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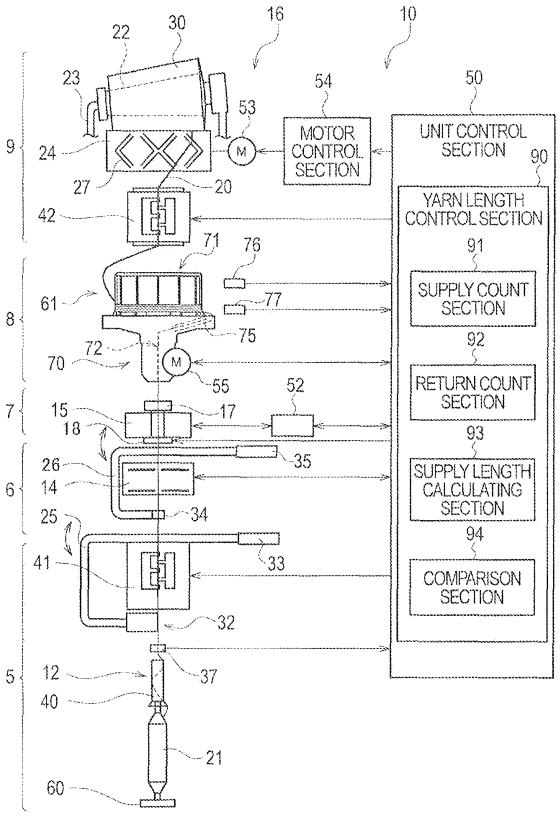
(54) Yarn winding device and automatic winder

(57) A winding unit 10 in an automatic winder is configured to wind a predetermined length of yarn 20 into a package 30. The winding unit 10 includes a yarn pool section 71, a servo motor 55, and a yarn length control section 90. The yarn pool section 71 accumulates that the yarn before being wound into the package 30. The servo motor 55 is driven to supply the yarn to the yarn pool section 71. The yarn length control section 90 allows a supply count section 91 to count a forward rotation pulse signal from the servo motor 55 so that the predetermined length of yarn is wound into the package 30. Then, based on the count value in the forward rotation pulse signal, the length of the yarn wound into the package 30 is calculated (Fig. 1).

FIGURE 1



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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to a yarn winding device and an automatic winder, and specifically, to control of the length of a yarn wound into a package.

Description of Related Art

[0002] A yarn winding device (automatic winder) splices yarns from a yarn supplying bobbin together to form a package. To be used as a warp, the package is transferred to a warper process as a post-process. In the warper process, yarns from a large number of packages are simultaneously wound around a common beam under a uniform tension. Thus, if the length of the yarn varies among the packages, a winding operation is performed based on the package with the smallest winding length. Consequently, for each of the other packages, a part of the yarn which corresponds to the amount by which the yarn length of the package exceeds that of the package with the smallest winding length is disposed of, resulting in a large amount of wasteful yarn.

[0003] To inhibit possible wasteful yarns, a yarn winding device has been proposed which is configured to perform a winding operation while monitoring a yarn speed and the yarn length so as to prevent the yarn length from varying with the package. A yarn winding device of this kind is disclosed in, for example, the Unexamined Japanese Patent Application Publication (Tokkai) No. 2002-348044. A yarn winding area in a spinning machine in the Unexamined Japanese Patent Application Publication (Tokkai) No. 2002-348044 has a device that accurately determines the length of a yarn passing by a yarn sensor and an elevation device that stores a length of yarn having passed by. The device accurately determining the length of the passing yarn has a measuring head including two measuring points arranged in tandem in a direction in which the passing yarn moves, and a travel time correlater that processes detected measured values. The yarn winding area includes a device that determines the length of a yarn removed within the range of a yarn splicing device. When a yarn defect is detected and the yarn is then cut, the evaluation device subtracts the length of a part of the yarn to be removed from the yarn length determined from the length of the yarn having passed by the yarn sensor. According to the Unexamined Japanese Patent Application Publication (Tokkai) No. 2002-348044, the above-described configuration allows a predetermined yarn length required for a traverse winding bobbin to be more appropriately maintained.

BRIEF SUMMARY OF INVENTION

[0004] However, with the configuration in which the yarn is sensed directly by the measuring head as is the case with the Unexamined Japanese Patent Application Publication (Tokkai) No. 2002-348044, complicated calculations (executed by, for example, the above-described travel time correlater) are required to determine the speed and length of the yarn being wound. This complicates the configuration and increases costs.

[0005] On the other hand, the yarn winding device may calculate the speed and length of the yarn being wound, based on the rotation of a winding drum that drives the package. However, in actual package winding operations, the rotation speed of the winding drum may fail to match the speed at which the yarn is wound into the package. For example, corn winding packages have a winding diameter varying in the axial direction thereof. Thus, the actual speed at which the yarn is wound into the package varies depending on a winding position. Also for cheese winding packages, if, for example, control is performed so as to slip the package with respect to the winding drum in order to avoid a critical wind number that may result in ribbon winding, the actual yarn speed may differ from the rotation speed of the winding drum. Thus, the control based on the rotation of the winding drum has difficulty in accurately controlling the yarn length. This prevents possible wasteful yarns from being effectively inhibited.

[0006] The present invention has been made in view of these circumstances. An object of the present invention is to provide a yarn winding device and an automatic winder which are simply configured to allow the length of a yarn wound into a package to be accurately measured.

[0007] The problems to be solved by the present invention have been described. Means for solving the problems and the effects thereof will be described.

[0008] A first aspect of the present invention provides a yarn winding device winding a predetermined length of a yarn into a package and which is configured as described below. That is, the yarn winding device comprises a yarn pool section, a yarn accumulation driving section, and a count section. The yarn pool section accumulates that the yarn before being wound into the package. The yarn accumulation driving section is driven to supply the yarn to the yarn pool section. The count section counts driving amount of the yarn accumulation driving section. Based on the count value of the driving amount, the length of the yarn wound into the package is calculated.

[0009] Thus, by counting the driving amount of the yarn accumulation driving section, the length of the yarn to be wound into the package can be measured before the yarn is actually wound into the package. Thus, the calculation of the length of the yarn to be wound into the package can be accurately achieved without being affected by the package winding operation. As a result, the yarn length can be accurately set to a given value for each package, thus preventing the possible wasteful winding of the yarn. As a result, the productivity of the package can be improved.

[0010] The yarn winding device is preferably config-

ured as follows. That is, the yarn winding device comprises a yarn splicing device located on an upstream side of the yarn pool section to perform a yarn splicing operation. The count section counts the driving amount by which the yarn accumulation driving section is driven to draw out the yarn from the yarn pool section to the upstream side during the yarn splicing operation. Then, the length of the yarn wound into the package is calculated in view of a supply count value obtained by counting, until the yarn splicing operation is started, the driving amount by which the yarn accumulation driving section is driven to supply the yarn to the yarn pool section, and a return count value obtained by counting the driving amount by which the yarn accumulation driving section is driven to draw out the yarn from the yarn pool section to the upstream side for the yarn splicing operation.

[0011] Thus, by counting the driving amount of the yarn accumulation driving section during the yarn splicing operation, the length of the yarn returned from the yarn pool section to the upstream side can be accurately calculated. With the accurately calculated yarn length taken into account, the length of the yarn to be wound into the package can be more accurately calculated.

[0012] The yarn winding device is preferably configured as follows. That is, the yarn winding device comprises a yarn supplying bobbin set section enabling a yarn supplying bobbin to be replaceably set therein so that the yarn to be wound into the package is fed from the yarn supplying bobbin. For replacement of the yarn supplying bobbin, the driving amount by which the yarn accumulation driving section is driven to draw a required length of the yarn for the yarn splicing operation, from the yarn pool section to the upstream side is counted as the return count value. Then, in view of the return count value and the supply count value, the length of the yarn wound into the package is calculated.

[0013] Thus, the yarn length of the package formed by splicing yarns from a plurality of yarn supplying bobbins together can be accurately calculated.

[0014] The yarn winding device is preferably configured as follows. That is, the yarn winding device comprises a yarn defect detector detecting a yarn defect on the upstream side of the yarn pool section. When the yarn defect detector detects a yarn defect, the length of the yarn defect is calculated based on a count value obtained by counting the driving amount by which the yarn accumulation driving section is driven while the yarn defect detector is detecting the yarn defect.

[0015] Thus, the length of the yarn defect portion detected by the yarn defect detector can be accurately calculated by counting the driving amount.

[0016] A second aspect of the present invention provides an automatic winder comprising a plurality of the yarn winding devices.

[0017] Thus, an automatic winder can be provided which can inhibit a possible variation in the yarn length of the package formed by each of the yarn winding devices and form a package managed to have an accurate, constant yarn length.

[0018] 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

[0019] Figure 1 is a front view schematically showing the configuration of a winding unit according to an embodiment of the present invention.

[0020] Figure 2 is a schematic sectional view showing how an accumulator operates.

[0021] Figure 3 is a front view schematically showing the configuration of a winding unit according to a variation.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0022] A preferred embodiment of the present invention will be described with reference to the drawings. Figure 1 is a front view schematically showing the configuration of a winding unit 10 according to an embodiment of the present invention.

[0023] The winding unit (yarn winding device) 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.

[0024] The automatic winder according to the present embodiment includes a plurality of winding units 10 arranged in a line and a frame control device (not shown in the drawings) located at one end of the arrangement of the winding units in the direction of the arrangement. Each of the winding units 10 includes a winding unit main body 16 supported in a unit frame (not shown in the drawings).

[0025] As shown in Figure 1, the winding unit main body 16 includes a yarn supplying section 5, a yarn splicing section 6, a yarn defect detecting section 7, a yarn accumulating section 8, and a yarn winding section 9. In the description below, an upstream side and a downstream side in the direction in which the yarn 20 travels are sometimes simply referred as the "upstream side" and the "downstream side", respectively.

[0026] The yarn supplying section 5 includes a yarn supplying bobbin holding section (yarn supplying bobbin set section) 60, a yarn unwinding assisting device 12, and a first tenser 41 (first tension control mechanism).

[0027] The yarn supplying bobbin holding section 60 is configured so as to be able to replace and set the yarn supplying bobbin 21 from which the yarn 20 is fed. The yarn supplying bobbin holding section 60 connects to a bobbin supplying device (not shown in the drawings) that supplies the yarn supplying bobbin 21 to the yarn sup-

plying bobbin holding section 60. For example, a magazine type supplying device or a tray type supplying device may be adopted as the bobbin supplying device.

[0028] Once all of the yarn 20 is drawn out from the yarn supplying bobbin 21 set in the yarn supplying bobbin holding section 60 and the yarn supplying bobbin 21 becomes empty, the yarn supplying section 5 discharges the empty bobbin from the yarn supplying bobbin holding section 60. The bobbin supplying device can sequentially supply a new yarn supplying bobbins 21 to the yarn supplying bobbin holding sections 60 having discharged the respective empty bobbins.

[0029] 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 20 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 20 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 potion has lowered, the regulating member 40 is controllably lowered by, for example, an air cylinder (not shown in the drawings) in conjunction with the lowering of the chase portion.

[0030] A yarn feeler (upstream-side 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 feeler 37 is configured so as 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.

[0031] The first tenser 41 applies a predetermined tension to the traveling yarn 20. The first tenser 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 pivotally moved by a rotary solenoid (not shown in the drawings) so as to be engaged with or released from the fixed teeth. The first tenser 41 is not limited to the gate type. For example, a disc type tenser may be used.

[0032] The yarn splicing section 6 is located on the downstream side of the yarn supplying section 5. The yarn splicing section 6 includes a splicer device (yarn splicing device) 14, a downstream-side yarn guide pipe (downstream-side yarn catching means) 26, and an upstream-side yarn guide pipe (upstream-side yarn catching means) 25.

[0033] When, for example, a clearer 15 described below detects a yarn defect or the yarn being unwound from the yarn supplying bobbin 21 is broken, the splicer device 14 splices an upstream-side yarn 20 located on the yarn supplying bobbin 21 side and a downstream-side yarn 20 located on a package 30 side. For example, the splicer device 14 may be of a mechanical type or may use a fluid such as compressed air.

[0034] The upstream-side yarn guide pipe 25, which catches and guides the upstream-side yarn 20 located on the yarn supplying bobbin 21 side, is provided below the splicer device 14. The downstream-side yarn guide pipe 26, which catches and guides the downstream-side yarn 20 located on the package 30 side, is provided above the splicer device 14.

[0035] The downstream-side yarn guide pipe 26 is configured so as to be pivotally movable around a shaft 35 between a catch position where the downstream-side yarn guide pipe 26 catches the downstream-side yarn 20 and a guide position where the downstream-side yarn guide pipe 26 guides the caught downstream-side yarn 20 to the splicer device 14. The upstream-side yarn guide pipe 25 is configured so as to be pivotally movable around a shaft 33 between a catch position where the upstream-side yarn guide pipe 25 catches the upstream-side yarn 20 and a guide position where the upstream-side yarn guide pipe 25 guides the caught downstream-side yarn 20 to the splicer device 14.

[0036] A suction port 32 is formed at the tip of the upstream-side yarn guide pipe 25. Similarly, a suction port 34 is formed at the tip of the downstream-side yarn guide pipe 26. The upstream-side yarn guide pipe 25 and the downstream-side yarn guide pipe 26 are connected to respective negative pressure sources so that suction flows can act on the suction port 32 and the suction port 34.

[0037] The yarn defect detecting section 7 is located on the downstream side of the yarn splicing section 6. The yarn defect detecting section 7 includes a clearer (yarn defect detector) 15 that monitors the thickness of the traveling yarn 20.

[0038] The clearer 15 includes an appropriate sensor and is configured so as to be able to detect yarn defects such as slub by allowing an analyzer 52 to process signals from the sensor. The clearer 15 can also function as a sensor that senses the traveling speed of the yarn 20 and as a sensor that simply senses whether or not the yarn 20 is present.

[0039] A cutter (yarn cutting means) 18 is located in the vicinity of the clearer 15 to cut the yarn 20 when the clearer 15 detects a yarn defect. A waxing device 17 is located on the downstream side of the clearer 15 to wax the traveling yarn 20. Moreover, a suction section (not shown in the drawings) is provided on the downstream side of the waxing device 17. The suction section is connected to an appropriate negative pressure source. The suction section can suck and remove wax cake, yarn waste, and the like.

[0040] The yarn accumulating section 8 is located on the downstream side of the yarn defect detecting section 7. The yarn accumulating section 8 includes an accumu-

lator (yarn accumulating device) 61 that allows the yarn 20 unwound from the yarn supplying bobbin 21 to be accumulated in the yarn pool section 71. The yarn 20 unwound from the yarn supplying bobbin 21 is accumulated in the accumulator 61. The yarn 20 is thereafter drawn out from the accumulator 61 and wound into the package 30.

[0041] The accumulator 61 is configured so as to be able to simultaneously draw out the accumulated yarn 20 both to the upstream side and to the downstream side. In this configuration, while being wound into the package 30, the accumulated yarn 20 can be drawn out to the yarn supplying bobbin 21 side for a yarn splicing operation. The configuration of the accumulator 61 will be described below in detail.

[0042] The yarn winding section 9 is located on the downstream side of the yarn accumulating section 8. The yarn winding section 9 includes a cradle 23 configured so as 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, and a second tenser 42 (second tension control mechanism).

[0043] The cradle 23 is configured so as to be swingable in a direction in which the cradle 23 approaches or leaves the winding drum 24. Thus, the cradle 23 can absorb an increase in the diameter of package 30 in conjunction with winding of the yarn 20. 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.

[0044] The second tenser 42 is located on the 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 wound around the yarn winding bobbin 22 under an appropriate tension. Like the first tenser 41, the second tenser 42 may be of a gate type including movable comb teeth arranged with respect fixed comb teeth or of a disc type.

[0045] 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 a drum driving motor 53. The operation of the drum driving motor 53 is controlled by a motor control section 54. The motor control section 54 is configured to controllably operate and stop the drum driving motor 53 upon receiving operation signals from the unit control section 50.

[0046] During the winding of the package 30, when the rotation number of the winding drum 24 becomes equal to that of the package 30 multiplied or divided by an integral number, what is called ribbon winding may occur. In the ribbon winding, a traverse period synchronizes with the winding period of the package 30 to overlappingly concentrate the yarn 20 at one location. In the package 30 with the ribbon winding, the yarn 20 is likely to get tangled up, resulting in possible yarn breakage when the yarn 20 is unwound during a post-process. In view of this, the unit control section 50 (motor control section 54) according to the present embodiment rapidly increases and reduces the rotation speed of the winding drum 24 when the diameter is close to that at which the ribbon winding is expected to occur. The unit control section 50 thus causes slippage between the package 30 and the winding drum 24, thus allowing the traversed yarn 20 to be wound in such a way as to disperse the yarn path of the yarn 20 (disturb control). This allows the ribbon winding to be disturbed to form a package 30 from which the yarn 20 can be properly unwound.

[0047] Now, the accumulator 61 will be described with reference to Figure 2. Figure 2 is a schematic sectional view schematically showing the accumulator 61. As shown in Figure 2, the accumulator 61 includes a rotating shaft casing 70, a yarn pool section 71, and a yarn guiding section 72. The rotating shaft casing 70 includes a cylindrical cylinder portion 78 that is open at the top thereof, and a flange portion 79 formed at an open-side end of the cylinder portion 78.

[0048] The yarn pool section 71 is located above the flange portion 79. The yarn pool section 71 includes a support plate 81 formed like a disc, a plurality of rod members 82 projecting upward from the support plate 81, and a disc-like mounting plate 83 to which the tip portions of the plurality of rod members 82 are connected. The yarn pool section 71 is located so as to form a gap between the support plate 81 and the flange portion 79. An accumulation guide arm 75 described below can rotate through the gap.

[0049] The support plate 81 is located horizontally. The plurality of rod members 82 are arranged on the circumference of the top surface of the support plate 81 at equal intervals. The yarn pool section 71 is configured such that the rod members 82 form a generally cylindrical shape. By being wound around an outer peripheral portion of the yarn pool section 71, the yarn 20 is accumulated in the yarn pool section 71.

[0050] The yarn guiding section 72 is located inside the rotating shaft casing 70. In the rotating shaft casing 70, an introduction hole 80 is formed at the bottom of the cylinder portion 78 (at the end of the cylinder portion 78 located opposite the yarn pool section 71). The yarn 20 drawn out from the yarn supplying bobbin 21 is guided from the introduction hole 80 to the yarn guiding section 72.

[0051] A rotating shaft 73 is located inside the cylinder portion 78. The rotating shaft 73 is supported so as to be rotatable relative to the rotating shaft casing 70 and the yarn pool section 71. A servo motor (yarn accumulation driving section) 55 is incorporated between the rotating shaft 73 and the cylinder portion 78. The servo motor 55 can rotate the rotating shaft 73 forward and backward. A shaft hole-like yarn passage 74 is formed in the center of the rotating shaft 73.

[0052] The cylindrically formed accumulation guide arm (winding means) 75 is fixed to one end (located opposite the introduction hole 80) of the rotating shaft 73. The accumulation guide arm 75 is configured so as to

extend in a radial direction in such a way as to pass through the gap between the rotating shaft casing 70 (flange portion 79) and the support plate 81 while inclining slightly upward. A part of the tip portion of the accumulation guide arm 75 protrudes slightly outward from the rotating shaft casing 70. The accumulation guide arm 75 is configured so as to rotate integrally with the rotating shaft 73. The interior of the accumulation guide arm 75 is connected to the yarn passage 74.

[0053] In the above-described configuration, the yarn 20 is guided from the introduction hole 80 in the yarn guiding section 72 into the rotating shaft casing 70. The yarn 20 then passes through the interior of the yarn passage 74 and the accumulation guide arm 75. The yarn 20 is then discharged from the tip of the accumulation guide arm 75 and guided to a side surface potion of the yarn pool section 71. Consequently, driving the servo motor 55 in a forward direction allows the accumulation guide arm 75 to rotate together with the rotating shaft 73. Thus, the yarn 20 is wound around the side surface portion. To return the yarn 20 from the accumulator 61 to the upstream side, the servo motor 55 is brought into a neutral state (in which the servo motor 55 is freely rotatable). The downstream-side yarn guide pipe 26 holding the sucked and caught downstream-side yarn 20 rotates downward to draw out the yarn 20 to the upstream side. At this time, in conjunction with the draw-out of the yarn 20, the accumulation guide arm 75 rotates, together with the rotating shaft 73, in a direction in which the yarn 20 is drawn out. The servo motor 55 is reversed in a direction opposite to the driving direction in which the yarn 20 is wound around a yarn pool section 71.

[0054] Each of the plurality of rod members 82 arranged in the yarn pool section 71 is located so as to incline toward the inside of the yarn pool section 71 as the rod member 82 extends from the support plate 81-side end thereof toward the mounting plate 83-side end thereof. Since the first tenser 41 applies the constant tension to the yarn 20, the inclination of the rod member 82 allows the yarn 20 wound around the yarn pool section 71 to move naturally in such a way as to slide upward. Thus, when the yarn 20 is continuously wound by the accumulation guide arm 75, a portion of the yarn 20 which is wound around the inclining portion moves upward. Consequently, the yarn 20 is spirally alignigly accumulated on the side surface portion composed of the rod members 82.

[0055] In the present embodiment, the servo motor 55 is used as a yarn accumulation driving section for the accumulation guide arm 75. Thus, the quick stop of rotation of the accumulation guide arm 75, acceleration or deceleration thereof, or the like can be precisely performed. This enables the accurate control of the length of the yarn 20 supplied to the yarn pool section 71 and a timing for the supply, the length of the yarn 20 returned from the yarn pool section 71 to the upstream side and a timing for the return, and the like. As a result, various operations can be smoothly performed.

[0056] As shown in Figure 1, the winding unit 10 includes a first accumulation sensor 76 located on an upper portion of the yarn pool section 71 and a second accumulation sensor 77 located on a lower portion of the yarn pool section 71. Each of the two accumulation sensors (yarn accumulation amount detecting means) 76, 77 is composed of a non-contact type optical sensor or the like and electrically connected to the unit control section 50.

[0057] The first accumulation sensor 76 is located on the upper end side of the yarn pool 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, provided in the yarn pool section 71. The first accumulation sensor 76 thus senses the maximum accumulation condition of the accumulator 61. The second accumulation sensor 77 is located on the downstream side of the yarn pool 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 senses 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 rotation speed of the servo motor 55 (the speed at which the yarn 20 is supplied to the yarn pool section 71). This enables the amount of yarn 20 accumulated in the accumulator 61 to be adjusted so that the amount of the yarn 20 accumulated in the accumulator 61 is not excessive or insufficient.

[0058] When yarn winding is started, the speed at which the yarn 20 is wound around the yarn pool section 71 of the accumulator 61 (in other words, the speed at which the yarn is supplied to the yarn pool section 71) is controlled so as to be equal to or higher than the speed at which the yarn 20 is wound into the package 30 and which increases with the elapse of time. Then, when a predetermined time elapses from the beginning of the winding and an amount of yarn 20 required for the yarn splicing operation is accumulated in the accumulator 61, the yarn 20 is controllably wound around the yarn pool section 71 at a speed equal to the yarn winding speed for the package 30. Thus, the amount of yarn 20 accumulated in the accumulator 61 is maintained. The amount of yarn 20 required for the yarn splicing operation is the sum of the amount of yarn 20 drawn out from the accumulator 61 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 yarn pool section 71 preferably always maintains a condition in which an amount of yarn 20 equal to or more than the required amount is accumulated.

[0059] The yarn 20 unwound from the yarn pool section 71 of the accumulator 61 is wound into the package 30, which is driven by the winding drum 24. At this time, the tension applied to the yarn 20 by the second tenser 42

is controlled by the unit control section 50 according to the winding speed.

[0060] Now, the unit control section 50 will be described. The unit control section 50 is configured as a microcomputer comprising a CPU, a storage section, and the like. As shown in Figure 1, the unit control section 50 connects to the yarn supplying section 5, the yarn splicing section 6, the yarn defect detecting section 7, the yarn accumulating section 8, the yarn winding section 9, and the like of the winding unit main body 16 to control the winding operation as a whole. A setter (not shown in the drawings) that makes various settings is connected to the unit control section 50.

[0061] As shown in Figure 1, the unit control section 50 is electrically connected to the servo motor 55. The unit control section 50 includes a yarn length control section 90 that controls driving provided by the servo motor 55 to controllably adjust the length of the yarn 20 wound into the package 30. A yarn length control section (count section) 90 includes a supply count section 91, a return count section 92, a supply length calculating section 93, and a comparison section 94 as main components.

[0062] When the servo motor 55 rotates in a direction in which the yarn 20 is supplied to the yarn pool section 71, the supply count section 91 counts forward rotation pulse signals (which are indicative of the driving amount) from the servo motor 55 to update a supply count value.

[0063] When the servo motor 55 rotates in a direction in which the yarn 20 is drawn out from the yarn pool section 71 to the upstream side, the return count section 92 counts reverse rotation pulse signals (which are indicative of the driving amount) to update a return count value. The driving amount as used herein refers to the amount by which the servo motor 55 is driven in the reverse direction by drawing the yarn to the upstream side of the yarn pool section 71. The driving amount is not limited to the one by which the servo motor 55 is passively driven by drawing out the yarn 20. For example, to draw out the yarn 20 from the yarn pool section 71 to the upstream side, the servo motor 55 may be spontaneously reversed. In this configuration, the return count section 92 counts the driving amount for the spontaneous reverse rotation.

[0064] Based on the supply count value and the return count value, the supply length calculating section 93 calculates the cumulative value of the length of the yarn 20 supplied to the yarn pool section 71 until the current moment (however, the cumulative value does not involve the length of a part of the yarn 20 which is returned to the upstream side again after the supply; the cumulative value is hereinafter referred to as the "supply yarn length cumulative value").

[0065] The comparison section 94 determines whether or not a length of yarn 20 sufficient to obtain a full package 30 has been accumulated on the yarn pool section 71 side. A set winding length indicative of the length of the yarn 20 to be wound to complete the package 30 is preset for the unit control section 50 by the setter or the like. The comparison section 94 compares the supply yarn length with the set winding length to determine whether or not the package 30 becomes full given that all of the yarn 20 accumulated in the yarn pool section 71 is wound into the package 30. If the package 30 can be made full by winding the yarn 20 already accumulated in the yarn pool section 71, the unit control section 50 determines that the package 30 is full when all of the yarn 20 in the yarn pool section 71 has been wound into the package 30.

[0066] The yarn winding performed by the winding unit 10 configured as described above will be described. First, a preparatory operation is performed. With no yarn 20 accumulated in the yarn pool section 71, a new, empty yarn winding bobbin 22 is set in the cradle 23 of the winding unit main body 16. The yarn supplying bobbin 21 is set in the yarn supplying bobbin holding section 60. The yarn 20 is drawn out from the yarn supplying bobbin 21 and attached to the yarn winding bobbin 22.

[0067] Thereafter, the unit control section 50 is instructed to start winding. The unit control section 50 first resets both the supply count value and the return count value to zero. The unit control section 50 thereafter sequentially starts driving the accumulator 61 and the winding drum 24.

[0068] The servo motor 55 for the accumulator 61 starts winding the yarn 20 around the yarn pool section 71. Then, a signal indicative of the rotating condition of the servo motor 55 is input to the unit control section 50. The supply count section 91 adds to the supply count value based on the pulse signal output by the servo motor 55 every time the servo motor 55 rotates in the forward direction by a predetermined angle. In the meantime, the yarn 20 accumulated in the yarn pool section 71 is further drawn out to the downstream side and then wound into the package 30 driven by the winding drum 24.

[0069] During the winding, if for example, the clearer 15 detects a yarn defect, the unit control section 50 allows the cutter 18 to cut the yarn 20 and sets the servo motor 55 for the accumulator 61 neutral (free). The unit control section 50 then allows the downstream-side yarn guide pipe 26 to catch the downstream-side yarn end. The unit control section 50 then allows the downstream-side yarn guide pipe 26 to rotate downward to draw out the yarn 20 to the upstream side. This reduces the amount of the yarn 20 accumulated in the accumulator 61 (yarn pool section 71). The return count section 92 adds to the return count value based on the pulse signal output by the servo motor 55 every time the servo motor 55 is rotated (driven) in the reverse direction.

[0070] The yarn 20 unwound from the yarn pool section 71 to the upstream side by the downstream-side yarn guide pipe 26 is guided to the splicer device 14. Then, the yarn defect portion is cut from the yarn 20, and the resultant yarn 20 is spliced to the yarn supplying bobbin 21-side yarn 20. The details of the control performed when a yarn defect is detected will be described below in detail.

[0071] When, during the winding, the yarn feeler 37

detects that all of the yarn 20 on the yarn supplying bobbin 21 has been unwounded, the unit control section 50 sets the servo motor 55 for the accumulator 61 neutral (free). The unit control section 50 then allows the downstream-side yarn guide pipe 26 to draw out the yarn 20 to the upstream side. As is the case with the detection of a yarn defect, the return count section 92 adds to the return count value based on the pulse signal output by the servo motor 55 every time the servo motor 55 is rotated in the reverse direction. The yarn 20 unwound from the yarn pool section 71 to the upstream side is drawn out to the splicer device 14 by the downstream-side yarn guide pipe 26. The yarn 20 is then spliced to the yarn 20 on the yarn supplying bobbin 21 newly set in the yarn supplying bobbin holding section 60. The control performed for replacement of the yarn supplying bobbin 21 will be described below in detail.

[0072] The supply length calculating section 93 subtracts the return count value from the supply count value and multiplies the result by a predetermined constant. The supply length calculating section 93 thus calculates the cumulative value (the above-described supply yarn length cumulative value) of the length of the yarn already supplied to the yarn pool section 71. Here, the yarn 20 supplied to the yarn pool section 71 is all wound into the package 30 unless the yarn 20 is drawn out to the upstream side. Thus, the current supply yarn length cumulative value corresponds to the length of the yarn already wound into the package 30 plus the length of the yarn to be wound into the package 30 in the near future.

[0073] The comparison section 94 compares the supply yarn length cumulative value obtained by the supply length calculating section 93 with a predetermined set winding length. When the supply yarn length cumulative value is larger than the value of the set winding length, the need for the further supply of the yarn 20 to the yarn pool section 71 is eliminated. Thus, the driving provided by the servo motor 55 is stopped. The unit control section 50 thereafter continues driving the winding drum 24 until all of the yarn 20 accumulated in the yarn pool section 71 is wound into the package 30. Thereafter, a doffing operation of removing the full package 30 from the cradle 23 is performed using a doffing device (not shown in the drawings) or the like.

[0074] The unit control section 50 controls the servo motor 55 as described above to adjust the length of the yarn 20 accumulated in the yarn pool section 71. The unit control section 50 controls the length of the yarn 20 finally wound into the package 30. Here, as described above, the yarn 20 is accumulated in (supplied to) the yarn pool section 71 by rotating the accumulation guide arm 75 to wind the yarn 20 around the side surface portion of the yarn pool section 71. Thus, the length of the accumulated yarn 20 can be accurately and easily calculated based on the rotation angle of the accumulation guide arm 75 and the diameter of the yarn winding portion of the yarn pool section 71.

[0075] Instead of directly calculating the winding length value for the winding in the yarn winding section 9, the yarn length control section 90 calculates the supply yarn length cumulative value for the accumulation in the yarn accumulating section 8, which takes place before the winding. This eliminates the adverse effects of errors resulting from the winding operation, such as the slippage of the package 30 caused by the above-described disturb control. The yarn length control section 90 can thus accurately determine whether or not a predetermined length of yarn has been wound into the package 30.

[0076] When the yarn pool section 71-side yarn 20 needs to be drawn out to the splicer device 14 for the yarn splicing operation, the draw-out length can be accurately calculated by counting the angle (number of times) by which the servo motor 55 is reversed. Specifically, the length of the yarn 20 returned (drawn out) from the yarn pool section 71 to the upstream side can be accurately calculated based on the reverse rotation angle of the accumulation guide arm 75 and the diameter of the yarn winding portion of the yarn pool section 71. Thus, the possible adverse effects of the yarn splicing operation during the process of winding the yarn 20 can be accurately taken into account in determining whether or not a predetermined length of yarn has been wound into the package 30.

[0077] The winding unit 10 according to the present embodiment is configured such that a given length of yarn 20 is accumulated in the yarn pool section 71 of the yarn accumulating section 8. Thus, the supply yarn length cumulative value for the accumulation in the yarn accumulating section 8 does not correspond directly to the length of the yarn 20 wound into the package 30. However, the length of the yarn 20 actually wound into the package 30 can be easily determined through calculations in view of the accumulation amount counted when the winding of the package 30 is started and the accumulation amount counted when the winding of the package 30 is completed, in connection with the supply yarn cumulative value.

[0078] Now, the control performed when the clearer 15 detects a yarn defect will be described. Upon detecting a yarn defect through monitoring of the yarn thickness, 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 shuts down the servo motor 55 for the accumulator 61 to stop the rotation of the accumulation guide arm 75. Moreover, the unit control section 50 drives the cutter 18 to cut the yarn 20. Thus, a part of the yarn 20 located on the downstream side of the cut portion is stopped below the introduction hole 80 in the accumulator 61. Provided that the yarn 20 is stopped below the introduction hole 80 in the accumulator, the unit control section 50 may controllably allow the cutter 18 to cut the yarn 20 simultaneously with the controllable stop of rotation of the accumulation guide arm 75.

[0079] The unit control section 50 can calculate the length of a part of the yarn 20 having a yarn defect, based

on the angle (number of times) by which the accumulation guide arm 75 has been rotated in the forward direction since the detection of the yarn defect by the clearer 15. That is, the unit control section 50 counts forward rotation pulse signals obtained after the reception of the detection signal from the clearer 15 and before the end of detection of the defect. Based on the count value, the unit control section 50 calculates the yarn length of the yarn defect portion.

[0080] Then, the unit control section 50 allows the downstream-side yarn guide pipe 26 to suck and catch the downstream-side yarn 20 positioned below the introduction hole 80 in the accumulator 61. The unit control section 50 then allows the downstream-side yarn guide pipe 26 to move pivotally to a guide position located below the splicer device 14. Thus, the downstream-side yarn guide pipe 26 draws out the yarn 20 having the yarn defect portion, from the yarn pool section 71. Then, the return count section 92 adds to the return count value based on the pulse signal from the servo motor 55, which is reversed in response to the draw-out of the yarn 20. In this case, the downstream-side yarn guide pipe 26 unwinds, from the yarn pool section 71, the yarn length portion corresponding to the sum of the length of the part of the yarn 20 having the yarn defect portion and the length required for the yarn splicing operation. The downstream-side yarn guide pipe 26 then draws out the yarn length portion to the upstream side. The value of the yarn length required for the yarn splicing operation may be preset based on, for example, the positional relationship between accumulator 61 and the splicer device 14.

[0081] The unit control section 50 allows the upstream-side yarn guide pipe 25 to suck and catch the upstream-side yarn 20 and then move pivotally to a guide position located above the splicer device 14. Once the upstream-side yarn guide pipe 25 and the downstream-side yarn guide pipe 26 guide the upstream-side yarn 20 and the downstream-side yarn 20, respectively, to the splicer device 14, the splicer device 14 starts the yarn splicing operation. The yarn end of the downstream-side yarn containing the yarn defect is cut and removed by the cutter of the splicer device 14.

[0082] The above-described yarn splicing operation is performed in parallel with the operation of winding the yarn 20 into the package 30. Thus, the yarn defect can be removed without the need to stop and reverse 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. Thus, the update of the supply count value is resumed. The supply length calculating section 93 calculates the supply yarn length cumulative value as required, with the supply count value and the return count value taken into account.

[0083] Now, the control performed to allow the yarn supplying bobbin 21 to be replaced with a new one will be described. Upon detecting that the supply of the yarn 20 from the yarn supplying bobbin 21 is stopped, the yarn feeler 37 transmits a yarn absence detection signal to the unit control section 50. Upon receiving the yarn absence detection signal, the unit control section 50 stops the supply of the yarn 20 to the accumulator 61.

[0084] Then, the unit control section 50 sets the servo motor 55 neutral (free). The unit control section 50 controllably allows the downstream-side yarn guide pipe 26 to draw out a required length of yarn 20 for the yarn splicing operation from the accumulator 61 to the upstream side. The length required for the yarn splicing operation is preset in view of, for example, the positional relationship related to the path from the accumulator 61 to the splicer device 14. Then, the yarn 20 is drawn out to the upstream side to reverse the servo motor 55. Based on the pulse signal indicative of the reverse rotation of the servo motor 55, the return count section 92 adds to the return count value.

[0085] The empty yarn supplying bobbin 21 is discharged from the yarn supplying bobbin holding section 60. A new yarn supplying bobbin 21 is supplied to the yarn supplying bobbin holding section 60. Thereafter, as is the case with the detection of a yarn defect, the downstream-side yarn 20, located on the accumulator 61 side, is caught and drawn out to the splicer device 14 by the downstream-side yarn guide pipe 26. The upstream-side yarn 20 from the new yarn supplying bobbin 21 is caught and drawn out to the splicer device 14 by the upstream-side yarn guide pipe 25. The downstream-side yarn 20 and upstream-side yarn 20 are then spliced together by the splicer device 14. The unit control section 50 then controls the servo motor 55 so that the accumulation guide arm 75 is rotated again in the direction in which the yarn 20 is accumulated. Thus, the update of the supply count value is resumed. The supply length calculating section 93 calculates the supply yarn length cumulative value as required, with the supply count value and the return count value taken into account.

[0086] The unit control section 50 preferably performs control such that at least immediately after the completion of the yarn splicing operation, the speed at which the yarn 20 is supplied to the yarn pool section 71 is higher than the winding speed of the package 30. This allows the accumulation amount of the yarn pool section 71 reduced during the yarn splicing operation to be quickly recovered.

[0087] As shown above, the winding unit 10 according to the present embodiment is configured to wind a predetermined length of yarn 20 into the package 30. The winding unit 10 includes the yarn pool section 71, the servo motor 55, and the yarn length control section 90. The yarn pool section 71 accumulates that the yarn 20 before being wound into the package 30. The servo motor 55 is driven to supply the yarn 20 to the yarn pool section 71. The yarn length control section 90 counts the forward rotation pulse signal from the servo motor 55. Then, based on the count value in the forward rotation pulse signal, the length of the yarn 20 wound into the package 30 is calculated.

[0088] Thus, counting the forward rotation pulse signal from the servo motor 55 allows measurement of the length of the yarn 20 to be wound into the package 30 before the yarn 20 is actually wound into the package 30. Thus, even if the disturb control during the winding operation such as in the present embodiment causes the package 30 to be slipped, the length of the yarn 20 to be wound into the package 30 can be accurately calculated. As a result, the yarn length can be accurately set to the given value for each package 30. Thus, when the yarn 20 in the package 30 is used, as a warp, in a warper process serving as a post-process, a part of the yarn 20 which corresponds to a deviation from the given length and which needs to be disposed of as a wasteful yarn can be reduced. Consequently, the productivity of the series of processes can be improved.

[0089] The winding unit 10 according to the present embodiment includes the splicer device 14 located on the upstream side of the yarn pool section 71 to perform the yarn splicing operation. The yarn length control section 90 counts the reverse rotation pulse signal from the servo motor 55 obtained when the yarn 20 is drawn out from the yarn pool section 71 to the upstream side during the yarn splicing operation. Then, the length of the yarn 20 wound into the package 30 is calculated in view of the supply count value determined by counting the forward rotation pulse signal from the servo motor 55 driven to supply the yarn 20 to the yarn pool section 71 until the yarn splicing operation is started and the return count value determined by counting the reverse rotation pulse signal form the servo motor 55 driven to draw out the yarn from the yarn pool section 71 to the upstream side for the yarn splicing operation.

[0090] Thus, counting the reverse rotation pulse signal from the servo motor 55 during the yarn splicing operation allows the length of the yarn 20 returned from the yarn pool section 71 to the upstream side to be accurately calculated. With the accurately calculated yarn length taken into account, the length of the yarn 20 to be wound into the package 30 can be more accurately calculated.

[0091] The winding unit 10 according to the present embodiment comprises the yarn supplying bobbin holding section 60 enabling the yarn supplying bobbin 21 to be replaceably set therein so that the yarn 20 to be wound into the package 30 is fed from the yarn supplying bobbin 21. For replacement of the yarn supplying bobbin 21, the reverse rotation pulse signal from the servo motor 55 driven to draw a required length of the yarn 20 for the yarn splicing operation, from the yarn pool section 71 to the upstream side is counted as the return count value. Then, in view of the return count value and the supply count value, the length of the yarn 20 wound into the package 30 is calculated.

[0092] Thus, the yarn length of the package 30 formed by splicing yarns 20 from the yarn supplying bobbins 21 together can be accurately calculated.

[0093] The winding unit 10 according to the present embodiment includes the clearer 15 detecting a yarn defect on the upstream side of the yarn pool section 71. When the clearer 15 detects a yarn defect, the yarn length control section 90 calculates the length of the yarn defect based on the count value obtained by counting the forward rotation pulse signal from the servo motor 55 obtained while the clearer 15 is detecting the yarn defect.

[0094] Thus, the length of the yarn defect portion detected by the yarn defect detector 15 can be accurately calculated by counting the driving amount. Therefore, the yarn length required to remove the yarn defect can be accurately calculated.

[0095] The automatic winder according to the present embodiment includes a plurality of the winding units 10.

[0096] Thus, the automatic winder configured as described above can inhibit a possible variation in the yarn length of the package 30 formed by each of the winding units 10 and form a package 30 managed to have an accurate, constant yarn length.

[0097] The preferred embodiment of the present invention has been described. However, the above-described configuration can be modified as follows.

[0098] The servo motor 55 according to the above-described embodiment is configured to be controlled by the unit control section 50. However, the present invention is not limited to this configuration. For example, as shown in Figure 3, the winding unit 10 may include a servo motor control section 150 controlling the servo motor 55. The servo motor control section 150 may include the yarn length control section 90.

[0099] The above-described embodiment adds to the supply count value based on the forward rotation pulse signal from the servo motor 55, adds to the return count value based on the reverse rotation pulse signal from the servo motor 55, and finally subtracts the return count value from the supply count value. However, the embodiment may be modified such that the return count value is subtracted from the supply count value when the reverse rotation pulse signal from the servo motor 55 is input.

[0100] In the above-described embodiment, the supply yarn length cumulative value is calculated based on the supply and return count values added to based on the signals from the servo motor 55. The supply yarn length cumulative value is then compared with the set winding length. However, alternatively, the value corresponding to the set winding length may be set to an appropriate variable when the winding of the yarn 20 around an empty yarn winding bobbin 22 is started. The variable may then be counted down based on the forward rotation pulse signal from the servo motor 55. In this case, the comparison section compares the value of the variable with zero. In contrast, when the yarn 20 is returned from the yarn pool section 71 to the upstream side for the yarn splicing operation or the like, the variable is counted up based on the reverse pulse signal from the servo motor 55 to allow the length of the yarn 20 returned to the upstream side to be taken into account.

[0101] 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 winding a predetermined length of yarn into a package, the yarn winding device being **characterized by** comprising:

a yarn pool section (71) that accumulating the yarn before being wound into the package;
a yarn accumulation driving section (55) driven to supply the yarn to the yarn pool section (71);
a count section (90) counting driving amount of the yarn accumulation driving section (55), and
in that based on the count value of the driving amount, the length of the yarn wound into the package is calculated.

2. The yarn winding device according to Claim 1, **characterized by** further comprising a yarn splicing device located on an upstream side of the yarn pool section (71) to perform a yarn splicing operation, and

in that the count section (90) counts the driving amount by which the yarn accumulation driving section (55) is driven to draw out the yarn from the yarn pool section (71) to the upstream side during the yarn splicing operation, and
the length of the yarn wound into the package is calculated in view of a supply count value obtained by counting, until the yarn splicing operation is started, the driving amount by which the yarn accumulation driving section (55) is driven to supply the yarn to the yarn pool section (71), and a return count value obtained by counting the driving amount by which the yarn accumulation driving section (55) is driven to draw out the yarn from the yarn pool section (71) to the upstream side for the yarn splicing operation.

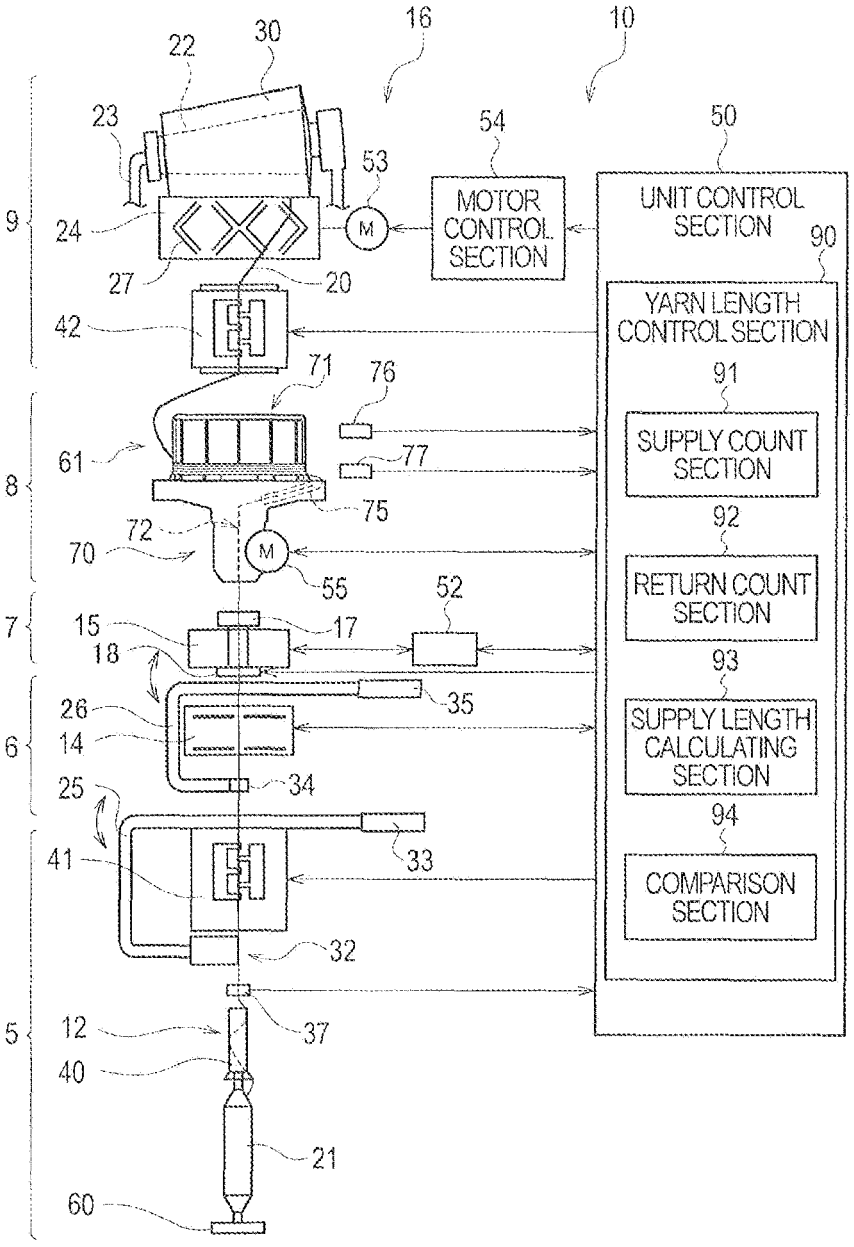
3. The yarn winding device according to Claim 2, **characterized by** further comprising a yarn supplying bobbin set section (60) enabling a yarn supplying bobbin to be replaceably set therein so that the yarn to be wound into the package is fed from the yarn supplying bobbin,

for replacement of the yarn supplying bobbin, the driving amount by which the yarn accumulation driving section (55) is driven to draw a required length of the yarn for the yarn splicing operation, from the yarn pool section (71) to the upstream side is counted as the return count value, and
in view of the return count value and the supply count value, the length of the yarn wound into the package is calculated.

4. The yarn winding device according to any one of Claims 1 to 3, **characterized by** further comprising a yarn defect detector detecting a yarn defect on the upstream side of the yarn pool section (71), and
in that when the yarn defect detector (15) detects a yarn defect, the length of the yarn defect is calculated based on a count value obtained by counting the driving amount by which the yarn accumulation driving section (55) is driven while the yarn defect detector is detecting the yarn defect.

5. An automatic winder comprising a plurality of the yarn winding devices according to any one of Claims 1 to 4.

FIGURE 1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MOTOR CONTROL SECTION
UNIT CONTROL SECTION
9
24
M
90
27
20
YARN LENGTH CONTROL SECTION
42
71
76
91
61
SUPPLY COUNT SECTION
77
8
75
72
92
70
M
RETURN COUNT SECTION
55
52
7
15
17
93
18
35
SUPPLY LENGTH CALCULATING SECTION
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94
25
33
41
COMPARISON SECTION
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5
12
37
40
21
60

FIGURE 2

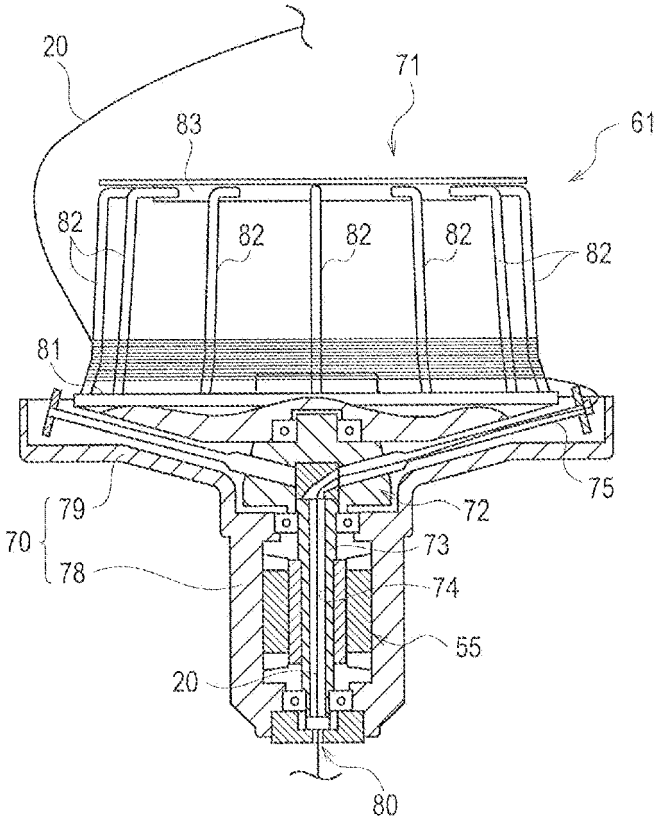
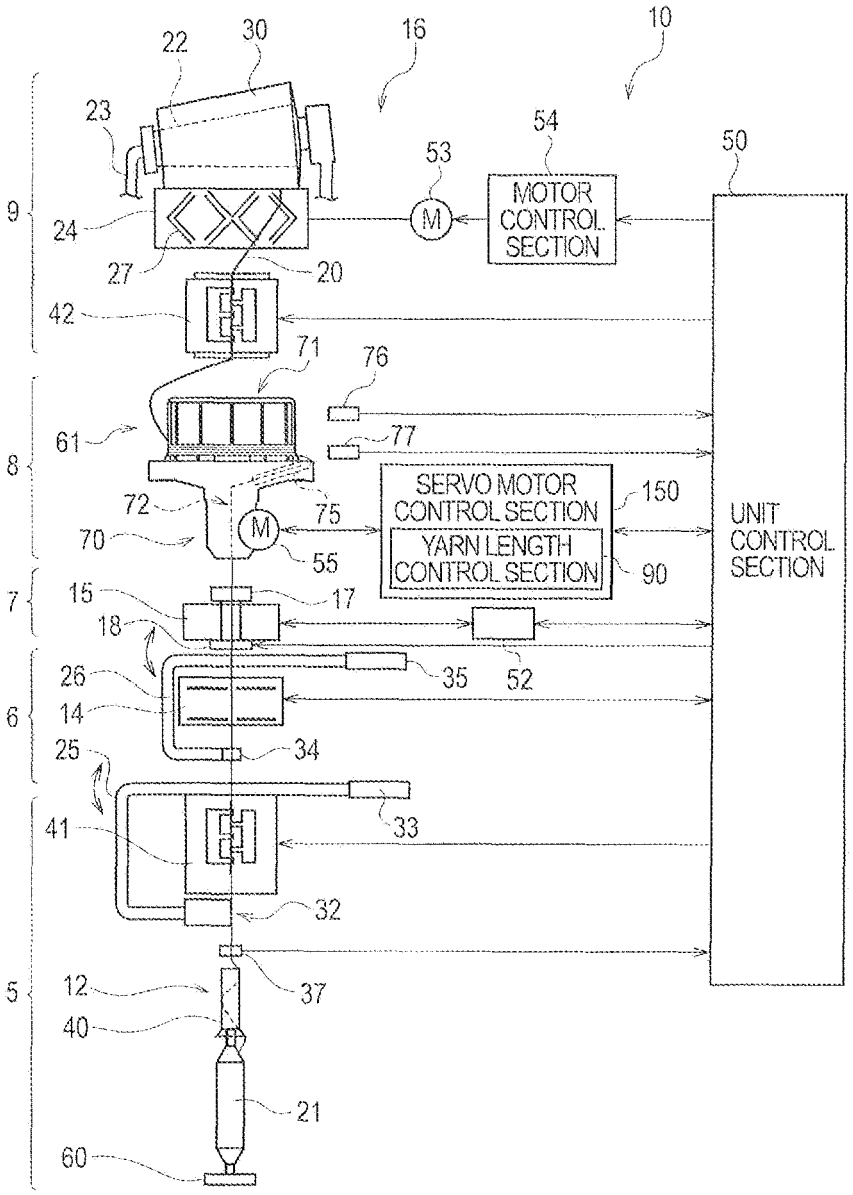


FIGURE 3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REFERENCES CITED IN THE DESCRIPTION

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