(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 159 181 A2

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
03.03.2010 Bulletin 2010/09

(21) Application number: **09168025.6**

(22) Date of filing: **18.08.2009**

(51) Int Cl.:
***B65H 51/22** (2006.01)* ***B65H 61/00** (2006.01)*
***B65H 63/06** (2006.01)*

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK SM TR
Designated Extension States:
AL BA RS

(30) Priority: **25.08.2008 JP 2008215583**

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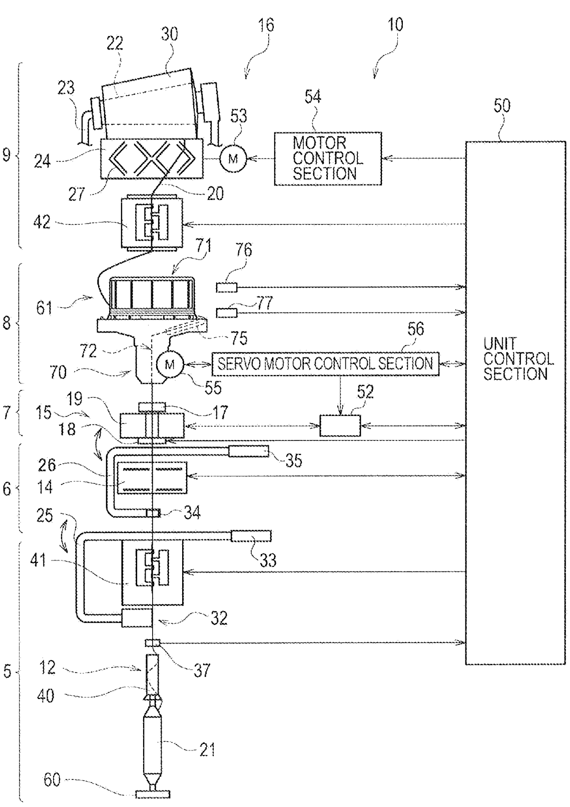
(54) Yarn winding device and automatic winder comprising the same

(57) A winding unit 10 includes a yarn pool section 71 accumulating a yarn 20 not wound into a package 30 yet, and a servo motor 55 driven to supply the yarn 20 to the yarn pool section 71. The winding unit 10 includes a clearer 15 located on the upstream side of the yarn pool section 71 in order to detect the yarn defect. The winding unit 10 calculates the length of the uneven-thickness portion having passed through the clearer 15 based the amount by which the yarn is fed to the upstream side of the yarn pool section 71 (Fig. 1).

FIGURE 1



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Description

Field of the Invention

[0001] The present invention relates to a yarn winding device and an automatic winder, and in particular, to detection of a defective portion of a yarn wound into a package.

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 (automatic winder). In the yarn winding device, yarns on a plurality of yarn supplying bobbins conveyed to the yarn winding device are spliced together by a yarn splicing device to generate a package with a predetermined length. As such a yarn winding device, a configuration has been proposed which measures the amount by which the yarn is fed in being wound into a package (the feed length of the yarn or the speed of the yarn), to calculate the length of yarn wound into the package and the length of a defective portion. The yarn winding devices of this kind are disclosed in the Unexamined Japanese Patent Application Publication (Tokkai) Nos. 2002-348043 and 2005-194024.

[0003] The Unexamined Japanese Patent Application Publication (Tokkai) No. 2002-348043 discloses a configuration in which a yarn winder winding a yarn around a yarn winding bobbin includes a clearer (yarn defect detector) having a travel time correlater. The yarn winder in the Unexamined Japanese Patent Application Publication (Tokkai) No. 2002-348043 includes two yarn sensors at respective measurement points. Measurement values from the two yarn sensors are evaluated via the travel time correlater. Furthermore, the yarn speed is checked. The yarn winding bobbin is configured so as to be rotationally moved by the rubbing action of a driving roller. A pole wheel is located on the driving roller. When poles on the pole wheel individually pass through an angle sensor, pulses are generated. The pulses are supplied to the travel time correlater in order to provide a range for correct locking for an adjustment circuit.

[0004] The Unexamined Japanese Patent Application Publication (Tokkai) No. 2005-194024 discloses an automatic winder that winds a spun yarn while measuring the speed of the traveling spun yarn. The automatic winder is configured as follows. That is, the automatic winder in the Unexamined Japanese Patent Application Publication (Tokkai) No. 2005-194024 is configured to allow a package to rotate in conjunction with rotation of a traverse drum, which serves as a driving source. The automatic winder includes light receiving elements arrayed at equal intervals in a yarn traveling direction to convert incident light into an electric signal, and a projecting light source that applies light to the spun yarn to project an image of the spun yarn on the light receiving elements. During traveling of the spun yarn, the image of which is projected on the light receiving elements and which has countless hairinesses, the yarn winding device uses a change in light current occurring on the light receiving elements in connection with the number of hairiness, to determine the feed length of the spun yarn. Specifically, a signal obtained by each of the light receiving elements is subjected to waveform shaping through a bandpass filter and thus converted into a pulse train. Then, a counter is used to count the number of pulses. The yarn length of the spun yarn can then be determined based on the count value.

BRIEF SUMMARY OF THE INVENTION

[0005] However, in the configuration in which the yarn is sensed directly by a measuring head as in the case of the Unexamined Japanese Patent Application Publication (Tokkai) No. 2002-348043, complicated calculations (which are performed by, for example, the above-described correlater) are required to determine the yarn speed of the yarn being wound. This complicates the configuration and increases costs.

[0006] In the Unexamined Japanese Patent Application Publication (Tokkai) No. 2002-348043, the angle sensor detects the rotational movement of a winding drum (driving roller) that rotates the package (yarn winding bobbin). Then, control is performed with a signal of a value proportional to the value for rotational movement taken into account, thus improving measurement accuracy. However, in an actual package winding operation, the rotation speed of the winding drum fails to equal the speed at which the yarn is wound into the package. For example, a cone winding package has a winding diameter varying in the axial direction thereof. Thus, the actual speed at which the yarn is wound varies depending on a winding position. For cheese winding package, if for example, the package is controllably slipped with respect to the winding drum in order to avoid a critical wind number for ribbon winding, the rotation speed of the winding drum deviates from the actual yarn speed. Consequently, even with the rotation speed of the winding drum taken into account for the measurement of the yarn speed, the improvement of the measurement accuracy is limited. In this regard, the configuration in the Unexamined Japanese Patent Application Publication (Tokkai) No. 2002-348043 has room for improvement.

[0007] In the configuration disclosed in the Unexamined Japanese Patent Application Publication (Tokkai) No. 2005-194024, where the bandpass filter is used to remove noise from detection signals from the light receiving elements, pulse signals from the traverse drum may be utilized to determine a frequency band to be removed. However, the difference between the rotation speed of the winding drum (traverse drum) and the actual yarn speed as described above may prevent the noise from being appropriately removed, thus precluding the yarn feed length from being accurately measured.

[0008] 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 and an automatic winder which accurately calculate the amount by which the yarn is fed in passing through a yarn defect detector, thus allowing the accuracy with which yarn defects are detected to be improved.

[0009] The problems to be solved by the present invention have been described. Now, means for solving the problems and the effects thereof will be described.

[0010] A first aspect of the present invention provides a yarn winding device winding a yarn into a package and configured as follows. That is, the yarn winding device comprises a yarn pool section, a yarn accumulation driving section, and a yarn defect detector. The yarn pool section accumulates 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 yarn defect detector is located on an upstream side of the yarn pool section in order to detect a yarn defect. The yarn winding device calculates length of an uneven-thickness portion having passed through the yarn defect detector based on an amount by which the yarn is fed to the upstream side of the yarn pool section.

[0011] Thus, the yarn pool section can prevent a variation in yarn speed associated with a winding operation for the package from being transmitted to the upstream side. Driving of the yarn accumulation driving section is controlled to allow the amount by which the yarn is fed in passing through the yarn defect detector to be accurately controlled. Thus, the amount by which the yarn is fed in passing through the yarn defect detector is stabilized to allow the detection accuracy of the yarn defect detector to be improved. Consequently, an uneven-thickness portion with a length appropriate to determine the portion to be a yarn defect can be prevented from being wound into a package. Furthermore, an uneven-thickness portion with a tolerable length can be prevented from being removed as a yarn defect.

[0012] In the yarn winding device, preferably, the amount of yarn supplied to the yarn pool section by driving the yarn accumulation driving section is used to calculate the length of the uneven-thickness portion having passed through the yarn defect detector.

[0013] Thus, the yarn feed amount can be easily calculated based on the driving speed of the yarn accumulation driving section. Therefore, the configuration can be simplified.

[0014] A second aspect of the present invention provides a yarn winding device winding a yarn into a package and configured as follows. That is, the yarn winding device comprises a yarn pool section, a yarn accumulation driving section, a yarn defect detector, and a yarn feed amount detector. The yarn pool section accumulates 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 yarn defect detector is located on an upstream side of the yarn pool section in order to detect a yarn defect. The yarn feed amount detector is located on an upstream side of the yarn pool section. The yarn feed amount detector measures speed or feed length of the yarn supplied to the yarn pool section by driving the yarn accumulation driving section.

[0015] Thus, the yarn pool section can prevent a variation in yarn speed associated with a winding operation for the package from being transmitted to the upstream side. Driving of the yarn accumulation driving section is controlled to allow the amount by which the yarn is fed in passing through the yarn defect detector to be accurately controlled. Thus, the yarn feed amount detector can measure the yarn speed or the yarn feed length of the yarn on the upstream side of the yarn pool section to be accurately performed without being affected by a possible variation in yarn speed associated with the winding operation. The detection accuracy of the yarn defect detector can be improved based on the accurate yarn feed amount determined without the adverse effect of the winding operation. Thus, an uneven-thickness portion with a length appropriate to determine the portion to be a yarn defect can be prevented from being wound into a package. Furthermore, an uneven-thickness portion with a tolerable length can be prevented from being removed as a yarn defect.

[0016] The yarn winding device preferably calculates length of an uneven-thickness portion having passed through the yarn defect detector based on the yarn speed or the yarn feed length detected by the yarn feed amount detector.

[0017] Thus, the yarn defect portion can be accurately identified based on the accurate yarn speed or yarn feed length.

[0018] In the yarn winding device, the yarn feed amount detector can be configured so as to measure the yarn feed length based on a spatial filter method.

[0019] Thus, the yarn feed length can be accurately measured without the need for a complicated calculation.

[0020] In the yarn winding device, the yarn feed amount detector can be configured so as to measure the yarn speed based on a two-point measuring method.

[0021] Thus, detection values acquired at two measurement points can be compared with each other to accurately measure the yarn speed.

[0022] According to a third aspect of the present invention provides an automatic winder comprising a plurality of the yarn winding devices.

[0023] Thus, an automatic winder can be provided which enables yarn defects to be accurately detected, allowing high-quality packages to be efficiently formed.

[0024] 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

[0025]

Figure 1 is a front view schematically showing the configuration of a winding unit according to a first embodiment.

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

Figure 3 is a front view schematically showing the configuration of a winding unit according to a second embodiment.

Figure 4 is a schematic diagram showing how a yarn feed length is detected according to the second embodiment.

Figure 5 is a schematic diagram showing how a yarn speed is detected in a winding unit according to a third embodiment.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0026] 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 a first embodiment.

[0027] The winding unit (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.

[0028] 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).

[0029] 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.

[0030] 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 tension control mechanism 41.

[0031] 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 a new yarn supplying bobbin 21 to the yarn supplying 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.

[0032] 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 new yarn supplying bobbins 21 to the yarn supplying bobbin holding sections 60 having discharged the respective empty bobbins.

[0033] 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 20 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 chase 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.

[0034] 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.

[0035] The first tension control mechanism 41 applies a predetermined tension to the traveling yarn 20. The first tension control mechanism 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 tension control mechanism 41 is not limited to the gate type. For example, a disc type tension control mechanism may be used.

[0036] 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.

[0037] When, for example, a clearer (yarn defect detector) 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.

[0038] 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.

[0039] 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.

[0040] 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 appropriate negative pressure sources so that suction flows can act on the suction port 32 and the suction port 34.

[0041] 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.

[0042] The clearer 15 includes a sensor head 19 on which a yarn unevenness sensor (not shown in the drawings) is located, and an analyzer (yarn defect determining section) 52 that processes signals from the yarn unevenness sensor. The analyzer 52 processes a signal from the yarn unevenness sensor to determine whether or not a yarn defect such as slub to be removed is present. 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.

[0043] 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.

[0044] 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 accumulator (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.

[0045] 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, in parallel with 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.

[0046] 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 tension control mechanism 42.

[0047] 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 associated 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.

[0048] The second tension control mechanism 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 tension control mechanism 41, the second tension control mechanism 42 may be of a gate type including movable comb teeth arranged with respect fixed comb teeth or of a disc type.

[0049] 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.

[0050] 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. When the ribbon winding occurs, 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 the subsequent 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 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 traverse 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.

[0051] Now, the accumulator 61 will be described with reference to Figure 2. Figure 2 is a schematic sectional view schematically showing the configuration of 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.

[0052] 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.

[0053] 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 on the yarn pool section 71.

[0054] 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.

[0055] 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.

[0056] 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.

[0057] 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 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 the yarn pool section 71.

[0058] 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 tension control mechanism 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 aligningly accumulated on the side surface portion composed of the rod members 82.

[0059] In the present embodiment, the servo motor 55 is used as a yarn accumulation driving section for the accumulation guide arm 75. Thus, the rotation of the accumulating guide arm 75 can be precisely controlled. This allows the accurate control of the speed and timing at which the yarn 20 is supplied to the yarn pool section 71 and of the length of the yarn 20 supplied to the yarn pool section 71. Therefore, the feed length and speed of the yarn 20 passing through the clearer 15 can be accurately controlled.

[0060] 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.

[0061] 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 is not excessive or insufficient.

[0062] 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 20 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.

[0063] 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.

[0064] 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 tension control mechanism 42 is controlled by the unit control section 50 according to the winding speed.

[0065] The unit control section 50 is configured as a microcomputer composed of a CPU, a storage section, and the like. As shown in Figure 1, the unit control section 50 is connected 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 yarn winding operation as a whole. A setter (not shown in the drawings) that makes various settings is connected to the unit control section 50. As shown in Figure 1, the unit control section 50 is electrically connected to the servo motor 55 via a servo motor control section 56.

[0066] In this configuration, the servo motor 55 drives the accumulating guide arm 75 in the forward direction. Then, as described above, the accumulating guide arm 55 is rotated to accumulate the yarn 20 on the yarn pool section 71. Thus, determining the rotation angle of the servo motor 55 (the rotation angle of the accumulating guide arm 75) allows the calculation of the length of the yarn 20 to be wound around the yarn pool section 71. The present embodiment utilizes this to allow the amount of yarn 20 to be supplied to the yarn pool section 71 to be precisely calculated based on pulse signals output by the rotating servo motor 55. More specifically, the yarn feed amount can be determined by calculating the feed length of the yarn 20 conveyed in a predetermined time, the yarn conveying speed, and the like.

[0067] During the operation of the winding unit 10, the disturb control performed by the yarn winding section 9 or the like may result in a difference between the actual speed at which the yarn 20 is wound into the package 30 and the rotation speed of the winding drum 24. However, in the present embodiment, the yarn speed on the upstream side of the yarn pool section 71 is set according to the rotation speed of the servo motor 55. Thus, for example, even with the disturb control performed by the yarn winding section 9, variation in yarn speed occurring on the downstream side of the yarn pool section 71 is prevented from propagating to the upstream side.

[0068] The accumulator 61 is configured such that the yarn 20 is wound around and spirally accumulated the same portion of the yarn pool section 71 by the accumulating guide arm 75. This allows the winding length (supply length) of the yarn 20 per rotation of the accumulating guide arm 75 to be always maintained constant. The yarn 20 is wound around the yarn pool section 71 while forming a simple spiral. Thus, the yarn 20 is prevented from being improperly unwound as a result of overlapping (ribbon winding). This eliminates the need for the disturb control or the like during accumulation. Consequently, the yarn speed on the upstream side of the yarn pool section 71 is exactly proportional to the rotation speed of the accumulating guide arm 75. As a result, the servo motor control section 56 controls the rotation speed of the accumulating guide arm 75 to allow the yarn speed on the upstream side of the yarn pool section 71 to be accurately controlled.

[0069] Now, yarn defect detection performed by the clearer 15 will be described.

[0070] A yarn unevenness sensor (not shown in the drawings) allowing the yarn thickness to be detected is located in the sensor head 19, provided in the clearer 15. The yarn unevenness sensor detects thickness unevenness in the yarn 20. A value detected by the yarn unevenness sensor is used to determine whether or not a yarn defect is present. The detection signal from the yarn unevenness sensor is transmitted to the analyzer 52.

[0071] The analyzer 52 includes a CPU or the like (not shown in the drawings) which functions as a control section and a signal processing section. When the detected value input to the analyzer 52 by the yarn unevenness sensor meets a predetermined condition, the analyzer 52 determines the value to indicate a yarn defect. The analyzer 52 then transmits a yarn defect detection signal to the unit control section 50. For example, if the yarn 20 continuously exhibits a thickness equal to 150% of the average one over a length of at least 3 mm, the analyzer 52 determines the corresponding portion to be slub or the like.

[0072] The procedure in which the analyzer 52 detects a yarn unevenness defect will be described taking the detection of slub for instance. When a signal resulting from the detection performed by the sensor head 19, provided in the clearer 15, indicates that the yarn thickness is at least 150% of the average one (defect occurrence signal), this defect occurrence signal is transmitted to the analyzer 52. Upon receiving the defect occurrence signal, the analyzer 52 counts the pulse signal transmitted by the servo motor 55. The analyzer 52 thus monitors the rotation angle of the accumulating guide arm 75 with respect to the position of the accumulating guide arm 75 located at the time of the reception of the defect occurrence signal. Then, when the rotation angle of the accumulating guide arm 75 reaches a predetermined value corresponding to a yarn length of 3 mm during the reception of the yarn occurrence signal, the analyzer 52 determines that slub has been generated. Then, the analyzer 52 transmits the yarn defect detection signal to the unit control section 50.

[0073] Here, a possible variation in yarn speed during the actual winding of the yarn 20 by the yarn winding section 9 is blocked by the yarn pool section 71 as described above. Thus, the yarn speed on the upstream side of the yarn pool section 71 (the speed of the yarn 20 passing through the clearer 15) can be accurately controlled by the servo motor control section 56. Thus, for example, if an adequate amount of yarn 20 is accumulated on the yarn pool section 71, the servo motor 55 can also be controlled such that the yarn 20 travels at a constant speed suitable for allowing the clearer 15 to detect yarn defects. This allows the accurate determination of the presence or absence of a yarn defect using the clearer 15. Therefore, the quality of the package 30 can be ensured without the need to set determination conditions for yarn defects more strictly than required so as to provide a large margin. This inhibits an otherwise tolerable yarn unevenness portion from being removed, enabling production efficiency to be improved.

[0074] The pulse signal from the servo motor 55 is input to the analyzer 52 via the servo motor control section 56. Then, based on the pulse signal from the servo motor 55, the analyzer 52 calculates the continuous length of the uneven-thickness portion of the yarn 20. Thus, for example, even when the rotation speed of the accumulating guide arm 75 is changed in order to adjust the amount of yarn 20 accumulated in the yarn pool section 71, the accuracy with which the clearer 15 detects yarn defects can be appropriately maintained.

[0075] Now, how the relevant sections operate when the clearer detects a yarn defect will be described. Based on the yarn defect detection signal from the clearer 15, the unit control section 50 halts the servo motor 55 of the accumulator 61 to stop the rotation of the 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 port 80 in the accumulator. Provided that the yarn 20 is stopped below the introduction port 80 in the accumulator, the yarn 20 may be cut by the cutter 18 simultaneously with the stop of rotation of the accumulating guide arm 75.

[0076] The unit control section 50 brings the servo motor 55 into a neutral state (free state). The unit control section 50 thus allows the downstream-side yarn guide pipe 26 to suck and catch the downstream-side yarn 20 positioned below the introduction port 80 in the accumulator 61. Then, with the yarn end of the downstream-side yarn 20 caught, the unit control section 50 allows the downstream-side yarn guide pipe 26 to be pivotally moved to the guide position. Since the servo motor 55 is in the neutral state, the downstream-side yarn guide pipe 26 rotates downward to rotate the accumulating guide arm 75 in a direction in which the yarn 20 is unwound. Then, the yarn 20 is drawn out to the upstream side of the accumulator 61. Thus, even with the yarn defect potion wound around the yarn pool section 71, the yarn defect can be drawn from the yarn pool section 71 back to the upstream side. The unit control section 50 then allows the upstream-side yarn guide pipe 25 to suck and catch the upstream-side yarn 20 and then pivotally move to the guide position above the splicer device 14.

[0077] 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 to the splicer device 14, the splicer device 14 starts a 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.

[0078] The 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. Once 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.

[0079] The unit control section 50 preferably performs control such that at least immediately after 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 for the package 30. This allows the quick recovery of the accumulation amount of the yarn pool section 71, reduced during the yarn splicing operation.

[0080] As shown above, the winding unit 10 according to the present embodiment includes the yarn pool section 71, the servo motor 55, and the clearer 15. The yarn pool section 71 accumulates 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 clearer 15 is located on the upstream side of the yarn pool section 71 in order to detect the yarn defect. The winding unit 10 calculates the length of the uneven-thickness portion having passed through the clearer 15 based the amount (yarn speed) by which the yarn 20 is fed to the upstream side of the yarn pool section.

[0081] Thus, the yarn pool section 71 allows a possible variation in yarn speed associated with the yarn winding operation for the package 30 to be prevented from being transmitted to the upstream side. Driving of the servo motor 55 is controlled to allow the amount by which the yarn 20 is fed in passing through the clearer 15 to be accurately controlled. Thus, the amount by which the yarn 20 is fed in passing through the clearer 15 is stabilized to allow the detection accuracy of the clearer 15 to be improved. Consequently, an uneven-thickness portion with a length appropriate to determine the portion to be a yarn defect can be prevented from being wound into the package 30. Furthermore, an uneven-thickness portion with a tolerable length can be prevented from being removed as a yarn defect.

[0082] In the winding unit 10 according to the present embodiment, the amount of yarn 20 supplied to the yarn pool section 71 by driving the servo motor 55 is used to calculate the length of the uneven-thickness portion having passed through the clearer 15.

[0083] Thus, the length of the yarn defect portion can be easily calculated based on the driving speed of the servo motor 55. Therefore, the configuration can be simplified.

[0084] In the present embodiment, the feed length or the speed of the yarn 20 traveling on the upstream side of the accumulator 61 can be calculated directly from the rotation number of the servo motor 55. Thus, the present embodiment does not include such a yarn feed amount detector as shown in a second embodiment and a third embodiment described below. Therefore, the configuration for detecting the yarn speed can be simplified, thus enabling a reduction in manufacturing costs.

[0085] The automatic winder according to the present embodiment includes a plurality of the winding units 10.

[0086] The automatic winder of this configuration enables yarn defects to be accurately detected, allowing a high-quality package to be efficiently formed.

[0087] Now, a yarn winding device will be described which includes a yarn feed amount detector that detects the feed length and speed of a yarn 20 at a predetermined position. The second embodiment shown below measures the yarn feed length using a spatial filter method. The third embodiment shown below measures the yarn speed using a two-point measuring method.

[0088] The second embodiment will be described with reference to Figures 3 and 4. Figure 3 is a front view schematically showing the configuration of a winding unit 10a according to the second embodiment. Figure 4 is a schematic view showing how the yarn feed length is detected in the winding unit 10a. The configuration of the second embodiment is similar to that of the first embodiment except for the yarn feed amount detector. Here, the yarn feed amount detector will be mainly described, and the remaining part of the configuration will not be described.

[0089] As shown in Figure 3, the winding unit main body 16 of the winding unit 10a according to the present embodiment includes a yarn feed amount detector 101 that detects the speed of a yarn 20. The yarn feed amount detector 101 includes a detection head 115 and a yarn feed amount calculating section 111. The detection head 115 is located on the upstream side of a clearer 15 and the downstream side of a splicer device 14. The detection head 115 is located in the vicinity of the clearer 15 and configured so as to be able to measure the yarn feed amount immediately before the yarn 20 passes through the clearer 15.

[0090] As shown in Figure 4, the detection head 115 includes a light source 121, a diffusion lens 122, a slit 123, and a light receiver 124 as main components. A gap is formed between the set of the light source 121 and the diffusion lens 122 on a light emission side, and, the set of the slit 123 and the light receiver 124 on a light reception side. The yarn 20 unwound from the yarn supplying bobbin 21 travels toward an accumulator 61 in such a way as to pass through the gap.

[0091] The slit 123 prevents unwanted scattering light and the like from entering the light receiver 124. A plurality of openings 131 are formed in the slit 123 so as to be arrayed at a predetermined pitch.

[0092] The light receiver 124 is composed of a plurality of light receiving elements arranged at a predetermined pitch along a traveling path for the yarn 20. Each of the light receiving elements 125 has a light source conversion characteristic and is configured so as to be able to detect the level of shade of the traveling yarn 20.

[0093] In this configuration, light from the light source 121 is diffused by the diffusion lens 122 and applied to the traveling yarn 20. The possible thickness unevenness of the traveling yarn 20 is projected on the light receiving elements 125 through the slit 123 as a shade. Detection signals from the light receiving elements 125 are transmitted to the yarn feed amount calculating section 111.

[0094] The yarn feed amount calculating section 111 is configured as a microcomputer composed of a CPU, a storage section, and the like. The detection signals from the light receiving elements 125 are input to the yarn feed amount calculating section 111. A pulse signal from a servo motor 55 for the accumulator 61 is input to the yarn feed amount calculating section 111 via a servo motor control section 56. The yarn feed amount calculating section 111 includes a bandpass filter (not shown in the drawings). That bandpass filter removes noise from the detection signals obtained from the light receiving elements 125.

[0095] To remove the noise, the bandpass filter sets a particular frequency band with reference to the pulse signal from the servo motor 55, while attenuating the other frequency bands. In this manner, the noise is removed with the pulse signal (that is, the signal indicative of the speed at which the yarn 20 is supplied to the yarn pool section 71) from the servo motor 55 taken into account. Thus, the feed length of the yarn 20 can be accurately measured based on the frequency component with the appropriate waveform.

[0096] The yarn feed amount calculating section 111 removes the noise by the bandpass filter and then shapes the waveform so as to convert the signal into a pulse train. A counter (not shown in the drawings) provided in the yarn feed amount calculating section 111 counts the number of pulses in the pulse train. The yarn feed amount calculating section 111 then calculates the yarn feed length based on the number of pulses obtained and the array pitch of the openings 131. The calculated yarn feed length is input to an analyzer 52 of the clearer 15 and used to determine whether or not a yarn defect is present. By measuring the yarn feed length, the yarn feed amount calculating section 111 can also easily detect the average yarn speed.

[0097] As described in the first embodiment, the traveling speed of the yarn 20 can be determined directly from the rotation speed of the servo motor 55. However, for example, if a very stretchy yarn 20 is wound and when the clearer 15 and the accumulator 61 are arranged at a relatively long distance from each other, the yarn 20 may be slightly expanded and contracted between the clearer 15 and the accumulator 61. In this case, the speed at which the yarn 20 is wound around the yarn pool section 71 may differ slightly from the speed at which the yarn 20 passes through the clearer 15. This may reduce the accuracy with which the clearer 15 detects yarn defects.

[0098] In this regard, in the present embodiment, the detection head 115 of the yarn feed amount detector 101 is located in the vicinity of the clearer 15. Thus, with the possible adverse effect of expansion and contraction of the yarn 20 prevented, the speed at which the yarn 20 passes through the clearer 15 can be accurately determined. The pulse signal from the servo motor 55 is input to the yarn feed amount calculating section 111 of the yarn feed amount detector 101 as an auxiliary signal. Then, based on the auxiliary signal, noise removal is performed. Consequently, the yarn feed amount detector 101 provides accurate measured values. The analyzer 52 then uses the yarn speed measured by the yarn feed amount detector 101 to determine whether or not a yarn defect is present. Therefore, even with a very stretchy yarn, yarn defects can be accurately detected.

[0099] As shown above, the winding unit 10a includes the yarn pool section 71, the servo motor 55, the clearer 15, and the yarn feed amount detector 101. The yarn pool section 71 accumulates 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 clearer 15 is located on the upstream side of the yarn pool section 71 in order to detect a yarn defect. The yarn feed amount detector 101 is located on an upstream side of the yarn pool section 71. The yarn feed amount detector 101 measures the speed or feed length of the yarn 20 supplied to the yarn pool section 71 by driving the servo motor 55.

[0100] Thus, the yarn pool section 71 can prevent a variation in yarn speed associated with the yarn winding operation for the package 30 from being transmitted to the upstream side. The feed amount of the yarn 20 passing through the clearer 15 is accurately controlled by controlling the driving of the servo motor 55.

[0101] Thus, the yarn speed or yarn feed length of the yarn 20 on the upstream side of the yarn pool section 71, without being affected by a variation in yarn speed associated with the yarn winding operation, can be accurately measured by the yarn amount detector 101. The detection accuracy of the clearer 15 can be improved based on the accurate yarn feed amount (yarn speed) determined without the adverse effect of the yarn winding operation. Thus, an uneven-thickness portion with a length appropriate to determine the portion to be a yarn defect can be prevented from being wound into a package. Furthermore, an uneven-thickness portion with a tolerable length can be prevented from being removed as a yarn defect.

[0102] The winding unit 10a according to the second embodiment calculates the length of an uneven-thickness portion having passed through the clearer 15 based on the yarn speed or the yarn feed length detected by the yarn feed amount detector 101.

[0103] Thus, the yarn defect portion can be accurately identified based on the accurate yarn speed or the yarn feed length.

[0104] In the winding unit 10a according to the second embodiment, the yarn feed amount detector 101 measures the yarn feed length based on the spatial filter method.

[0105] Thus, the yarn feed length (yarn length) can be accurately measured without the need for a complicated calculation.

[0106] Now, a third embodiment in which the two-point measuring method is used to measure the yarn speed will be described with reference to Figure 5. Figure 5 is a schematic diagram showing how the yarn speed is detected according to the third embodiment. A is the case with the second embodiment, the configuration of the third embodiment is similar to that of the first embodiment except for the yarn feed amount detector. Here, the yarn feed amount detector will be mainly described, and the remaining part of the configuration will not be described.

[0107] A yarn feed amount detector 201 provided in a winding unit 10a according to the present embodiment includes a detection head 215 and a yarn feed amount calculating section 211. As is the case with the second embodiment, the detection head 215 is located on the upstream side of a clearer 15 and the downstream side of a splicer device 14. The detection head 215 is located in the vicinity of the clearer 15 and configured so as to be able to measure the yarn speed immediately before the yarn 20 passes through the clearer 15.

[0108] As shown in Figure 5, the detection head 215 includes a first yarn unevenness sensor 221 and a second yarn unevenness sensor 222. The first yarn unevenness sensor 221 and the second yarn unevenness sensor 222 are arranged along the traveling path of a yarn 20. The first yarn unevenness sensor 221 is located on the downstream side of the second yarn unevenness sensor 222.

[0109] The first yarn unevenness sensor 221 and the second yarn unevenness sensor 222 are electrically connected to the yarn feed amount calculating section 211. The yarn feed amount calculating section 211 is configured as a microcomputer including a CPU. The yarn feed amount calculating section 211 is configured so as to be able to receive pulse signals from a servo motor 55 via a servo motor control section.

[0110] The CPU of the yarn feed amount calculating section 211 samples an analog waveform measured by the first yarn unevenness sensor 221 and the second yarn unevenness sensor 222, based on a predetermined sampling frequency.

[0111] The two yarn unevenness sensors 221, 222 measures the same yarn 20. Thus, the same waveform is observed. However, since the first yarn unevenness sensor 221 is located on the downstream side of the second yarn unevenness sensor 222, the waveform detected by the first yarn unevenness sensor 221 is delayed with respect to that detected by the second yarn unevenness sensor 222. The yarn feed amount calculating section 211 uses a well-known cross-correlation method to estimate the delay time based on the two waveforms. The yarn speed can be measured based on the delay time and the arrangement distance between the yarn unevenness sensors 221, 222.

[0112] A very stretchy yarn 20 may be used in the winding unit 10b according to the present embodiment. In this case, however, the speed at which the yarn 20 is supplied to the yarn pool section 71 of the accumulator 61 does not deviate significantly from the speed at which the yarn passes through the yarn feed amount accumulator 201. Utilizing this, the yarn feed amount 211 eventually determines the measured value of the speed at which the yarn passes through the yarn feed amount detector 201, with reference to the yarn speed obtained from the pulse signal from the servo motor 55.

[0113] As shown above, in the winding unit 10b according to the third embodiment, the yarn feed amount detector 201 measures the yarn speed based on the two-point measuring method.

[0114] Thus, the two-point measuring method can be used to accurately measure the yarn speed while comparing the detection values from the first yarn unevenness sensor 221 and the second yarn unevenness sensor 222 with each other. Since the pulse signal from the servo motor 55 is referenced to eventually determine the measured value of the yarn speed, the yarn speed can be more accurately detected.

[0115] The preferred embodiments of the present invention have been described. However, the above-described configurations may be modified as described below.

[0116] In the second and third embodiments, the detection head of the yarn feed amount detector is located on the upstream side of the clearer 15. However, the present invention is not limited to this configuration. For example, the detection head may be located on the downstream side of the clearer 15. However, to allow the speed of the yarn passing through the clearer 15 to be accurately measured, the detection head is preferably located in the vicinity of the clearer 15.

[0117] The yarn feed amount calculating section 111 according to the second embodiment and the yarn feed amount calculating section 211 according to the third embodiment may be provided on the unit control section 50 side.

[0118] In the second and third embodiments, the yarn feed amount detector is located separately from the clearer 15. This configuration may be modified such that the clearer 15 also serves as a yarn feed amount detector. In short, provided that at least one of the yarn defect detector and the yarn feed amount detector uses the pulse signal from the servo motor 55 as an auxiliary signal, the accuracy of the results of detection by the detector can be improved.

[0119] In the first to third embodiments, the servo motor 55 is controlled by the servo motor control section 56. However, the present invention is not limited to this configuration. For example, the servo motor 55 may be controlled directly by the unit control section 50. The configuration may be modified such that the pulse signal from the servo motor 55 is input directly to the clearer 15 or the yarn feed amount detector 101, 201 without passing through the servo motor control section 56.

[0120] 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 yarn into a package, the device being **characterized by** comprising:

   a yarn pool section (71) 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); and
   a yarn defect detector (15) located on an upstream side of the yarn pool section (71) in order to detect a yarn defect, and
   in that the yarn winding device calculates length of an uneven-thickness portion having passed through the yarn defect detector (15) based on an amount by which the yarn is fed to the upstream side of the yarn pool section (71).

2. The yarn winding device according to Claim 1, **characterized in that** the amount of yarn supplied to the yarn pool section (71) by driving the yarn accumulation driving section (55) is used to calculate the length of the uneven-thickness portion having passed through the yarn defect detector (15).

3. A yarn winding device winding a yarn into a package, the device being **characterized by** comprising:

   a yarn pool section (71) 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 yarn defect detector (15) located on an upstream side of the yarn pool section (71) in order to detect a yarn defect; and
   a yarn feed amount detector (101, 201) located on an upstream side of the yarn pool section (71), and
   in that the yarn feed amount detector (101, 201) measures speed or feed length of the yarn supplied to the yarn pool section (71) by driving the yarn accumulation driving section (55).

4. The yarn winding device according to Claim 3, **characterized in that** the yarn winding device calculates length of an uneven-thickness portion having passed through the yarn defect detector (15) based on the yarn speed or the yarn feed length detected by the yarn feed amount detector (101, 201).

5. The yarn winding device according to Claim 3 or Claim 4, **characterized in that** the yarn feed amount detector (101) measures the yarn feed length based on a spatial filter method.

6. The yarn winding device according to Claim 3 or Claim 4, **characterized in that** the yarn feed amount detector (201) measures the yarn speed based on a two-point measuring method.

7. An automatic winder comprising a plurality of the yarn winding devices according to any one of Claims 1 to 6.

FIGURE 1

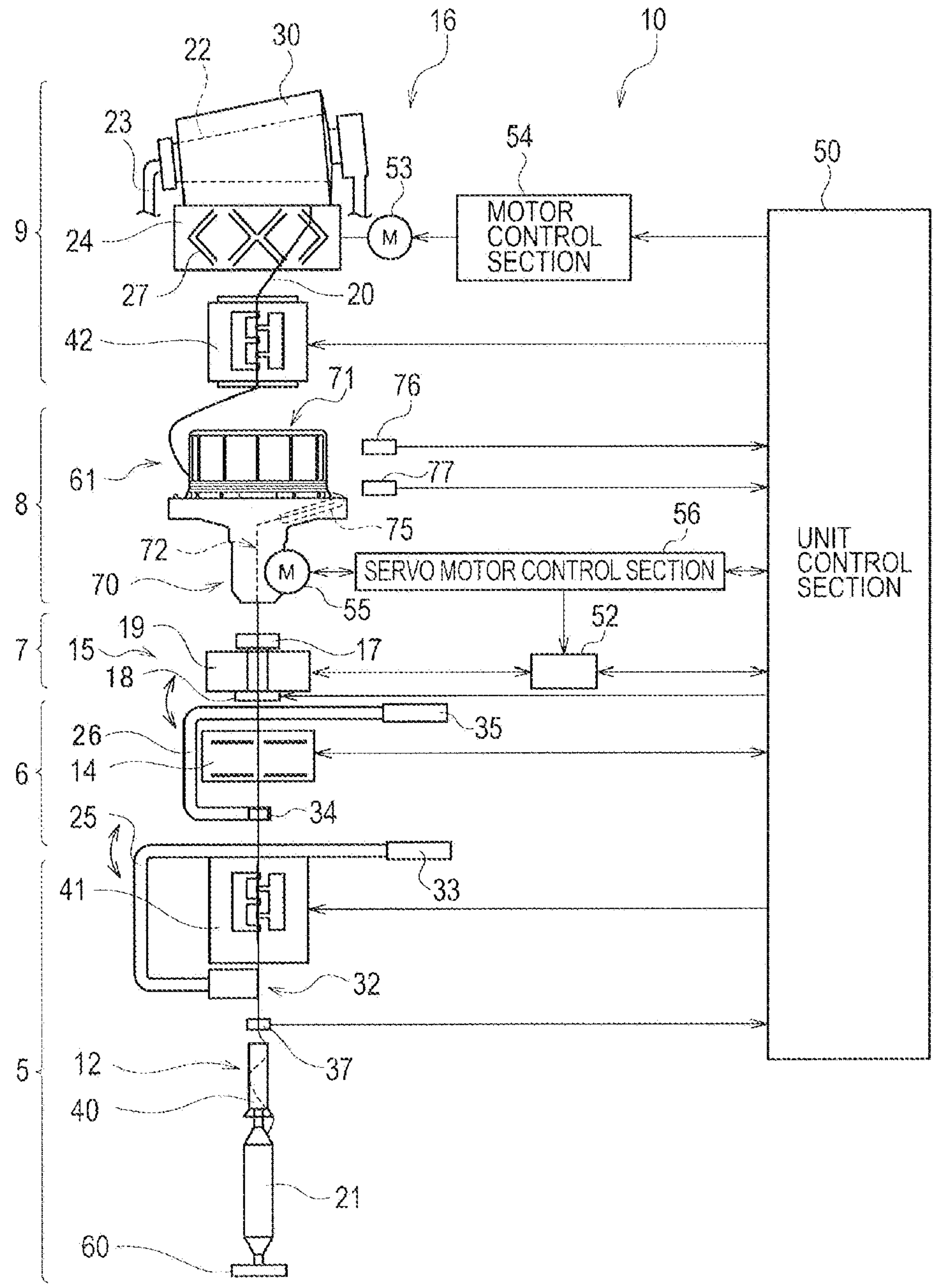
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FIGURE 2

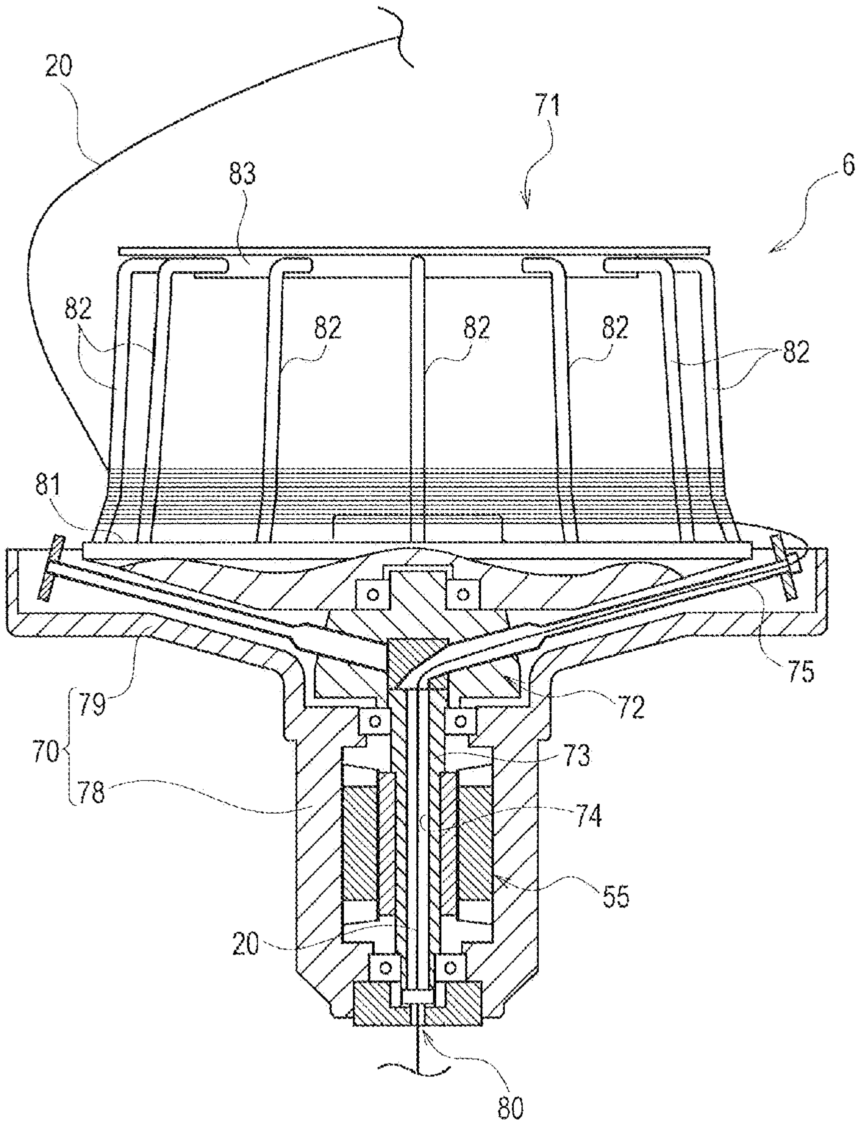

FIGURE 3

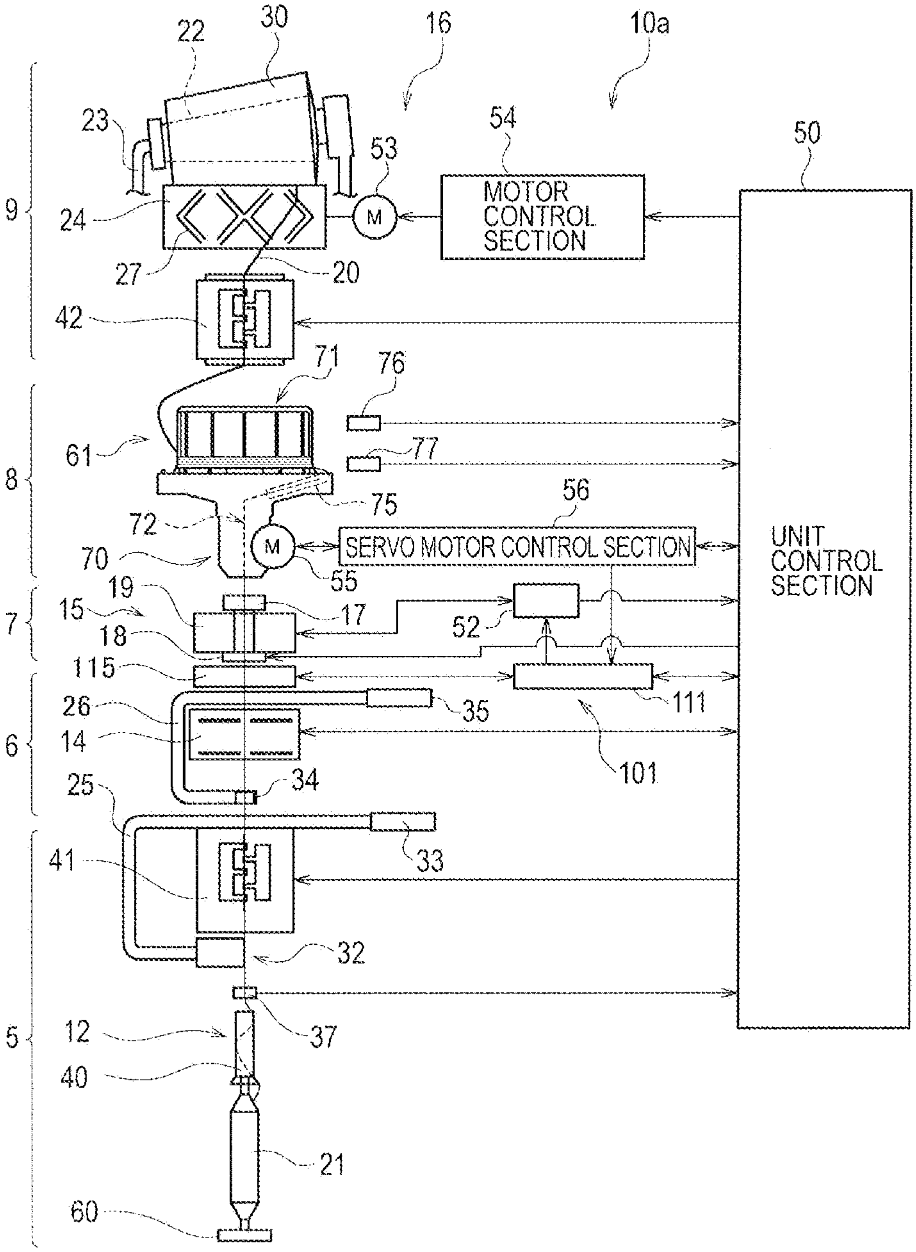

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FIGURE 4

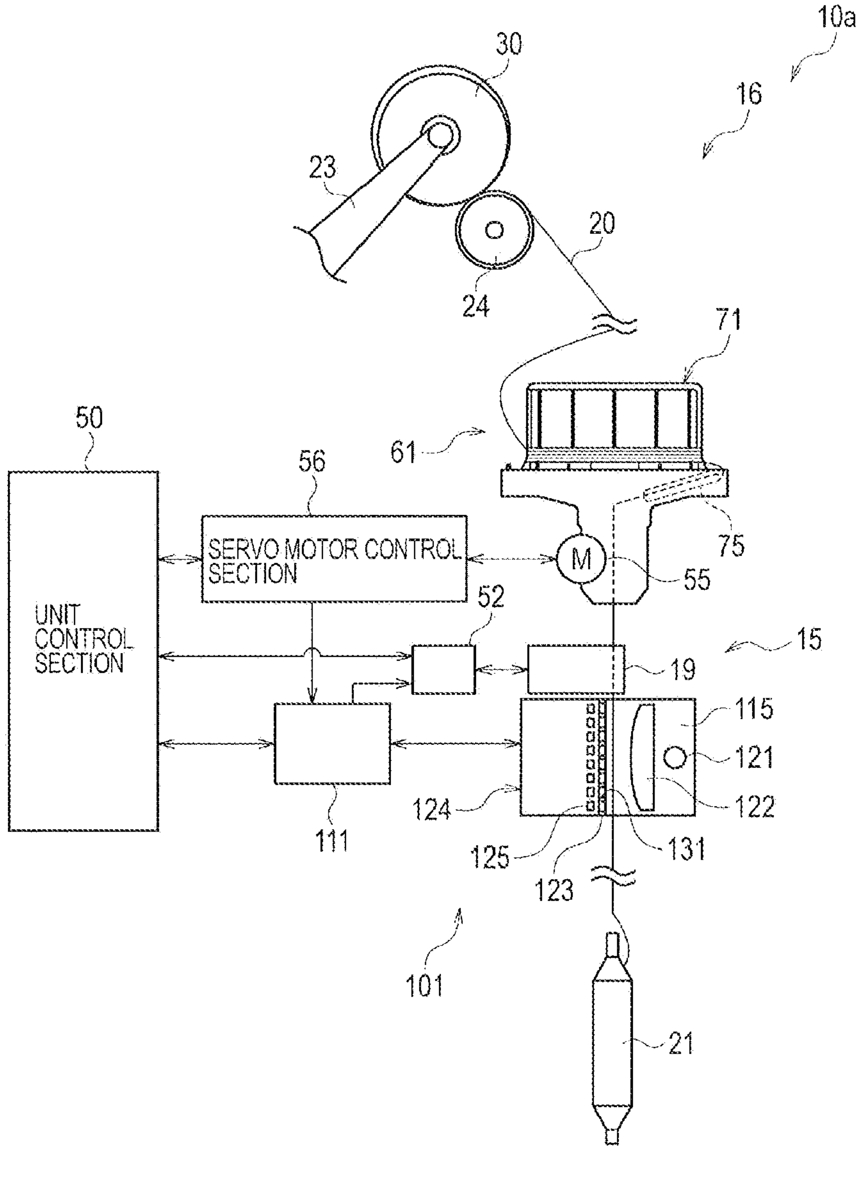
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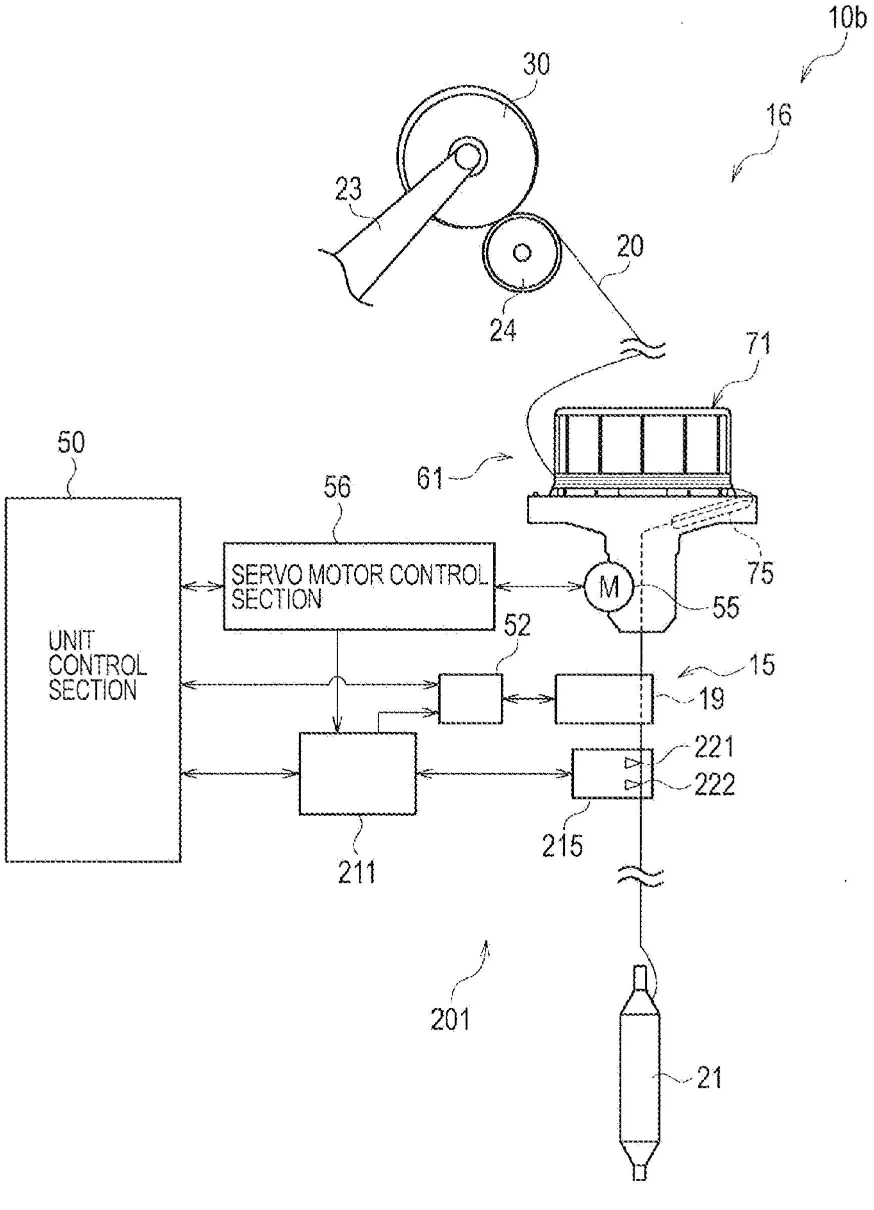
FIGURE 5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REFERENCES CITED IN THE DESCRIPTION

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- JP 2005194024 A **[0002] [0004] [0007]**