a rotating plate 17 adapted to be capable of rotating with the swinging shaft 48 as a center. The cradle 23 swings with the swinging shaft 48 as a center in a unified manner with the rotating plate 17. A spring 18 formed as a tension spring for gradually decreasing contact pressure, and an air cylinder (switching device) 60 are connected to the rotating plate 17. A predetermined swinging torque can be applied to the cradle 23 by the spring 18 and the air cylinder 60.

**[0046]** The air cylinder 60 is formed as a double-acting cylinder that includes a piston 601 in an interior thereof. In FIG. 4, compressed air of air pressure P1 and compressed air of air pressure P2 are respectively supplied to a cylinder chamber in a right side and a cylinder chamber in a left side of a drawing of the piston 601.

**[0047]** An electro-pneumatic regulator 61 is connected to a pipe that supplies the compressed air of the air pressure P2 to the air cylinder 60. The electro-pneumatic regulator 61 is capable of adjusting the air pressure P2 steplessly. The electro-pneumatic regulator 61 performs control of the air pressure P2 based on a control signal input from the unit control section 50.

**[0048]** In a configuration illustrated in FIG. 4, since force of the air cylinder 60 to pull the cradle 23 increases when the air pressure P2 is reduced, torque that causes the cradle 23 to swing to a front side of the winding unit main body 16 with the swinging shaft 48 as a center increases. Since the contact roller 29 is arranged closer to the front side of the winding unit main body 16 than the swinging shaft 48, contact pressure between the package 30 and the contact roller 29 can be increased with the decrease of the air pressure P2. On the contrary, since the force of the air cylinder 60 to pull the cradle 23 decreases when the air pressure P2 is increased, torque that causes the cradle 23 to swing to a rear side of the winding unit main body 16 with the swinging shaft 48 as a center increases. Consequently, the contact pressure between the package 30 and the contact roller 29 can be weakened. By further increasing the air pressure P2, the package 30 can even be located away from a surface of the contact roller 29.

**[0049]** The air cylinder 60 can swing the cradle 23 and thereby move the package 30. In this case, the package 30 can be moved to a position where the package 30 is located away from the contact roller 29 (a position where the package 30 is not in contact with the contact roller 29) and a position where the package 30 is in contact with the contact roller 29. In other words, the air cylinder 60 can switch the package 30 and the contact roller 29 between a contacting state and a non-contacting state.

**[0050]** The unit control section 50 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 program to control each component of the winding unit main body 16 is recorded in the ROM. Each section, which is provided in the winding unit main body 16, and the machine setting device 90 are connected to the I/O port and the communication port, which enables communication of control information or the like. Consequently, the unit control section 50 can control movements of each section provided in the winding unit main body 16.

**[0051]** The unit control section 50 transmits a drive signal to the package driving control section 42 to control a rotational driving (rotational speed) of the package driving motor 41. The unit control section 50 controls movements of the lower-yarn catching member 25 and the upper-yarn catching member 26 (swings of the lower yarn pipe arm 33 and the upper yarn pipe arm 36) by controlling a motor, which is not illustrated.

**[0052]** The setting section 91 of the machine setting device 90 illustrated in FIG. 1 sets a number of rotations, which is a number of times the package 30 is rotated at a yarn-end catching speed (to be described later in detail) in the unwinding direction A, when continuation of the yarn 20 is disconnected (hereinafter referred to as a "yarn disconnection and the like") such as a yarn cut performed by the clearer 15 upon detection of a yarn defect, or a yarn breakage during unwinding of the yarn 20 from the yarn supplying bobbin 21. The setting section 91 sets the number of rotations of the package 30 based on, e.g., the diameter of the package 30 detected by the angle sensor 44 or the like. In a case, e.g., where the diameter of the package 30 is small, the setting section 91 sets the number of rotations large since the yarn end 30a is unlikely to come off a surface of the package 30. While in a case where the diameter of the package 30 is large, the setting section 91 sets the number of rotations small since the yarn end 30a is likely to come off the surface of the package 30. The setting section 91 transmits the set of number of rotations of the package 30 to the unit control section 50.

**[0053]** The setting section 91 may set the rotational number of the package 30 in the unwinding direction A at the time of the yarn disconnection and the like based on information that has been set and input in advance. In other words, the setting section 91 sets the rotational number of the package 30 based on information input

from the setting section 91 with a key operation and the like by an operator. In such a configuration, the operator can set the rotational number of the package 30 to a desired number.

**[0054]** In the above-described winder unit 10, when the yarn disconnection and the like occurs, the lower yarn and the upper yarn are required to be joined by the splicer device 14. Thus, the upper yarn of the package 30 is required to be caught and withdrawn with the upper yarn suction mouth 35, and the lower yarn of the yarn supplying bobbin 21 is required to be caught with the lower yarn suction mouth 32. Control of a withdrawing operation of the upper yarn and a yarn withdrawal method both performed in the winder unit 10 will be described in detail with reference to FIGS. 2 to 9.

**[0055]** As illustrated in FIG. 3, during winding operation before the yarn disconnection and the like occurs, the surface of the package 30 is in contact with the contact roller 29. A position of the package 30 where the package 30 is in contact with the contact roller 29 is hereinafter referred to as a "contact position" and is indicated by a reference symbol "Q2" in FIGS. 4 and 8.

**[0056]** Immediately after the yarn disconnection and the like occurs during the winding operation, the unit control section 50 transmits a drive signal to the electro-pneumatic regulator 61. Since the electro-pneumatic regulator 61 is driven based on the drive signal, the air pressure P2 of the air cylinder 60 is changed, thereby, as illustrated in FIGS. 5 and 8, causing the cradle 23 to be driven in a direction in which the cradle 23 moves away from the contact roller 29. The unit control section 50 transmits a drive signal to the traverse control section 78 to drive the traverse driving section 76 and causes the traverse arm 74 to standby at a position located at one end in the traverse direction.

**[0057]** The package 30 is moved away from the contact roller 29 and is held at a predetermined position where the package 30 is not in contact with the contact roller 29. The position of the transferred package 30 of this time is hereinafter referred to as a "non-contact position" and is indicated by a reference symbol "Q1" in FIG. 8. Simultaneously, the unit control section 50 transmits the drive signal to the package driving control section 42 to decelerate and stop the rotation of the package 30 and then to start the rotation of the package 30 in the unwinding direction (a direction indicated by an arrow A). At this time, as illustrated in FIG. 9, the unit control section 50 rotationally drives the package driving motor 41 at the yarn-end catching speed.

**[0058]** The unit control section 50 sets the yarn-end catching speed, e.g., as follows. In the case where the diameter of the package 30 is small, since the yarn end 30a is unlikely to come off the surface of the package 30, the unit control section 50 sets the yarn-end catching speed so as to slowly rotate the package 30. In the case where the diameter of the package 30 is large, since the yarn end 30a is likely to come off the surface of the package 30, the unit control section 50 sets the yarn-end catching speed faster in comparison with the case where the diameter of the package 30 is small.

**[0059]** Furthermore, the unit control section 50 swings the upper yarn pipe arm 36 by transmitting a drive signal to the upper-yarn catching member 26 and, as illustrated in FIGS. 5 and 9, moves the upper yarn suction mouth 35 to a position at a catching region R1 in proximity to the surface of the package 30. Under a state where the package 30 at the non-contact position Q1 is rotated at the yarn-end catching speed in the unwinding direction A, the upper yarn suction mouth 35 performs the catching operation. By the above-described catching operation, the yarn end 30a of the upper yarn connected to the package 30 can be sucked and caught by the upper yarn suction mouth 35.

**[0060]** When the package 30 is rotated at the yarn-end catching speed the number of times set by the setting section 91 and the yarn end 30a is sucked and caught by the upper yarn suction mouth 35 in the above-described catching operation, the unit control section 50 drives the cradle 23 in a direction in which the cradle 23 becomes closer to the contact roller 29. Consequently, the package 30 returns to the contact position Q2 where the package 30 is in contact with the contact roller 29. At this time, since the rotation of the package 30 in the unwinding direction A is continued, the package 30 rotates in the unwinding direction A while being in contact with the contact roller 29, and thereby the contact roller 29 rotates with the package 30.

**[0061]** When the yarn end 30a of the package 30 is sucked and caught by the upper yarn suction mouth 35, the unit control section 50 controls the upper-yarn catching member 26 to swing the upper yarn pipe arm 36 and, as illustrated in FIGS. 6 and 9, move the upper yarn suction mouth 35 to a position at a standby region R2 where the upper yarn suction mouth 35 is located away from the package 30, and then stop the upper yarn suction mouth 35. Simultaneously, the unit control section 50 transmits the drive signal to the package driving control section 42 and, as illustrated in FIG. 9, rotationally drives the package 30 at a yarn guiding speed, which is faster than the yarn-end catching speed, in the unwinding direction A. With the above-described catching operation, the upper yarn of the package 30 is further sucked and caught by the upper yarn suction mouth 35.

**[0062]** In a case, e.g., where the clearer 15 detects a yarn defect of the yarn 20 and cuts the yarn 20 with the cutter 39, a standby time (stopping time) of the upper-yarn catching member 26 at the standby region R2 may be set based on a length of the yarn defect of the yarn 20, which is detected by the clearer 15.

**[0063]** Subsequently, the unit control section 50 controls the upper-yarn catching member 26 to swing the upper yarn pipe arm 36 and, as illustrated in FIGS. 7 and 9, move the upper yarn suction mouth 35 to the yarn joining region R3. Simultaneously, the unit control section 50 transmits the drive signal to the package driving control section 42 to decelerate and stop the rotation of the

package 30. Consequently, the package 30 stops being rotationally driven. As described above, the yarn end 30a of the package 30 is caught with the upper yarn suction mouth 35 and the yarn 20 is guided to the splicer device 14.

**[0064]** As described above, in the winder unit 10 of the present embodiment, when the upper-yarn catching member 26 is located at the standby region R2 after catching at the catching region R1, the yarn end 30a of the package 30 rotating at the yarn-end catching speed, the unit control section 50 controls the package driving motor 41 to rotationally drive the package 30 at the yarn guiding speed that is faster than the yarn-end catching speed. Consequently, in the winder unit 10, the yarn 20 can be guided to the splicer device 14 at a high speed by the upper-yarn catching member 26, thereby allowing reduction in time. In the winder unit 10, operation efficiency thus can be improved.

**[0065]** In the present embodiment, the unit control section 50 performs control such that the upper-yarn catching member 26 catches the yarn end 30a of the package 30 at the catching region R1 and then moves to the standby region R2. Consequently, in the winder unit 10, the upper-yarn catching member 26 can be prevented from sucking and catching the yarn 20 on the surface of the package 30 other than the yarn end 30a of the package 30.

**[0066]** In the present embodiment, the unit control section 50 controls the package driving motor 41 to rotationally drive the package 30 the number of rotations set by the setting section 91 at the yarn guiding speed. Then, after the package 30 has been rotated the number of rotations, the unit control section 50 controls the package driving motor 41 to proceed to an operation of rotationally driving the package 30 at the yarn guiding speed. In this manner, in the winder unit 10, by assuming without using a sensor and the like that the upper-yarn catching member 26 has caught the yarn end 30a of the package 30, switching from the yarn-end catching speed to the yarn guiding speed can be performed with a simple configuration and control.

**[0067]** In the present embodiment, when continuation of the yarn 20 is disconnected, the unit control section 50 controls the traverse arm 74 to standby at one end in the traverse direction. Therefore, in the winder unit 10, when performing the yarn joining operation or the like upon disconnection of the yarn 20, the yarn 20 can be restrained from being caught in the traverse arm 74. Consequently, damage on the traverse arm 74 and/or a disconnection of the yarn 20 guided by the upper-yarn catching member 26 can be prevented.

**[0068]** In the present embodiment, when the upper-yarn catching member 26 catches the yarn end 30a of the package 30, in other words, when the upper yarn suction mouth 35 of the upper-yarn catching member 26 is located at the catching region R1, the air cylinder 60 of the winder unit 10 brings the package 30 and the contact roller 29 into the non-contacting state. Consequently, in the winder unit 10, when catching the yarn end 30a of the package 30, the yarn end 30a can be prevented from being sandwiched between the package 30 and the contact roller 29 and sticking to the surface of the package 30. In the winder unit 10, the yarn end 30a of the package 30 thus can be reliably caught.

**[0069]** The present invention is not limited to the above-described embodiment. As illustrated in FIG. 10, the unit control section 50 may control the package driving motor 41 such that the rotational speed of the package 30 under the yarn-end catching speed is changed in two stages. The yarn-end catching speed includes a first speed in which the upper-yarn catching member 26 starts catching the yarn end 30a of the package 30 and a second speed that is faster than the first speed.

**[0070]** The unit control section 50 controls the package driving motor 41 such that the package 30 is rotated at the second speed after being rotationally driven at the first speed. Consequently, the yarn end 30a of the package 30 can be reliably caught by the upper yarn suction mouth 35 of the upper-yarn catching member 26.

**[0071]** As illustrated in FIG. 11, the unit control section 50 rotationally drives the package 30 at the yarn-end catching speed in the unwinding direction A, and causes the upper yarn suction mouth 35 of the upper-yarn catching member 26 to be located at the catching region R1 to catch the yarn end 30a of the package 30. After rotationally driving the package 30 in the un-winding direction A a predetermined number of times, the unit control section 50 moves the upper yarn suction mouth 35 of the upper-yarn catching member 26 in the direction to be located away from the package 30 and rotationally drives the package 30 in the winding direction. Then, after rotationally driving the package 30 in the winding direction a predetermined number of times, the unit control section 50 rotationally drives the package 30 at the yarn-end catching speed in the unwinding direction A and causes the upper yarn suction mouth 35 of the upper-yarn catching member 26 to be located at the catching region R1 again.

**[0072]** Subsequently, the unit control section 50 rotationally drives the package 30 at the yarn guiding speed in the unwinding direction A and causes the upper yarn suction mouth 35 of the upper-yarn catching member 26 to be located at the standby region R2. Consequently, since a slack of the yarn 20 can be eliminated on the package 30, the upper-yarn catching member 26 can be prevented from catching the yarn 20 that is located on a surface layer of the package 30.

**[0073]** In an embodiment illustrated in FIG. 11, after rotationally driving the package 30 at the yarn-end catching speed in the unwinding direction A, the package 30 is rotationally driven in the winding direction. However, without rotationally driving the package 30 in the winding direction at this point, the rotational driving in the unwinding direction A may be maintained. Even in this case, the slack in the yarn 20 can be eliminated. In this case, a stopping time at the catching region R1 when the upper

yarn suction mouth 35 temporarily moves to the catching region R1 may be short.

**[0074]** In the above-described embodiment, although the upper yarn suction mouth 35 is stopped at the standby region R2, the upper yarn suction mouth 35 is not required to be stopped at the standby region R2.

**[0075]** In the above-described embodiment, the package 30 is rotationally driven directly by the package driving motor 41, however, in the present invention, any method in which the contact roller is driven to rotate the package 30 may be employed. In this case, if the package 30 is moved to the non-contact position Q1 and rotated in the unwinding direction A, a mechanism for rotating the package 30 in the unwinding direction A is further provided in the winder unit 10. In the case of the method in which the contact roller 29 is driven to rotate the package 30, rotational speed of the package 30 is not directly controlled, but rotational speed of the contact roller 29 is controlled.

**[0076]** In the above-described embodiment, although the rotational speeds (yarn-end catching speed, yarn guiding speed) of the package 30 are controlled by controlling the package driving motor 41 with the unit control section 50, the unit control section 50 is sufficient to control a peripheral speed of the package 30 (travelling speed of the yarn 20) as the rotational driving of the package 30.

**[0077]** In the above-described embodiment, although the arm-type traverse device 70 is described as an example, the traverse device may be a drum including a traverse groove, a belt-type traverse or a rod-type traverse.

**[0078]** In the above-described embodiment, although the configuration in which the winder unit 10 includes the air cylinder (switching device) 60 is described as an example, the winder unit 10 needs not necessarily include the air cylinder 60.

**[0079]** In the above-described embodiment, although an assumption is made that the upper-yarn catching member 26 has caught the yarn 20 when the package 30 is rotationally driven in the unwinding direction A the number of rotations set by the setting section 91, a sensor may be provided in the upper-yarn catching member 26, and the sensor may detect that the yarn 20 has been caught by the upper-yarn catching member 26.

**[0080]** In the above-described embodiment, although the diameter of the package 30 is detected by detecting the swing angle of the cradle 23 with the angle sensor 44, the diameter of the package 30 may be detected by another method. The diameter of the package 30 can be obtained based on, e.g., a total length of the yarn 20 that has been wound into the package 30, a winding speed of the yarn 20 and a yarn type (a thickness and the like of the yarn 20).

**[0081]** The diameter of the package 30 may also be obtained by measuring time from the start of winding the yarn 20. In a case where the winding speed and the yarn type (the thickness and the like of the yarn 20) are known, the diameter of the package 30 can be obtained by calculation based on the time elapsed from the start of winding the yarn 20. By storing in advance a relation between the time elapsed from the start of winding and the diameter of the package 30 in the unit control section 50, the diameter of the package 30 can be obtained based on the elapsed time. When the winding is interrupted by the yarn disconnection, the yarn joining operation, or the like, measurement of the elapsed time from the start of winding is interrupted.

**[0082]** The diameter of the package 30 may also be calculated based on the travelling speed of the yarn 20. Specifically, a traverse angle is calculated with the travelling speed of the yarn 20 and a traverse speed. Furthermore, the peripheral speed of the package 30 is obtained based on the traverse angle and the yarn travelling speed. Then, the diameter of the package 30 is calculated based on the rotational speed of the package 30 and the peripheral speed of the package 30.

## Claims

**1.** A yarn winding machine (10) comprising:

a driving section (41) adapted to rotationally drive a package (30) around which a yarn (20) is wound;
a first catching and guiding device (26) adapted to catch and guide a yarn end (30a) of the package (30); and
a control section (42, 50) adapted to control movements of the driving section (41) and the first catching and guiding device (26),
**characterized in that** when the first catching and guiding device (26) is located at a catching region (R1) and starts catching the yarn end of the package (30), the control section (42, 50) is adapted to control the driving section (41) to rotationally drive the package (30) at a first speed, the first speed being one of yarn-end catching speeds;
after the package (30) is rotationally driven at the first speed, the control section (42, 50) is adapted to maintain the first catching and guiding device (26) at the catching region (R1), and to control the driving section (41) to rotationally drive the package (30) at a second speed, the second speed being one of the yarn-end catching speeds and faster than the first speed, and
when the first catching and guiding device (26) moves from the catching region (R1) to a guiding target (14), the control section (42, 50) is adapted to control the driving section (41) to rotationally drive the package (30) at a yarn guiding speed, the yarn guiding speed being faster than the yarn-end catching speeds.

2. The yarn winding machine according to claim 1, **characterized by** further comprising a setting section (91) adapted to set a number of rotations, the number of rotations being a number of times the package (30) is rotated at the yarn-end catching speeds,
wherein the control section (42, 50) is adapted to control the driving section (41) to rotationally drive the package (30) at the yarn-end catching speeds while the package (30) is being rotated the number of rotations set by the setting section (91), and
after the package (30) is rotated the number of rotations, the control section (42, 50) is adapted to control the driving section (41) to rotationally drive the package (30) at the yarn guiding speed.

3. The yarn winding machine according to claim 1 or claim 2, **characterized by**:

a yarn supplying section (11) adapted to supply the yarn (20) to be wound around the package (30);
a second catching and guiding device (25) adapted to catch and guide a yarn end from the yarn supplying section (11); and
a yarn joining device (14) adapted to join the yarn (20) of the package (30) guided by the first catching and guiding device (26) and the yarn (20) from the yarn supplying section (11) guided by the second catching and guiding device (25) when continuation of the yarn (20) between the yarn supplying section (11) and the package (30) is disconnected,
wherein when guiding the yarn (20) of the package (30) by the first catching and guiding device (26) to the yarn joining device (14), the control section (42, 50) is adapted to control the driving section (41) to rotationally drive the package (30) at the yarn guiding speed.

4. The yarn winding machine according to any one of claim 1 through claim 3, **characterized by**:

a yarn defect detecting device (15) adapted to detect a presence or an absence of a yarn defect included in the yarn (20) wound around the package (30); and
a cutting device (39) adapted to cut the yarn (20) upon detection of the presence of the yarn defect by the yarn defect detecting device (15),
wherein when the cutting device (39) cuts the yarn (20), the control section (42, 50) is adapted to control the first catching and guiding device (26) to catch the yarn end (30a) of the package (30) while rotationally driving the package (30) at the yarn-end catching speeds, and then to control the first catching and guiding device (26) to guide the yarn (20) of the package (30) while rotationally driving the package (30) at the yarn guiding speed.

5. The yarn winding machine according to any one of claim 1 through claim 4, **characterized in that** the first catching and guiding device (26) includes a suction mouth (35) adapted to suck the yarn end (30a) of the package (30), and is arranged such that the suction mouth (35) is adapted to be movable to the catching region (R1), a standby region (R2) and a yarn joining region (R3), the standby region (R2) being a region located farther away from the package (30) than the catching region (R1), and the yarn joining region (R3) being a region where the yarn (20) of the package (30) is guided to the yarn joining device (14), and
when the suction mouth (35) is located at the standby region (R2) , the control section (42, 50) is adapted to control the driving section (41) to rotationally drive the package (30) at the yarn guiding speed.

6. The yarn winding machine according to any one of claim 1 through claim 5, **characterized in that** the driving section (41) is adapted to directly drive the package (30).

7. The yarn winding machine according to any one of claim 1 through claim 6, **characterized by**:

a contact roller (29) adapted to be rotated in contact with the package (30); and
a traverse guide (74) arranged independently from the contact roller (29) and adapted to traverse the yarn (20) to be wound around the package (30),
wherein when continuation of the yarn (20) is disconnected, the control section (78, 50) is adapted to control the traverse guide (74) to standby at one end in a traverse direction of the traverse guide (74).

8. The yarn winding machine according to any one of claim 1 through claim 6, **characterized by**:

a contact roller (29) adapted to be rotated in contact with the package (30); and
a switching device (60) adapted to switch the package (30) and the contact roller (29) between a contacting state and a non-contacting state,
wherein when the first catching and guiding device (26) catches the yarn end of the package (30), the switching device (60) is adapted to switch the package (30) and the contact roller (29) to the non-contacting state.

9. A yarn withdrawal method for withdrawing a yarn end (30a) of a package in a yarn winding machine including a driving section (41) adapted to rotationally drive

the package (30) around which the yarn (20) is wound, and a catching and guiding device (26) adapted to catch and guide the yarn end of the package (30), the yarn withdrawal method being **characterized by** the following steps:

rotationally driving the package (30) at a first speed, which is one of yarn-end catching speeds, when the catching and guiding device (26) is located at a catching region (R1) and starts catching the yarn end (30a) of the package (30);

after the package (30) is rotationally driven at the first speed, maintaining the catching and guiding device (26) at the catching region (R1), and rotationally driving the package (30) at a second speed, the second speed being one of the yarn-end catching speeds and faster than the first speed; and

when moving the catching and guiding device (26) from the catching region (R1) to a guiding target (14), rotationally driving the package (30) at a yarn guiding speed, the yarn guiding speed being faster than the yarn-end catching speeds.

FIG. 1

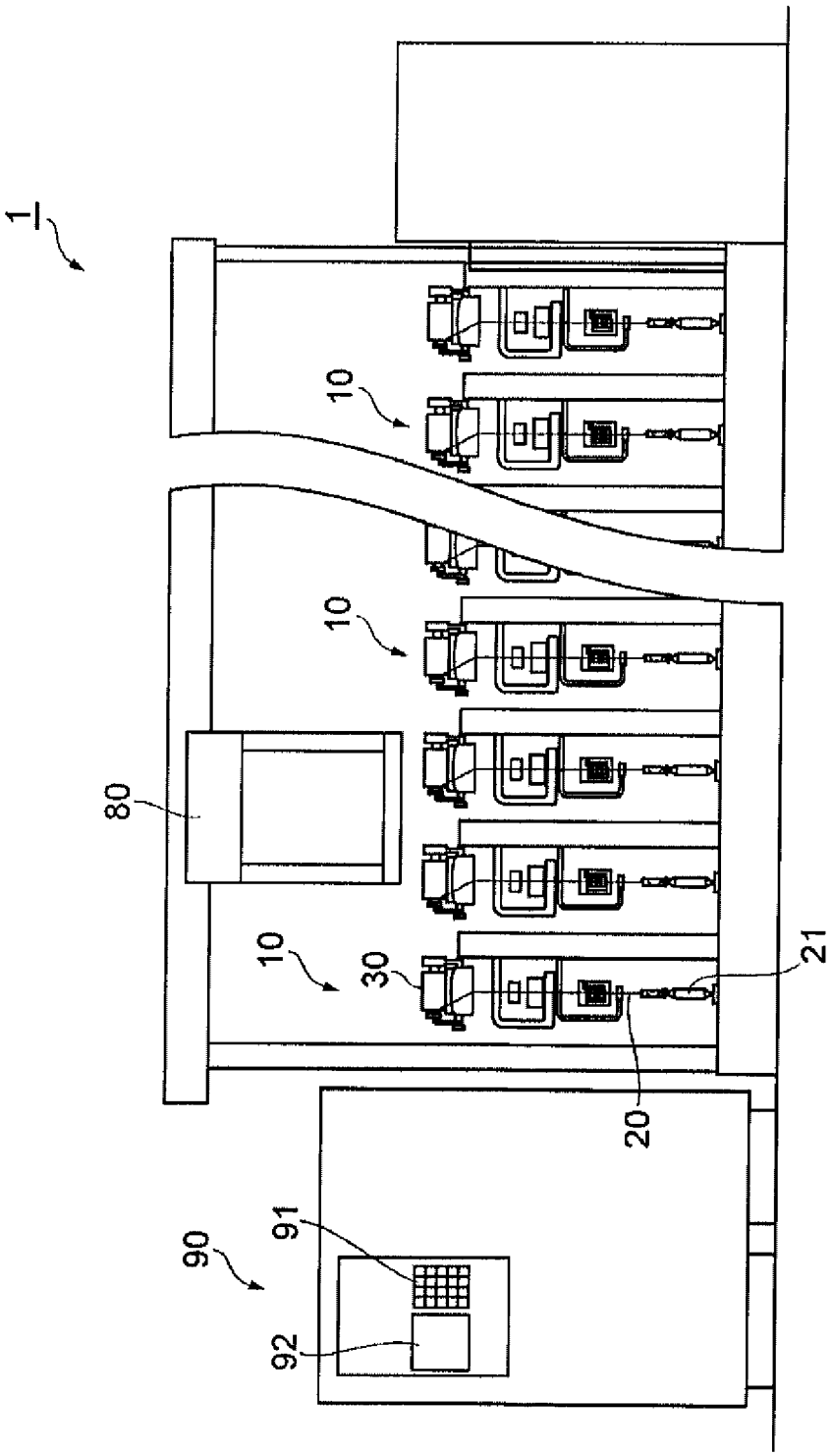


FIG. 2

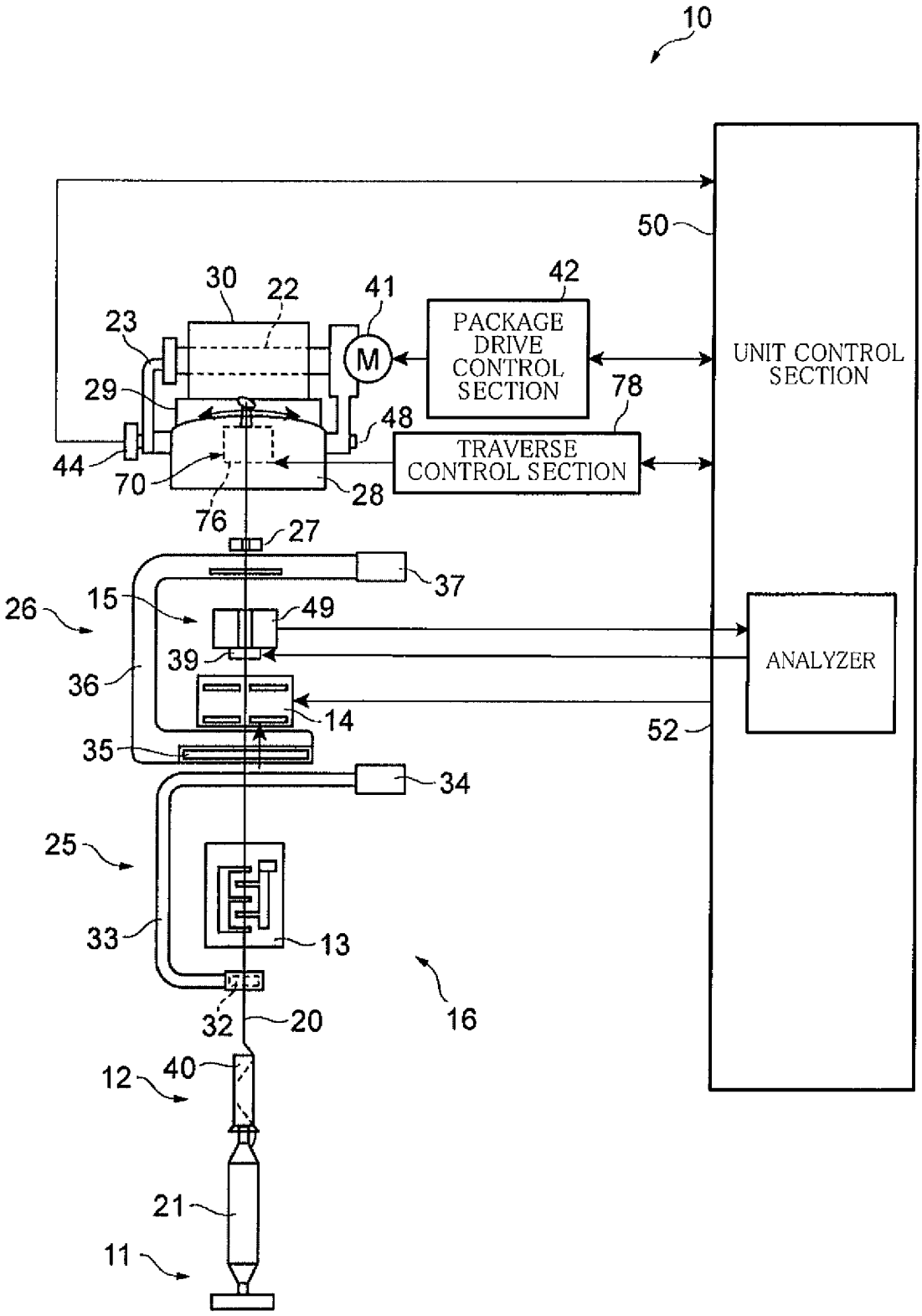

10
50
UNIT CONTROL SECTION
30
22
41
42
23
M
PACKAGE DRIVE CONTROL SECTION
29
78
48
TRAVERSE CONTROL SECTION
44
70
28
76
27
37
26
15
49
ANALYZER
39
36
14
52
35
34
25
33
13
16
32
20
12
40
21
11

FIG. 3

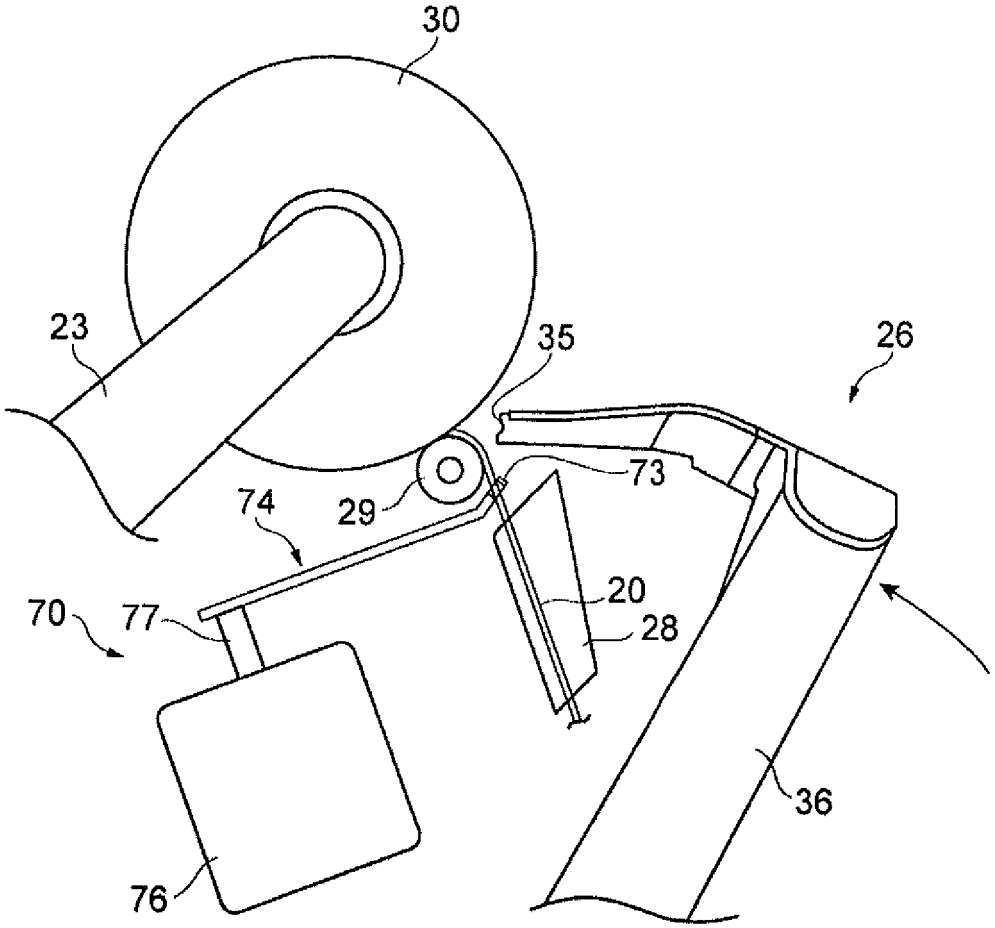


FIG. 4

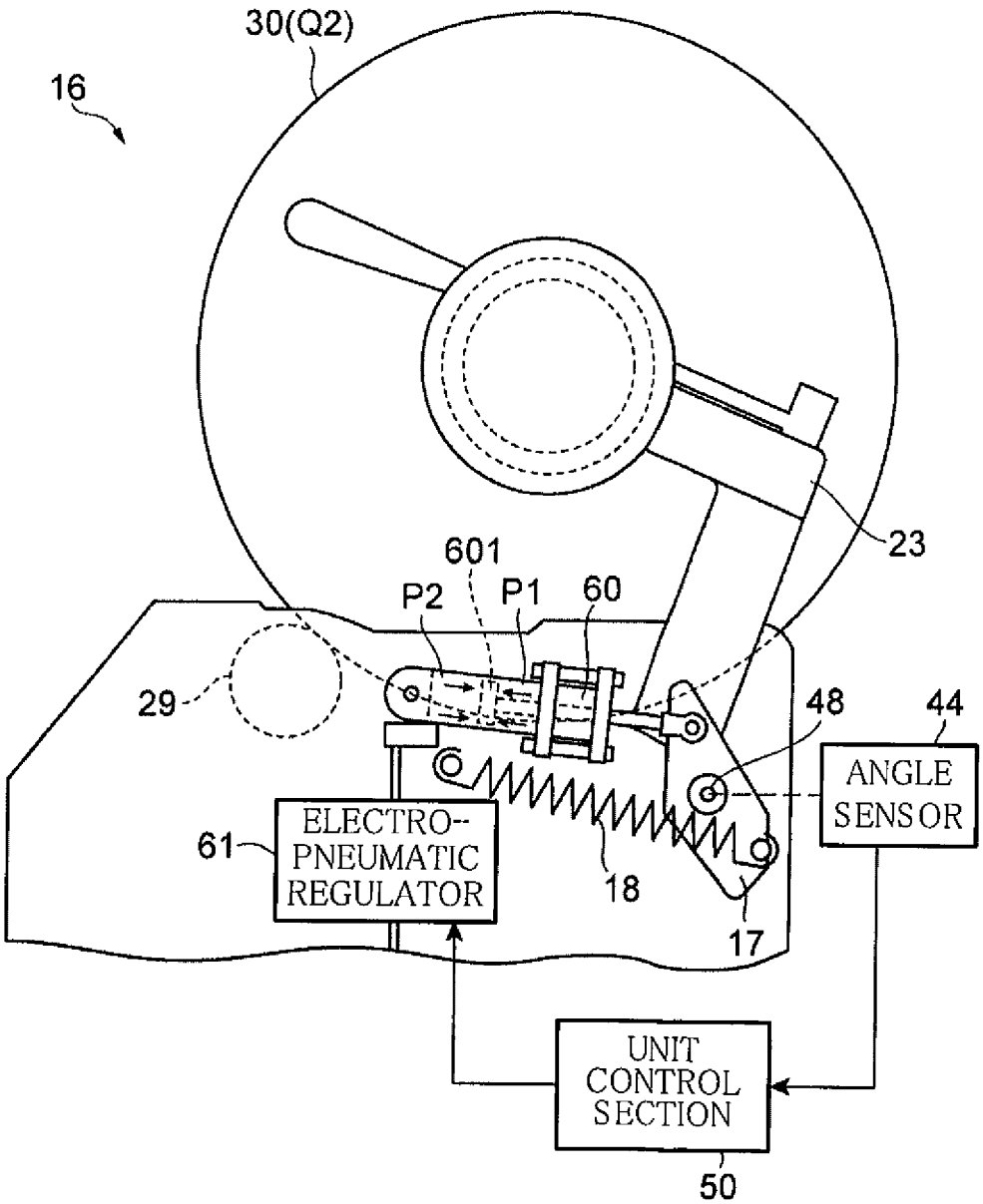

30(Q2)
16
23
601
P2
P1
60
29
48
44
ANGLE SENSOR
61
ELECTRO-PNEUMATIC REGULATOR
18
17
UNIT CONTROL SECTION
50

FIG. 6

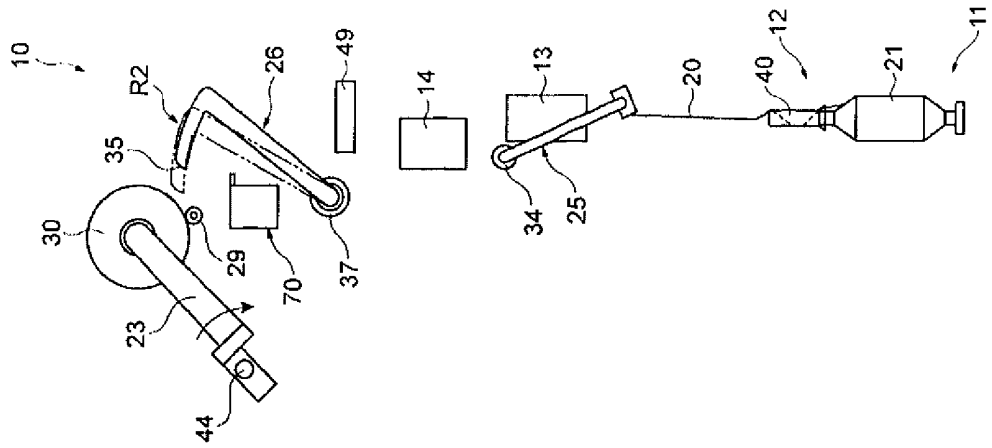

10
R2
26
49
35
14
13
20
40
12
21
11
30
29
70
37
34
25
23
44

FIG. 5

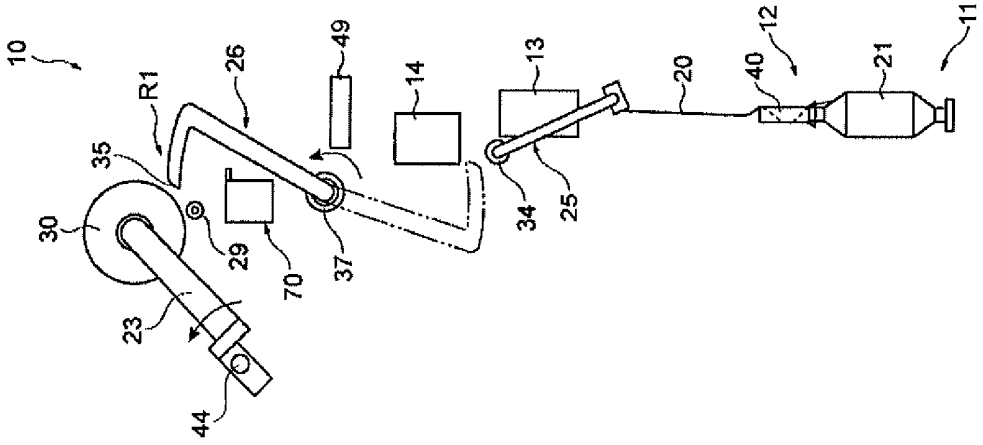

10
R1
26
49
35
14
13
20
40
12
21
11
30
29
70
37
34
25
23
44

FIG. 7

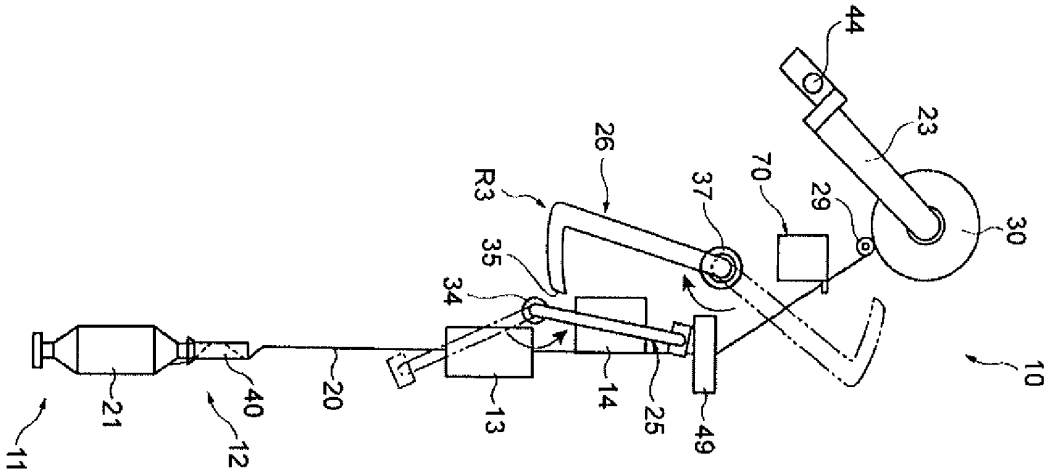

44
23
26
R3
37
70
29
30
35
34
10
14
25
49
13
20
40
21
12
11

FIG. 8

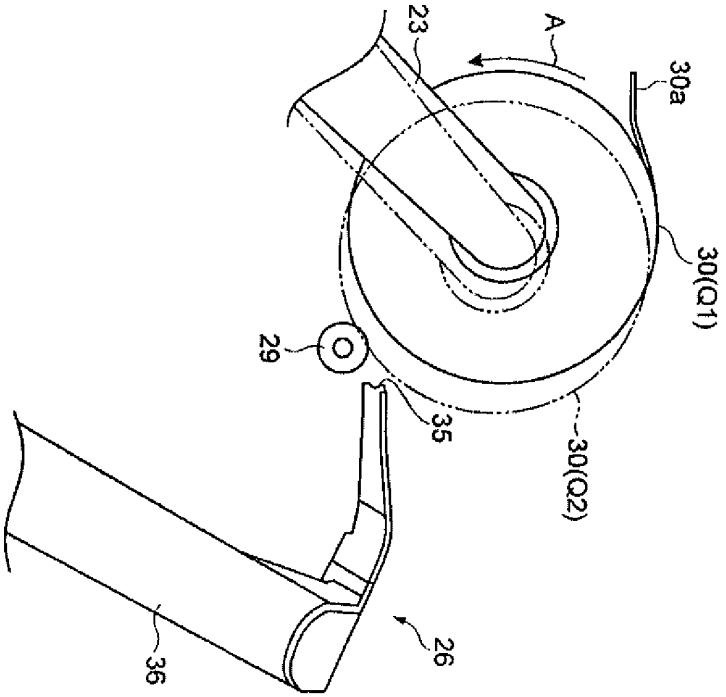

23
A
30a
30(Q1)
29
35
30(Q2)
36
26

FIG. 9

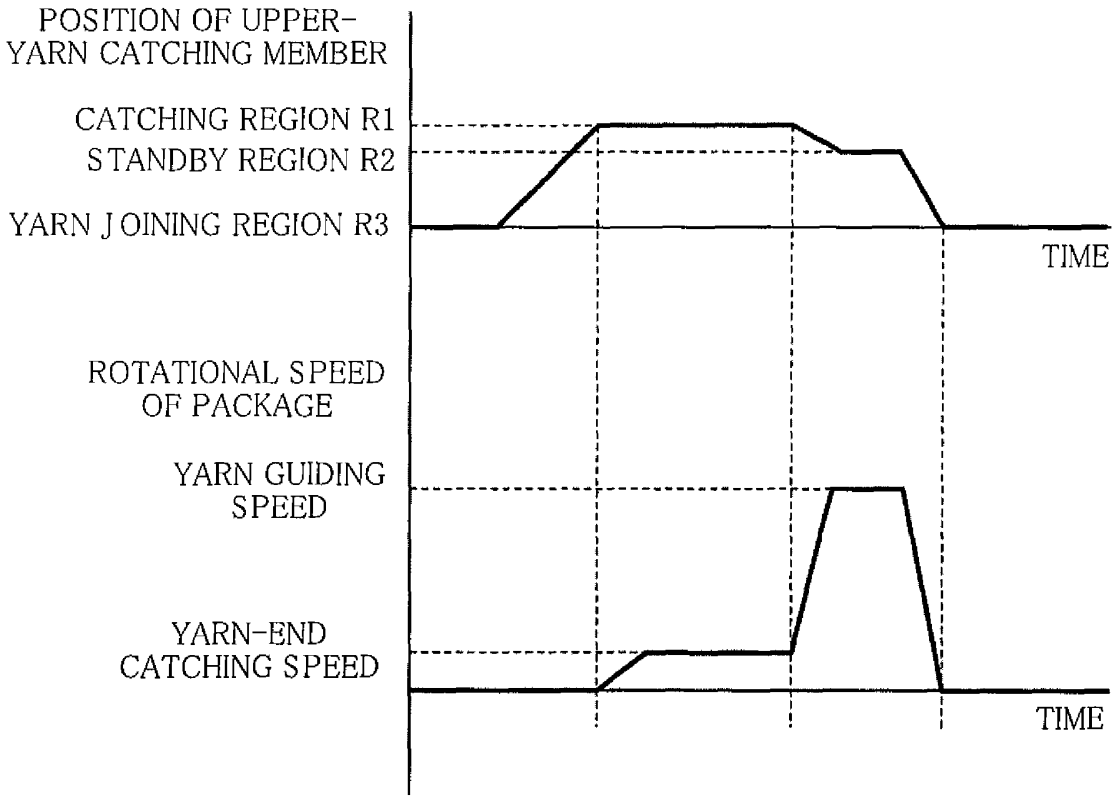

POSITION OF UPPER-YARN CATCHING MEMBER
CATCHING REGION R1
STANDBY REGION R2
YARN JOINING REGION R3
TIME
ROTATIONAL SPEED OF PACKAGE
YARN GUIDING SPEED
YARN-END CATCHING SPEED
TIME

FIG. 10

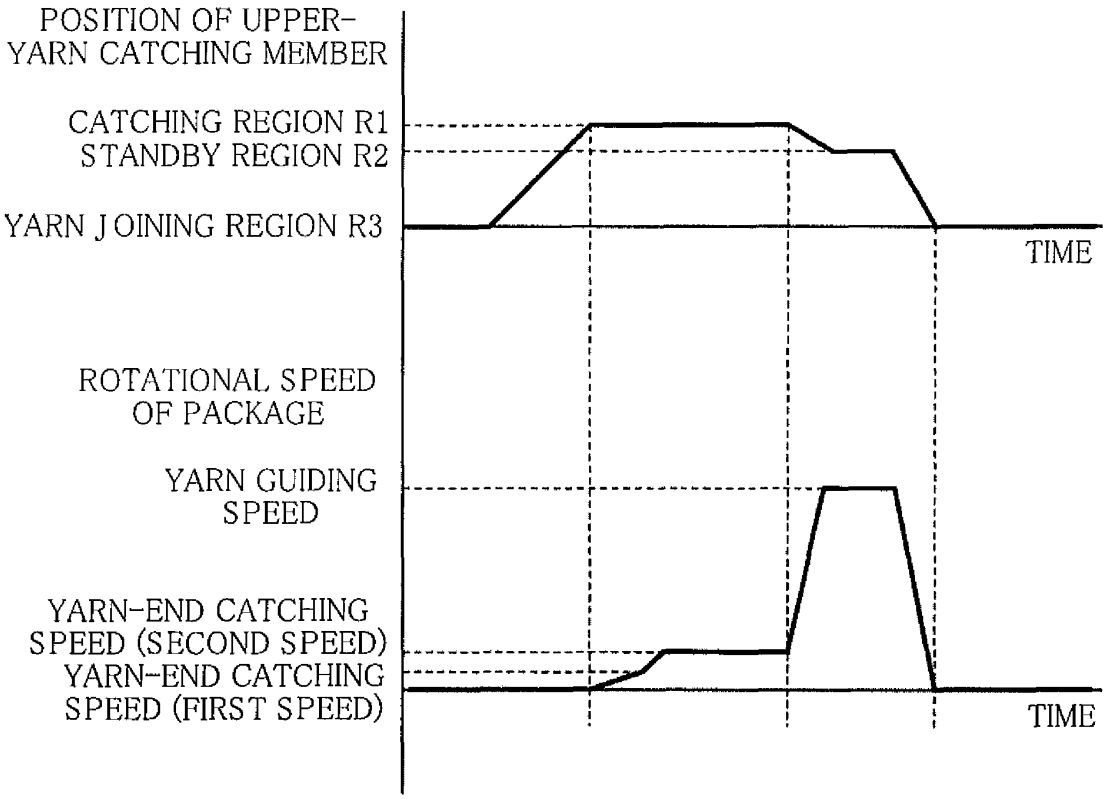
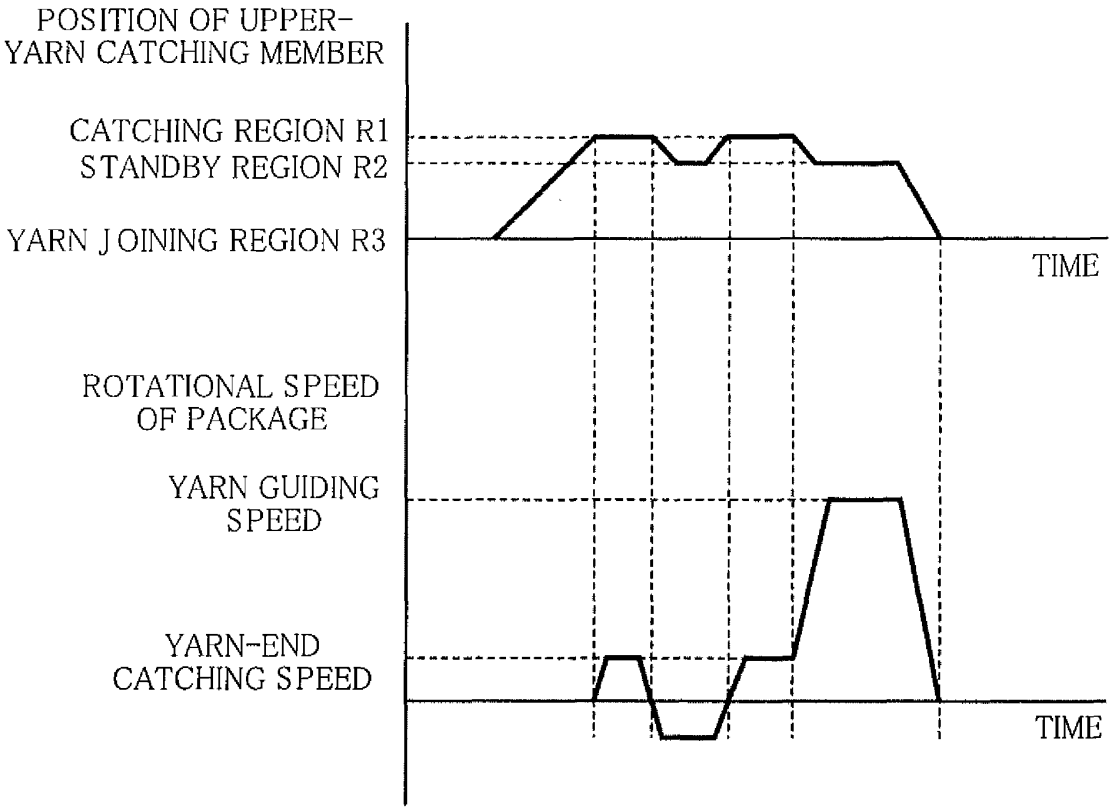

POSITION OF UPPER-YARN CATCHING MEMBER
CATCHING REGION R1
STANDBY REGION R2
YARN JOINING REGION R3
TIME
ROTATIONAL SPEED OF PACKAGE
YARN GUIDING SPEED
YARN-END CATCHING SPEED (SECOND SPEED)
YARN-END CATCHING SPEED (FIRST SPEED)
TIME

FIG. 11


POSITION OF UPPER-YARN CATCHING MEMBER
CATCHING REGION R1
STANDBY REGION R2
YARN JOINING REGION R3
TIME
ROTATIONAL SPEED OF PACKAGE
YARN GUIDING SPEED
YARN-END CATCHING SPEED
TIME

## REFERENCES CITED IN THE DESCRIPTION

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### Patent documents cited in the description


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