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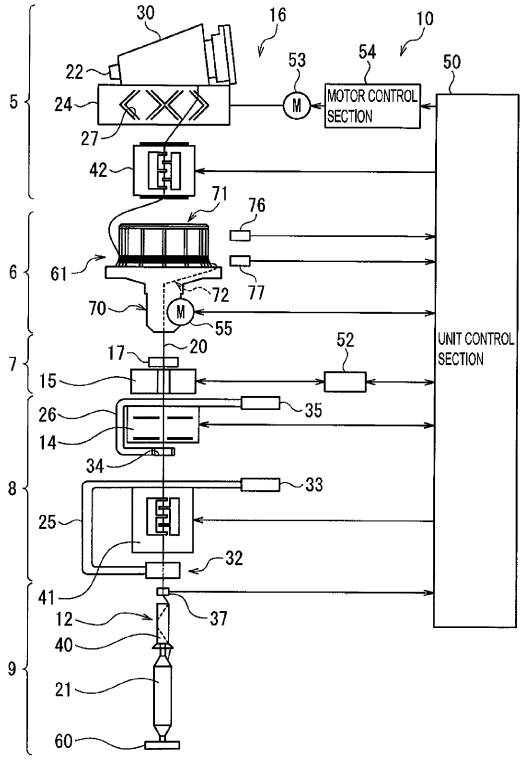
(54) Yarn winding device and automatic winder

(57) An automatic winder includes a drum driving motor 53 rotating a package 30, an accumulator 61 allowing a yarn 20 to be accumulated before the yarn 20 is wound into the package 30 and allowing the accumulated yarn 20 to be drawn out to a yarn supplying bobbin 21 side, a clearer 15 detecting a yarn defect, and a splicer device 14 performing a yarn splicing operation. The automatic winder includes a first tension applying section 41 located between the yarn supplying bobbin 21 and the accumulator 61, a second tension applying section 42 located between the accumulator 61 and the package 30, and a unit control section 50 controlling the first tension applying section 41 and the second tension applying section 42.

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 tension applied to a yarn being 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. In the yarn winding device, a yarn splicing device splices yarns from a plurality of yarn supplying bobbins conveyed to the yarn winding device, to generate a package of a predetermined length. Such a yarn winding device may include a tension control mechanism for applying an appropriate tension to the yarn being wound, to inhibit a possible change in winding tension.

[0003] Such a yarn winding device as described above is disclosed in, for example, the Unexamined Japanese Patent Application Publication (Tokkai-Hei) No. 5-766. A winding unit corresponding to the yarn winding device the Unexamined Japanese Patent Application Publication (Tokkai-Hei) No. 5-766 includes a gate type tension applying section disposed on a yarn path between a yarn supplying bobbin from which the yarn is unwound and a package into which the yarn is wound; the gate sensor includes a pair of comb-like members that engage with each other.

[0004] For improved production efficiency, there has been a demand for an increase in package winding speed. However, the increased winding speed increases a load on the traveling yarn, resulting in frequent yarn breakage. When yarn breakage occurs, the yarn needs to be drawn out from the package and then spliced to a yarn supplying bobbin-side yarn. However, during a yarn splicing operation, when the package is reversely rotated to allow the package-side yarn to be caught, a surface portion of the package may be pulled by the suction force of the suction arm. This may damage the surface of the package.

[0005] During the yarn splicing operation, a winding operation is suspended to allow the package to be reversely rotated. Thus, after the yarn splicing, the winding speed needs to be increased from zero to a steady-state speed. At this time, the winding tension is likely to change. When only a small amount of yarn is remaining on the yarn supplying bobbin, the yarn unwound from the yarn supplying bobbin may entangle with the bobbin to significantly change the tension. The tension change affects the winding tension of the package, leading to yarn breakage or degraded package quality.

[0006] The configuration in the Unexamined Japanese Patent Application Publication (Tokkai-Hei) No. 5-766 prevents a generation of a possible peak tension to reduce the frequency of yarn breakage. However, a particularly significant tension change occurs during replacement of the yarn supplying bobbin. Thus, even if the winding unit includes a tension control mechanism, when a significant tension change occurs, the adverse effect on the package could not be properly eliminated.

[0007] Furthermore, a configuration in U.S. Patent No. 3314621 uses a brake to enable a given tension to be applied to the yarn being wound into the package. However, U.S. Patent No. 3314621 fails to disclose that the applied tension is flexibly changed depending on a package winding condition or yarn quality.

BRIEF SUMMARY OF THE INVENTION

[0008] The present invention has been made in view of these circumstances. An object of the present invention is to provide a yarn winding device that allows the winding tension of a package to be controllably maintained in a given condition from winding start to winding end of the package.

[0009] A first aspect of the present invention provides a method of operating a yarn winding device that winds a yarn drawn out from a replaceable yarn supplying bobbin into a package. The yarn winding device includes a tension transmission interrupting mechanism and a tension control mechanism. The tension transmission interrupting mechanism interrupts transmission of a tension change occurring on the yarn supplying bobbin side to prevent the tension change from being transmitted to the package. The tension control mechanism flexibly controls tension of the yarn being wound into the package.

[0010] Thus, the tension transmission interrupting mechanism can interrupt propagation of the tension change so as to prevent the tension change from affecting a winding operation on the package side. With the tension change interrupted by the tension transmission interrupting mechanism, the tension is controlled by the tension control mechanism. Thus, the tension of the yarn being wound into the package can be maintained constant. Consequently, the package can be prevented from being affected by the tension change. Therefore, a package in a proper wound state can be produced.

[0011] The yarn winding device preferably further includes another tension control mechanism for flexibly controlling the tension applied to the yarn after the yarn is unwound from the yarn supplying bobbin and before the yarn reaches the tension transmission interrupting mechanism.

[0012] This allows the tension of the yarn to be maintained constant throughout the winding operation. The tension of the yarn is flexibly controlled at two positions. As a result, a high-quality package in the proper wound state can be formed.

[0013] A second aspect of the present invention provides a yarn winding device that winds a yarn drawn out

from a replaceable yarn supplying bobbin into a package. The yarn winding device includes a winding driving section, a yarn accumulating device, a yarn defect detecting section, a yarn splicing section, a first tension control mechanism, a second tension control mechanism, and a control section. The winding driving section rotates the package. The yarn accumulating device allows the yarn to be accumulated before the yarn is wound into the package, and allows the accumulated yarn to be drawn out to the yarn supplying bobbin side. The yarn defect detecting section detects a yarn defect. The yarn splicing section performs a yarn splicing operation. The first tension control mechanism is located between the yarn supplying bobbin and the yarn accumulating device. The second tension control mechanism is located between the yarn accumulating device and the package. The control section controls the first tension control mechanism and the second tension control mechanism.

[0014] Thus, in order to prevent a tension change that may occur at the start or the end of unwinding of the yarn from the yarn supplying bobbin from affecting the winding operation at the package side, the yarn accumulating device interrupts the propagation of the tension change. Thus, even if a significant tension change occurs on the yarn supplying bobbin side, the yarn can be continuously wound into the package with the winding tension maintained constant. When a yarn defect or yarn breakage occurs or when the yarn supplying bobbin is replaced with a new one, the yarn splicing operation can be performed by drawing out the yarn from the yarn accumulating device to the yarn supplying bobbin side, while winding the yarn accumulated in the yarn accumulating device, into the package. The winding operation can be continuously performed without reversely rotating the package. Thus, waste yarn that generates during the yarn splicing can be prevented from being mixed in the package, and the package can be prevented from being formed into an improper winding shape. The first tension control mechanism allows an appropriate tension to be applied to the yarn before the yarn is accumulated in the yarn accumulating device, The second tension control mechanism allows an appropriate tension to be applied to the yarn before the yarn is wound into the package. Consequently, the winding tension can be controllably maintained constant throughout the winding operation, allowing possible yarn breakage to be effectively prevented. As described above, the yarn can be continuously wound into the package in a constant condition. Therefore, a high-quality package in the proper wound state can be formed.

[0015] In the yarn winding device, the control section preferably allows the second tension control mechanism to adjust the tension applied to the yarn according to a winding speed of the package.

[0016] Thus, even if the package winding speed changes, for example, if the winding speed increases, the tension applied to the yarn is controllably reduced to allow the winding operation to be performed with the winding tension maintained constant.

[0017] The yarn winding device further includes a yarn accumulation amount detecting mechanism for detecting amount of yarn accumulated in the yarn accumulating device. Preferably, the control section changes the package winding speed according to the amount of yarn accumulated in the yarn accumulating device. The control section further allows the second tension control mechanism to adjust the tension applied to the yarn according to the changed winding speed.

[0018] Thus, even if the package winding speed is changed so as to accumulate an appropriate amount of yarn in the yarn accumulating device, the second tension control mechanism applies the tension to the yarn according to the winding speed. Therefore, the amount of yarn accumulated in the yarn accumulating device can be adjusted while maintaing the constant winding tension.

[0019] A third aspect of the present invention provides an automatic winder including a plurality of the above-described yarn winding devices.

[0020] Thus, an automatic winder that can produce a high-quality package can be provided.

[0021] 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

[0022]

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

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

Figure 3 is a graph showing a relationship between a winding speed and application of tension by a tension applying section for each yarn count.

Figure 4 is a flowchart showing control of a second tension applying section performed to adjust winding speed according to an amount of yarn accumulated in an accumulator when a yarn defect is detected.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0023] A preferred embodiment of the present invention will be described below with reference to the drawings.

[0024] A winding unit 10 shown in Figure 1 winds a yarn 20 unwound from a yarn supplying bobbin 21, around a yarn winding bobbin 22 while traversing the yarn 20. The winding unit 10 thus forms a package 30 with a predetermined length and a predetermined shape.

An automatic winder according to the present embodiment includes a plurality of the winding units 10 arranged in a line, and a frame control device (not shown in the drawings) located at one end of an arrangement of the winding units 10 in an arrangement direction. Each of the winding units 10 includes a unit frame (not shown in the drawings) provided on one of lateral sides of the winding unit 10 as viewed from the front, and a winding unit main body 16 provided on a side of the unit frame.

[0025] The winding unit main body 16 includes a winding section 5, a yarn accumulating section 6, a yarn defect detecting section 7, a yarn splicing section 8, and a yarn supplying section 9. The winding section 5 includes a cradle (not shown in the drawings) that can 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 applying section 42 (a second tension control mechanism) described below. The cradle can be swung in a direction in which the cradle approaches or leaves the winding drum 24. Thus, the package 30 comes into contact with or separates from the winding drum 24. As shown in Figure 1 , a spiral traverse groove 27 is formed in an outer peripheral surface of the winding drum 24 to allow the yarn 20 to be traversed. The yarn accumulating section 6 includes an accumulator 61 in which the yarn 20 is accumulated before being wound into a package 30. The yarn defect detecting section 7 includes a clearer 15 that detects a yarn defect. The yarn splicing section 8 includes a splicer device (yarn splicing device) 14 that performs a yarn splicing operation, a lower yarn guide pipe (lower yarn catching mechanism) 25, and an upper yarn guide pipe (upper yarn catching mechanism) 26. The yarn supplying section 9 includes a yarn supplying bobbin holding section 60 that holds the yarn supplying bobbin 21, a yarn unwinding assisting device 12, and a first tension applying section 41 (a first tension control mechanism).

[0026] The cradle is provided with a liftup mechanism and a package brake mechanism (neither of the mechanisms is shown in the drawings). When defective yarn supplying bobbins are consecutively supplied or a machine trouble or the like occurs, the liftup mechanism elevates the cradle to allow the package 30 to be separated from the winding drum 24. The package brake mechanism is configured to stop rotation of the package 30 gripped by the cradle at the same time when the cradle is elevated by the liftup mechanism.

[0027] The yarn supplying section 9 further includes a bobbin supply device (not shown in the drawings) that supplies a new yarn supplying bobbin 21 to a yarn supplying bobbin holding section 60. The bobbin supply device may be of a magazine type or a tray type. The present embodiment uses the magazine type bobbin supply device. When all of the yarn 20 is drawn out from the yarn supplying bobbin 21 set in the winding unit 10, the yarn supplying section 9 discharges the empty bobbin held in the yarn supplying bobbin holding section 60. The bobbin supply device then sequentially supplies a new yarn supplying bobbin 21 to the yarn supplying bobbin holding section 60.

[0028] 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 yarn balloon formed above the yarn supplying bobbin 21 by the rotation and centrifugal force of the yarn unwound from the yarn supplying bobbin 21. The regulating member 40 thus applies an appropriate tension to the yarn balloon to assist in unwinding the yarn 20.

[0029] 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 can then be lowered by, for example, an air cylinder (not shown in the drawings) in conjunction with the lowering of the chase portion.

[0030] A yarn detection part (lower yarn detecting sensor) 37 that can determine whether or not the yarn 20 is present is provided in the vicinity of the yarn unwinding assisting device 12. When the yarn detection part 37 detects that there is no more yarn 20 to be drawn out from the yarn supplying bobbin 21, the yarn detection part 37 transmits a yarn absence detection signal to a unit control section 50.

[0031] The first tension applying section 41 applies a predetermined tension to the traveling yarn 20. As the first tension applying section 41, the present embodiment uses a gate type including movable comb teeth arranged with respect to fixed comb teeth. The movable comb teeth can be moved by a rotary solenoid (not shown in the drawings) so as to be engaged with or released from the fixed comb teeth. The first tension applying section 41 allows a predetermined tension to be applied to the yarn 20 being wound. The quality of the package 30 can thus be improved. Control performed for the first tension applying section 41 will be described below in detail.

[0032] For example, when the clearer 15 detects a yarn defect or when yarn breakage occurs during unwinding of the yarn 20 from the yarn supplying bobbin 21 , the splicer device 14 splices a lower yarn located on the yarn supplying bobbin 21 side and an upper yarn located on the package 30 side. The splicer device 14 may be of a mechanical type or may use a fluid such as compressed air.

[0033] The clearer 15 monitors the thickness of the yarn 20 by an appropriate sensor to detect a defect. A signal from the sensor of the clearer 15 is processed by an analyzer 52. Accordingly, a yarn defect such as slub can be detected. The clearer 15 can also function as a sensor that detects the traveling speed of the yarn 20 or a sensor that simply determines whether or not the yarn 20 is present.

[0034] A waxing device 17 is located on a downstream

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

[0035] The accumulator 61 is configured as a yarn accumulating device that can accumulate a predetermined amount of yarn 20. The yarn 20 supplied from the yarn supplying bobbin 21 is accumulated in the accumulator 61. Thereafter, the yarn 20 is drawn out from the accumulator 61 and wound into the package 30.

[0036] The accumulator 61 is configured such that the accumulated yarn 20 can be drawn out to both the upstream and downstream sides. The accumulator 61 allows the accumulated yarn 20 to be wound into the package 30, while concurrently drawing out the yarn 20 to the yarn supplying bobbin 21 side for a yarn splicing operation. The structure of the accumulator 61 and the operation of the accumulator 61 during the yarn splicing operation will be described below in detail.

[0037] The second tension applying section 42 is located on a downstream side of the accumulator 61 to control tension when the yarn 20 is wound into the package 30 from the accumulator 61. Thus, the yarn 20 drawn out from the accumulator 61 is subjected to the appropriate tension when wound around the winding bobbin 22. Like the first tension applying section 41 , the second tension applying section 42 used in the present embodiment is of the gate type including the movable comb teeth arranged with respect to the fixed comb teeth. The tension applied to the yarn 20 by the second tension applying section 42 is controlled according to the winding speed by the unit control section 50.

[0038] The lower yarn guide pipe (lower yarn catching mechanism) 25, which catches and guides the lower yarn located on the yarn supplying bobbin 21 side, is provided below the splicer device 14. The upper yarn guide pipe (upper yarn catching mechanism) 26, which catches and guides the upper yarn located on the package 30 side, is provided above the splicer device 14. A lower yarn suction port 32 is formed at a tip of the lower yarn guide pipe 25. An upper yarn suction port 34 is formed at a tip of the upper yarn guide pipe 26. An appropriate negative pressure source is connected to each of the lower yarn guide pipe 25 and the upper yarn guide pipe 26 to allow a suction flow to act at the lower yarn suction port 32 and the upper yarn suction port 34, respectively.

[0039] The lower yarn guide pipe 25 moves pivotally around a shaft 33 to guide the lower yarn to the splicer device 14. The upper yarn guide pipe 26 moves pivotally around a shaft 35 to a catch position shown by a chain line in Figure 1. At the catch position, the upper yarn guide pipe 26 sucks and catches the yarn 20. As shown in Figure 1 , at the catch position, the upper yarn suction port 34 of the upper yarn guide pipe 26 faces the yarn 20 which is located in the vicinity of the accumulator 61. In this state, the upper yarn guide pipe 26 sucks and catches the yarn 20 via the upper yarn suction port 34, and then moves pivotally to the original position. The yarn 20 can thus be guided to the splicer device 14.

[0040] The yarn winding bobbin 22 is driven by rotationally driving the winding drum 24, which is located facing the yarn winding bobbin 22. The winding drum 24 is coupled to an output shaft of the drum driving motor 53, which is the winding driving section. Operation of the drum driving motor 53 is controlled by a motor control section 54. The motor control section 54 receives an operation signal from the unit control section 50 and controls to operate and stop the drum driving motor 53.

[0041] Next, the accumulator 61 will be described with reference to Figure 2. The accumulator 61 includes a rotating shaft casing 70, an accumulation section 71, and a yarn guiding section 72. The rotating shaft casing 70 includes a cylindrical portion 78 the top of which is open, and a flange portion 79 formed at the open end of the cylindrical portion 78.

[0042] The accumulation section 71 is located above the flange portion 79. The accumulation section 71 includes a disk-shaped support plate 81, a plurality of rod members 82 projecting upward from the support plate 81, and a disk-shaped mounting plate 83 to which tip portions of the plurality of rod members 82 are connected. Furthermore, the accumulation section 71 is provided to form a gap between the support plate 81 and the flange portion 79. The accumulation section 71 is configured such that a winding cylinder 75 described below can rotate through the gap.

[0043] The plurality of rod members 82 are arranged at equal intervals on a circumference. The accumulation section 71 is configured to form a substantially cylindrical shape by the rod members 82. The yarn 20 is wound around an outer peripheral portion of the substantially cylindrical accumulation section 71, which includes the plurality of rod members 82. Accordingly, the yarn 20 is accumulated in the accumulation section 71.

[0044] 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 cylindrical portion 78 (the end of the cylindrical portion 78 located opposite to the accumulation section 71). The yarn 20 drawn out from the yarn supplying bobbin 21 is guided through the introduction hole 80 to the yarn guiding section 72.

[0045] A rotating shaft 73 is located inside the cylindrical portion 78. The rotating shaft 73 is mounted rotatable relative to the rotating shaft casing 70 and the accumulation section 71. A servo motor (yarn accumulation driving section) 55 is provided between the rotating shaft 73 and the cylindrical portion 78. The servo motor 55 allows the rotating shaft 73 to be rotated forward and backward. A yarn passage 74 like an axial hole is formed in the center of the rotating shaft 73.

[0046] A cylindrical winding cylinder (winding mechanism) 75 is fixed to one end of the rotating shaft 73 (the end of the rotating shaft 73 which is located opposite to

the introduction hole 80). The winding cylinder 75 extends in a radial direction so 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 a tip portion of the winding cylinder 75 projects slightly from the rotating shaft casing 70. The winding cylinder 75 is configured to rotate integrally with the rotating shaft 73. The interior of the winding cylinder 75 is connected to the yarn passage 74.

[0047] In the above-described configuration, the yarn 20 is guided through the introduction hole 80 in the yarn guiding section 72 into the rotating shaft casing 70. The yarn 20 then passes through the yarn passage 74 and the interior of the winding cylinder 75. The yarn 20 is then discharged from a tip of the winding cylinder 75. The yarn 20 is thus guided to a side surface portion of the accumulation section 71. Thus, when the servo motor 55 is driven forward, the winding cylinder 75 rotates together with the rotating shaft 73 to wind the yarn 20 around the side surface portion of the accumulation section 71.

[0048] In the accumulation section 71, the rod members 82 are arranged to incline gradually towards the inner side of the accumulation section 71. That is, an end portion of each of the rod members 82 located at the mounting plate 83 side is arranged inward than an end portion located at the support plate 81 side. The inclination of the rod members 82 causes the yarn 20 wound around the accumulating portion 71 to move slidably upward. Thus, when the yarn 20 is continuously wound by the winding cylinder 75, a portion of the yarn 20 wound around the inclining portion moves upward. Accordingly, the yarn 20 is spirally aligned and accumulated on the side surface portion composed of the rod members 82.

[0049] In the present embodiment, the servo motor 55 is used as a yarn accumulation driving section. Thus, a quick stop of rotation of the winding cylinder 75, acceleration or deceleration thereof, or the like can be precisely performed. Accordingly, an amount of the yarn 20 drawn out, timing for drawing out the yarn 20, and the like can be accurately controlled. Thus, the yarn splicing operation can be more smoothly performed.

[0050] As shown in Figure 1, the winding unit 10 includes a first accumulation sensor 76 located at an upper portion of the accumulation section 71 and a second accumulation sensor 77 located at a lower portion of the accumulation section 71. Each of the two accumulation sensors (yarn accumulation amount detecting mechanism) 76 and 77 is a non-contact type optical sensor or the like and electrically connected to the unit control section 50. The first accumulation sensor 76 is located at an upper end side of the accumulation section 71 so as to detect a portion of the yarn 20 wound on the upper end portion of the rod members 82 of the accumulation section 71. The first accumulation sensor 76 thus detects a maximum accumulation state of the accumulator 61. The second accumulation sensor 77 is located at a lower end side of the accumulation section 71 so as to detect a portion of the yarn 20 wound on the lower end side of the rod members 82. The second accumulation sensor 77 detects a shortage of yarn accumulation in the accumulator 61. Based on yarn detection signals from the first accumulation sensor 76 and the second accumulation sensor 77, the unit control section 50 controls the speed at which the yarn 20 is wound around the accumulation section 71. Accordingly, the amount of yarn 20 accumulated in the accumulator 61 can be adjusted so that the amount is not excessive or insufficient.

[0051] When yarn winding is started, the speed at which the yarn 20 is wound around the accumulation section 71 of the accumulator 61 (in other words, the speed at which the yarn 20 is fed from the yarn supplying bobbin 21 to the accumulator 61) is controlled to be equal to or higher than the speed at which the yarn 20 is wound into the package 30 and which is sequentially increased. Then, when a predetermined period of 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 driving of the servo motor 55 is controlled such that the yarn 20 is wound around the accumulation section 71 at a speed equal to the yarn winding speed for the package 30. Thus, the amount of yarn 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 concurrently with the yarn splicing operation. The accumulation section 71 preferably always maintains a state in which an amount of yarn 20 equal to the required amount is accumulated. In this manner, the amount of yarn 20 accumulated in the accumulator 61 is maintained constant. Thus, an unwinding position of the yarn 20 drawn out to the downstream side of the accumulator 61 can be set within a predetermined range. Consequently, the tension of the yarn 20 drawn out from the accumulator 61 can be maintained constant.

[0052] Next, the yarn splicing operation performed when the clearer 15 detects a yarn defect will be described. Upon detecting a yarn defect by monitoring the thickness of the yarn 20, the clearer 15 transmits a yarn defect detection signal to the unit control section 50. Based on the yarn defect detection signal, the unit control section 50 operates a cutter (yarn cutting mechanism) provided below the clearer 15 to cut the yarn 20. At the same time, the unit control section 50 stops the servo motor 55 of the accumulator 61 to stop the rotation of the winding cylinder 75. Thus, the upper yarn is stopped below the introduction hole 80 of the accumulator 61.

[0053] Then, the unit control section 50 pivotally moves the upper yarn guide pipe 26 around the shaft 35 to the catch position to suck and catch a portion of the yarn 20 located in the vicinity of an inlet of the accumulator 61. Then, the upper yarn guide pipe 26 moves pivotally down-

ward to guide the upper yarn to the splicer device 14. The unit control section 50 pivotally moves the lower yarn guide pipe 25 upward around the shaft 33 with the lower yarn sucked and caught by the lower yarn suction port 32, to guide the lower yarn to the splicer device 14. The unit control section 50 allows the splicer device 14 to splice the upper and lower yarns. The unit control section 50 then controls the servo motor 55 again so that the winding cylinder 75 rotates in a direction in which the yarn 20 is accumulated.

[0054] Next, a description will be made of the yarn splicing operation performed when the yarn supplying bobbin 21 is replaced. Upon detecting that the yarn to be supplied from the yarn supplying bobbin 21 is exhausted, the yarn detection part 37 transmits a yarn absence detection signal to the unit control section 50. Upon receiving the yarn absence detection signal, the unit control section 50 stops the supply of the yarn 20 to the accumulator 61.

[0055] Then, the unit control section 50 pivotally moves the upper yarn guide pipe 26 to the catch position to suck and catch a portion of the yarn 20 which is located in the vicinity of the inlet of the accumulator 61. Then, the upper yarn guide pipe 26 is pivotally moved downward to guide the upper yarn to the splicer device 14. When a new yarn supplying bobbin 21 is supplied by the above-described magazine type supply device, the yarn end of the new yarn supplying bobbin 21 is guided to the splicer device 14 by the lower yarn guide pipe 25. The unit control section 50 allows the splicer device 14 to splice the upper and lower yarns. The unit controller 50 thereafter controls the servo motor 55 such that the winding cylinder 75 rotates in the direction in which the yarn 20 is accumulated.

[0056] Next, with reference to Figure 3, how the first tension applying section 41 and the second tension applying section 42 apply the tension according to the winding speed will be described. Figure 3 is a graph showing the relationship between the yarn speed and the current value of the second tension applying section 42 for each yarn count (10, 20, 30, 60, 80, 100). The current value of the second tension applying section 42 corresponds to the tension applied to the yarn 20. A small current value means a small value of the tension applied to the yarn 20. Furthermore, the yarn counts correspond to cotton counts. The diameter of the yarn decreases with increasing yarn count. For example, in Figure 3, the diameter of the yarn with a yarn count of 20 is smaller than that of the yarn with a yarn count of 10. Similarly, the diameter of the yarn with a yarn count of 30 is smaller than that of the yarn with a yarn count of 20.

[0057] Winding tension generated when the yarn 20 is wound into the package 30 is the sum of the tension generated by traveling of the yarn 20 and the tension applied by the tension control mechanism (the second tension applying section 42). A change in yarn winding speed correspondingly changes the tension generated by the traveling of the yarn 20. By adjusting the tension applied to the yarn 20 by the second tension applying section 42 according to the tension change, the winding tension can be maintained constant. Specifically, for example, as shown in Figure 3, the value (current value) of the tension applied by the second tension applying section 42 is controllably reduced as the winding speed increases, to maintain the winding tension constant.

[0058] In the present embodiment, the winding tension of the package 30 can be maintained constant by changing the tension applied by the second tension applying section 42 to the yarn 20 being unwound from the accumulator 61. Specifically, an increase in the winding speed of the yarn 20 increases the tension generated by the traveling of the yarn 20. Thus, in this case, the tension applied by the second tension applying section 42 is controllably reduced by the increased amount. On the other hand, a decrease in the winding speed of the yarn 20 reduces the tension generated by the traveling of the yarn 20. Thus, in this case, the tension applied by the second tension applying section 42 is controllably increased by the decreased amount. As a result, the winding tension can be maintained constant.

[0059] The winding unit 10 according to the present embodiment, which winds the yarn 20 drawn out from the replaceable yarn supplying bobbin 21 into the package 30 as described above, includes the accumulator (tension transmission interrupting mechanism) 61, and the second tension applying section (tension control mechanism) 42. The accumulator 61 interrupts transmission of a tension change occurring on the yarn supplying bobbin 21 side to prevent the tension change from being transmitted to the package 30. The second tension applying section 42 allows the tension of the yarn 20 being wound into the package 30 to be flexibly controlled.

[0060] Accordingly, the accumulator 61 can interrupt propagation of the tension change so as to prevent the tension change from affecting the winding operation on the package 30 side. With the tension change interrupted by the accumulator 61 , the second tension applying section 42 appropriately controls the tension of the yarn 20 being wound into the package 30. Thus, the tension of the yarn 20 being wound can be maintained constant. Consequently, the possible adverse effect of the tension change on the package 30 can be inhibited. A package 30 in a proper wound state can therefore be produced. Even during the yarn splicing operation, the winding operation on the package 30 side can be continuously performed. This enables a reduction in a possible loss of winding time caused by suspension of the winding operation. Therefore, production efficiency can be improved.

[0061] The winding unit 10 according to the present embodiment includes the first tension applying section (another tension control mechanism) 41 for flexibly controlling the tension applied to the yarn 20 after the yarn 20 is unwound from the yarn supplying bobbin 21 and before the yarn 20 reaches the accumulator 61.

[0062] Accordingly, the tension of the yarn 20 can be maintained constant throughout the winding operation. The tension of the yarn 20 is flexibly controlled at two

pos itions. As a result, the high-quality package 30 in the proper wound state can be formed.

[0063] Alternatively, the winding unit 10 according to the present embodiment includes the drum driving motor 53, the accumulator 61, the clearer 15, the splicer device 14, the first tension applying section 41, the second tension applying section 42, and the unit control section 50. The drum driving motor 53 rotates the package 30. The accumulator 61 allows the yarn 20 to be accumulated before the yarn 20 is wound into the package 30, and allows the accumulated yarn 20 to be drawn out to the yarn supplying bobbin 21 side. The clearer 15 detects a yarn defect. The splicer device 14 performs the yarn splicing operation. The first tension applying section 41 is located between the yarn supplying bobbin 21 and the accumulator 61. The second tension applying section 42 is located between the accumulator 61 and the package 30. The unit control section 50 controls the first tension applying section 41 and the second tension applying section 42.

[0064] In this configuration, in order to prevent a tension change that may occur at the start or the end of unwinding of the yarn from the yarn supplying bobbin 21 from affecting the winding operation on the package 30 side, the accumulator 61 interrupts the propagation of the tension change. Even if a significant tension change occurs in the yarn supplying bobbin 21 side, the yarn 20 can be continuously wound into the package 30 with the winding tension maintained constant. When a yarn defect or yarn breakage occurs or when the yarn supplying bobbin 21 is replaced with a new one, the yarn splicing operation can be performed by drawing out the yarn 20 from the accumulator 61 to the yarn supplying bobbin 21 side, while winding the yarn 20 accumulated in the accumulator 61 into the package 30. The winding operation can be continuously performed without reversely rotating the package 30. The first tension applying section 41 allows the appropriate tension to be applied to the yarn 20 before the yarn 20 is accumulated in the accumulator 61. The second tension applying section 42 allows the appropriate tension to be applied to the yarn 20 before the yarn 20 is wound into the package 30. Consequently, the winding tension can be controllably maintained constant throughout the winding operation, allowing possible yarn breakage to be effectively prevented. After a predetermined period of time elapses from the beginning of winding, the package 30 rotates at a constant winding speed. Even if for example, a yarn defect is detected, the winding is not stopped (the winding speed remains unchanged). Consequently, the tension remains unchanged. As described above, the operation of winding the yarn into the package 30 can be continuously performed under the constant state. Therefore, a high-quality package 30 in the proper wound state can be formed.

[0065] In the automatic winder according to the present embodiment, the unit control section 50 controls the second tension applying section 42 to adjust the tension applied to the yarn 20 according to the winding speed of the package 30.

[0066] Thus, even if the winding speed of the package 30 changes, for example, if the winding speed increases, the tension applied to the yarn 20 is controllably reduced to allow the winding operation to be performed with the winding tension maintained constant.

[0067] In the present embodiment, the automatic winder includes a plurality of the winding units 10 describe above. Accordingly, the automatic winder can efficiently produce high-quality packages 30.

[0068] In the above-described embodiment, after the predetermine period of time elapses from the beginning of winding, the winding is performed under the constant state with the winding speed remaining unchanged (rated speed). However, the winding speed may be changed when a yarn defect is detected or when the yarn splicing operation is performed. With reference to Figure 4, a description will be given below of an arrangement in which when a yarn defect is detected, the unit control section 50 controls the winding speed according to the amount of the accumulated yarn 20. Figure 4 is a flowchart showing the control of the winding drum 24 and the second tension applying section 42 performed to adjust the amount of yarn accumulated in the accumulator 61 when a yarn defect is detected.

[0069] In the description below of the flowchart, the phrase "sufficient amount of yarn" refers to a sufficient amount of yarn required for the yarn splicing operation performed when a yarn defect is detected or when the yarn supplying bobbin is replaced. The sufficient amount of yarn corresponds to the amount of yarn detected by the first accumulation sensor 76, which detects the maximum accumulation state of the accumulator 61. In the description below of the flowchart, a "state in which the amount of accumulated yarn is insufficient" refers to a state in which the sufficient amount of yarn required for the yarn splicing operation performed when a yarn defect is detected or when the yarn supplying bobbin replaced has not been accumulated. That is, the "state in which the amount of accumulated yarn is insufficient" corresponds to a state in which the first accumulation sensor 76 has not detected the yarn.

[0070] When the flow in Figure 4 is started, the unit control section 50 checks whether or not the amount of yarn 20 accumulated in the accumulator 61 is sufficient, based on detection values from the accumulation sensors 76 and 77 (S101). Upon determining that the amount of yarn 20 accumulated in the accumulator 61 is not sufficient, the unit control section 50 controls the drum driving motor 53 such that the rotation speed of the winding drum 24 becomes lower than a rated speed (so as to reduce the rotation speed) (S102). The tension applied to the yarn 20 by the second tension applying section 42 is increased according to the rotation speed of the winding drum 24, to maintain the winding tension constant (S103).

[0071] The yarn defect portion is removed, and the yarn splicing operation is performed to complete a yarn

defect removing operation (S104). Then, the unit control section 50 controls the accumulation sensors 76 and 77 to check whether or not the amount of yarn 20 accumulated in the accumulator 61 is sufficient (S105). If the amount of accumulated yarn 20 is sufficient, the unit control section 50 controls the drum driving motor 53 so as to return the rotation speed thereof to the speed before the yarn defect has been detected (S106). The unit control section 50 controls the second tension applying section 42 so that the second tension applying section 42 applies the tension corresponding to the rotation speed of the drum driving motor 53 (S107). The unit control section 50 then terminates the flow.

[0072] On other hand, upon determining in S101 that the amount of accumulated yarn 20 is sufficient, the unit control section 50 proceeds directly to the yarn defect removing operation (S108) without controlling the rotation speed of the winding drum 24 and the tension applied by the second tension applying section 42.

Once the yarn defect removing operation is completed, the unit control section 50 terminates the flow for yarn defect detection.

[0073] As described above, the automatic winder that performs the control shown in Figure 4 includes the first accumulation sensor 76 and the second accumulation sensor 77, which detect the amount of yarn 20 accumulated in the accumulator 61. The unit control controls 50 controls the winding speed of the package 30 according to the yarn amount. The unit control section 50 further controls the second tension applying section 42 to adjust the tension applied to the yarn 20 according to the winding speed of the package 30.

[0074] The winding speed of the package 30 can be changed so as to allow an appropriate amount of yarn 20 to be accumulated in the accumulator 61. When a yarn defect or yarn breakage occurs or the yarn supplying bobbin 21 is replaced, if only a small amount of yarn 20 is accumulated in the accumulator 61, the winding speed can be controllably reduced so as to prevent the yarn accumulation amount from becoming zero. Since the second tension applying section 42 applies the tension corresponding to the winding speed to the yarn 20, the amount of yarn 20 accumulated in the accumulator 61 can be adjusted with the winding tension maintained constant.

[0075] Instead of the configuration according to the above-described embodiment, the winding speed may be automatically reduced when a yarn defect is detected and when the yarn splicing operation is performed. When a yarn defect is detected, the unit control section 50 controls the drum driving motor 53 so as to reduce the winding speed. The unit control section 50 further controls the second tension applying section 42 to increase the tension applied to the yarn 20. After the yarn defect is removed and the yarn splicing operation is performed, the unit control section 50 returns the rotation speed of the winding drum 24 to the original speed, The unit control section 50 further controls the second tension applying section 42 to reduce the applied tension according to the rotation speed of the winding drum 24. Even if only a small amount of yarn 20 is accumulated, the yarn 20 can be continuously wound into the package 30.

[0076] The winding speed may similarly be reduced when a new yarn supplying bobbin 21 is supplied. When the yarn detecting part 37 detects that the yarn 20 is exhausted, the unit control section 50 controllably reduces the winding speed and controls the second tension applying section 42 to increase the tension applied to the yarn 20 according to the reduction in winding speed. Under this state, the operation of splicing the yarn to a yarn from the newly supplied yarn supplying bobbin 21 is performed. After the yarn splicing operation is completed, the unit control section 50 controllably returns the rotation speed of the winding drum 24 to the original speed. The control unit section 50 further controls the second tension applying section 42 to reduce the applied tension according to the rotation speed of the winding drum 24.

[0077] Preferred embodiments of the present invention have been described. However, the above-described configuration may further be modified as described below.

[0078] In addition to the configuration of the above--described embodiment, the rotation of the winding drum 24 may be stopped when a given condition is met. For example, when the clearer 15 detects a yarn defect for three consecutive times, the unit control section 50 may determine that a defective yarn supplying bobbin has been supplied and stop the winding.

[0079] In the above-described embodiment, the first tension applying section 41 and the second tension applying section 42, which control the tension, are of the gate type. However, the tension control mechanism may be appropriately changed; for example, instead of the above-described gate-type, tensors of a disk type may be used. In place of the first tension applying section 41 according to the above-described embodiment, the yarn unwinding assisting device 12 may perform the tension control between the yarn supplying bobbin 21 and the accumulator 61. The control of the tension applying section may be appropriately modified within the scope of the present invention; for example, the first tension applying section 41 and the second tension applying section 42 may be cooperatively controlled during the yarn splicing operation performed when a yarn defect or the like is detected.

[0080] In the above-described embodiment, two accumulation sensors 76 and 77 are used to detect the amount of yarn accumulated in the accumulator 61. However, the method of detecting the yarn amount may be appropriately changed: for example, at least three accumulation sensors may be used.

[0081] In the above-described embodiment, two accumulation sensors 76 and 77 are used as the yarn accumulation detecting mechanism to detect the yarn accumulation amount of the accumulator 61. The unit control section 50 then controls the winding driving section (drum

driving motor) 53 according to the detected yarn accumulation amount. However, a monitor section that monitors the occurrence frequency of yarn defect removals may be provided as the yarn accumulation amount detecting mechanism so that the drum driving motor 53 is controlled based on the result of the monitoring. For example, if the monitor section detects that a yarn defect removing operation has been performed a plurality of times during a predetermined period of time, the unit control section 50 determines that the amount of yarn accumulated in the accumulator 61 is smaller than the length of the yarn wound into the package 30 until the yarn defect removing operation is completed. The unit control section 50 can then control the drum driving motor 53 to a reduced speed, Moreover, the monitor section may control the winding driving section 53 by taking into account not only the yarn defect removal but also, for example, occurrence timings of the yarn supplying bobbin replacing operation and the yarn defect removal.

[0082] In the winding unit 10 described above, the yarn supplying bobbin 21 is supplied by the magazine type supply device. However, the yarn supplying bobbin 21 may be supplied to the winding unit 10 by conveying a tray with the yarn supplying bobbin 21 set thereon, along an appropriate path.

[0083] 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 their scope.

Claims

1. Method of operating a yarn winding device (10), which winds a yarn drawn out from a replaceable yarn supplying bobbin (21) into a package (30), the yarn winding device (10) comprising:

   a tension transmission interrupting mechanism (61), which interrupts transmission of a tension change occurring on the yarn supplying bobbin (21) side to prevent the tension change from being transmitted to the package (30), and
   a tension control mechanism (42) for flexibly controlling tension of the yarn being wound into the package (30), **characterized by** keeping the tension of the yarn constant by reducing the tension of the yarn applied by the tension control mechanism (42) when the speed of the yarn increases and
   increasing the tension of the yarn applied by the tension control mechanism (42), when the speed of the yarn decreases.

2. Method according to Claim 1, **characterized by** further using another tension control mechanism (41) for flexibly controlling the tension applied to the yarn after the yarn is unwound from the yarn supplying bobbin (21) and before the yarn reaches the tension transmission interrupting mechanism (61).

3. A yarn winding device (10), which winds a yarn drawn out from a replaceable yarn supplying bobbin (21) into a package, the yarn winding device (10) comprising:

   a winding driving section (53), which rotates the package (30),
   a yarn accumulating device (61), which accumulates the yarn before the yarn is wound into the package (30) and allows the accumulated yarn to be drawn out to the yarn supplying bobbin (21) side,
   a yarn defect detecting section (15), which detects a yarn defect,
   a yarn splicing section (14), which performs a yarn splicing operation,
   a first tension control mechanism (41) located between the yarn supplying bobbin (21) and the yarn accumulating device (61),
   a second tension control mechanism (42) located between the yarn accumulating device (61) and the package (30), and
   characterized by a control section (50), which controls the first tension control mechanism (41) and the second tension control mechanism (42) to keep the tension of the yarn constant by reducing the tension of the yarn applied by each of the tension control mechanism (41, 42) when the speed of the yarn increases and
   increasing the tension of the yarn applied by each of the tension control mechanism (41, 42) when the speed of the yarn decreases.

4. The yarn winding device (10) according to Claim 3, **characterized by** further comprising a yarn accumulation amount detecting mechanism (76, 77) for detecting an amount of yarn accumulated in the yarn accumulating device (61),
   and in that the control section (50) changes the winding speed of the package according to the amount of yarn accumulated in the yarn accumulating device (61),
   and controls the second tension control mechanism (42) to adjust the tension applied to the yarn according to the changed winding speed.

5. An automatic winder **characterized by** comprising a plurality of the yarn winding devices (10) according to any one of Claims 3 to 4.

FIGURE 1

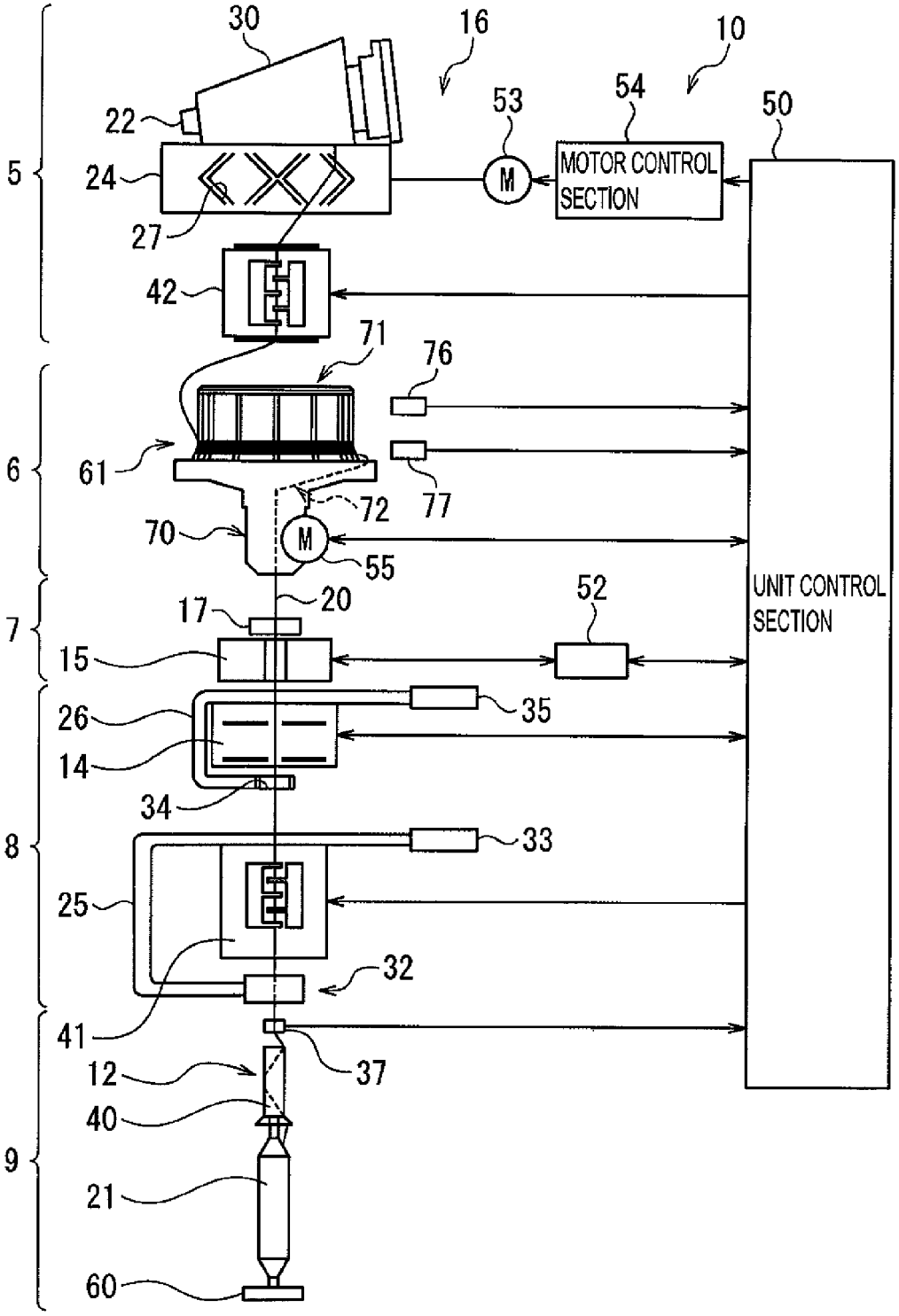

30
16
10
22
53
54
50
5
24
M
MOTOR CONTROL SECTION
27
42
71
76
6
61
72
77
70
M
55
UNIT CONTROL SECTION
7
17
20
52
15
26
35
14
34
8
33
25
32
41
37
12
40
9
21
60

FIGURE 2

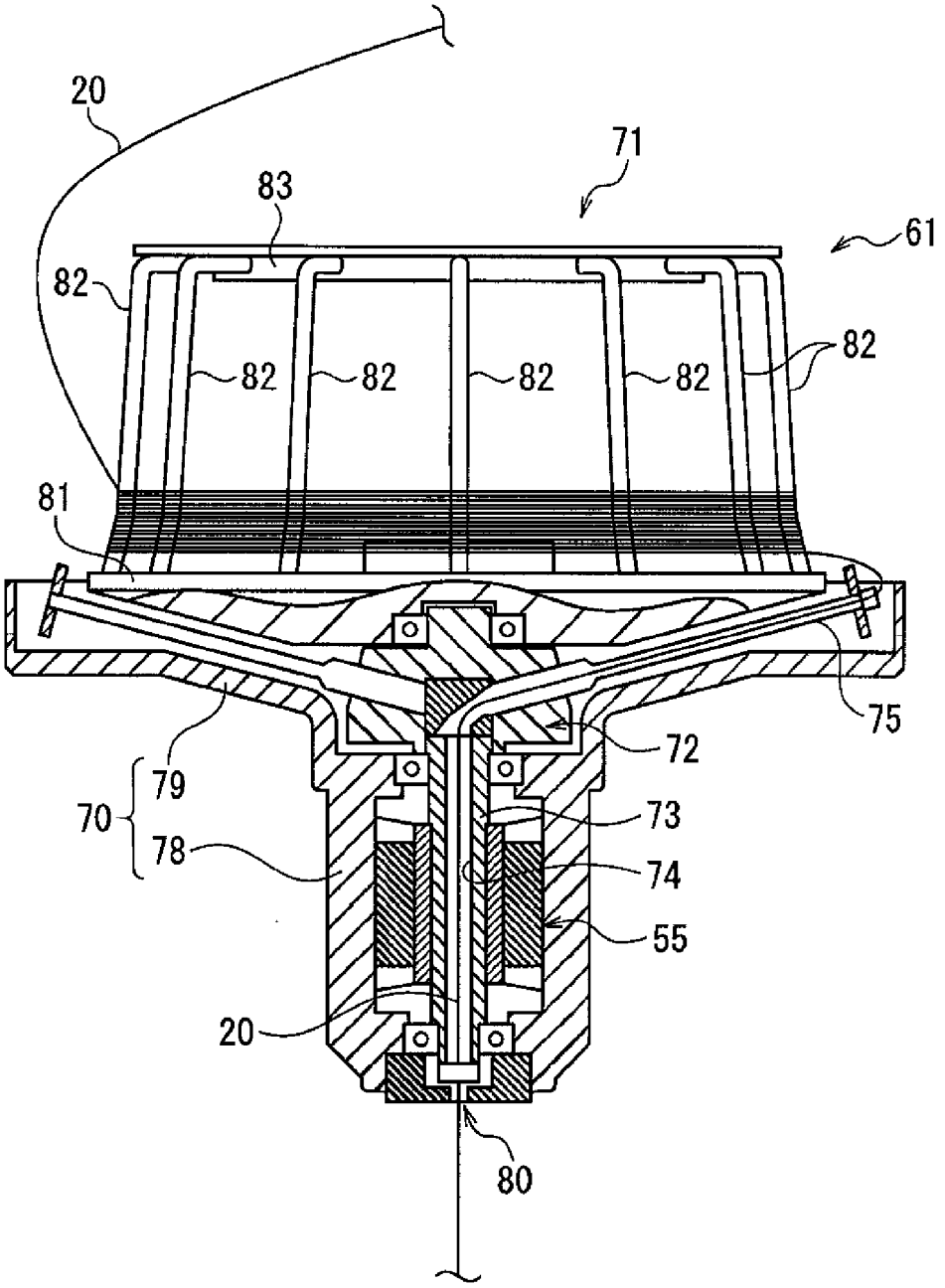


FIGURE 3

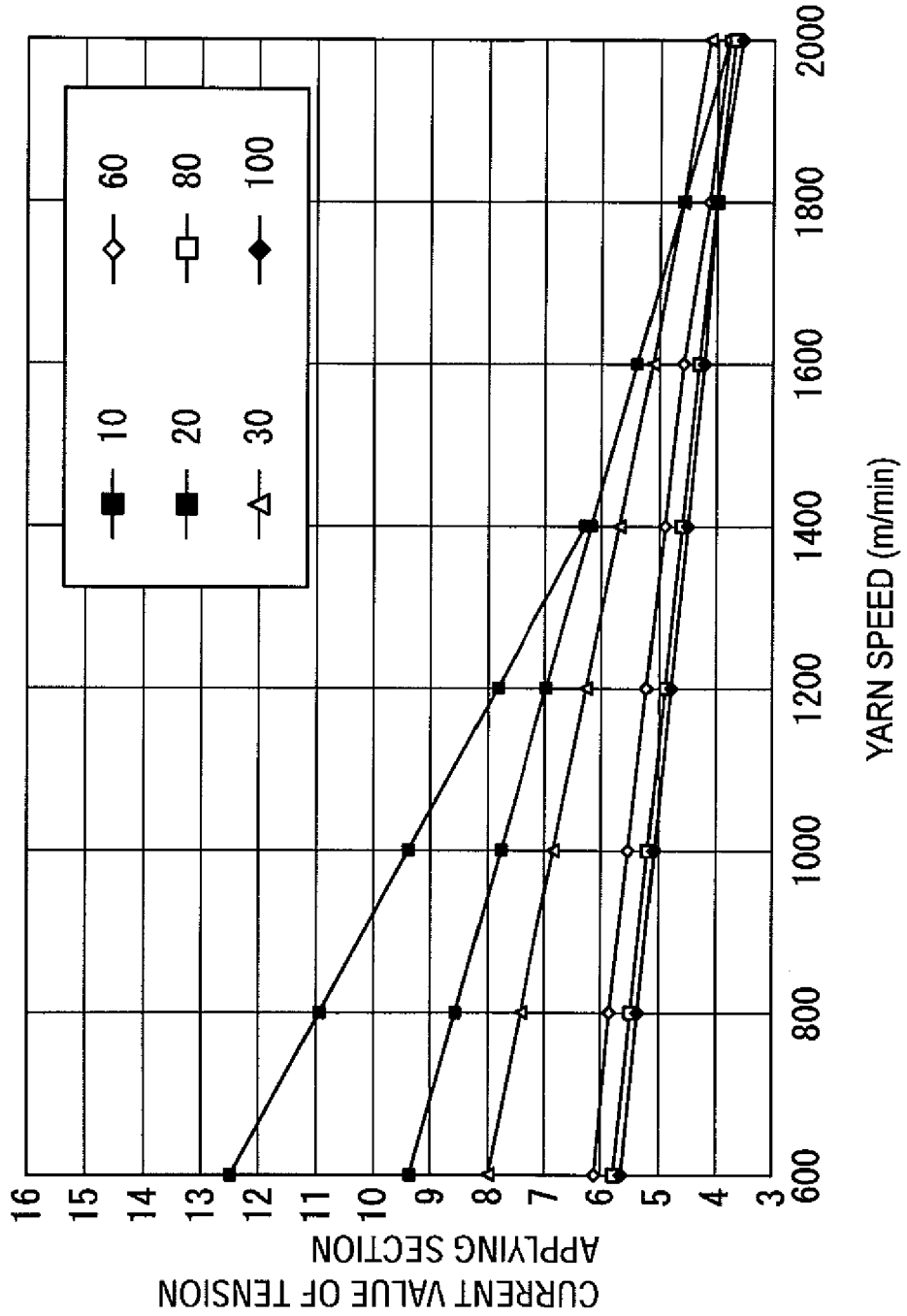
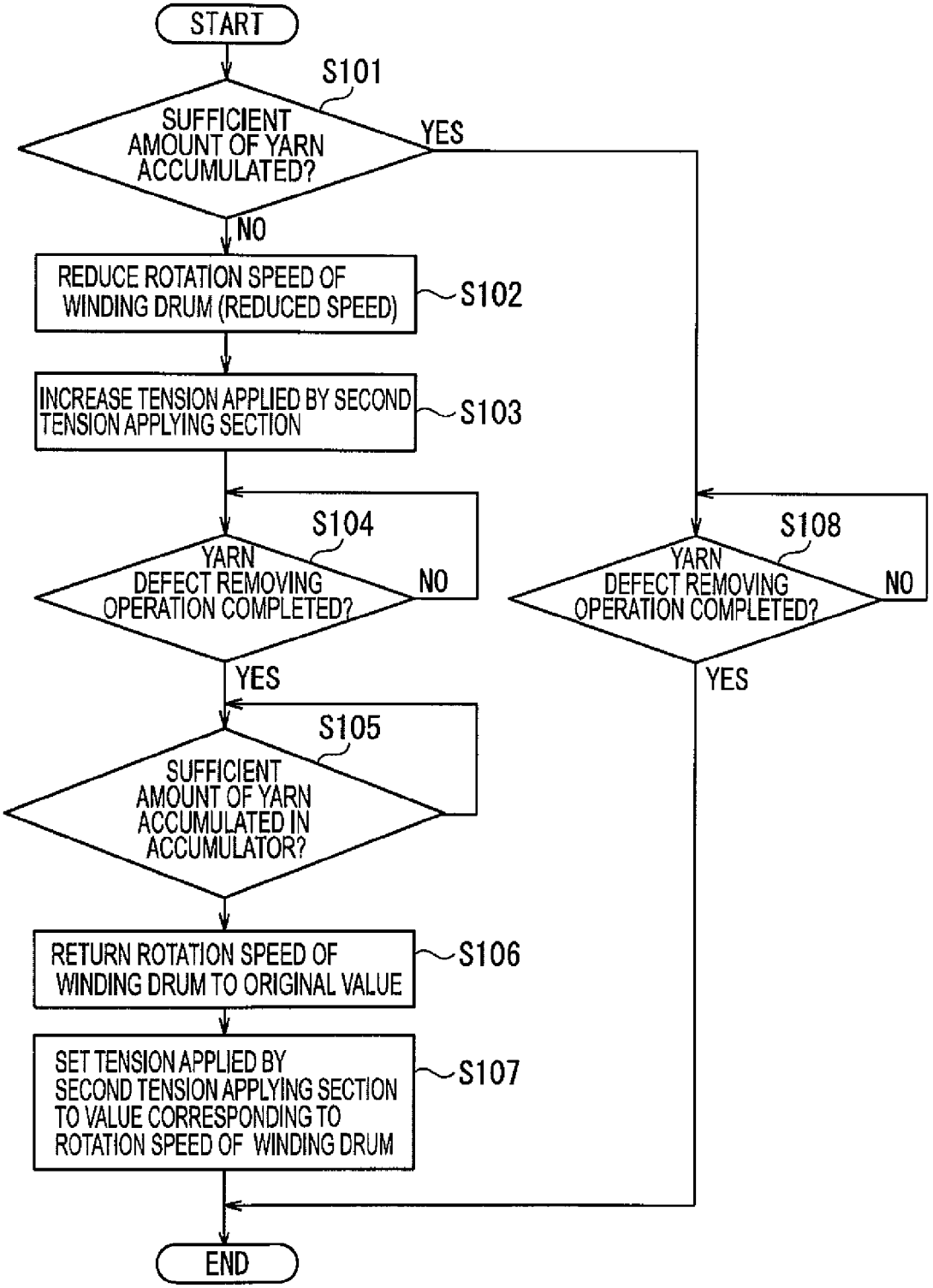

CURRENT VALUE OF TENSION APPLYING SECTION
16
15
14
13
12
11
10
9
8
7
6
5
4
3
600
800
1000
1200
1400
1600
1800
2000
YARN SPEED (m/min)
10
20
30
60
80
100

FIGURE 4


START
S101
SUFFICIENT AMOUNT OF YARN ACCUMULATED?
YES
NO
REDUCE ROTATION SPEED OF WINDING DRUM (REDUCED SPEED)
S102
INCREASE TENSION APPLIED BY SECOND TENSION APPLYING SECTION
S103
S104
YARN DEFECT REMOVING OPERATION COMPLETED?
NO
YES
S105
SUFFICIENT AMOUNT OF YARN ACCUMULATED IN ACCUMULATOR?
RETURN ROTATION SPEED OF WINDING DRUM TO ORIGINAL VALUE
S106
SET TENSION APPLIED BY SECOND TENSION APPLYING SECTION TO VALUE CORRESPONDING TO ROTATION SPEED OF WINDING DRUM
S107
S108
YARN DEFECT REMOVING OPERATION COMPLETED?
NO
YES
END

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EUROPEAN SEARCH REPORT

Application Number
EP 12 17 6221

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B65H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	17 August 2012	Pussemier, Bart

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1

EPO FORM 1503 03.82 (P04C01)

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