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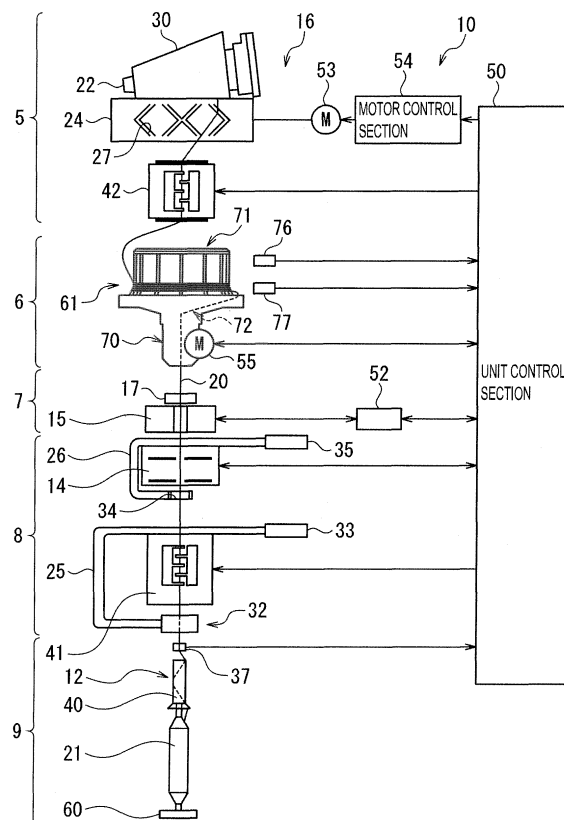
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(54) **Yarn winding device and automatic winder comprising yarn winding device**

(57) The invention relates to a winding unit (10) that includes an accumulator (61) which enables that a yarn (20) can be accumulated before it is wound into a package (30), and can be drawn out to a yarn supplying bobbin (21) side under the control of a unit control section (50). When a clearer (15) detects a yarn defect, the unit control section (50) draws out a portion of the yarn containing the yarn defect from the accumulator (61) to the yarn supplying bobbin (21) side. The drawn-out yarn (20) is caught and guided to a splicer device (14) by an upper yarn guide pipe (26). Furthermore, a lower yarn caught by a lower yarn guide pipe (25) is guided to the splicer device (14) for a yarn splicing operation.

FIGURE 1



Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to a yarn winding device, and specifically, to an operation performed by the yarn winding device to remove a yarn defect in a wound yarn.

Description of Related Art

[0002] A yarn produced by a spinning machine or the like is wound around a yarn supplying bobbin, which is then conveyed to a yarn winding device. In the yarn winding device, a yarn splicing device splices a plurality of yarn supplying bobbins conveyed to the yarn winding device, to generate a package of a predetermined length. A conventionally known yarn winding device with such a yarn splicing device includes a suction arm that catches and guides a yarn winding bobbin-side yarn end to the yarn splicing device and a relay pipe that catches and guides a yarn supplying bobbin-side yarn end to the yarn splicing device. In the description below, the yarn splicing operation is divided into an operation performed when yarn breakage or cutting occurs and an operation performed when a new yarn supplying bobbin is supplied.

[0003] When yarn breakage or cutting occurs during a yarn winding operation, an upper yarn is wound around the yarn winding bobbin, which is rotating by inertia. A lower yarn is held by an appropriate trap means. Then, the yarn splicing operation is performed as follows. That is, the stopped yarn winding bobbin is reversely rotated to unwind the yarn. The yarn end of the unwound upper yarn is sucked and caught by a tip of the suction arm. The yarn end is then guided to the yarn splicing device. Furthermore, almost at the same time, the yarn end of the lower yarn held by the trap means is sucked and caught by a tip of the relay pipe. The lower yarn is thus unwound from the yarn supplying bobbin and guided to the yarn splicing device. Thereafter, the yarn splicing device splices the yarn ends of the upper and lower yarns. The yarn winding operation is then resumed.

[0004] On the other hand, when all of the yarn on the yarn supplying bobbin is wound around the yarn winding bobbin and a new yarn supplying bobbin is then supplied, the yarn splicing operation is performed as follows. That is, the stopped yarn winding bobbin is reversely rotated to unwind the upper yarn. The yarn end of the upper yarn is sucked and caught by a suction mouth provided at the tip of the suction arm. The yarn end is then guided to the yarn splicing device. Furthermore, almost at the same time, the yarn end of the yarn (lower yarn) on the new yarn supplying bobbin side is blown up by an air flow. The yarn end is then sucked and caught by the tip of the relay pipe. Then, the lower yarn is unwound from the yarn supplying bobbin. The relay pipe guides the yarn end of

the lower yarn to the yarn splicing device. Then, the yarn splicing device splices the yarn ends of the upper and lower yarns. The yarn winding operation is then resumed.

[0005] The yarn winding bobbin is stopped, as described above, by a lift-up mechanism and a package brake mechanism both provided in the yarn winding device. The lift-up mechanism raises a cradle to separate the yarn winding bobbin from a winding driving section. The package brake mechanism stops rotation of the bobbin gripped by the cradle at the same time when the cradle is lifted by the lift-up mechanism. Thus, the rotation of the yarn winding bobbin is stopped, and the yarn winding operation is suspended.

[0006] Furthermore, although the objective is different from that of the above-described yarn winding device, an arrange winder generating one package from a plurality of packages in respective colors is disclosed in, for example, the Unexamined Japanese Patent Application Publication (Tokkai) No. 2004-156186. The arrange winder is configured to manufacture a yarn winding package by continuously winding various color yarns and yarn types in a longitudinal direction of the yarns while measuring off a predetermined length of the yarn. Specifically, in the arrange winder, a selection device selects at least one yarn from a plurality of packages of different colors or yarn types. A yarn splicing device then performs yarn splicing. The yarn then passes through a yarn length measuring and accumulating device that measures off the predetermined length of the yarn, while simultaneously accumulating the yarn. As a result, packages are consecutively wound.

[0007] Moreover, a yarn winding method and device avoiding suspending the yarn winding operation when yarn breakage occurs is disclosed in U.S. Patent No. 3314621. According to the specification, the disclosed device accumulates the yarn unwound from the bobbin, and when yarn breakage occurs, uses the accumulated yarn to continue winding until the yarn splicing operation is completed.

BRIEF SUMMARY OF THE INVENTION

[0008] There has been a demand for an increased package winding speed for improved production efficiency. However, the increased winding speed increases a load on the traveling yarn, resulting in frequent yarn breakage. When yarn breakage occurs, the yarn needs to be drawn out from the package and spliced to the yarn supplying bobbin-side yarn. However, when during the yarn splicing operation, the package is reversely rotated to allow the package-side yarn to be caught, a surface portion of the package may be pulled by the suction force of the suction arm, resulting in a traversing error. Furthermore, during the yarn splicing operation, the yarn winding operation is suspended to allow the package to be reversely rotated. Thus, the production efficiency is not necessarily improved simply by increasing the winding speed. Moreover, every time the yarn winding oper-

ation is suspended, a routine is repeated in which the package rotating at high speed is quickly stopped, and after the yarn splicing operation, re-accelerated up to a rotation speed used before the stop of the package. This requires high power consumption.

[0009] In this regard, in the winding package configuration disclosed in the Unexamined Japanese Patent Application Publication (Tokkai) No. 2004-156186, a yarn accumulation section is provided so as to allow the yarn to be continuously wound. However, the configuration in the Unexamined Japanese Patent Application Publication (Tokkai) No. 2004-156186 is intended to generate one yarn from the plurality of packages in the respective colors and includes no arrangement for removing yarn defects. Thus, a portion of the yarn which contains a yarn defect is wound into the package intact. Furthermore, even if the yarn defect is removed, when the portion containing the yarn defect is wound around the yarn accumulation section, removing the yarn defect is difficult because of the configuration of the yarn splicing device.

[0010] Furthermore, the yarn winding method and device disclosed in U.S. Patent No. 3314621 includes a yarn accumulation container in which the yarn is accumulated to allow the yarn winding operation to be continued even when yarn breakage occurs or a defect removing operation needs to be performed. With the yarn winding method and device, importantly, when yarn breakage occurs or the defect removing operation needs to be performed, the defect removal or yarn splicing is efficiently performed without exhausting the accumulated yarn, in order to allow the package winding operation to be continued. However, U.S. Patent No. 3314621 fails to specifically describe that the yarn splicing and defect removal are performed with the package winding operation continued.

[0011] The present invention has been made in view of the above-described circumstances. An object of the present invention is to provide a yarn winding device that can continuously wind the yarn from winding start to winding end for the package.

[0012] According to a first aspect of the present invention, a yarn winding device winding a yarn drawn out from a yarn supplying bobbin, into a package is configured as follows. That is, the yarn winding device includes a winding section winding the yarn into the package while traversing the yarn, a yarn accumulating device allowing the yarn to be accumulated before the yarn is wound into the package, a yarn defect detecting section detecting a yarn defect, a yarn splicing device performing a yarn splicing operation, a yarn supplying section holding the yarn supplying bobbin, and a draw-out mechanism drawing out the yarn accumulated in the yarn accumulating device, to an upstream side in a yarn traveling direction.

[0013] Thus, the draw-out mechanism enables the yarn to be drawn out from the yarn accumulating device, allowing the yarn splicing operation to be performed. This enables a reduction in a possible loss of winding time resulting from suspension of a package winding opera-

tion. Package production efficiency can thus be improved. Furthermore, since the yarn winding operation is not suspended, the adverse effect, on traversing, of variation in winding tension that may occur at the beginning of package rotation can be minimized. This also enables a reduction in the amount of power consumed to accelerate the stopped package up to a winding speed used during the yarn winding operation. Energy can thus be saved.

[0014] The yarn winding device is preferably configured as follows. The draw-out mechanism includes an upper yarn catching portion for catching and guiding an upper yarn that is a package-side yarn, to the yarn splicing device, a yarn accumulation driving section serving as a driving portion for the yarn accumulating device, and a control section controlling the yarn accumulation driving section.

[0015] Thus, while controlling the yarn accumulation driving section of the yarn accumulating device, the control section allows the upper yarn catching portion to draw out and catch the yarn from the yarn accumulating device. For example, the control section allows the yarn catching portion to catch the yarn, while driving the driving portion driven so that the yarn in the yarn accumulating device is drawn out to the upstream side in the yarn traveling direction.

[0016] The yarn winding device is preferably configured as follows. The yarn supplying section includes a yarn supplying bobbin holding section discharging the empty yarn supplying bobbin and receiving a new yarn supplying bobbin. The yarn splicing device splices a yarn end on the new yarn supplying bobbin received by the yarn supplying bobbin holding section and a yarn end on the yarn accumulating device side.

[0017] Thus, the yarn supplying bobbin can be replaced with new one without the need to stop the yarn winding operation. The package production efficiency can thus be further improved.

[0018] According to a second aspect of the present invention, a yarn winding device winding a yarn drawn out from a replaceable yarn supplying bobbin, into a package is configured as follows. That is, the yarn winding device includes a winding driving section driving a winding drum, a yarn accumulating device, a yarn defect detecting section, a yarn splicing device, an upper yarn catching portion, a lower yarn catching portion, and a control section. The winding driving section rotates the package in contact with the winding drum. The yarn accumulating device allows the yarn to be accumulated before the yarn is wound into the package. The yarn defect detecting section detects a yarn defect. The yarn splicing device performs a yarn splicing operation. The upper yarn catching portion catches and guides an upper yarn that is the package-side yarn, to the yarn splicing device. The lower yarn catching portion catches and guides a lower yarn that is the yarn supplying bobbin-side yarn, to the yarn splicing device. When the yarn defect detecting section detects a yarn defect, the control section con-

trollably cuts a portion of the yarn located on an upstream side of the detected yarn defect in a yarn winding direction, while simultaneously stopping the accumulation of the yarn by the yarn accumulating device so that the upper yarn stopped below the yarn accumulating device is caught and guided by the upper yarn catching portion, while the lower yarn caught by the lower yarn catching portion is guided to the yarn splicing device for a yarn splicing operation.

[0019] Thus, even during the yarn splicing operation, the yarn winding operation can be performed without the need to reverse or stop the package so as to allow the package-side yarn to be drawn out. This enables a reduction in a possible loss of winding time resulting from suspension of a package winding operation. Package production efficiency can thus be improved. Furthermore, the package is prevented from being reversely rotated or stopped so as to allow the yarn splicing operation to be performed. Thus, the yarn can be continuously and stably wound from winding start to winding end for the package without being drawn out from the package. This reduces the frequency at which the stopped package is re-driven up to the rotation speed used during the yarn winding operation. Thus, power consumption is reduced, thus enabling energy saving. Furthermore, the upper yarn catching portion is configured to avoid directly catching the package-side yarn. Consequently, when the package-side yarn is caught, possible degradation of package quality such as a traversing error is prevented. Additionally, even if a yarn defect is detected, the portion of the yarn which is located on the upstream side of the yarn defect portion in the yarn winding direction is drawn out and cut for the yarn splicing operation. Thus, the yarn defect can be reliably removed. Moreover, when the yarn on the yarn supplying bobbin is exhausted, the yarn accumulated on the downstream side is prevented from running short. Thus, with the yarn continuously wound into the package, the yarn end can be easily caught at a position upstream of the yarn accumulating device and spliced to the yarn from the new yarn supplying bobbin.

[0020] The yarn winding device is preferably configured as follows. That is, the yarn accumulating device includes an accumulation section around which the yarn is wound for accumulation, a winding portion attached to the accumulation section so as to be rotatable relative to the accumulation section, and a yarn accumulation driving section rotating the winding portion forward and backward. When the upper yarn catching portion guides the upper yarn to the yarn accumulating device, the control section performs control such that the yarn accumulation driving section is reversely rotated or no load is imposed on the yarn accumulation driving section.

[0021] Thus, by controlling the yarn accumulation driving section such that a forward rotation speed of the winding portion is varied, the amount of accumulated yarn can be easily adjusted. Furthermore, controlling the reverse rotation of the winding portion allows the yarn to be drawn out to the upstream side at an appropriate draw-

out amount and at an appropriate timing. As a result, the yarn splicing operation can be more precisely performed.

[0022] The yarn winding device is preferably configured as follows. The yarn accumulating device has a casing covering at least a part of the winding portion. An introduction hole is formed in the casing to introduce the yarn drawn out from the yarn supplying bobbin, into the yarn accumulating device. When yarn breakage or cutting occurs on the upstream side of the yarn accumulating device in the yarn winding direction, the control section controls the yarn accumulation driving section so that the winding portion is stopped before the yarn end of the upper yarn is introduced into the introduction hole.

[0023] Thus, the yarn can be reliably guided into the yarn accumulating device. Furthermore, even if yarn breakage or cutting occurs, the upper yarn can be prevented from being wound around the yarn accumulating device. Additionally, the yarn end of the upper yarn can be stopped at a position where the yarn end can be easily caught. This allows the upper yarn guiding and catching portion to more reliably catch the yarn end.

[0024] The yarn winding device is preferably configured as follows. That is, the yarn winding device includes a yarn accumulation amount detecting portion for detecting the amount of yarn accumulated in the yarn accumulating device. Furthermore, the control section controls the yarn accumulation driving section according to the yarn accumulation amount detected by the yarn accumulation amount detecting section.

[0025] Thus, by changing the forward rotation speed of the winding portion of the yarn accumulation driving section, a sufficient amount of yarn can be accumulated in the yarn accumulating device with the package winding speed maintained constant. For example, when only a small amount of yarn is accumulated in the yarn accumulating device, the rotation speed of yarn accumulation driving section is increased to allow an appropriate accumulation amount to be always ensured.

[0026] According to a third aspect of the present invention, a yarn winding device winding a yarn drawn out from a replaceable yarn supplying bobbin, into a package is configured as follows. That is, the yarn winding device winds the yarn drawn out from the yarn supplying bobbin, into the package and includes a winding section winding the yarn into the package while traversing the yarn, a yarn accumulating device allowing the yarn to be accumulated before the yarn is wound into the package, a yarn defect detecting section detecting a yarn defect, a yarn splicing device performing a yarn splicing operation, a yarn supplying section holding the yarn supplying bobbin, a yarn accumulation driving section serving as driving section for the yarn accumulating device, a control section controlling the yarn accumulation driving section, and a yarn accumulation amount detecting portion for detecting amount of yarn accumulated in the yarn accumulating device. The control section controls rotation number of a winding driving section provided in the winding section according to the yarn accumulation amount

detected by the yarn accumulation amount detecting section.

[0027] This enables prevention of a possible situation in which all of the accumulated yarn is unwound while the yarn accumulating device is not accumulating the yarn, for example, when a yarn defect is detected and needs to be removed or when the bobbin is replaced with a new one.

[0028] According to a fourth aspect of the present invention, an automatic winder characterized by comprising a plurality of the yarn winding devices is provided.

[0029] The fourth aspect thus provides the automatic winder that enables the yarn winding operation to be consecutively performed, thus improving package production efficiency.

[0030] Other features, elements, processes, steps, characteristics and advantages of the present invention will become more apparent from the following detailed description of preferred embodiments of the present invention with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0031]

Figure 1 is a front view showing a general configuration of a winding unit according to an embodiment of the present invention.

Figure 2 is a schematic sectional view showing a configuration of an accumulator according to the present embodiment.

Figure 3 is a front view showing how an upper yarn guide pipe moves pivotally from a standby position to a catch position.

Figure 4 is a flowchart showing how the accumulator and pivotal movement of the upper yarn guide pipe is controlled when a yarn defect is detected.

Figure 5 is a flowchart showing how the accumulator and the pivotal movement of the upper yarn guide pipe are controlled when a yarn supplying bobbin is replaced with a new one.

Figure 6 is a flowchart showing how the accumulator and the pivotal movement of the upper yarn guide pipe are controlled when a drum driving motor is adjusted according to the amount of yarn accumulated in the accumulator when a yarn defect is detected.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0032] A preferred embodiment of the present invention will be described below with reference to the drawings. Figure 1 is a front view showing a general configuration of a winding unit (yarn winding device) 10 provided in an automatic winder according to an embodiment of the present invention.

[0033] The winding unit 10 shown in Figure 1 winds a yarn 20 unwound from a yarn supplying bobbin 21,

around a yarn winding bobbin 22 while traversing the yarn 20. The winding unit 10 thus forms a package 30 with a predetermined length and a predetermined shape. The automatic winder according to the present embodiment includes a plurality of the winding units 10 arranged in a line, and a frame control device (not shown in the drawings) located at one of an arrangement of the winding units in an arrangement direction. Each of the winding units 10 includes unit frames (not shown in the drawings) provided on respective lateral sides of the unit as viewed from the front, and a winding unit main body 16 provided on a side of the unit frame.

[0034] The winding unit main body 16 includes a winding section 5, a yarn accumulating section 6, a yarn defect detecting section 7, a yarn splicing section 8, and a yarn supplying section 9. The winding section 5 includes a cradle (not shown in the drawings) configured to be able to hold the yarn winding bobbin 22, a winding drum (traverse drum) 24 that traverses the yarn 20, while rotating the yarn winding bobbin 22, a winding driving section (drum driving motor) 53 that drives the winding drum 24, and a second tension applying section 42 described below. The cradle is configured to be swingable in a direction in which the cradle approaches or leaves the winding drum 24. Thus, the package comes into contact with or separates from the winding drum 24. As shown in Figure 1, a spiral traverse groove 27 is formed in an outer peripheral surface of the winding drum 24 to allow the yarn 20 to be traversed.

[0035] The yarn accumulating section 6 includes an accumulator 61 in which the yarn 20 is accumulated before being wound into a package 30. Furthermore, the yarn defect detecting section 7 includes a clearer 15 that detects a yarn defect. The yarn splicing section 8 includes a splicer device (yarn splicing device) 14 that performs a yarn splicing operation, a lower yarn guide pipe (lower yarn catching portion) 25, and an upper yarn guide pipe (upper yarn catching section) 26. The yarn supplying section 9 includes a yarn supplying bobbin holding section 60 that holds the yarn supplying bobbin 21, a yarn unwinding assisting device 12, and a first tension applying section 41.

[0036] Furthermore, the yarn supplying section 9 further includes a bobbin supply device (not shown in the drawings) that supplies a new yarn supplying bobbin 21 to a yarn supplying bobbin holding section 60. The bobbin supply device may be of a magazine type or a tray type. When all of the yarn 20 is drawn out from the yarn supplying bobbin 21 set in the winding unit 10, the yarn supplying section 9 discharges the empty bobbin held in the yarn supplying bobbin holding section 60. The bobbin supply device then sequentially supplies a new yarn supplying bobbin 21 to the yarn supplying bobbin holding section 60 for replacement.

[0037] The yarn unwinding assisting device 12 lowers a regulating member 40 that covers a core tube of the yarn supplying bobbin 21, in conjunction with unwinding of the yarn from the yarn supplying bobbin 21. The yarn

unwinding assisting device 12 thus assists in unwinding the yarn from the yarn supplying bobbin 21. The regulating member 40 comes into contact with a balloon formed above the yarn supplying bobbin 21 by the rotation and centrifugal force of the yarn unwound from the yarn supplying bobbin 21. The regulating member 40 thus applies an appropriate tension to the balloon to assist in unwinding the yarn 20. A sensor (not shown in the drawings) is provided in the vicinity of the regulating member 40 to detect a chase portion of the yarn supplying bobbin 21. When the sensor detects that the chaser portion has lowered, the regulating member 40 can then be lowered by, for example, an air cylinder (not shown in the drawings) in conjunction with the lowering of the chase portion.

[0038] A yarn detection part (lower yarn detecting sensor) 37 that can determine whether or not the yarn 20 is present is provided in the vicinity of the yarn unwinding assisting device 12. The yarn detection part 37 is configured to be able to detect that the yarn 20 to be drawn out from the yarn supplying bobbin 21 is exhausted, to transmit a yarn absence detection signal to a unit control section 50.

[0039] The first tension applying section 41 applies a predetermined tension to the traveling yarn 20. The first tension applying section 41 may be, for example, of a gate type including movable comb teeth arranged with respect fixed comb teeth. The movable comb teeth can be rotated pivotally by a rotary solenoid (not shown in the drawings) so as to be engaged with or released from the fixed teeth. The first tension applying section 41 allows a predetermined tension to be applied to the yarn 20 accumulated in the accumulator 61, described below, so that the yarn 20 is orderly wound and accumulated in the accumulator 61.

[0040] For example, when the clearer 15 detects a yarn defect or when yarn breakage occurs during unwinding of the yarn 20 from the yarn supplying bobbin 21, the splicer device 14 splices a lower yarn located on the yarn supplying bobbin 21 side and an upper yarn located on the package 30 side. The splicer device 14 may be a mechanical type or may use a fluid such as compressed air.

[0041] The clearer 15 is configured to monitor the thickness of the yarn 20 using an appropriate sensor, to detect a defect. A signal from the sensor of the clearer 15 is processed by an analyzer 52. Then, a yarn defect such as slab can be detected. The clearer 15 can also function as a sensor that detects the traveling speed of the yarn 20 or a sensor that simply determines whether or not the yarn 20 is present.

[0042] A waxing device 17 is located on a downstream side of the clearer 15 to wax the traveling yarn 20. A suction section (not shown in the drawings) is provided on a downstream side of the waxing device 17. The suction section is connected to an appropriate negative pressure source to allow residues of the wax and waste yarns to be sucked and removed.

[0043] The accumulator 61 is configured as a yarn ac-

cumulating device that can accumulate a predetermined amount of the yarn 20. The yarn 20 conveyed from the yarn supplying bobbin 21 is accumulated in the accumulator 61. Thereafter, the yarn 20 is drawn out from the accumulator 61 and wound into the package 30.

[0044] The accumulator 61 is configured to be able to draw out the accumulated yarn 20 to both the upstream and downstream sides. In this configuration, while the accumulated yarn 20 is being wound into the package 30, the yarn 20 can concurrently be drawn out to the yarn supplying bobbin 21 side for a yarn splicing operation. The structure of the accumulator 61 and the operation of the accumulator 61 during the yarn splicing operation will be described below in detail.

[0045] The second tension applying section 42 is located on a downstream side of the accumulator 61 to control tension generated when the yarn 20 is unwound from the accumulator 61. Thus, the yarn 20 drawn out from the accumulator 61 is subjected to the appropriate tension when wound around the yarn winding bobbin 22. Like the first tension applying section 41, the second tension applying section 42 may be of the gate type including the movable comb teeth arranged with respect to the fixed comb teeth.

[0046] The lower yarn guide pipe (lower yarn catching portion) 25, which catches and guides the lower yarn, located on the yarn supplying bobbin 21 side, is provided below the splicer device 14. The upper yarn guide pipe (upper yarn catching section) 26, which catches and guides the upper yarn, located on the package 30 side, is provided above the splicer device 14. A lower yarn suction port 32 is formed at a tip of the lower yarn guide pipe 25. Similarly, an upper yarn suction port 34 is formed at a tip of the upper yarn guide pipe 26. An appropriate negative pressure source is connected to each of the lower yarn guide pipe 25 and the upper yarn guide pipe 26 to allow a suction flow to act at the lower yarn suction port 32 and the upper yarn suction port 34, respectively.

[0047] The yarn winding bobbin 22 is driven by rotationally driving the winding drum 24, located opposite the yarn winding bobbin 22. The winding drum 24 is coupled to an output shaft of the drum driving motor 53. Operation of the drum driving motor 53 is controlled by a motor control section 54. The motor control section 54 is configured to receive an operation signal from the unit control section 50 to controllably operate and stop the drum driving motor 53.

[0048] Next, the accumulator 61 will be described with reference to Figure 2. Figure 2 is a schematic sectional view showing a general configuration of the accumulator 61. As shown in Figure 2, the accumulator 61 includes a rotating shaft casing 70, an accumulation section 71, and a yarn guiding section 72. Furthermore, the rotating shaft casing 70 includes a cylindrical portion 78 the top of which is open and a flange section 79 formed at the open end of the cylindrical portion 78.

[0049] The accumulation section 71 is located above the flange section 79. The accumulation section 71 in-

cludes a support plate 81 formed like a disk, a plurality of rod members projecting upward from the support plate 81, and a disk-like mounting plate 83 to which tip portions of the plurality of rod members 82 are connected. Furthermore, the accumulation section 71 is located to form a gap between the support plate 81 and the flange section 79. The accumulation section 71 is configured such that a winding cylinder 75 described below can rotate through the gap.

[0050] The plurality of rod members 82 are arranged at equal intervals on a circumference that is orthogonal to a vertical direction. The accumulation section 71 is configured such that the rod members 82 form a generally cylindrical shape. The yarn 20 is wound around an outer peripheral portion of the generally cylindrical accumulation section 71, composed of the plurality of rod members 82, to accumulate the yarn 20 in the accumulation section 71.

[0051] The yarn guiding section 72 is located inside the rotating shaft casing 70. An introduction hole 80 is formed at the bottom of the cylindrical portion 78 (the end of the cylindrical section 78 located opposite the accumulation section 71) so as to guide the yarn 20 drawn out from the yarn supplying bobbin 21, through the introduction hole 80 to the yarn guiding section 72.

[0052] A rotating shaft 73 is located inside the cylindrical portion 78; the rotating shaft 73 is mounted in the cylindrical member 78 so as to be rotatable relative to the rotating shaft casing 70 and the accumulation section 71. A servo motor (yarn accumulation driving section) 55 is incorporated between the rotating shaft 73 and the cylindrical section 78. The servo motor 55 allows the rotating shaft 73 to be rotated forward and backward. Furthermore, a yarn passage 74 like an axial hole is formed in the center of the rotating shaft 73.

[0053] A cylindrically formed winding cylinder (winding portion) 75 is fixed to one end of the rotating shaft 73 (the end of the rotating shaft 73 which is located opposite the introduction hole 80). The winding cylinder 75 is configured to extend in a radial direction so as to pass through the gap between the rotating shaft casing 70 (flange section 79) and the support plate 81 while inclining slightly upward, with a part of a tip portion of the winding cylinder 75 projecting slightly from the rotating shaft casing 70. The winding cylinder 75 is configured to rotate integrally with the rotating shaft 73. Furthermore, the interior of the winding cylinder 75 is connected to the yarn passage 74.

[0054] Furthermore, the winding unit 10 according to the present embodiment includes a draw-out mechanism that draws out the yarn 20 accumulated on the accumulating section 71, to the upstream side. The draw-out mechanism includes the upper yarn guide pipe 26, the servo motor 55, and the unit control section 50, which controls the servo motor 55. The draw-out mechanism allows the yarn 20 to be smoothly drawn out.

[0055] In the above-described configuration, the yarn 20 guided through the introduction hole 80 in the yarn guiding section 72 into the rotating shaft casing 70

passed through the yarn passage 74 and the interior of the winding cylinder 75 and is then discharged from a tip of the winding cylinder 75. The yarn 20 is thus guided to a side surface portion of the accumulation section 71. Thus, when the servo motor 55 is driven forward, the winding cylinder 75 rotates together with the rotating shaft 73 to wind the yarn 20 around the side surface portion.

[0056] Furthermore, each of the plurality of rod members 82 arranged in the accumulation section 71 is located so as to incline toward the inside of the accumulation section 71 as the rod member 82 extends from the support plate 81-side end toward the mounting plate 83-side end. Thus, when the yarn 20 is continuously wound by the winding cylinder 75, a portion of the yarn 20 which is wound around the inclining portion moves upward. Thus, the yarn 20 is spirally aligningly accumulated on the side surface portion composed of the rod members 82.

[0057] In the present embodiment, the servo motor 55 is used as a yarn accumulation driving section. Thus, the quick stop of rotation of the winding cylinder 75, acceleration or deceleration thereof, or the like can be precisely performed. This enables the amount by which the yarn 20 is drawn out, timing for the draw-out, and the like to be accurately controlled. The yarn splicing operation can be more smoothly performed.

[0058] Furthermore, as shown in Figure 2, the winding unit 10 includes a first accumulation sensor 76 located on an upper portion of the accumulation section 71 and a second accumulation sensor 77 located on a lower portion of the accumulation section 71. Each of the two accumulation sensors (yarn accumulation amount detecting section) 76, 77 is composed of a non-contact type optical sensor or the like and electrically connected to the unit control section 50. The first accumulation sensor 76 is located on an upper end side of the accumulation section 71 so as to be able to detect a portion of the yarn 20 which is wound on the upper end side of the rod members 82, comprising the accumulation section 71. The first accumulation sensor 76 thus detects a maximum accumulation condition of the accumulator 61. Furthermore, the second accumulation sensor 77 is located on a downstream side of the accumulation section 71 so as to be able to detect a portion of the yarn 20 which is wound on the lower end side of the rod members 82. The second accumulation sensor 77 detects the shortage of yarn accumulation in the accumulator 61. Based on yarn detection signals from the first accumulation sensor 76 and the second accumulation sensor 77, the unit control section 50 controls the speed at which the yarn 20 is wound around the accumulation section 71. This enables the amount of yarn 20 accumulated in the accumulator 61 to be adjusted so that the amount is not excessive or insufficient.

[0059] When yarn winding is started, the speed at which the yarn 20 is wound around the accumulation section 71 of the accumulator 61 (in other words, the speed at which the yarn 20 is fed from the yarn supplying bobbin

21, located on the upstream side, to the accumulator 61) is controlled to be equal to or higher than the speed at which the yarn 20 is wound into the package 30 and which is sequentially increased. Then, when a predetermined time elapses from the beginning of the winding and an amount of the yarn 20 required for the yarn splicing operation is accumulated in the accumulator 61, the driving of the servo motor 55 is controlled such that the yarn 20 is wound around the accumulation section 71 at a speed equal to the yarn winding speed for the package 30. Thus, the amount of yarn accumulated in the accumulator 61 is maintained. Here, the amount of yarn 20 required for the yarn splicing operation is the sum of the amount of yarn drawn out from the accumulator to the upstream side for the yarn splicing operation performed in the splicer device 14, described below, and the amount of yarn 20 drawn out from the accumulator 61 to the downstream side for the winding of the yarn 20 into the package 30, which is performed in parallel with the yarn splicing operation. The accumulation section 71 preferably always maintains a condition in which an amount of yarn 20 equal to or more than the required amount is accumulated.

[0060] The yarn 20 unwound from the accumulation section 71 of the accumulator 61 is wound into the package 30, driven by the winding drum 24. At this time, tension applied to the yarn 20 by the second tension applying section 42 is controlled by the unit control section 50 according to the winding speed.

[0061] Next, the yarn splicing operation performed when the clearer 15 detects a yarn defect will be described. Upon detecting a yarn defect by monitoring the thickness of the yarn 20, the clearer 15 transmits a yarn defect detection signal to the unit control section 50. Based on the yarn defect detection signal, the unit control section 50 operates a cutter (yarn cutting means) provided below the clearer 15 to cut the yarn 20. At the same time, the unit control section 50 stops the servo motor 55 of the accumulator 61 to stop the rotation of the winding cylinder 75. Thus, the upper yarn is stopped below the introduction hole 80 in the accumulator 61.

[0062] A catching position of the upper guide pipe 26 will be described with reference to Figure 3. Figure 3 is a front view showing that the upper yarn guide pipe 26 is in the catching position. After the yarn 20 is cut, the unit control section 50 pivotally moves the upper yarn guide pipe 26, around a shaft 35, to the catching position shown in Figure 3. In the catching position, the upper yarn suction port 34 at the tip of the upper yarn guide pipe 26 lies opposite the yarn hanging down from the introduction hole 80 in the accumulator 61.

[0063] At this time, the servo motor 55 is driven in the reverse direction so that a portion of the yarn 20 which contains a yarn defect is drawn out from the accumulator 61 and sucked into the upper yarn suction port 34, or a neutral condition is maintained until the yarn defect is sucked into the upper yarn suction port 34. As described above, the negative pressure source is connected to the upper yarn guide pipe 26. Thus, a suction flow generated

in the vicinity of the upper yarn suction port 34 allows the upper yarn to be caught and guided to the splicer device 14. Then, the lower yarn suction port 32 of the lower yarn guide pipe 25 catches the lower yarn at a position shown in Figure 1. Thereafter, the lower yarn guide pipe 25 moves pivotally upward around the shaft 33 to guide the lower yarn to the splicer device 14. In this condition, the guided upper and lower yarns are spliced by the splicer device 14, thus completing the yarn splicing operation. At this time, the yarn end of the upper yarn containing the yarn defect is cut by the cutter of the splicer device 14. The cut yarn end is then sucked and removed by the negative pressure source (not shown in the drawings) connected to the upper yarn guide pipe 26. Thereafter, the unit control section 50 drives the servo motor 55 forward again to rotate the winding cylinder 75 in a direction in which the yarn 20 is accumulated.

[0064] Next, the yarn splicing operation performed to allow the yarn supplying bobbin 21 to be replaced will be described. Upon detecting that the yarn 20 to be fed from the yarn supplying bobbin 21 is exhausted, the yarn detection part 37 transmits a yarn absence detection signal to the unit control section 50. Upon receiving the yarn absence signal, the unit control section 50 stops the supply of the yarn 20 to the accumulator 61. At this time, timing for stopping the servo motor 55 is adjusted such that the yarn end is stopped at a predetermined position. This facilitates catching of the yarn 20. Moreover, preferably, the yarn 20 can be inhibited from being wastefully used.

[0065] Then, the unit control section 50 pivotally moves the upper yarn guide pipe 26 to the catching position to suck and catch a portion of the yarn 20 which is located in the vicinity of an inlet of the accumulator 61. In this condition, the upper yarn guide pipe 26 is pivotally moved downward to guide the upper yarn to the splicer device 14. Furthermore, when a new yarn supplying bobbin 21 is supplied by the above-described magazine type supply device, the yarn 20 located on the side of the new yarn supplying bobbin 21 is guided to the splicer device 14 by the lower yarn guide pipe 25. Then, the unit control section 50 allows the splicer device 14 to splice the upper and lower yarns. The unit controller 50 thereafter controls the servo motor 55 such that the winding cylinder 75 is rotated in the direction in which the yarn 20 is accumulated.

[0066] Next, with reference to Figure 4, a description will be given of how the accumulator 61 and the upper yarn guide pipe 26 are controlled until the upper yarn is guided to the splicer device 14 when a yarn defect is detected. When a flow in Figure 4 is started, the unit control section 50 stands by until receiving a signal indicating that a yarn defect has been detected, from the clearer 15 (S101). Upon receiving the yarn defect detection signal, the unit control section 50 immediately stops the forward rotation of the servo motor 55 (S102). The unit control section 50 then cuts the yarn 20 with the cutter (not shown in the drawings) (S103).

[0067] Then, to draw out an amount of yarn 20 required to pivotally move the upper yarn guide pipe 26, the unit control section 50 reversely rotates the servo motor 55 by a predetermined number of times (S104). Subsequently, the unit control section 50 pivotally moves the upper yarn guide pipe 26 to the catching position shown by a solid line in Figure 3, where the upper yarn guide pipe 26 comes to rest (S105). Then, the unit control section 50 allows a suction flow from the upper yarn suction port 34 to act on the upper yarn hanging down from the introduction hole 80 in the accumulator 61 to suck and catch the upper yarn (S106). Then, the unit control section 50 pivotally moves the upper yarn guide pipe 26 to a guide position located below (S107). Thus, the upper yarn and yarn defect portion introduced into the accumulator 61 can be drawn out. In the processing in S104, the arrangement in which the servo motor 55 is reversely rotated the predetermined number of times may be changed to an arrangement in which the servo motor 55 is set to the neutral condition.

[0068] Once the pivotal movement of the upper yarn guide pipe 26 to the guide position is completed, the unit control section 50 checks the signal from the clearer 15 (S108). That is, in the present embodiment, when the upper yarn guide pipe 26 properly guides the upper yarn to the splicer device 14, the yarn path of the upper yarn simultaneously passes through the clearer 15. The clearer 15 thus senses the yarn 20. Consequently, when the clearer 15 senses the yarn 20, this means that the upper yarn has successfully been guided to the splicer device 14. Thus, the upper yarn guide pipe 26 is moved to the standby position, where the upper yarn guide pipe 26 does not interfere with the yarn winding operation (S109). Then, the control flow for the guidance of the upper yarn is completed. When the clearer 15 fails to sense the upper yarn, this means that the guidance of the upper yarn has failed. Thus, the unit control section 50 returns to the processing in S105, where the upper yarn guide pipe 26 attempts to catch the yarn end of the upper yarn again. In the yarn winding device according to the present embodiment, the upper yarn can be caught within the specified range of the introduction hole 80 in the accumulator 61. Therefore, the yarn winding device according to the present embodiment is unlikely to fail to catch the upper yarn compared to the conventional art.

[0069] When the guidance of the upper yarn fails, the unit control section 50 may return to the processing in S104 instead of the processing in S105, where the servo motor 55 is additionally reversely rotated to draw out the yarn 20 further to the upstream side. Furthermore, in the processing in S106, the suction flow is allowed to act on the upper yarn, which is thus sucked and caught. However, the upper yarn may be caught by being gripped by a grip mechanism or the like.

[0070] Through the series of flow shown above, the upper yarn guided to the splicer device 14 is spliced to the lower yarn guided by the lower yarn guide pipe 25. Since the yarn splicing operation is performed in parallel

with the operation of winding the yarn 20 into the package 30, the yarn defect can be removed without the need to stop or reversely rotate the winding drum 24. When the yarn splicing operation is completed, the servo motor 55 starts rotating forward to resume the supply of the yarn 20 to the accumulator 61. To recover the amount of yarn 20 consumed by the yarn splicing operation, the speed at which the yarn 20 is supplied to the accumulation section 71 is controlled to be higher than the winding speed for the package 30. Once a predetermined amount of yarn 20 is accumulated, the unit control section 50 returns the speed at which the yarn 20 is supplied to the accumulator 61 to the original value, which is equal to the yarn winding speed for the package 30.

[0071] Next, with reference to Figure 5, a description will be given of how the accumulator 61 and the upper yarn guide pipe 26 are controlled until the upper yarn is guided to the splicer device 14 when the yarn 20 on the yarn supplying bobbin 21 is exhausted. When a flow in Figure 5 is started, the unit control section 50 stands by until receiving the yarn absence detection signal from the yarn detection part 37 (S201). Upon receiving the yarn absence detection signal, the unit control section 50 stops the forward rotation of the servo motor 55 to stop the supply of the yarn 20 to the accumulator 61 (S202). Then, the unit control section 50 pivotally moves the upper yarn guide pipe 26 to the catching position shown by the solid line in Figure 3, where the upper yarn guide pipe 26 comes to rest (S203). The unit control section 50 allows the suction flow from the upper yarn suction port 34 to act on the yarn 20 drawn out from the accumulator 61, to suck and catch the upper yarn (S204). To draw out an amount of yarn 20 required to pivotally move the upper yarn guide pipe 26, the unit control section 50 reversely rotates the servo motor 55 by a predetermined number of times (S205). Then, the unit control section 50 pivotally moves the upper yarn guide pipe 26 to the catching position, located below (S206). When in the processing in S207, the clearer 15 fails to sense the yarn 20, the unit control section 50 returns to the processing in S204, where the upper yarn guide pipe 26 attempts to catch the yarn end of the upper yarn again. When the clearer 15 senses the yarn 20, the unit control section 50 moves the upper yarn guide pipe 26 to the standby position (S208) and then terminates the flow in Figure 5. In the processing in S203, the arrangement in which the servo motor 55 is reversely rotated the predetermined number of times may be changed to the arrangement in which the servo motor 55 is set to the neutral condition.

[0072] In the present embodiment, when the yarn 20 on the yarn supplying bobbin 21 is exhausted, the unit control section 50 controllably stops the supply of the yarn 20 to the accumulator 61 (S201, S202 in Figure 5). With this configuration, when the yarn 20 on the yarn supplying bobbin 21 is exhausted, the yarn end can be easily caught at a position upstream of the accumulator 61 and spliced to the yarn 20 on the new yarn supplying bobbin 21, with the winding of the yarn 20 into the pack-

age 30 continued on the downstream side.

[0073] Since the yarn splicing operation shown above is performed in parallel with the operation of winding the yarn 20 into the package 30, the yarn supplying bobbin 21 can be replaced with a new one without the need to stop or reversely rotate the winding drum 24. When the yarn splicing operation is completed, the servo motor 55 starts rotating forward to feed the yarn 20 from the new yarn supplying bobbin 21 to the accumulator 61.

[0074] As shown above, the winding unit 10 according to the present embodiment includes the winding drum 24, which winds the yarn 20 into the package 30 while traversing the yarn 20, the accumulator 61, which allows the yarn 20 to be accumulated before the yarn 20 is wound into the package 30, the yarn defect detecting section 7, which detects a yarn defect, the yarn splicing section 8, which performs the yarn splicing operation, the yarn supplying bobbin holding section 60, which holds the yarn supplying bobbin 21, and the draw-out mechanism, which draws out the yarn 20 accumulated in the accumulator 61, to the upstream side in the yarn traveling direction.

[0075] This configuration enables the draw-out mechanism to draw out the yarn 20 from the accumulator 61 for the yarn splicing operation, while allowing the yarn winding operation to be continuously operated on the package 30 side. This enables a reduction in a possible loss of winding time resulting from suspension of the yarn winding operation for the package 30. The production efficiency for the package 30 can thus be improved. Furthermore, since the yarn winding operation for the package 30 is not suspended, the adverse effect, on traversing, of variation in winding tension that may occur at the beginning of rotation of the package 30 can be minimized. This also enables a reduction in the amount of power consumed to accelerate the package 30 up to a winding speed used during the yarn winding operation. Energy can thus be saved.

[0076] Alternatively, the winding unit 10 according to the present embodiment is configured as described below. The draw-out mechanism is composed of the upper yarn guide pipe 26, which catches and guides the upper yarn that is the package 30-side yarn, to the splicer device 14, the servo motor 55, provided in the accumulator 61, and the unit control section 50, which controls the servo motor 55.

[0077] With this arrangement, while controlling the driving of the servo motor 55, the unit control section 50 allows the upper yarn guide pipe 26 to draw out the yarn 20 from the accumulator 61 and to guide the yarn 20 to the splicer device 14. As shown in the above-described embodiment, the unit control section 50 allows the upper yarn guide pipe 26 to suck and catch the yarn 20 in the accumulator 61, while driving the servo motor 55 so that the yarn 20 is drawn out from the accumulator 61 to the upstream side in the yarn traveling direction.

[0078] Alternatively, the winding unit 10 according to the present embodiment is configured as follows. The

yarn supplying section 9 includes the yarn supplying bobbin holding section 60, which discharges the empty yarn supplying bobbin 21 and receives a new yarn supplying bobbin 21. The yarn splicer device 14 splices the yarn end on the new yarn supplying bobbin 21 received by the yarn supplying bobbin holding section 60 and the yarn end on the accumulator 61 side.

[0079] This configuration allows the yarn supplying bobbin 21 to be replaced with new one without the need to stop the yarn winding operation. The package production efficiency can thus be further improved.

[0080] Alternatively, the winding unit 10 according to the present embodiment includes the drum driving motor 53, the accumulator 61, the yarn defect detecting section 7, the splicer device 14, the upper yarn guide pipe 26, the lower yarn guide pipe 25, and the unit control section 50. The drum driving motor 53 is configured to rotate the package 30. The accumulator 61 allows the yarn 20 to be accumulated before the yarn 20 is wound into the package 30. The accumulated yarn 20 can be drawn out to the yarn supplying bobbin 21 side. The yarn defect detecting section 7 is configured to detect a yarn defect. The splicer device 14 is configured to perform the yarn splicing operation. The upper yarn guide pipe 26 catches and guides the yarn 20 located on the package 30 side, to the splicer device 14. The lower yarn guide pipe 25 catches and guides the yarn 20 located on the yarn supplying bobbin 21 side to the splicer device 14. When the clearer 15 detects a yarn defect, the unit control section 50 controllably cuts a portion of the yarn 20 located on the upstream side of the detected yarn defect in the yarn winding direction, while simultaneously stopping the accumulation of the yarn 20 by the accumulator 61 so that the upper yarn stopped below the introduction hole 80 in the accumulator 61 is caught and guided to the splicer device 14 by the upper yarn guide pipe 26 for the yarn splicing operation.

[0081] With this configuration, even during the yarn splicing operation, the yarn winding operation can be performed without the need to reverse or stop the package 30 so as to allow the package 30-side yarn 20 to be drawn out. This enables a reduction in a possible loss of winding time resulting from the suspension of the yarn winding operation for the package 30. The production efficiency for the package 30 can thus be improved. Furthermore, the upper yarn guide pipe 26 is configured to avoid directly sucking the surface of the package 30. Thus, when the package 30-side yarn 20 is caught, possible degradation of the quality of the package 30 such as a traversing error is prevented. Additionally, even if a yarn defect is detected, the portion of the yarn 20 which is located on the upstream side of the yarn defect section in the yarn winding direction is drawn out from the accumulator 61 and cut for the yarn splicing operation. Thus, the yarn defect can be reliably removed. Moreover, even when the yarn 20 on the yarn supplying bobbin 21 is exhausted, a sufficient amount of yarn 20 is accumulated on the downstream side. Thus, with the winding of the yarn 20

into the package 30 continued, the yarn end can be easily caught at the position located upstream of the accumulator 61 and spliced to the yarn 20 from the new yarn supplying bobbin 21.

[0082] In the conventional configuration in which the upper yarn is caught directly on the surface of the package 30, the position of the yarn end on the surface of the package 30 is unspecified. Thus, in the conventional configuration, the suction port at the tip of the upper yarn catching section needs to be formed to be elongate so as to allow the entire surface of the package to be sucked. However, the configuration according to the present embodiment has only to catch the yarn 20 hanging down from the introduction port 80 in the accumulator 61. This eliminates the need to configure the upper yarn suction port 34 to be wide enough to cover the entire winding width of the package 30 as is the case with the conventional suction mouth. Consequently, the upper yarn catching section (upper yarn guide pipe 26) can be compactly configured. Furthermore, compared to the conventional configuration in which the yarn end on the surface of the package 30 is caught, the present invention enables a reduction in the suction range of the upper yarn suction port 34. This improves the rate at which the yarn 20 is successfully caught, enabling a further reduction in the cycle time of the yarn splicing operation. Moreover, since the present embodiment is configured to avoid catching the upper yarn on the surface of the package 30, a possible phenomenon (what is called "yarn stitching") is prevented in which while the upper yarn catching section is attempting to catch the yarn end, the yarn end falls from the surface of a yarn layer.

[0083] Furthermore, in the winding unit 10 according to the present embodiment, the accumulator 61 includes the accumulation section 71, around which the yarn 20 is wound for accumulation, the winding cylinder 75, mounted in the accumulation section 71 so as to be rotatable relative to the accumulation section 71, and the servo motor 55, which rotates the winding cylinder 75 forward and backward. When the upper yarn guide pipe 26 guides the upper yarn to the accumulator 61, the unit control section 50 performs control such that the servo motor 55 is reversely rotated or set to the neutral condition.

[0084] With this arrangement, the servo motor 55 controls the speed at which the winding cylinder 75 rotates forward, to allow the amount of the accumulated yarn 20 to be easily adjusted. Furthermore, controlling the reverse rotation of the winding cylinder 75 allows the yarn 20 to be drawn out at the appropriate draw-out amount and at the appropriate timing. As a result, the yarn splicing operation can be more precisely performed, contributing to reliable removal of the yarn defect and prevention of the wasteful use of the yarn 20.

[0085] The winding unit 10 according to the present embodiment is configured as follows. The accumulator 61 has the rotating shaft casing 70, which covers at least a part of the winding cylinder 75. The introduction hole

80 is formed in the rotating shaft casing 70 to introduce the yarn 20 drawn out from the yarn supplying bobbin 21, into the accumulator 61. When yarn breakage or cutting occurs on the upstream side of the accumulator 61 in the yarn winding direction, the unit control section 50 controls the servo motor 55 so that the rotation of the winding cylinder 75 is stopped before the yarn end of the upper yarn is introduced into the introduction hole 80.

[0086] With this arrangement, the yarn 20 can be reliably guided into the accumulator 61. Furthermore, even if yarn breakage or cutting occurs, the upper yarn can be prevented from being wound around the accumulator 61. Additionally, the yarn end of the upper yarn can be stopped at the position where the yarn end can be easily caught. This allows the upper yarn guide pipe 26 to more reliably catch the yarn end.

[0087] Furthermore, the winding unit 10 according to the present embodiment is configured as follows. That is, the winding unit 10 includes the first accumulation sensor 76 and the second accumulation sensor 77, which detect the amount of yarn 20 accumulated in the accumulator 61. Additionally, the unit control section 50 controls the servo motor 55 according to the yarn accumulation amount detected by the first accumulation sensor 76 and the second accumulation sensor 77.

[0088] This arrangement allows the amount of yarn accumulated in the accumulator 61 to be adjusted to the appropriate value. In the present embodiment, by changing the forward rotation speed of the winding cylinder 75 of the accumulator 61, a sufficient amount of yarn can be accumulated in the accumulator 61 with the winding speed for the package 30 maintained constant. For example, when only a small amount of yarn is accumulated in the accumulator 61, the rotation speed of the servo motor 55 is increased to allow the appropriate accumulation amount to be always ensured.

[0089] Furthermore, the automatic winder according to the present embodiment includes a plurality of the winding units 10. This configuration provides the automatic winder that enables the yarn winding operation to be consecutively performed, thus improving package production efficiency.

[0090] Furthermore, the winding unit 10 according to the present embodiment 10 removes the yarn defect using a method including the following steps. That is, in a first step, the yarn 20 drawn out from the yarn supplying bobbin 21 is accumulated before being wound into the package 30. In a step, when a yarn defect is detected, the accumulated yarn 20 containing the yarn defect is drawn out to the upstream side in the yarn traveling direction. In a third step, the yarn 20 drawn out in the first step is guided to the splicer device 14. In a fourth step, the yarn supplying bobbin 21-side yarn is guided to the splicer device 14. In a fifth step, the yarn 20 guided in the third step is spliced to the yarn 20 guided in the fourth step.

[0091] With this configuration, even when the yarn defect is to be removed, winding can be continuously per-

formed without the need to reversely rotate or stop the package 30 so as to draw out the package 30-side yarn. Furthermore, the yarn splicing operation is performed after the portion containing the yarn defect has been drawn out. Thus, the yarn defect can be reliably removed.

[0092] A configuration different from the one according to the above-described embodiment is possible in which in detecting a yarn defect, the unit control section 50 controls the rotation number of the drum driving motor 53 according to the amount of the accumulated yarn 20. With Figure 6, a description will be given of how the winding drum 24 and the accumulator 61 are controlled so as to control the rotation of the package 30 according to the yarn accumulation amount when a yarn defect is detected. Figure 6 is a flowchart showing how the accumulator and the pivotal movement of the upper yarn guide pipe 26 are controlled so as to adjust the amount of yarn accumulated in the accumulator 61 when the yarn defect is detected.

[0093] When a flow in Figure 6 is started, the unit control section 50 stands by until receiving the signal indicating that a yarn defect has been detected, from the clearer 15 (S301). Upon receiving the yarn defect detection signal, the unit control section 50 checks whether or not a sufficient amount of yarn 20 is accumulated in the accumulator 61, based on detection values from the accumulation sensors 76, 77, corresponding to the yarn accumulation amount detecting section (S302). When a sufficient amount of yarn 20 is accumulated in the accumulator 61, the unit control section 50 quickly stops the forward rotation of the servo motor 55 and then reversely rotates the servo motor 55 by a predetermined number of times (S304). In the processing in S302, upon determining that a sufficient amount of yarn 20 is not accumulated in the accumulator 61, the unit control section 50 controllably reduces the rotation speed of the winding drum 24 (S303). The unit control section 50 then shifts to the processing in S304. The processing in subsequent steps S305 to S311 is similar to that in S103 to S109, described with reference to Figure 4 and will thus not be described.

[0094] As shown above, the automatic winder configured as shown in Figure 6 includes the first accumulation sensor 76 and the second accumulation sensor 77, which detect the amount of yarn 20 accumulated in the accumulator 61. The unit control section 50 controls the drum driving motor 53 according to the amount of yarn accumulated in the accumulator 61.

[0095] This configuration allows the winding speed for the package 30 to be varied according to the amount of the accumulated yarn 20. For example, when only a small amount of yarn 20 is accumulated in the accumulator 61, the rotation speed of the drum driving motor 53 is reduced to set the amount of the yarn 20 accumulated in the accumulator 61 to be larger than that of the yarn 20 drawn out from the accumulator 61. Then, the appropriate accumulation amount can always be ensured. This enables prevention of a possible situation in which all of the yarn

20 accumulated is unwound while the winding section of the yarn accumulation driving section is stopped, for example, when a yarn defect is detected and needs to be removed or when the bobbin is replaced with a new one.

[0096] The preferred embodiment of the present invention has been described. However, the above-described configuration can be modified as described below.

[0097] The above-described embodiment may be additionally configured such that the rotation of the winding drum 24 is stopped when a given condition is met. For example, when the clearer 15 detects a yarn defect three consecutive times, the supplied yarn supplying bobbin 21 is determined to be defective, and the winding is thus stopped. Then, a new bobbin is supplied as a yarn supplying bobbin 21. Once a sufficient amount of yarn 20 is accumulated in the accumulator 61, the winding drum 24 is rotated to resume the winding.

[0098] The configuration may be modified such that when the yarn detection part 37 senses that the yarn 20 on the yarn supplying bobbin 21 is exhausted, the unit control section 50 reduces the yarn supply speed instead of stopping the supply of the yarn 20 to the accumulator 61. That is, provided that the yarn end can be caught by the upper yarn guide pipe 26 before being completely drawn into the accumulator 61, the yarn 20 can be guided to the splicer device 14 for the yarn splicing operation even though the yarn is completely stopped. Thus, when the yarn 20 on the yarn supplying bobbin 21 is exhausted, the yarn end can be easily caught at the position upstream of the accumulator 61 and spliced to the yarn 20 on the new yarn supplying bobbin 21, with the winding of the yarn 20 into the package 30 continued on the downstream side.

[0099] Furthermore, the above-described embodiment may be additionally configured such that the winding speed for the package 30 is varied according to the amount of yarn 20 accumulated in the accumulator 61. For example, when only a small amount of yarn 20 is accumulated in the accumulator 61, the winding speed for the package 30 is reduced to adjustably prevent an excessive amount of yarn 20 from being drawn out from the accumulator 61. Then, the appropriate yarn accumulation amount can be ensured.

[0100] Additionally, in the above-described embodiment, the first tension applying section 41 and the second tension applying section 42, which control the tension, are of the gate type. However, the configuration of the tension control section may be appropriately changed; for example, disk type tensors may be used instead.

[0101] Furthermore, in the above-described embodiment, when a yarn defect is detected, the yarn 20 is cut immediately after being drawn out from the accumulator 61. However, this arrangement may be modified such that the yarn 20 is cut at any timing after the yarn defect portion has been drawn out from the accumulator 61.

[0102] Additionally, in the above-described embodiment, the two accumulation sensors 76, 77 are used to

detect the amount of yarn 20 accumulated in the accumulator 61. However, the method of detecting the yarn amount may be appropriately changed; for example, at least three accumulation sensors may be used.

[0103] Furthermore, in the above-described embodiment, the two accumulation sensors 76, 77 are used as the yarn accumulation detecting section to detect the yarn accumulation amount of the accumulator 61. The unit control section 50 then controls the winding driving section (drum driving motor) 53 according to the detected yarn accumulation amount. However, a monitor section monitoring the occurrence frequency of yarn defect removals may be provided as the yarn accumulation amount detecting section so that the drum driving motor 53 can be controlled based on the result of the monitoring. Moreover, the monitor section may control the winding driving section 53 taking into account not only the yarn defect removal but also, for example, occurrence timings for the yarn supplying bobbin 21 replacing operation and the yarn defect removal.

[0104] Furthermore, in the above-described embodiment, the winding driving section 53 rotates the package 30 via the winding drum 24. However, the winding driving section 53 may directly rotate the package 30.

[0105] While the present invention has been described with respect to preferred embodiments thereof, it will be apparent to those skilled in the art that the disclosed invention may be modified in numerous ways and may assume many embodiments other than those specifically set out and described above. Accordingly, it is intended by the appended claims to cover all modifications of the present invention that fall within the true spirit and scope of the present invention.

Claims

1. A yarn winding device (10) winding a yarn drawn out from a yarn supplying bobbin (21), into a package (30), the yarn winding device being **characterized by** comprising a winding section (5) winding the yarn into the package (30) while traversing the yarn, a yarn accumulating device (61) allowing the yarn to be accumulated before the yarn is wound into the package (30), a yarn defect detecting section (7) detecting a yarn defect, a yarn splicing device (14) performing a yarn splicing operation, a yarn supplying section (9) holding the yarn supplying bobbin (21), and draw-out mechanism drawing out the yarn accumulated in the yarn accumulating device (61), to an upstream side in a yarn traveling direction.
2. The yarn winding device (10) according to Claim 1, **characterized in that** the draw-out mechanism comprises an upper yarn catching section (26) for catching and guiding an upper yarn that is a package (30)-side yarn, to the yarn splicing device (14), a yarn accumulation driving section (55) serving as a driving

portion for the yarn accumulating device (61), and a control section (50) controlling the yarn accumulation driving section (55).

3. The yarn winding device (10) according to Claim 1 or Claim 2, **characterized in that** the yarn supplying section (9) comprises a yarn supplying bobbin holding section (60) discharging the empty yarn supplying bobbin (21) and receiving a new yarn supplying bobbin (21), and the yarn splicing device (14) splices a yarn end on the new yarn supplying bobbin received by the yarn supplying bobbin holding section (60) and a yarn end on the yarn accumulating device (61) side.
4. A yarn winding device (10) winding a yarn drawn out from a replaceable yarn supplying bobbin (21), into a package (30), the yarn winding device being **characterized by** comprising a winding driving section (53) rotating the package (30), a yarn accumulating device (61) allowing the yarn to be accumulated before the yarn is wound into the package (30), a yarn defect detecting section (7) detecting a yarn defect, a yarn splicing device (14) performing a yarn splicing operation, upper yarn catching section (26) catching and guiding an upper yarn that is a package 30-side yarn, to the yarn splicing device (14), lower yarn catching section (25) catching and guiding a lower yarn that is a yarn supplying bobbin 21-side yarn, to the yarn splicing device (14), and a control section (50) which, when the yarn defect detecting section (7) detects a yarn defect, controllably cuts a portion of the yarn located on an upstream side of the detected yarn defect in a yarn winding direction, while simultaneously stopping the accumulation of the yarn by the yarn accumulating device (61) so that the upper yarn stopped below the yarn accumulating device (61) is caught and guided to the yarn splicing device (14) by the upper yarn catching section (26), while the lower yarn caught by the lower yarn catching section (25) is guided to the yarn splicing device (14) for the yarn splicing operation.
5. The yarn winding device (10) according to Claim 4, **characterized in that** the yarn accumulating device (61) comprises an accumulation section (71) around which the yarn is wound for accumulation, a winding section (75) attached to the accumulation section (71) so as to be rotatable relative to the accumulation section (71), and a yarn accumulation driving section (55) rotating the winding section (75) forward and backward, and when the upper yarn catching section (26) guides the upper yarn to the yarn splicing device (14), the control section (50) performs control such that the yarn accumulation driving section (55) is reversely rotated or no load is imposed on the yarn accumulation driving section (55).

6. The yarn winding device (10) according to Claim 5, **characterized in that** the yarn accumulating device (61) has a casing (70) covering at least a part of the winding section (75), and an introduction hole (80) is formed in the casing (70) to introduce the yarn drawn out from the yarn supplying bobbin (21), into the yarn accumulating device (61), and **in that** when yarn breakage or cutting occurs on the upstream side of the yarn accumulating device (61) in the yarn winding direction, the control section (50) controls the yarn accumulation driving section (55) so that the winding section (75) is stopped before the yarn end of the upper yarn is introduced into the introduction hole (80). 5 10 15
7. The yarn winding device (10) according to any one of Claim 2, 5, or 6, **characterized by** further comprising a yarn accumulation amount detecting section for detecting amount of yarn accumulated in the yarn accumulating device (61), and in that the control section (50) controls the yarn accumulation driving section (55) according to the yarn accumulation amount detected by the yarn accumulation amount detecting section. 20 25
8. A yarn winding device (10) winding a yarn drawn out from a yarn supplying bobbin (21) into a package (30), the yarn winding device being **characterized by** comprising a winding section (5) winding the yarn into the package (30) while traversing the yarn, a yarn accumulating device (61) allowing the yarn to be accumulated before the yarn is wound into the package (30), a yarn defect detecting section (7) detecting a yarn defect, a yarn splicing device (14) performing a yarn splicing operation, a yarn supplying section (9) holding the yarn supplying bobbin (21), a yarn accumulation driving section (55) serving as a driving section for the yarn accumulating device (61), a control section (50) controlling the yarn accumulation driving section (55), and a yarn accumulation amount detecting section for detecting amount of yarn accumulated in the yarn accumulating device (61), and in that the control section (50) controls rotation number of a winding driving section (53) provided in the winding section (5) according to the yarn accumulation amount detected by the yarn accumulation amount detecting section. 30 35 40 45
9. The yarn winding device (10) according to Claim 8, **characterized in that** the yarn supplying section (9) comprises a yarn supplying bobbin holding section (60) discharging the empty yarn supplying bobbin (21) and receiving a new yarn supplying bobbin (21), and the yarn splicing device (14) splices a yarn end on the new yarn supplying bobbin received by the yarn supplying bobbin holding section (60) and a yarn end on the yarn accumulating device (61) side. 50 55
10. The automatic winder **characterized by** comprising a plurality of the yarn winding devices (10) according to any one of claims 1 to 9.

FIGURE 1

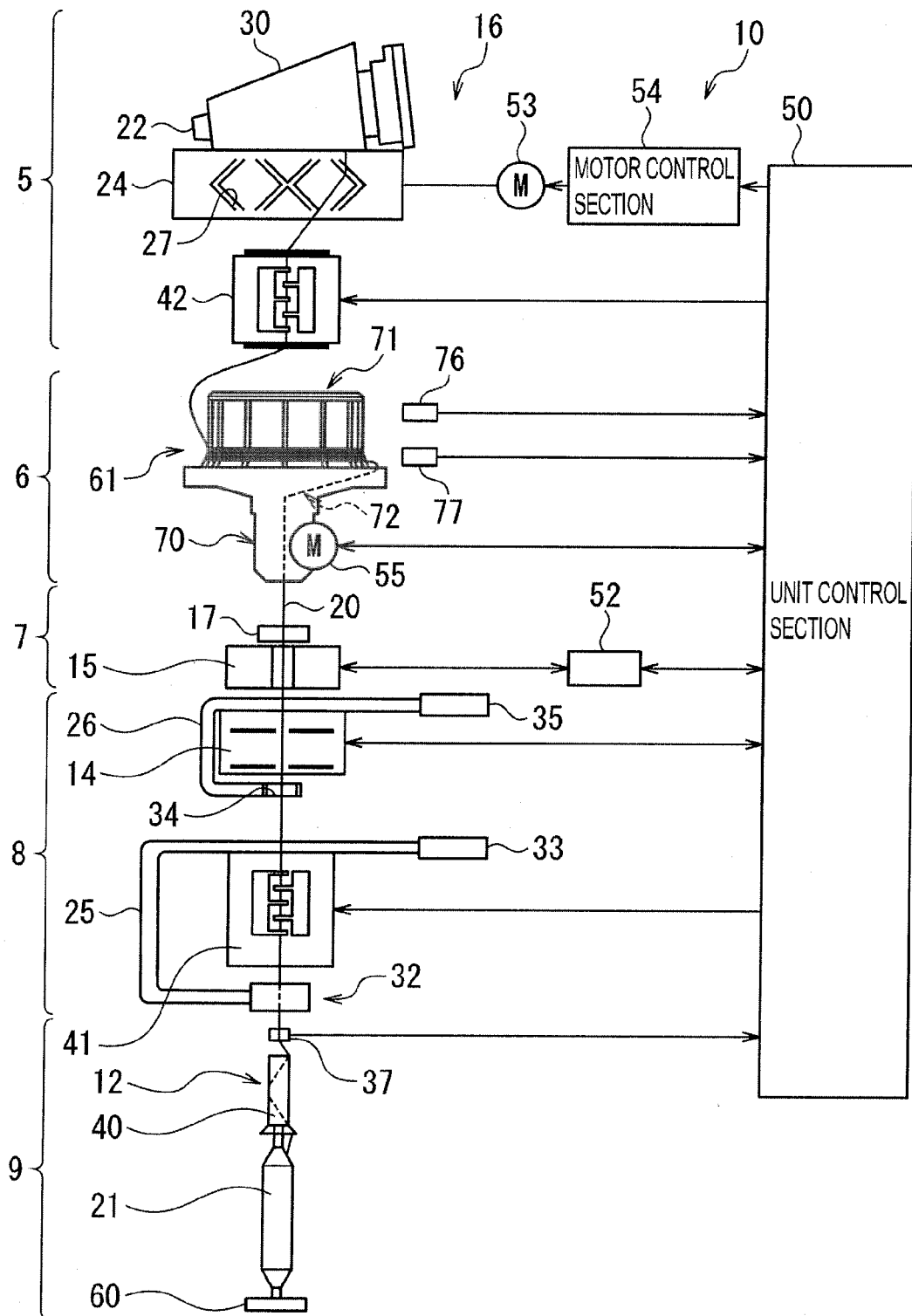


FIGURE 2

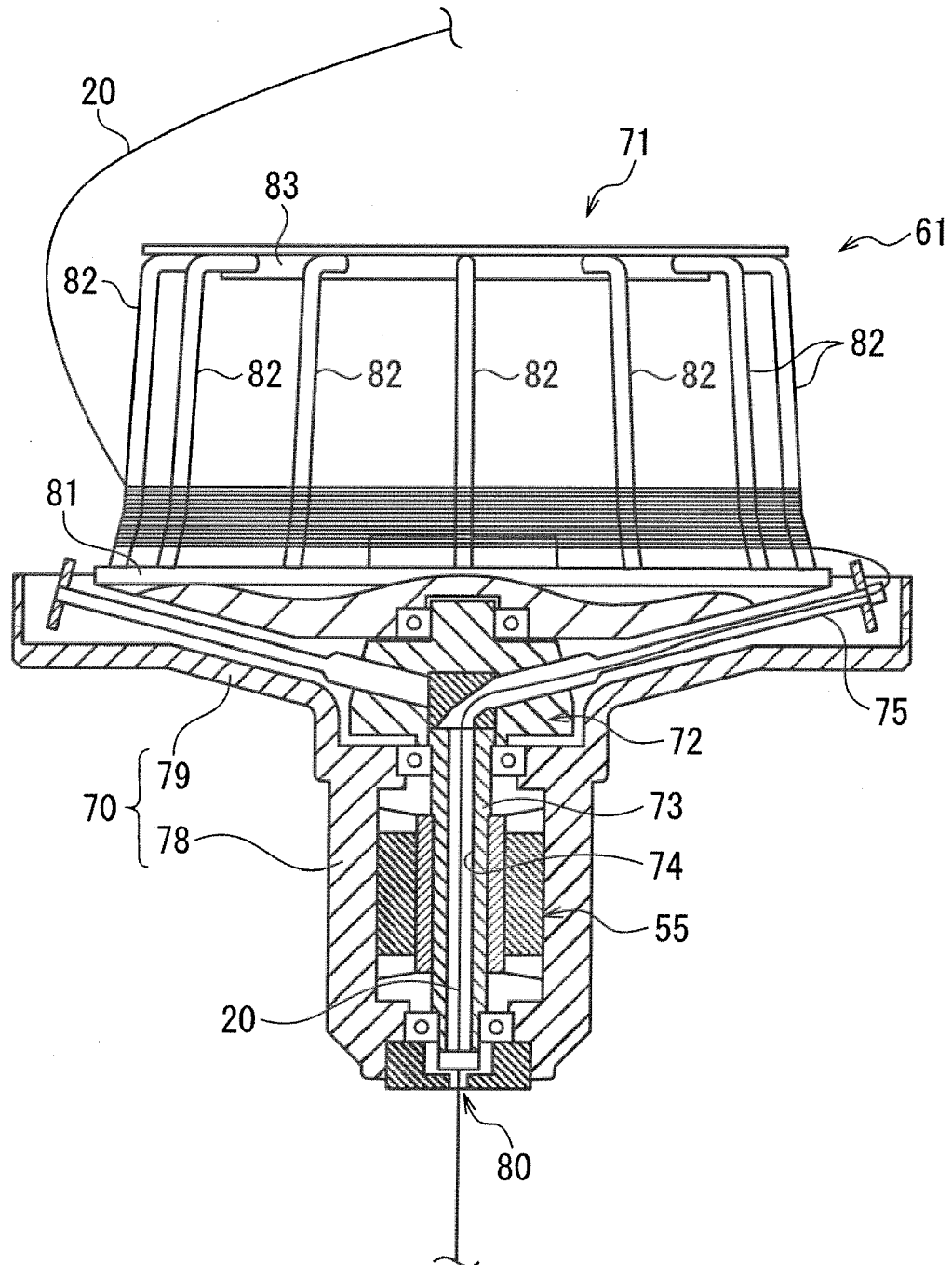


FIGURE 3

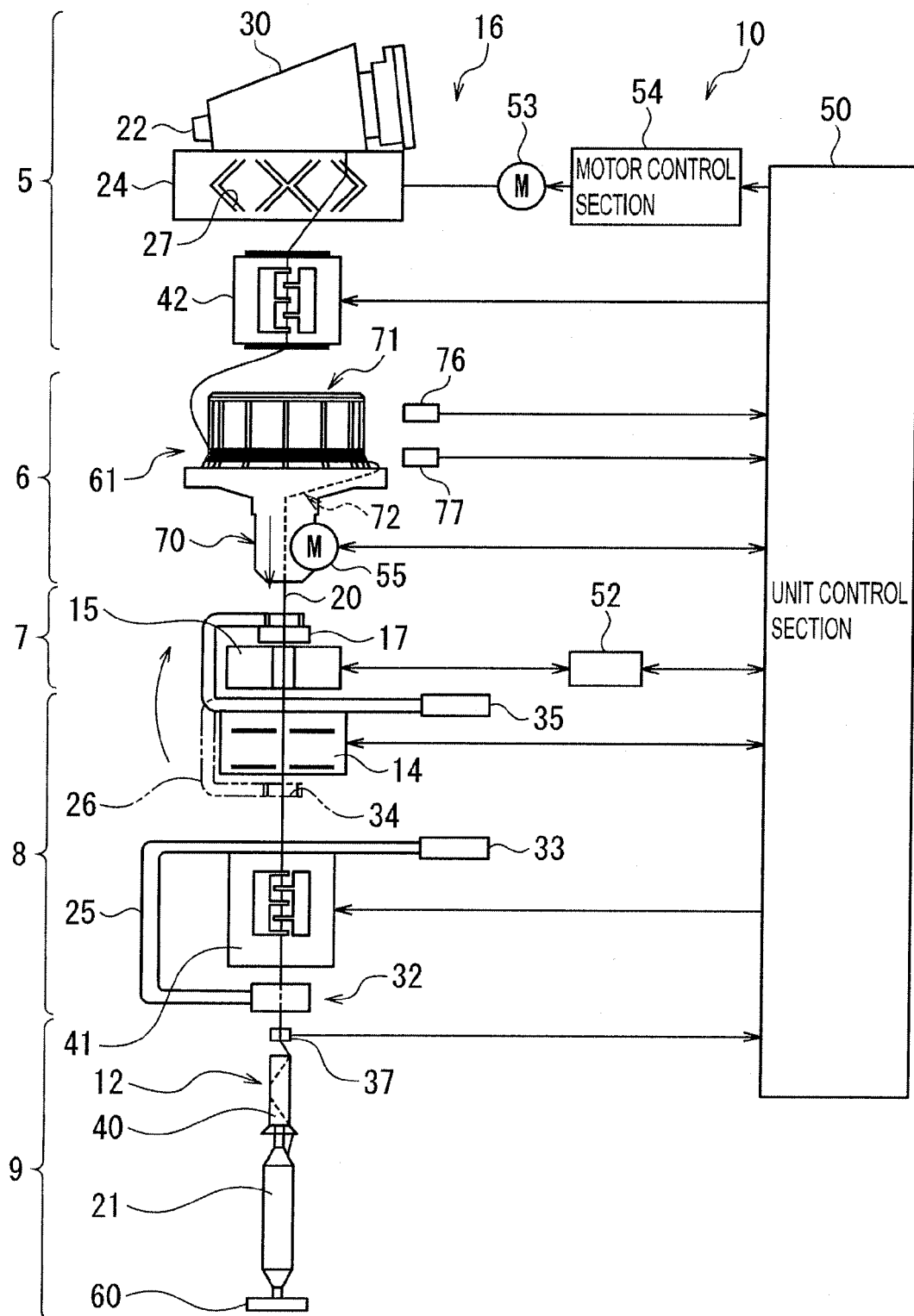


FIGURE 4

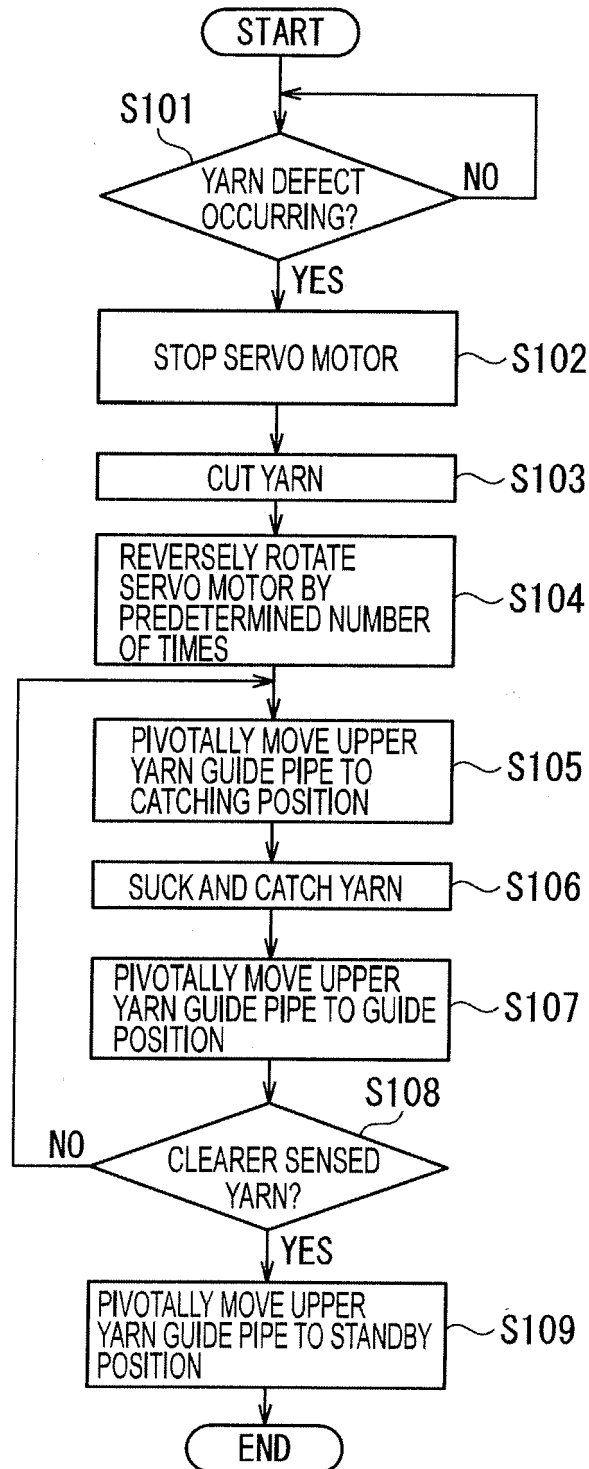


FIGURE 5

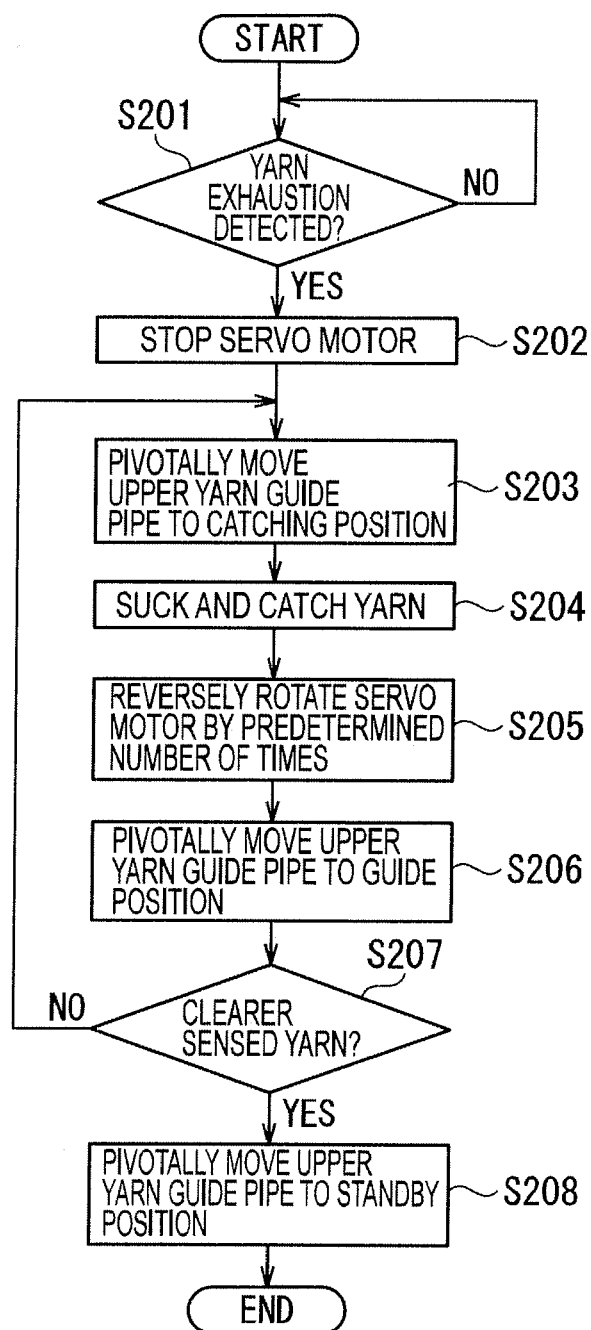
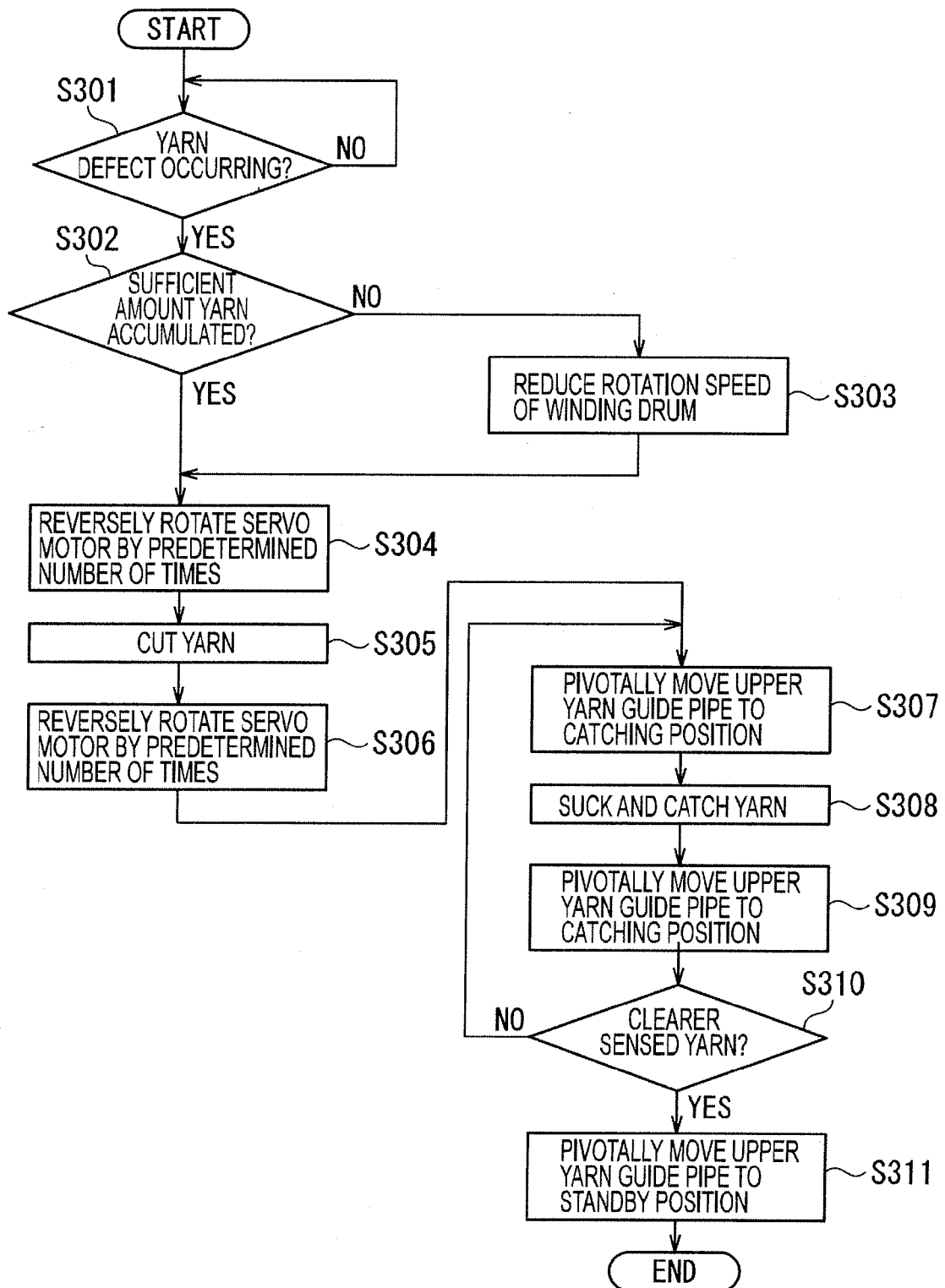


FIGURE 6



REFERENCES CITED IN THE DESCRIPTION

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