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(71) Applicant: **Murata Machinery, Ltd.**
Kyoto-shi, Kyoto 601-8326 (JP)

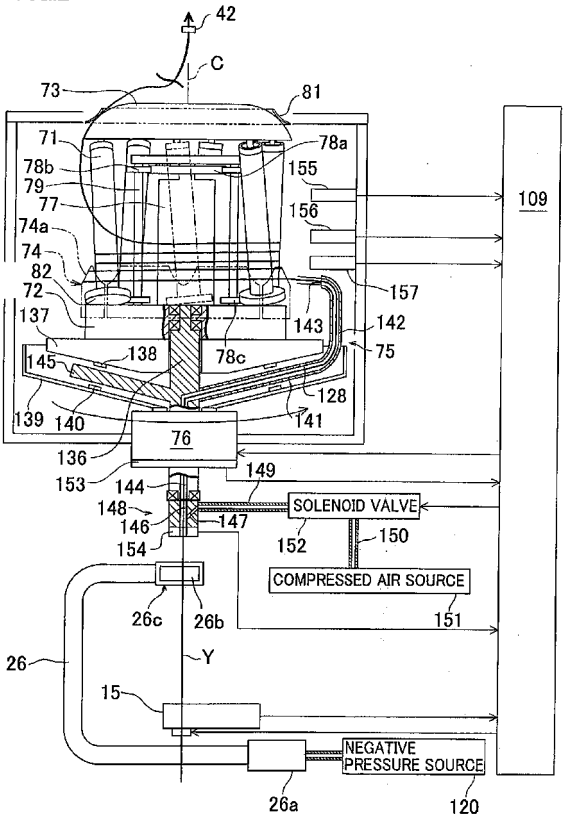
(72) Inventors:
- **KINO, Yoshihiro**
  Kyoto-shi
  Kyoto 612-8686 (JP)
- **FUKUDA, Isao**
  Kyoto-shi
  Kyoto 612-8686 (JP)

(74) Representative: **Vogeser, Werner**
Hansmann & Vogeser
Patent- und Rechtsanwälte
Maximilianstrasse 4b
82319 Starnberg (DE)

(54) YARN WINDER

(57) In an yarn winder, a yarn is seamlessly wound without interruption. An accumulator 61 is provided with six rollers 71 that are provided on a circle and are inclined with respect to the vertical direction. As a winding arm 75 rotates around the six rollers 71, the yarn is wound onto the lower end portions of the rollers 71. As the winding arm 75 rotates in the opposite direction, the yarn Y wound on the rollers 71 is drawn out. The yarn Y wound on the rollers 71 is transported upward by five drive rollers 71a to 71e out of the six rollers 71. The remaining one adjusting roller 71f is a driven roller and is arranged so that the upper end portion thereof is inclined with respect to the vertical direction to be on a virtual circle A3 which is outside the virtual circle A1 on which the upper end portions of the other rollers 71a to 71e are positioned. With this, the circumferential length of the yarn Y wound on the rollers 71 is kept constant.

FIG.2



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Description

Technical Field

[0001] The present invention relates to a yarn winder (yarn winding device) which winds yarn unwound from a yarn supplying bobbin so as to form a package.

Background Art

[0002] A yarn produced by using a spinning machine or the like is wound onto a yarn supplying bobbin and transported to a yarn winder. The yarn winder joints, by using a predetermined yarn jointing device, transported yarns of a plurality of yarn supplying bobbins with one another, so as to form a package with a predetermined length. A known yarn winder having such a yarn jointing device is typically arranged to include a suction arm which catches the yarn end on the winding bobbin side and guides the yarn to the yarn jointing device and a relay pipe which catches the yarn end on the yarn supplying bobbin side and guides the yarn to the yarn jointing device.

[0003] When yarn breakage, yarn cutting or the like occurs in this yarn winder during a winding operation, the upper yarn is wound onto the winding bobbin rotating by inertia whereas the lower yarn is retained by a suitable trapping means. Then a yarn jointing operation is carried out as below. That is, the winding bobbin having stopped the rotation is reverse-rotated, the end of the upper yarn to be unwound is sucked and caught by the leading end of the suction arm, and this yarn is guided to the yarn jointing device. Almost at the same time, the end of the lower yarn retained by the trapping means is sucked and caught by the leading end of the relay pipe, with the result that the lower yarn is unwound from the yarn supplying bobbin and guided to the yarn jointing device. Thereafter, the ends of the upper yarn and the lower yarn are jointed with each other by the yarn jointing device, and the winding operation starts.

[0004] On the other hand, when the yarn of the yarn supplying bobbin is completely wound onto the winding bobbin and a new yarn supplying bobbin is supplied, the winding bobbin having stopped the rotation is reverse-rotated, the end of the upper yarn to be unwound is sucked and caught by the leading end of the suction arm, and the yarn is guided to the yarn jointing device. Almost at the same time, the yarn (lower yarn) on the new yarn supplying bobbin is blown up by an airflow and is sucked and caught by the leading end of the relay pipe, and then the lower yarn is unwound and guided to the yarn jointing device. Thereafter, the ends of the upper yarn and the lower yarn are jointed with each other by the yarn jointing device, and the winding operation is resumed.

[0005] It is noted that the winding bobbin is stopped as above by a lift-up mechanism and a package braking mechanism of the yarn winder. The lift-up mechanism moves up a cradle so as to move the winding bobbin away from a winding driving unit. The package braking mechanism stops the rotation of the winding bobbin supported by the cradle, at the same time as the cradle is moved up by the lift-up mechanism. The rotation of the winding bobbin is stopped in this way, and the winding operation is discontinued.

[0006] In the meantime, even though an object is different from the yarn winder above, a winder for generating a single package from packages of a plurality of colors is recited in Patent Literature 1. The winder recited in Patent Literature 1 is arranged so that a wound yarn package is formed by serially winding different types or colors of yarns while measuring a predetermined length in each yarn in the longitudinal direction of the yarns. More specifically, the winder selects, by a selection device, at least one yarn from packages of different colors or of different yarn types, joints yarns by the yarn jointing device, and seamlessly forms a package by a yarn storage device which measures and stores the yarns at the same time.

[0007] In addition to the above, Patent Literature 2 recites a yarn winding method and device that make it possible to continue winding without interruption even at the time of yarn breakage. The device recited in Patent Literature 2 is arranged so that a yarn unwound from a bobbin is stored, and the winding is continued at the time of yarn breakage by using the stored yarn until the yarn jointing operation is completed.

Citation List

Patent Literatures

[0008]

Patent Literature 1: Japanese Unexamined Patent Publication No. 2004-156186
Patent Literature 2: Specification of U.S. Patent No. 3314621

Summary of Invention

Technical Problem

[0009] Increase in the winding speed for forming a package has been demanded to improve the production efficiency. Such increase in the winding speed, however, overtaxes the running yarn, with the result that yarn breakage frequently occurs. At the time of yarn breakage, it is necessary to pull out the yarn from the package and joint the same with the yarn on the yarn supplying bobbin side. In this regard, when reverse-rotating the package and catching the yarn on the package side in the yarn jointing operation, the sucking force of the suction arm may pull the surface of the package and disrupt the alignment of the wound yarn. Furthermore, because the winding is interrupted by the reverse rotation of the package in the yarn jointing operation, simply increasing the winding speed does not always result in the improvement in

the production efficiency. Furthermore, since a routine of abruptly stopping the package rotating at a high speed and regaining the same high rotation speed after the yarn jointing operation is carried out each time the winding operation is discontinued, the power consumption is high.

[0010] In this regard, the wound yarn package of Patent Document 1 is arranged so that yarn winding without interruption is achieved on account of a storage section of the yarn. The winder of Patent Document 1, however, is arranged to form a package from a plurality of packages formed by a yarn winder having a yarn defect removal mechanism. The latter packages are the target of the present invention, and hence the winder of Patent Document 1 does not have any mechanism of removing yarn defects. For this reason, a defect of a yarn is wound from a yarn supplying bobbin onto a package. Furthermore, the structure of the yarn jointing device makes it difficult to remove such a yarn defect.

[0011] In the meanwhile, the yarn winding method and device recited in Patent Document 2 are arranged so that the formation of a package is continued even if yarn breakage occurs, thanks to a storage container for storing a yarn. It is important in this yarn winding method and device to efficiently remove a defect and joint yarns before the yarn stored for continuing the formation of the package runs out, when yarn breakage occurs or defect removal is needed. In this regard, Patent Document 2 does not include any specific descriptions concerning the yarn jointing and defect removal while continuing package formation. Furthermore, since no mechanism for aligning and storing a yarn is included, yarn entanglement may occur.

[0012] The present invention was done to solve the problems above, and an object of the present invention is to provide a yarn winder which can wind a yarn without interruption from the start to the end of the formation of a package.

Solution to Problem

[0013] A yarn winder according to the first aspect of the invention includes: a yarn supplying portion which unwinds a yarn from a yarn supplying bobbin; a yarn winding section which winds the yarn to form a package; and a yarn storage section which is provided between the yarn supplying portion and the yarn winding section and stores the yarn, the yarn storage section including: a yarn storage which stores the yarn as the yarn is wound thereon; and a yarn winding mechanism which winds the yarn onto the yarn storage, and the yarn storage is constituted by a plurality of rollers each of which is rotatable and has a rotation axis on a first virtual circle.

[0014] According to this arrangement, since the yarn wound on the rollers moves upward by being transported by the rollers, the load (friction force) on the yarn is small when moving upward and hence the deterioration of the quality of the yarn is avoided. Furthermore, since the yarn is orderly stored as being wound on the rollers by the yarn winding mechanism, the yarn is not entangled in the yarn storage section and hence the winding of the yarn is not interrupted.

[0015] According to the second aspect, the yarn winder of the first aspect is further arranged so that the yarn storage section further includes: a roller drive motor which rotates at least one of the plurality of rollers as a drive roller, and because the rotation axis of each of the plurality of rollers is arranged to be inclined in a circumferential direction of the first virtual circle, the yarn wound on the plurality of rollers is transported in a unwinding direction in which the yarn is unwound by the yarn winding section.

[0016] According to this arrangement, since the rollers on which the yarn is wound are arranged to be inclined in a circumferential direction of the first virtual circle, the yarn wound on the rollers by the yarn winding mechanism is continuously transported by the rotation of the drive roller and moves in a direction (hereinafter, transportation direction) orthogonal to the plane surrounded by the first virtual circle. This prevents the yarn from remaining at a part of the yarn storage and the operation to store the yarn from being stagnated.

[0017] According to the third aspect, the yarn winder of the second aspect is further arranged so that the yarn storage section further includes a winding intervals changing means which changes winding intervals of the yarn wound on the plurality of rollers.

[0018] This makes it possible to change the winding intervals (distance in the transportation direction) of the yarn wound onto the rollers, in accordance with, for example, the type of the yarn wound by the yarn winder.

[0019] According to the fourth aspect, the yarn winder of the third aspect is further arranged so that the winding intervals changing means includes an angle change mechanism that changes an inclination angle of each of the plurality of rollers in the circumferential direction of the first virtual circle.

[0020] According to this arrangement, the traveling speed of the yarn in the transportation direction is changeable by changing the inclination angle of the rollers, and this makes it possible to change the ratio between the winding speed of the yarn and the traveling speed of the yarn in the transportation direction. With this, the winding intervals of the yarn are changeable by changing the ratio between the winding speed of the yarn and the traveling speed of the yarn in the transportation direction.

[0021] According to the fifth aspect, the yarn winder of the fourth aspect is further arranged so that the angle change mechanism is a mechanism that moves at least one end portion of each of the plurality of rollers in the circumferential direction of the first virtual circle.

[0022] According to this arrangement, the inclination angle of the rollers is easily changeable by moving at least one end portions of the rollers in a circumferential direction of the first virtual circle.

[0023] According to the sixth aspect, the yarn winder

of fourth or fifth aspect is further arranged so that the yarn winding mechanism is arranged to wind the yarn onto a winding-side end portion which is one end portion of each of the plurality of rollers, the winding-side end portion of each of the plurality of rollers is positioned on the first virtual circle, and an unwinding-side end portion which is the other end portion of each of rollers that are more than half of the plurality of rollers is positioned with reference to a second virtual circle having a shorter diameter than the first virtual circle, with the result that said more than half of the plurality of rollers are inclined in a radial direction of the first virtual circle.

[0024] When a roller is inclined in a circumferential direction of the first virtual circle, the central part of the roller is at the innermost position whereas the respective end portions are at the outermost positions, provided that the rollers are not inclined in a radial direction. For this reason, the circumferential length of the yarn is shortest at the central portions of the rollers and the length increases toward the end portions. In the meanwhile, when a yarn is transported by rollers, it is difficult to transport a portion of the yarn to another portion which is outside said portion.

[0025] Because of the above, on each roller, the range where the yarn is actually wound is substantially limited to a range between one of the end portions where the yarn is wound by the yarn winding means and the innermost part of the roller. In short, the range where the yarn can be wound is limited to abut a half of the roller.

[0026] In this regard, since in the present invention each roller is inclined such that the end opposite to the end where the yarn is wound by the yarn winding means is positioned to be inside the end where yarn is wound by the yarn winding means, the innermost part of the roller is closer to the aforesaid opposite end from the central portion. This widens the range where the yarn can be wound on the roller, with the result that the amount of the yarn stored in the yarn storage section is increased.

[0027] In addition to the above, since the winding-side end portion and the unwinding-side end portion of each of the more than half of the rollers are positioned with reference to the first and second virtual circles, these rollers are uniformly inclined at the same angle.

[0028] In addition to the above, since the unwinding-side end portion is positioned with reference to the second virtual circle which is short in diameter than the first virtual circle on which the winding-side end portion is provided, the circumferential length of the yarn wound on the rollers does not increase in the unwinding direction in which the yarn is unwound by the yarn winding section. This prevents the yarn from remaining at a part of the roller and the operation to store the yarn from being stagnated.

[0029] According to the seventh aspect, the yarn winder of the sixth aspect is further arranged so that at least one of rollers that are not said more than half of the plurality of rollers is an adjusting roller for adjusting a circumferential length of the wound yarn and that the unwinding-side end of the adjusting roller is positioned with reference to a third virtual circle having a longer diameter than the first virtual circle.

[0030] When no adjusting roller is provided, the roller is inclined outward toward the yarn winding-side end portion, in the range where the yarn can be wound. The yarn transported by the rollers is therefore transported from a part where the circumferential length of the wound yarn is long to a part where the circumferential length of the wound yarn is short, with the result that the yarn may be loosen.

[0031] In this regard, since in the present invention the adjusting roller is arranged so that the end opposite to the end where the yarn is wound by the yarn winding means is positioned with reference to the third virtual circle, the length of the yarn is uniform at all parts of the rollers, thereby preventing the occurrence of the loosening of the yarn as above.

[0032] According to the eighth aspect, the yarn winder of the seventh aspect is further arranged so that the adjusting roller is a driven roller.

[0033] In regard to this arrangement, when the roller drive motor rotates the adjusting roller along with the other rollers, the direction to transport the yarn by the adjusting roller is different from the direction to transport the yarn by the other rollers on account of a difference in the inclination angle with respect to the first and second virtual circles, and hence the tension on the wound yarn may not be uniform.

[0034] In this connection, since in the present invention the adjusting roller is a driven roller and the adjusting roller is merely rotated by the movement of the yarn at the time of the transportation of the yarn by the rotation of the other rollers, it is possible to keep the tension on the wound yarn to be uniform.

[0035] According to the ninth aspect, the yarn winder of any of the first to eighth aspects is arranged to further include: a guide member which is arranged to be rotatable around the plurality of rollers and guides the yarn on the plurality of rollers; and a guide member drive motor that rotates the guide member, the yarn winding mechanism being constituted by the guide member and the guide member drive motor.

[0036] According to this arrangement, the yarn winding mechanism is constituted by the guide member and the guide member drive motor.

[0037] According to the tenth aspect, the yarn winder of any one of third to eights aspects further includes: a guide member which is arranged to be rotatable around the plurality of rollers and guides the yarn on the plurality of rollers, the guide member being driven by the roller drive motor as being connected to the roller drive motor via a transmission mechanism, and the yarn winding mechanism being constituted by the guide member and the roller drive motor.

[0038] According to this arrangement, since the guide member drive motor rotating the guide member functions also as a roller drive motor rotating the rollers, it is un-

necessary to provide the guide member drive motor and the roller drive motor to be independent from each other, and hence the device configuration is simplified.

[0039] According to the eleventh aspect, the yarn winder of the tenth aspect is further arranged so that the winding intervals changing means is provided in the transmission mechanism to constitute a speed change mechanism capable of changing a ratio between a rotation speed of the roller drive motor and a rotation speed of the drive roller.

[0040] According to this arrangement, the ratio between the rotation speed of the guide member and the rotation speed of the drive roller (i.e., the transportation speed of the yarn in the aforesaid transportation direction) is changeable by changing the ratio between the rotation speed of the guide member drive motor and the rotation speed of the drive roller by the speed change mechanism, thereby making it possible to change the winding intervals of the yarn.

[0041] According to the twelfth aspect, the yarn winder according to any one of third to eighth aspects further includes: a guide member which is arranged to be rotatable around the plurality of rollers and guides the yarn on the plurality of rollers; and a guide member drive motor that rotates the guide member, the guide member and the guide member drive motor constituting the yarn winding mechanism, and the winding intervals changing means including a speed control mechanism which individually controls a rotation speed of the roller drive motor and a rotation speed of the guide member drive motor.

[0042] According to this arrangement, the rotation speed of the guide member and the rotation speed of the drive roller (i.e., the transportation speed of the yarn in the aforesaid transportation direction) is changeable by individually controlling the rotation speed of the roller drive motor and the rotation speed of the guide member drive motor, thereby making possible to change the winding intervals of the yarn.

[0043] According to the thirteenth aspect, the yarn winder of any one of the ninth to twelfth aspects is further arranged so that the yarn storage section further includes: a yarn drawing mechanism which draws out, toward the yarn supplying portion, the yarn wound on the plurality of rollers.

[0044] According to this arrangement, since the yarn storage section is provided between the yarn supplying portion and the yarn winding section, it is possible to carry out the yarn jointing while the yarn winding section winds the yarn stored in the yarn storage section, and hence the yarn winding operation is continuously done without interruption.

[0045] According to the fourteenth aspect, the yarn winder of the thirteenth aspect is further arranged so that the guide member drive motor is capable of rotating the guide member in both directions, and the yarn drawing mechanism is constituted by the guide member and one of the guide member drive motor and the roller drive motor.

[0046] According to this arrangement, since the yarn drawing mechanism is constituted by the guide member and one of the guide member drive motor and the roller drive motor constituting the yarn winding mechanism, it is unnecessary to provide the yarn drawing mechanism to be independent from the yarn winding mechanism, and hence the device configuration is simplified.

[0047] According to the fifteenth aspect, the yarn winder according to any one of first to fourteenth aspects is further arranged so that the guide member drive motor is capable of rotating the guide member in both directions, and the yarn drawing mechanism is constituted by the guide member and one of the guide member drive motor and the roller drive motor.

[0048] According to this arrangement, since the transmission of the tension of the yarn is blocked by providing the yarn storage section between the yarn supplying bobbin and the winding section, it is possible to prevent a tension change due to the traversal of the winding section from being transferred to the unwinding tension part of the yarn supplying bobbin. Furthermore, since the yarn unwinding from the yarn supplying bobbin is stably performed because the unwinding assist unit is attached to the yarn supplying bobbin, it is possible to prevent yarn breakage and to increase the speed of unwinding from the yarn supplying bobbin. The efficiency in the unwinding from the yarn supplying bobbin is therefore improved.

Effects

[0049] According to the present invention, since the yarn wound on a plurality of rollers is transported by the rotation of the rollers, the load (friction force) on the yarn is small and hence the quality degradation of the yarn is avoided. Furthermore, since the yarn is orderly stored as being wound on the rollers by the yarn winding mechanism, the yarn is not entangled in the yarn storage section and hence the winding of the yarn is not interrupted.

Brief Description of Drawings

[0050]

[Fig. 1] Fig. 1 is a schematic view of a winding unit according to an embodiment of the present invention.

[Fig. 2] Fig. 2 is a schematic view of the accumulator of Fig. 1.

[Fig. 3] Fig. 3 is a plan view showing the arrangement of the rollers of Fig. 2, wherein Fig. 3(a) shows the upper end portions of the rollers, Fig. 3(b) shows the lower end portions of the rollers, and Fig. 3 (c) shows the central parts of the rollers.

[Fig. 4] Fig. 4 is a functional block diagram of the controller of Fig. 1.

[Fig. 5] Fig. 5 is a flowchart showing the operation of the yarn winder.

[Fig. 6] Fig. 6 shows how a yarn is conveyed by rollers.

[Fig. 7] Fig. 7 shows a control flow indicating the op-

eration at the time of yarn breakage.

[Fig. 8] Fig. 8 shows a control flow indicating the operation at the time of the occurrence of yarn defect.

[Fig. 9] Fig. 9 shows a control flow indicating the operation at the time of bobbin change.

Description of Embodiments

[0051] The following will describe a preferred embodiment of the present invention.

[0052] Fig. 1 schematically shows winding units constituting an automatic winder of the present embodiment. The automatic winder is constituted by a plurality of winding units 2 (yarn winder) that are aligned in the crosswise directions of the plane of Fig. 1. Each winding unit 2 includes a yarn supplying portion 5, a winding section 6, a yarn defect detection section 7, a yarn jointing section 8, and a yarn storage section 9.

[0053] The yarn supplying portion 5 includes a yarn supplying bobbin supporter 60 that supports a yarn supplying bobbin 21, a yarn unwinding assisting device 12, and a first tensor 41. The yarn supplying portion 5 is further provided with an unillustrated bobbin supplier which supplies a new yarn supplying bobbin 21 to the yarn supplying bobbin supporter 60. Examples of the bobbin supplier include magazine-type suppliers and tray-type suppliers. When a yarn Y (hereinafter, yarn Y) is fully drawn out from a yarn supplying bobbin 21 set in the winding unit 10, the yarn supplying portion 5 ejects an empty bobbin supported by the yarn supplying bobbin supporter 60, and the bobbin supplier supplies a new yarn supplying bobbin 21 to the yarn supplying bobbin supporter 60 one by one.

[0054] The yarn unwinding assisting device 12 assists the unwinding of the yarn Y from the yarn supplying bobbin 21 by moving down a regulator 40 covering the core tube of the yarn supplying bobbin 21 in sync with the unwinding of the yarn Y from the yarn supplying bobbin 21. The regulator 40 contacts a balloon formed at an upper part of the yarn supplying bobbin 21 on account of the rotation of the yarn Y unwound from the yarn supplying bobbin 21 and a centrifugal force, so as to impart an appropriate tension to the balloon and assist the unwinding of the yarn Y. In an area below the regulator 40 is provided an unillustrated sensor for detecting a chase section of the yarn supplying bobbin 21. As the sensor detects that the chase section is moving down, the regulator 40 is accordingly moved down by, for example, an unillustrated air cylinder.

[0055] Around a yarn unwinding assisting device 12 is provided a yarn detector 37 that can detect the existence of a yarn Y. This yarn detector 37 is arranged to detect that the yarn Y is no longer drawn out from the yarn supplying bobbin 21 and to send an empty bobbin signal to the controller 109.

[0056] The first tensor 41 imparts a predetermined tension to a running yarn Y. An example of this first tensor 41 is a gate-type tensor having fixed comb teeth and movable comb teeth. The movable comb teeth are rotatable by an unillustrated rotary solenoid so that the two sets of teeth are engaged or disengaged. The first tensor 41 imparts a constant tension to the yarn Y stored in the later-described accumulator 61, and hence the yarn Y is neatly wound and stored in the accumulator 61.

[0057] The winding section 6 includes an unillustrated cradle arranged to be able to retain the winding bobbin 22, a winding drum 24 which is used for allowing the yarn Y to conduct traversal and for rotating the winding bobbin 22, and a second tensor 42. The cradle is arranged to be able to swing in directions approaching and moving away from the winding drum 24. This allows the package 30 to contact or move away from the winding drum 24. Furthermore, as shown in Fig. 1, on the outer circumference of the winding drum 24 is formed a spiral traversing groove 27 to cause the yarn Y to perform traversal.

[0058] The winding drum 24 rotates to drive the winding bobbin 22 which is provided to oppose the winding drum 24. This winding drum 24 is connected to the output axis of a winding drum motor 116 (see Fig. 4). This winding drum motor 116 is turned on or off by a drive signal supplied from the controller 109.

[0059] The second tensor 42 is provided for controlling the tension of the yarn Y when the yarn Y unwound from the later-described accumulator 61 of the yarn storage section 9 is wound onto the package 30. As a result, the yarn Y drawn out from the accumulator 61 is wound onto the winding bobbin 22 while a suitable tension is imparted thereto. An example of the second tensor 42 is, as in the case of the first tensor 41, a gate-type tensor having fixed comb teeth and movable comb teeth.

[0060] In addition to the above, on the downstream of the second tensor 42 is provided a waxing device 17 which waxes on a running yarn Y. On the downstream of the waxing device 17 is provided an unillustrated sucking section. This sucking section is connected to a suitable negative pressure source, and can suck and remove dregs of wax and yarn.

[0061] The yarn defect detection section 7 is provided with a yarn clearer 15 that detects a yarn defect. The yarn clearer 15 is arranged to detect a defect by monitoring the thickness of the yarn Y by an appropriate sensor. As a signal is supplied from the sensor of the yarn clearer 15, yarn defects such as slags and foreign matters are detected. In addition to this, the yarn clearer 15 is able to function as a sensor merely detecting the existence of the yarn Y. The yarn clearer 15 is provided with a cutter for cutting, when a yarn defect is detected, the yarn on the upstream of the yarn defect.

[0062] The yarn jointing section 8 includes a splicer 14 performing the yarn jointing operation, a lower yarn guide pipe 25, and an upper yarn guide pipe 26.

[0063] The splicer 14 joints the lower yarn on the yarn supplying bobbin 21 side with the upper yarn on the package 30 side, at the time of yarn breakage, the occurrence of a yarn defect, or bobbin change. Examples of the splicer 14 include a mechanical splicer and a splicer using a

fluid such as compressed air.

[0064] The lower yarn guide pipe 25 is supported to be rotatable about an axis 25a below the splicer 14, and is rotated by a lower pipe motor 122 (see Fig. 4). At the leading end of the lower yarn guide pipe 25 is provided a suction port 25b, and this suction port 25b is provided with an unillustrated clamping section. Furthermore, the lower yarn guide pipe 25 receives a negative pressure from an unillustrated negative pressure source, with the result that a suction flow for sucking the yarn Y is generated at the suction port 25b.

[0065] The upper yarn guide pipe 26 is supported to be rotatable about an axis 26a above the splicer 14, and is rotated by an upper pipe motor 121 (see Fig. 4). At the leading end of the upper yarn guide pipe 26 is provided a suction port 26b, and this suction port 26b is provided with a clamping section 26c (see Fig. 2). Furthermore, the upper yarn guide pipe 26 receives a negative pressure from a negative pressure source 120 (see Fig. 2), and hence a suction flow for sucking the yarn Y is generated at the suction port 26b.

[0066] The yarn storage section 9 is provided with the accumulator 61 which stores the yarn Y before being wound onto the package 30. Fig. 2 is a schematic view of the accumulator 61. Fig. 3 is a plan view showing the arrangement of the rollers of Fig. 2, wherein Fig. 3(a) shows the upper end portions of the rollers, Fig. 3(b) shows the lower end portions of the rollers, and Fig. 3 (c) shows the central parts of the rollers. In Fig. 3(a), the lower end portions of the rollers 71 are indicated by dotted lines in order to clarify in which direction the later-described rollers 71 incline as described below.

[0067] As shown in Fig. 2 and Fig. 3, the accumulator 61 includes components such as six rollers 71, a base 72, a rotation plate 73, three winding assist members 74, a winding arm 75, a winding arm motor 76, a speed reducer 77, pulleys 78a to 78c, and a shaft 79.

[0068] The base 72 is a substantially circular plate and supported at the leading end (upper end) of the output shaft 136 of the winding arm motor 76 via an unillustrated bearing. The rotation of the base 72 with respect to the winding arm motor 76 is regulated by the magnetic coupling strength between a magnet 138 adhered to a first magnet supporter 137 fixed to the lower surface of the base 72 and a magnet 140 adhered to a second magnet supporter 139 of the winding arm motor 76.

[0069] The six rollers 71 (yarn storages) are provided on the upper surface of the base 72 along a circle (i.e., along a later-described virtual circle), and the lower end portions (one end portions, winding-side end portions) thereof are pivoted on the upper surface of the base 72 whereas the upper end portions (other end portions, unwinding-side end portions) thereof are supported by the rotation plate 73.

[0070] The six rollers 71 are constituted by five drive rollers 71a to 71e (more than half of rollers) and a single adjusting roller 71f. As shown in Fig. 3 (a), the center of the lower end portion of each roller is on a virtual circle A1 (first virtual circle). The centers of the upper end portions of the respective drive rollers 71a to 71e are on a virtual circle A2 (second virtual circle) inside the virtual circle A1. The center of the upper end portion of the adjusting roller 71f is on a virtual circle A3 (third virtual circle) which is outside the virtual circle A1. The virtual circles A1 to A3 are concentric, and the circumferential directions of the virtual circles A1 to A3 will be referred to as virtual circumferential directions.

[0071] With the arrangement above, the drive rollers 71a to 71e are inclined such that the upper end portions (unwinding-side end portions) supported by the rotation plate 73 are inside the lower end portions (winding-side end portions) pivoted on the upper surface of the base 72. On the other hand, the adjusting roller 71f is inclined such that the upper end portion (unwinding-side end portion) is outside the lower end portion (winding-side end portion).

[0072] The rotation plate 73 (angle change mechanism, winding interval adjustment mechanism) is arranged to be rotatable about the rotation axis C of the winding arm motor 76. As the rotation plate 73 is rotated, the upper end portions of the rollers 71 supported by the rotation plate 73 move, in a virtual circle direction, for a distance equivalent to the same central angle. As the upper end portions of the rollers 71 move in the virtual circle direction by the rotation of the rotation plate 73, the rollers 71 are inclined in a virtual circle direction as shown in Fig. 2 and Fig. 3. The rollers 71a to 71e are inclined equally and at the same angle.

[0073] The rotation plate 73 is surrounded by a rubber ring 81 at the outer circumference. As described later, the yarn Y wound onto the rollers 71 is transported toward the winding section 6 through a gap between the rotation plate 73 and the rubber ring 81. In so doing, since the yarn Y is transported while being sandwiched between the rotation plate 73 and the rubber ring 81, broken filaments of the yarn Y are laid down. Furthermore, since the yarn Y is sandwiched between the rotation plate 73 and the rubber ring 81, it is possible to prevent the generation of ballooning of the yarn Y which is unwound from the roller 71 and running toward the winding section 6.

[0074] In addition to the above, to the lower surfaces of the drive rollers 71a to 71e are attached pulleys 82. These pulleys 82 are connected to: the speed reducer 77 that reduces the rotation speed of the winding arm motor 76 at a predetermined reduction ratio and transmits the rotation; the pulley 78a connected to the speed reducer 77; the pulley 78b connected to the pulley 78a; the pulley 78c connected to the pulley 82; and the output shaft 136 of the winding arm motor 76 via the shaft 79 connecting the pulley 78b with the pulley 78c. With the arrangement above, as the winding arm motor 76 rotates, the rotation is transmitted to the pulleys 82 via the speed reducer 77, the pulley 78a to 78c, and the shaft 79, with the result that the drive rollers 71a to 71e to which the pulleys 82 are attached are rotated.

[0075] To put it differently, the present embodiment is

arranged so that, as described below, the winding arm motor 76 (guide member drive motor) functions as a motor (roller drive motor) for rotating the drive rollers 71a to 71e, in addition to the function as a motor for rotating the winding arm 75. Furthermore, in the present embodiment, a group constituted by the speed reducer 77, the pulleys 78a to 78c, the shaft 79, and the pulleys 82, which connects the winding arm motor 76 with the drive rollers 71a to 71e, is equivalent to the transmission mechanism of the present invention.

[0076] On the other hand, the pulleys 78b and 78c and the shaft 79 are not provided for the adjusting roller 71f. The adjusting roller 71f is a driven roller that is not rotated by the rotation of the winding arm motor 76. A pulley 82 is also provided on the lower surface of the adjusting roller 71f. This is because the components of the adjusting roller 71f are identical with those of the drive rollers 71a to 71e.

[0077] The three winding assist members 74 are attached to the base 72 to surround the lower end portions of the rollers 71 and to be away from one another at about angles of 120 degrees. The winding assist member 74 has, at a part between neighboring rollers 71, a winding assist surface 74a for smoothly connecting the outer circumferences of the rollers 71 with each other. The lower end portions of the rollers 71 and the winding assist surface 74a form a surface that substantially continuously extends in the virtual circumferential directions. The winding assist surface 74a is inclined inward from bottom to top, with respect to the circumferential directions of the virtual circles A1 to A3.

[0078] The winding arm 75 (guide member) guides the yarn Y to the lower end portion of the roller 71. The winding arm 75 includes a yarn passage 128 in which the yarn Y is able to run, and is arranged to be rotatable about the axis C. The winding arm 75 is constituted by a linear portion 141 which is connected to the outer circumference of the output shaft 136 and extends radially outward therefrom and a curved portion 142 which circumvents the first magnet supporter 137 and reaches the vicinity of the lower end portion of the roller 71.

[0079] At the leading end of the curved portion 142 is formed an opening 143 opposing the lower end portion of the roller 71. With the arrangement above, the winding arm 75 is rotatable about the axis C between the above-described first magnet supporter 137 and second magnet supporter 139. As the winding arm 75 rotates about the axis C anticlockwise in plan view, as described later, the yarn Y which is guided into the yarn passage 128 of the winding arm 75 and on the yarn supplying portion 5 side is wound onto the lower end portions (winding-side end portions) of the six rollers 71.

[0080] The yarn passage 128 of the winding arm 75 is connected to a path 144 which is formed inside the output shaft 136. On the side opposite to the winding arm 75 over the output shaft 136, a balancer 145 integrated with the output shaft 136 is provided.

[0081] The winding arm motor 76 (guide member drive motor) is a position-controllable motor such as a servo motor, a DC brushless motor, and a stepping motor, and is electrically connected to the controller 109. The controller 109 can therefore flexibly control the rotation speed of the winding arm 75, i.e. the winding speed Vb which is the yarn speed of the yarn Y wound onto the rollers 71. In the present embodiment, a combination of the winding arm 75 and the winding arm motor 76 functions as both the yarn winding mechanism and yarn drawing means of the present invention.

[0082] Furthermore, as the rotation speed of the winding arm motor 76 is changed, the rotation speed of each of the drive rollers 71a to 71e is also changed. In this regard, the rotation speed of each of the drive rollers 71a to 71e is determined by the rotation speed of the winding arm motor 76, the reduction ratio of the speed reducer 77, and the ratio of the diameters of the pulleys 78a to 78c and 82.

[0083] On the yarn clearer 15 side of the winding arm motor 76 is provided a blowdown nozzle 148 having a yarn path 146 connected to the path 144 of the output shaft 136 and a blowdown path 147 which is connected to the yarn path 146 and is arranged to be inclined from the winding arm 75 side toward the upper yarn guide pipe 26.

[0084] The blowdown path 147 is connected to a compressed air source 151 via a connection pipe 149 and a connection pipe 150, and a solenoid valve 152 electrically connected to the controller 109 is provided between the connection pipe 149 and the connection pipe 150.

[0085] With the arrangement above, when the controller 109 opens the solenoid valve 152 and hence compressed air is discharged from the compressed air source 151 to the yarn path 146 while passing through the connection pipe 150, the connection pipe 149, and the blowdown path 147 in this order, an airflow flowing from the roller 71 side to the upper yarn guide pipe 26 side is generated in the yarn passage 128 of the winding arm 75, in the path 144 of the output shaft 136 of the winding arm motor 76, and in the yarn path 146 of the blowdown nozzle 148. The end of the yarn Y wound onto the rollers 71 is sucked by this airflow, and is drawn to the yarn jointing section 8 side.

[0086] In addition to the above, the winding arm motor 76 has a rotary encoder 153 capable of detecting the rotation angle of the winding arm 75. This rotary encoder 153 is electrically connected to the controller 109. The rotary encoder 153 transmits, to the controller 109, an angle signal corresponding to the rotation angle of the winding arm 75.

[0087] At the lower end of the blowdown nozzle 148 is provided a drawing sensor 154 capable of detecting whether the end of the yarn Y wound by the accumulator 61 has actually been drawn to the yarn jointing section 8 side. This drawing sensor 154 is electrically connected to the controller 109, and transmits a drawing detection signal to the controller 109 upon detecting that the end of the yarn Y has been drawn to the yarn jointing section

8 side.

[0088] The accumulator 61 is further provided with a storage upper limit sensor 155, a storage lower limit sensor 156, and a storage lowest limit sensor 157 for detecting the storage amount of the yarn Y. The storage upper limit sensor 155, the storage lower limit sensor 156, and the storage lowest limit sensor 157 are positioned to oppose the upper end of the yarn Y wound on the outer circumferences of the rollers 71 when the storage amount of the yarn Y in the accumulator 61 reaches 300m, 200m, and 40m, respectively.

[0089] This length, 300m, indicates the length longer than the length of the yarn Y wound by the winding section 6 while later-described yarn jointing is repeated for, for example, three times (at least once). With this, as described later, a shortage of yarn Y is less likely to occur in the accumulator 7 even if the winding of the yarn Y by the winding section 6 is continued while the yarn jointing is carried out.

[0090] With the arrangement above, the storage upper limit sensor 155, the storage lower limit sensor 156, and the storage lowest limit sensor 157 transmit, to the controller 109, a storage amount upper limit signal, a storage amount lower limit signal, and a storage amount lowest limit signal, respectively, when detecting that the yarn Y opposes each sensor.

[0091] Now, the structure of the controller 109 of the winding unit 2 will be described. That is to say, the controller 109 shown in Fig. 4 includes a CPU (Central Processing Unit) which is a processor, a ROM (Read Only Memory) which stores a control program executed by the CPU and data used by the control program, and a RAM (Random Access Memory) which temporarily stores data at the time of the execution of a program. As the control program stored in the ROM is read and executed by the CPU, the control program causes the hardware such as the CPU to function as a winding drum motor controller 160, a winding arm motor controller 161, a drawn yarn length calculation unit 163, and an upper pipe controller 164.

[0092] The winding drum motor controller 160 controls the rotation speed of the winding drum motor 116, and reduces the winding speed Va with which the winding section 6 winds the yarn Y, when the storage amount detected by the storage amount sensor falls below a predetermined value.

[0093] More specifically, when the storage amount lower limit signal is no longer transmitted from the storage lower limit sensor 156, the winding drum motor controller 160 gently reduces the winding speed Va to the extent that yarn layers of the package 30 are not disturbed. Furthermore, when the storage amount lowest limit signal is no longer transmitted from the storage lowest limit sensor 157, the winding drum motor controller 160 gently reduces the winding speed Va and eventually stops the winding by the winding section 6.

[0094] As such, the winding drum motor controller 160 reduces the winding speed Va when the storage amount of the yarn Y in the accumulator 61 becomes low, and stops the winding by the winding section 6 when the storage amount of the yarn Y of the accumulator 61 becomes extremely low. A shortage of the yarn Y in the accumulator 61 is therefore prevented.

[0095] The winding arm motor controller 161 controls the winding arm motor 76. When the yarn Y is wound onto the rollers 71, the winding arm motor 76 is controlled so that the winding arm 75 rotates in one direction. On the other hand, when the end of the yarn Y on the roller 71 is drawn to the yarn jointing section 8 side, the winding arm motor 76 is controlled so that the winding arm 75 rotates in the direction opposite to the direction of winding the yarn.

[0096] The drawn yarn length calculation unit 163 calculates the drawn yarn length which indicates the length of the yarn Y drawn out from the accumulator 61 to the yarn jointing section 8 side, based on the rotation angle of the winding arm 75 detected by the rotary encoder 153 since the drawing sensor 154 detects the yarn Y.

[0097] The upper pipe controller 164 compares the yarn defect length obtained from a yarn defect detection signal with the drawn yarn length calculated by the drawn yarn length calculation unit 163, and rotates the upper yarn guide pipe 26 while keeping the cramping state so as to guide the yarn Y which is on the winding section 6 side to the splicer 14 and places the yarn Y, when it is determined that the drawn yarn length reaches the yarn defect length.

[0098] Now, the operation of the winding unit 2 will be described with reference to Fig. 5 to Fig. 9.

[0099] An operator of the automatic winder (winding unit 2) unwinds the yarn Y from the yarn supplying bobbin 21, places this yarn Y on the yarn unwinding assisting device 12, the yarn detector 37, the first tensor 41, the yarn clearer 15, the accumulator 61, the second tensor 42, and the waxing device 17, and fixes the yarn Y to the winding bobbin 22. The yarn path of the yarn Y in the accumulator 61 is arranged as shown in Fig. 2. That is to say, the operator causes the yarn Y to pass through the drawing sensor 154, the yarn path 146 of the blow-down nozzle 148, the path 144 of the output shaft 136, and the yarn passage 128 of the winding arm 174 in this order. While this state is maintained, the operator draws out the yarn Y on the opening 143 side of the winding arm 75 and winds the yarn Y onto the rollers 71 and the winding assist member 74 for, for example, about five to twenty times, and then places the yarn Y to the second tensor 42. Although the yarn shown in Fig. 2 is thick and an interval between neighboring yarn parts is long for convenience of explanation, The rollers 71 in reality always store the yarn Y wound for about 600 times with very short intervals.

(Normal Winding)

[0100] When the winding unit 2 is powered on as shown in Fig. 5 while the state above is maintained

(S300), the controller 109 starts the rotation of the winding drum 24 so that the winding speed Va of the yarn Y wound by the winding section 6 is, for example, 1200m/min and starts the driving of the winding arm motor 76 so that the winding speed Vb of the yarn Y wound onto the accumulator 61 is, for example, 1500m/min (S310).

[0101] With this, the yarn Y wound onto the rollers 71 is serially unwound by the winding section 6 from the upper end portion side, and the yarn Y is wound onto the package 30 while being traversed by the winding drum 24.

[0102] At the same time, the yarn Y on the yarn supplying portion 5 side is, as shown in Fig. 2, guided to the lower end portions of the rollers 71 by the winding arm 75, and the winding arm 75 rotates about the axis C anticlockwise in plan view, so that the yarn Y is wound onto the lower end portions of the rollers 71.

[0103] Although the rollers 71 are arranged to be distanced from each other, the winding assist member 74 is provided to surround the lower end portions of the rollers 71 as described above, and the lower end portions of the rollers 71 and the winding assist surface 74a form a surface extending substantially continuously along the virtual circumferential directions. The yarn Y is therefore wound across the rollers 71 and the winding assist surface 74a. For this reason, it is possible to smoothly wind the yarn Y onto the rollers 71.

[0104] Furthermore, the drive rollers 71a to 71e rotate at this time, and hence the yarn Y wound onto the rollers 71 by the winding arm 75 is transported by the drive rollers 71a to 71e. In this connection, because the drive rollers 71a to 71e are inclined in the virtual circumferential directions as described above, as shown in Fig. 6, the yarn Y transported by the drive rollers 71a to 71e moves upward (in the transportation direction) toward the unwinding-side end portions. On the other hand, the adjusting roller 71f which is a driven roller is rotated as the yarn Y is transported by the rotation of the drive rollers 71a to 71e. As such, since in the present embodiment the yarn Y moves upward by being transported by the rollers 71, the load (friction force) on the yarn Y is small when moving upward. Furthermore, as the yarn Y is transported on the rollers 71, the broken filaments of the yarn Y are laid down.

[0105] In addition to the above, the yarn Y wound across the lower end portions of the rollers 71 and the winding assist member 74 moves upward not only by the rotation of the drive rollers 71a to 71e but also by the inclination of the winding assist surface 74a of the winding assist member 74. When the yarn Y is wound across the rollers 71 and the winding assist member 74, the transportation of the yarn Y by the rotation of the drive rollers 71a to 71e is less efficient than the case where the yarn Y is wound solely on the rollers 71 on account of a friction force between the yarn Y and the winding assist surface 74a. However, since the yarn Y is transported upward along the inclined winding assist surface 74a, the upward movement speed of the yarn Y is constant.

[0106] Furthermore, as described above, as the rotation plate 73 is rotated, the angle of the roller 71 with respect to the virtual circumferential directions increases as the rotation angle increases. A comparison between Fig. 6(a) and Fig. 6(b) in which the inclination angle of the roller 71 is larger than that of Fig. 6(a) shows that, as the inclination angle of the roller 71 increases with respect to the virtual circumferential directions, the travel distance h of the upward movement of the yarn Y in response to the same degree of rotation of the drive rollers 71a to 71e increases, i.e. the traveling speed of the upward movement of the yarn Y increases.

[0107] As the upward traveling speed of the yarn Y on account of the drive rollers 71a to 71e increases with respect to the winding speed of the yarn Y onto the rollers 71 by the winding arm 75, the winding intervals of the yarn Y on the rollers 71 are widened. For this reason, the winding intervals of the yarn Y wound onto the roller 71 are changeable by changing the inclination angles of the rollers 71 with respect to the virtual circumferential directions in accordance with, for example, the type of the yarn Y wound onto the winding bobbin 22.

[0108] When a roller 71 is inclined with respect to the virtual circumferential directions, the roller 71 is arranged so that the central part thereof is at the innermost position whereas the respective end portions are at the outermost positions, provided that the roller 71 is not inclined in the radial directions of the virtual circles A1 to A3 and the upper end portion and the lower end portion are at the same position with respect to the virtual circles A1 to A3. Therefore the circumferential length of the wound yarn Y is shortest at the central parts of the rollers 71 and the circumferential length of the yarn Y increases toward the end portions of the rollers 71. Such a difference in the circumferential lengths of the wound yarn Y is significant as the inclination angle of the roller 71 with respect to the virtual circumferential directions is large.

[0109] On the other hand, when the yarn Y wound on the rollers 71 is transported by the drive rollers 71a to 71e, it is difficult to transport the yarn Y from a part of the roller 71 to a different part of the roller 71 where the circumferential length of the wound yarn Y is longer than that of the aforesaid part.

[0110] Because of the above, a range of the roller 71 on which range the yarn Y is wound and stored is limited to the range from the lower end portion of the roller 71 to a part around the center of the roller 71 where the circumferential length of the wound yarn is the shortest. This indicates that the yarn Y can be wound on only about a half of the roller 71.

[0111] In this regard, in the present embodiment, since the drive rollers 71a to 71e are inclined so that the upper end portions thereof are inside of the lower end portions, the innermost parts of the drive rollers 71a to 71e are above the central parts thereof. This increases the range where the yarn Y is wound is practically widened on the roller 71, thereby making it possible to store a long yarn

Y. In the present embodiment, the storage upper limit sensor 155 detects the existence of the yarn Y at the upper end of the range where the yarn Y can be wound.

[0112] In addition to the above, since the rollers 71a to 71e are inclined in the radial directions of the virtual circles A1 to A3 such that the upper end portions (unwinding-side end portions) thereof are inside the lower end portions (winding-side end portions), the circumferential length of the yarn Y wound onto the rollers 71 does not increase in the unwinding direction in which the yarn Y is unwound by the winding section 6. This prevents the yarn Y from remaining at a part of the roller 71 and the operation to store the yarn Y from being stagnated.

[0113] Provided that no adjusting roller 71f is provided and a roller inclined in the same angle as the drive rollers 71a to 71e is provided in place of the adjusting roller 71f, each of the rollers 71 is arranged so that the range where the yarn Y is wound is close to the inside toward the upper end portion. In this case, the yarn Y is transported by the rollers 71 from a part of each roller 71 where the circumferential length of the wound yarn Y is long to a part where the circumferential length is short, and hence the yarn Y may be loosen.

[0114] In this regard, in the present embodiment the adjusting roller 71f is provided to be inclined such that the upper end portion thereof is outside the lower end portion thereof. For this reason, as compared to a case indicated by a dashed line in Fig. 3(c) in which the inclination of the adjusting roller 71f in the radial directions of the virtual circles A1 to A3 is identical with that of the drive rollers 71a to 71e, the circumferential length of the wound yarn Y is long in proportion to the inclination of the adjusting roller 71f as indicated by a full line in Fig. 3 (c), and the circumferential length of the wound yarn Y increases toward the upper end portion. As a result, the circumferential lengths of the wound yarn Y are identical at all parts of the rollers 71, and hence the above-described loosening of the yarn Y is less likely to occur.

[0115] In the normal winding in which the yarn Y is wound onto the package 30 while the yarn Y is undisrupted from the yarn supplying portion 5 to the winding section 6, the controller 109 checks, as shown in Fig. 5, whether a yarn breakage signal has been supplied (S320), whether a yarn defect detection signal has been supplied (S330), whether an empty bobbin signal has been supplied (S340), and whether a storage amount upper limit signal has been supplied (S350).

[0116] When it is determined that the yarn breakage signal has been supplied (S320: YES), the yarn defect detection signal has been supplied (S330: YES), or the empty bobbin signal has been supplied (S340, the control flows shown in Fig. 7, Fig. 8, and Fig. 9 are executed, respectively, (S325, S335, S345), and the process returns to the control flow shown in Fig. 5.

[0117] Since the winding speed Vb is higher than the winding speed Va for a while after the start of the winding, the storage amount of the yarn Y in the accumulator 61 increases. When the storage amount of the yarn Y reaches 300m, the storage upper limit sensor 155 sends a storage amount upper limit signal to the controller 109. Receiving the storage amount upper limit signal from the storage upper limit sensor 155 as shown in Fig. 5 (S350: YES), the controller 109 changes the winding speed Vb from 1500m/min to 1200m/min, for example (S360). The winding speed Va becomes identical with the winding speed Vb as a result, and the storage amount of the accumulator 61 is kept constant.

(Yarn Breakage)

[0118] Now, the control flow shown in Fig. 7 at the time of yarn breakage will be described. As yarn breakage occurs and the controller 109 receives a yarn breakage signal from the yarn clearer 15 (S320: YES), the controller 109 stops the rotation of the winding arm 75 in the first place (S410).

[0119] Subsequently, the controller 109 opens the solenoid valve 152 to generate an airflow from the roller 71 side to the upper yarn guide pipe 26 side, in the yarn passage 128 of the winding arm 75 or the like (S420).

[0120] At the same time, the controller 109 switches the suction port 26b of the upper yarn guide pipe 26 from the closed state to the open state, so as to generate an airflow from the suction port 26b side to the negative pressure source 120 side in the upper yarn guide pipe 26 (S420).

[0121] Thereafter, the winding arm motor controller 161 controls the winding arm motor 76 to drive at a slow speed in the direction opposite to the winding of the yarn Y by the winding arm 75, i.e., clockwise in plan view (S430), and a drawing detection signal from the drawing sensor 154 is waited for (S440: NO).

[0122] As a result, the end of the yarn Y on the lower end portion of the roller 71 is sucked into the opening 143 of the winding arm 75, and reaches the suction port 26b of the upper yarn guide pipe 26 via the yarn passage 28 of the winding arm 75 or the like. In this regard, since the winding arm motor 76 is capable of conducting position control, the winding arm 75 is precisely moved to a position opposing the end of the yarn Y at the lower end portion of the roller 71. This makes it possible to surely suck the yarn Y through the opening 143.

[0123] As the yarn Y passes through the drawing sensor 154 at this time, the drawing sensor 154 sends a drawing detection signal to the controller 109. Receiving the drawing detection signal from the drawing sensor 154 (S440: YES), the controller 109 switches the suction port 26b from the open state to the closed state while maintaining the low speed driving of the winding arm 75, clamps the yarn Y by the clamping section 26c, and rotates the upper yarn guide pipe 26 about the axis 26a downward. In this way, the controller 109 guides the yarn Y drawn out from the accumulator 61 to the splicer 14 of the yarn jointing section 8 (S450).

[0124] At this stage, the length of a newly drawn part of the yarn Y drawn out from the accumulator 61 by the

rotation of the upper yarn guide pipe 26 is about 60cm. To prevent the yarn breakage of the yarn Y between the clamping section 26c and the roller 71 at this time, the controller 109 synchronizes the rotation of the upper yarn guide pipe 26 with the rotation of the winding arm 75. After the completion of the guide of the yarn Y to the splicer 14 by the upper yarn guide pipe 26 (S450), the controller 109 stops the rotation of the winding arm 75 (S460).

[0125] In the meanwhile, the lower yarn guide pipe 25 sucks and captures the end of the yarn Y around the yarn detector 37 and guides this yarn Y to the splicer 14, in the same manner as the upper yarn guide pipe 26. When a part of the yarn Y on the accumulator 61 side and a part of the yarn Y on the yarn supplying portion 5 side are placed on the splicer 14, the controller 109 causes the splicer 14 to conduct the yarn jointing operation (S470).

[0126] Thereafter, the controller 109 starts, as shown in Fig. 2, to rotate the winding arm 75 anticlockwise in plan view (S980), and hence the normal winding state is resumed (S490). The number of rotations of the winding arm 75 at this time is arranged so that the winding speed Vb is 1500m/min (S480).

(When Yarn Defect Is Detected)

[0127] Now, the control flow shown in Fig. 8 at the time of the detection of a yarn defect will be described. It is noted that some steps in this process are identical with those in the yarn breakage, and hence such identical steps will not be detailed below.

[0128] When a yarn defect is detected and the controller 109 receives a yarn defect detection signal and a yarn cutting signal from the yarn clearer 15, the controller 109 conducts the steps S410 to S440 above in this order, in the same manner as in the case of yarn breakage. Receiving the drawing detection signal from the drawing sensor 154 (S440: YES), the drawn yarn length calculation unit 163 obtains the rotation angle of the winding arm 75 detected by the rotary encoder 153, which indicates how many angles the winding arm 75 rotates after the detection of the yarn Y by the drawing sensor 154 (S570), and the drawn yarn length is calculated based on this rotation angle (S580).

[0129] The upper pipe controller 64 then compares the length of the yarn defect obtained from the yarn defect detection signal with the drawn yarn length calculated by the drawn yarn length calculation unit 63 (S590). The upper pipe controller 164 then waits for the drawn yarn length to reach the yarn defect length (S590: NO). When reaching the yarn defect length (S590: YES), the steps S450 to S480 are conducted in this order in the same manner as in the case of yarn breakage, with the result that the yarn jointing is conducted and the normal winding operation is resumed.

(When Bobbin Is Changed)

[0130] Now, the following will describe the operation when the yarn supplying bobbin 21 becomes empty. It is noted that some steps in this operation are identical with those in the case of yarn breakage, and such identical steps will not be detailed below.

[0131] When the yarn supplying bobbin 21 becomes empty and the controller 109 receives an empty bobbin signal from the yarn detector 37 (S340: YES), the currently attached yarn supplying bobbin 21 is discharged and a new yarn supplying bobbin 21 is attached to the yarn supplying bobbin supporter 60, and the yarn Y of this yarn supplying bobbin 21 is guided so that the lower yarn guide pipe 25 is able to capture and suck the yarn Y (S710). Thereafter, in the same manner as in the case of yarn breakage, the yarn jointing is conducted and the normal winding operation is resumed by the steps S410 to S440.

[0132] Because of the steps above conducted in the winding unit 2, the winding of the yarn Y onto the package 30 in the winding section 6 is continued at least until the yarn jointing operation is conducted once, as the yarn Y stored in the yarn storage drum 71 is unwound during the yarn jointing in the yarn jointing section 8. To put it differently, it is possible to conduct the yarn jointing by the yarn jointing section 8 without interrupting the winding of the yarn Y onto the package 30 in the winding section 6.

[0133] In addition to the above, in the yarn winding unit 2 having the above-described structure, because the transmission of the tension of the yarn Y is blocked by providing the yarn storage section 9 between the yarn supplying bobbin 21 and the winding section 6, it is possible to prevent a tension change due to the traversal of the winding section 6 from being transferred to the unwinding tension part of the yarn supplying bobbin 21. Furthermore, since the yarn unwinding assist device 12 is attached to the yarn supplying bobbin 21, yarn unwinding from the yarn supplying bobbin 21 is stably conducted, with the result that yarn breakage is prevented and the speed of unwinding from the yarn supplying bobbin 21 is improved. The efficiency in the unwinding from the yarn supplying bobbin 21 is therefore improved.

[0134] Various modifications of the present embodiment will now be described. It is noted that the same components as in the embodiment are denoted by the same reference numerals as in the embodiment, respectively, and the description thereof will be omitted.

[0135] While in the embodiment above the inclination angle of the roller 71 with respect to the virtual circumferential directions is changed such that the rotation plate 73 rotatable about the axis C is rotated to move the upper end portion of the roller 71 in a virtual circle direction, the disclosed technology is not limited to this arrangement.

[0136] For example, the inclination angle of the roller 71 with respect to the virtual circumferential directions may be changed such that the upper end portion and the lower end portion of the roller 71 are both connected to

rotation plates rotatable about the axis C, these two rotation plates are rotated in opposite directions, and hence the upper end portion and the lower end portion of the roller 71 move in opposing virtual circumferential directions, respectively. Alternatively, the angle change mechanism by which the inclination angle of the roller 71 is changed with respect to the virtual circumferential directions may be constructed by members other than the rotation plate.

[0137] In addition to the above, the winding intervals of the yarn Y may be changed by a mechanism different from the inclination angle change mechanism above. For example, the winding intervals of the yarn Y wound onto the drive rollers 71a to 71e may be changed such that the speed reducer 77 is arranged to be a variable speed reducer (speed change mechanism) which is able to change a reduction ratio, and the ratio between the winding speed of the yarn Y by the winding arm 75 and the rotation speed of the drive rollers 71a to 71e (i.e., the upward traveling speed of the yarn Y) is changed by changing the reduction ratio by the variable speed reducer.

[0138] Alternatively, for example, in place of the speed reducer 77, the pulleys 78a to 78c, and the shaft 79, a motor (roller drive motor) for rotating the drive rollers 71a to 71e is provided along with the winding arm motor 76, a speed control mechanism is provided for individually controlling the rotation speed of the winding arm motor 76 and the rotation speed of the roller drive motor, and as the speed control mechanism changes the ratio between these rotation speeds, the ratio between the winding speed of the yarn Y by the winding arm 75 and the rotation speed of the drive rollers 71a to 71e (i.e., the upward traveling speed of the yarn Y) is changed, with the result that the winding intervals of the yarn Y wound onto the drive rollers 71a to 71e are changed.

[0139] It is noted that these mechanisms may be provided along with the inclination angle change mechanism, and the winding intervals of the yarn Y wound onto the rollers 71 may be changed by changing a combination of th mechanisms.

[0140] When the type of the yarn Y to be wound onto the winding bobbin 22 is determined in advance, the above-described winding interval adjustment mechanism changing the winding intervals of the yarn Y wound onto the rollers 71 may not be provided.

[0141] In addition to the above, while in the embodiment above the adjusting roller 71f is a driven roller which is not driven by the winding arm motor 76, the adjusting roller 71f may also be a roller rotated by the driving of the winding arm motor 76 in the same manner as the drive rollers 71a to 71e.

[0142] In addition to the above, while in the embodiment above all of the five rollers 71a to 71e except the adjusting roller 71f are drive rollers, only one or more of these rollers may be drive rollers.

[0143] In addition to the above, while in the embodiment above the upper end portions of the drive rollers 71a to 71e are arranged to be inside the lower end portions thereof, the upper end portions and the lower end portions of the drive rollers 71a to 71e may be on the same virtual circle (e.g., one of the virtual circles A1 to A3), and may not be inclined in a radial direction of the virtual circles A1 to A3.

[0144] In addition to the above, while in the embodiment above one of the six rollers 71 is the adjusting roller 71f which is inclined so that the upper end portion is positioned outside the lower end portion for adjusting the circumferential length of the wound yarn Y. In this regard, two or more adjusting rollers may be provided. Alternatively, the adjusting roller may not be provided.

[0145] In addition to the above, while in the embodiment above the adjusting roller 71f moves in a virtual circumferential direction along with the drive rollers 71a to 71e as the rotation plate 73 is rotated, the disclosed technology is not limited to this. The inclination angle of the adjusting roller 71f may be individually changeable.

[0146] While the number of rollers 71 is limited to six as in the embodiment above, the number of rollers may be two to five, seven, or more. Even though the number of components is increased as the number of rollers 71 is increased, the circumferential length of the yarn Y wound on the rollers 71 is increased.

[0147] In addition to the above, while in the present embodiment both of the yarn winding mechanism and the yarn drawing mechanism of the present invention are constructed by the winding arm 75 and the winding arm motor 76, the yarn winding mechanism and the yarn drawing mechanism may be provided to be independent from each other, and may be differently constructed from the above on condition that the yarn winding mechanism and the yarn drawing mechanism can wind the yarn Y onto the rollers 71 and draw out the yarn Y from the rollers 71.

[0148] In addition to the above, the embodiment above is arranged so that the yarn Y on the downstream side is fully wound onto the rollers 71 when yarn breakage occurs, when a yarn defect is detected, and when bobbin change is conducted. Alternatively, when yarn breakage occurs, when a yarn defect is detected, or when bobbin change is conducted, the occurrence of such an incident is detected in advance and the driving of the winding arm 75 is stopped before the yarn Y on the downstream side is fully wound onto the rollers 71. For example, when a yarn defect is detected, a cutter attached to the yarn clearer 15 cuts the yarn Y and at the same time as the driving of the winding arm 75 is stopped. For the bobbin change, a sensor for detecting the remaining yarn amount on the yarn supplying bobbin 21 is attached to the yarn unwinding assisting device 12 to monitor the remaining yarn amount on the yarn supplying bobbin 21. With this, the occurrence of the empty state of the yarn supplying bobbin 21 is detected in advance and the driving of the winding arm 75 is stopped before the yarn Y on the downstream side is fully wound onto the rollers 71.

[0149] As such, by stopping the driving of the winding

arm 75 before the yarn Y is fully wound onto the rollers 71, the end of the yarn Y is stopped while the end hangs down from the blowdown nozzle 148 of the accumulator 61.

[0150] Since this allows the upper yarn guide pipe 26 to capture the yarn end hanging down from the accumulator 61, the step of drawing out the yarn Y by the yarn end drawing mechanism is eliminated and hence the yarn jointing becomes more efficient. According to this arrangement, since the drawing sensor 154 is provided at the lower end of the blowdown nozzle 148, it is possible to check whether the end of the yarn Y stored in the accumulator 61 stops in the state of being receivable by the upper yarn guide pipe 26, i.e. , whether the end certainly stops in the state of hanging down from the accumulator 61. This makes it possible to shorten the time required for drawing out the end of the yarn Y from the yarn storage section to the yarn jointing section side.

[0151] As such, the drawing mechanism of the present invention is capable of not only drawing out the yarn Y having completely been enclosed inside the accumulator 61 but also drawing out the yarn Y stopping at the position below the accumulator 61 to the yarn jointing section 8 side.

[0152] In addition to the above, while in the arrangement above the rollers 71 are inclined in the virtual circumferential directions, the rollers 71 may not be inclined in the virtual circumferential directions.

Reference Signs List

[0153]

2	YARN WINDER
5	YARN WINDING SECTION
6	YARN STORAGE SECTION
9	YARN SUPPLYING PORTION
21	YARN SUPPLYING BOBBIN
30	PACKAGE
71a to 71f	ROLLER
73	ROTATION PLATE
74	WINDING ARM
76	WINDING ARM MOTOR
77	SPEED REDUCER

Claims

1. A yarn winder comprising:

a yarn supplying portion which unwinds a yarn from a yarn supplying bobbin;
a yarn winding section which winds the yarn to form a package; and
a yarn storage section which is provided between the yarn supplying portion and the yarn winding section and stores the yarn,
the yarn storage section including:
a yarn storage which stores the yarn as the yarn is wound thereon; and
a yarn winding mechanism which winds the yarn onto the yarn storage,
the yarn storage being constituted by a plurality of rollers each of which is rotatable and has a rotation axis on a first virtual circle.

2. The yarn winder according to claim 1, wherein,
the yarn storage section further includes:

a roller drive motor which rotates at least one of the plurality of rollers as a drive roller, and
because the rotation axis of each of the plurality of rollers is arranged to be inclined in a circumferential direction of the first virtual circle, the yarn wound on the plurality of rollers is transported in a unwinding direction in which the yarn is unwound by the yarn winding section.

3. The yarn winder according to claim 2, wherein,
the yarn storage section further includes a winding intervals changing means which changes winding intervals of the yarn wound on the plurality of rollers.

4. The yarn winder according to claim 3, wherein,
the winding intervals changing means includes an angle change mechanism that changes an inclination angle of each of the plurality of rollers in the circumferential direction of the first virtual circle.

5. The yarn winder according to claim 4, wherein,
the angle change mechanism is a mechanism that moves at least one end portion of each of the plurality of rollers in the circumferential direction of the first virtual circle.

6. The yarn winder according to claim 4 or 5, wherein,
the yarn winding mechanism is arranged to wind the yarn onto a winding-side end portion which is one end portion of each of the plurality of rollers,
the winding-side end portion of each of the plurality of rollers is positioned on the first virtual circle, and
an unwinding-side end portion which is the other end portion of each of rollers that are more than half of the plurality of rollers is positioned with reference to a second virtual circle having a shorter diameter than the first virtual circle, with the result that said more than half of the plurality of rollers are inclined in a radial direction of the first virtual circle.

7. The yarn winder according to claim 6, wherein,
at least one of rollers that are not said more than half of the plurality of rollers is an adjusting roller for adjusting a circumferential length of the wound yarn and the unwinding-side end of the adjusting roller is positioned with reference to a third virtual circle having a longer diameter than the first virtual circle.

8. The yarn winder according to claim 7, wherein, the adjusting roller is a driven roller.

9. The yarn winder according to any one of claims 1 to 8, further comprising:
a guide member which is arranged to be rotatable around the plurality of rollers and guides the yarn on the plurality of rollers; and
a guide member drive motor that rotates the guide member,
the yarn winding mechanism being constituted by the guide member and the guide member drive motor.

10. The yarn winder according to any one of claims 3 to 8, further comprising:

a guide member which is arranged to be rotatable around the plurality of rollers and guides the yarn on the plurality of rollers,
the guide member being driven by the roller drive motor as being connected to the roller drive motor via a transmission mechanism, and
the yarn winding mechanism being constituted by the guide member and the roller drive motor.

11. The yarn winder according to claim 10, wherein, the winding intervals changing means is provided in the transmission mechanism to constitute a speed change mechanism capable of changing a ratio between a rotation speed of the roller drive motor and a rotation speed of the drive roller.

12. The yarn winder according to any one of claims 3 to 8, further comprising:
a guide member which is arranged to be rotatable around the plurality of rollers and guides the yarn on the plurality of rollers; and
a guide member drive motor that rotates the guide member,
the guide member and the guide member drive motor constituting the yarn winding mechanism, and
the winding intervals changing means including a speed control mechanism which individually controls a rotation speed of the roller drive motor and a rotation speed of the guide member drive motor.

13. The yarn winder according to any one of claims 9 to 12, wherein,
the yarn storage section further includes:

a yarn drawing mechanism which draws out, toward the yarn supplying portion, the yarn wound on the plurality of rollers.

14. The yarn winder according to claim 13, wherein, the guide member drive motor is capable of rotating the guide member in both directions, and
the yarn drawing mechanism is constituted by the guide member and one of the guide member drive motor and the roller drive motor.

15. The yarn winder according to any one of claims 1 to 14, wherein,
the yarn supplying portion is provided with a yarn unwinding assisting device that assists the yarn to be unwound from the yarn supplying bobbin by moving down a regulator covering a core tube of the yarn supplying bobbin in sync with the movement of the yarn unwound from the yarn supplying bobbin.

FIG.1

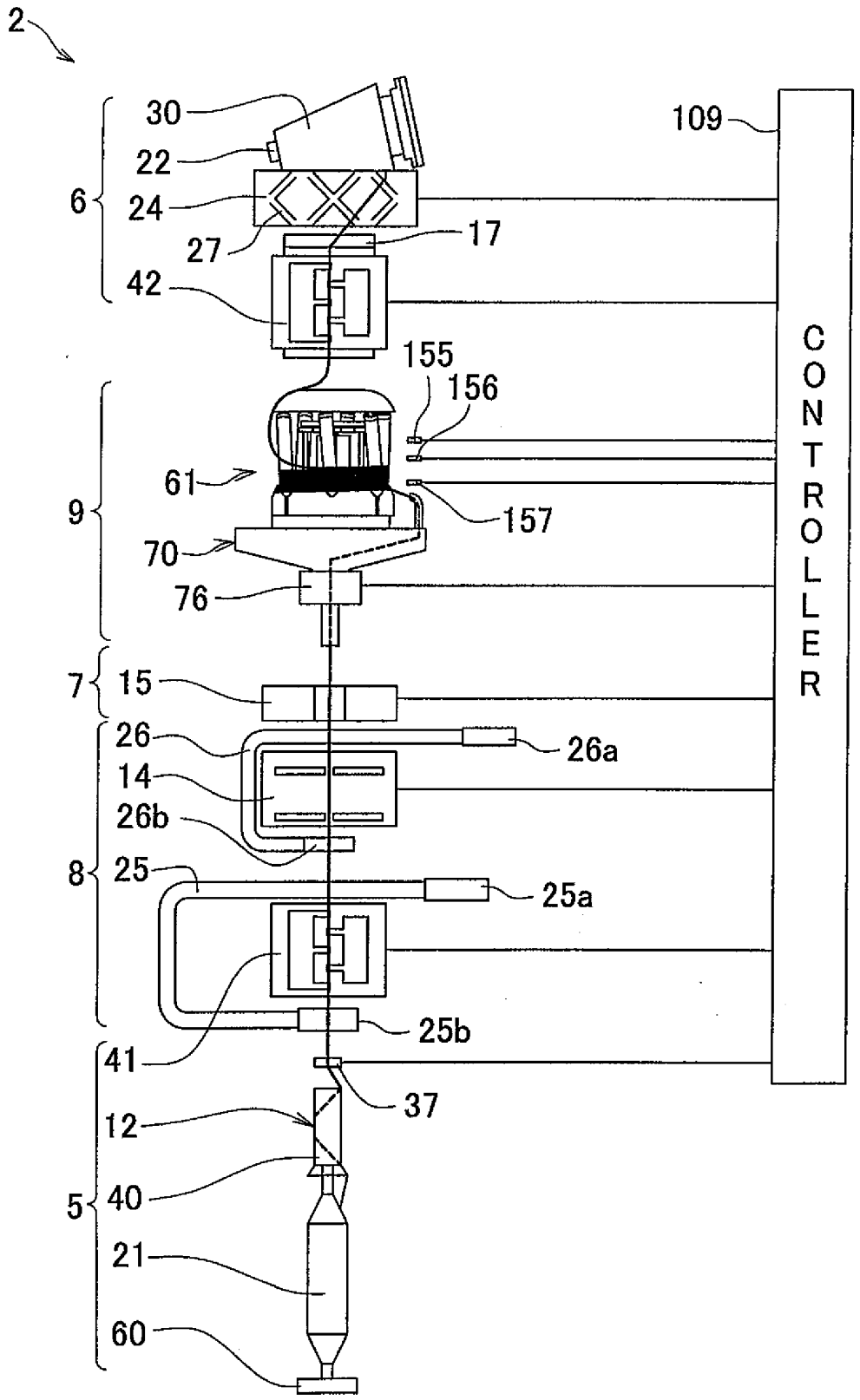

2
30
22
24
27
42
6
17
109
155
156
61
157
9
70
76
7
15
26
26a
14
26b
8
25
25a
25b
41
37
12
40
5
21
60
CONTROLLER

FIG.2

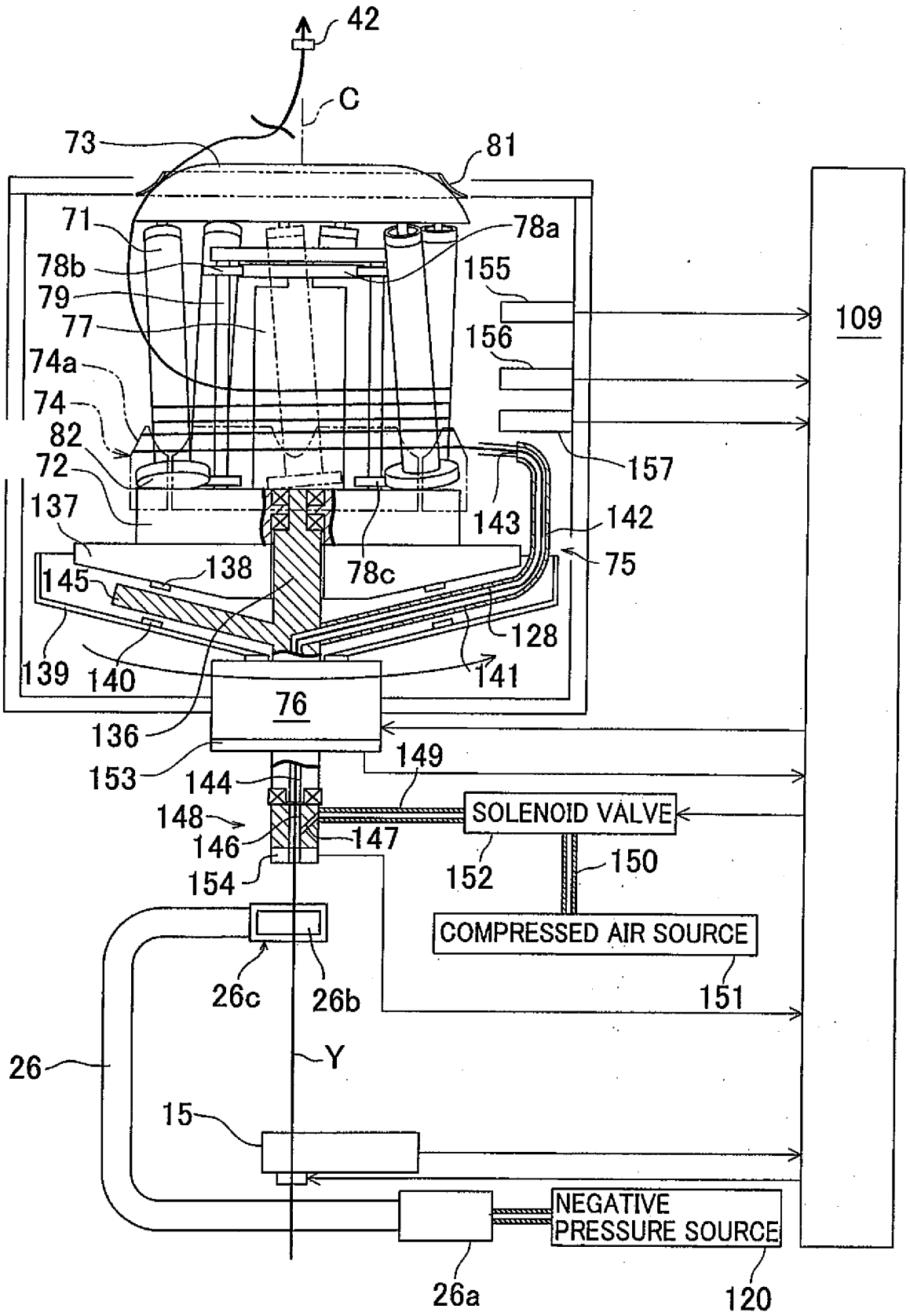

42
C
73
81
71
78a
78b
155
79
77
156
74a
74
82
157
72
137
143
142
78c
75
145
138
128
139
140
141
76
136
149
153
144
148
SOLENOID VALVE
146
147
152
150
154
COMPRESSED AIR SOURCE
26c
26b
151
26
Y
15
NEGATIVE PRESSURE SOURCE
26a
120
109

FIG.3(a)

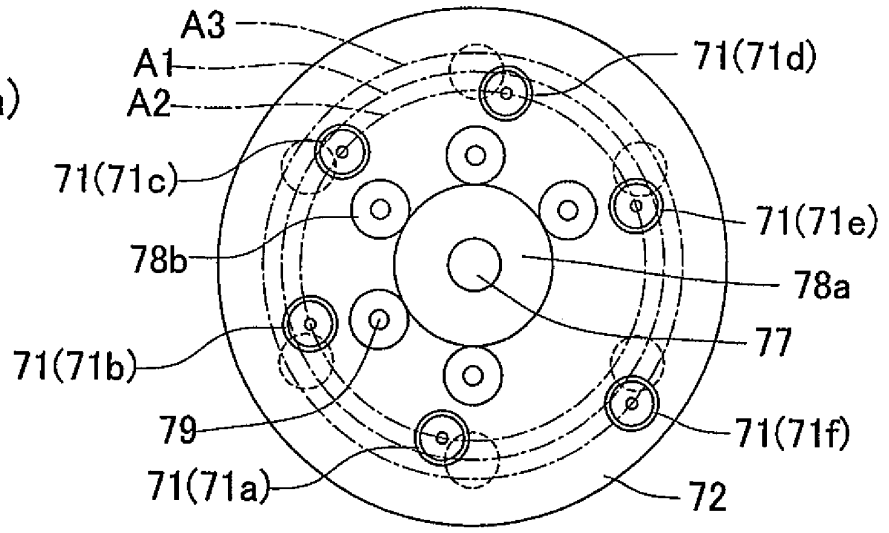


FIG.3(b)

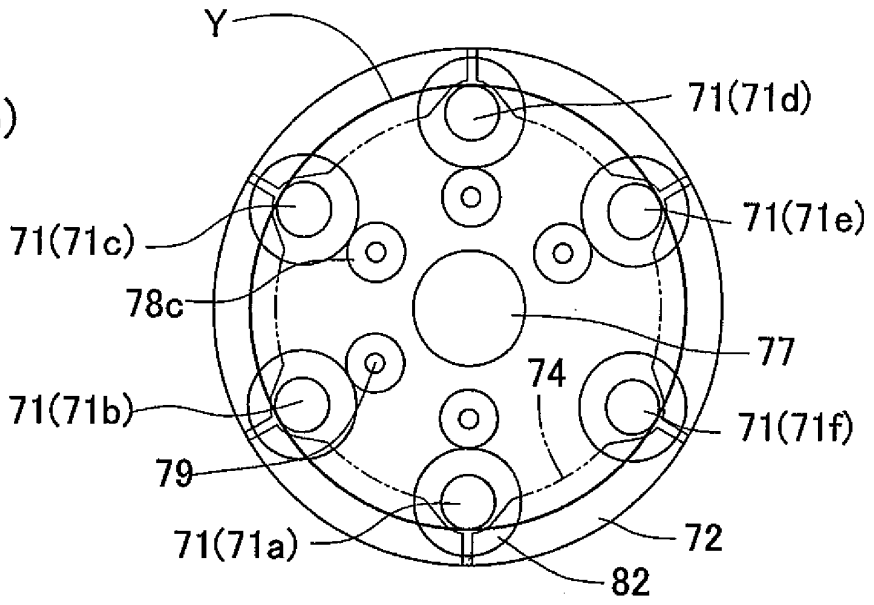


FIG.3(c)

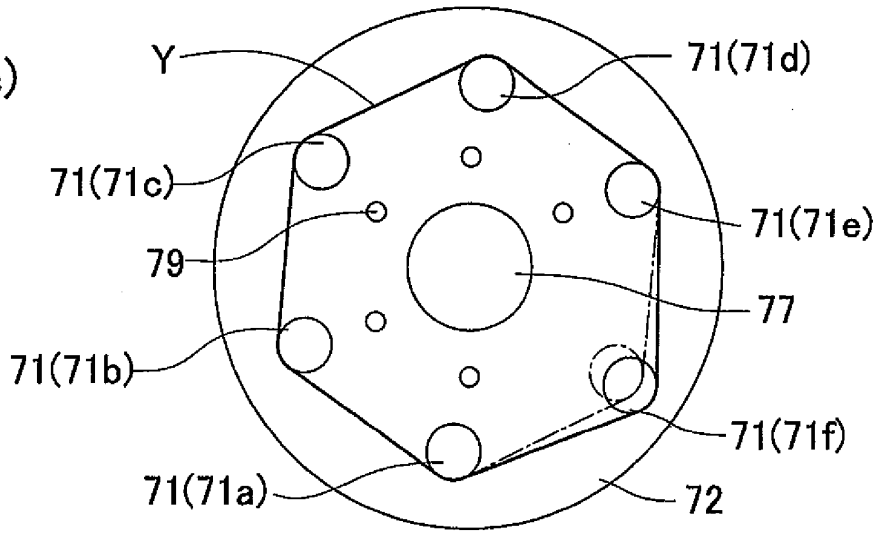


FIG.4

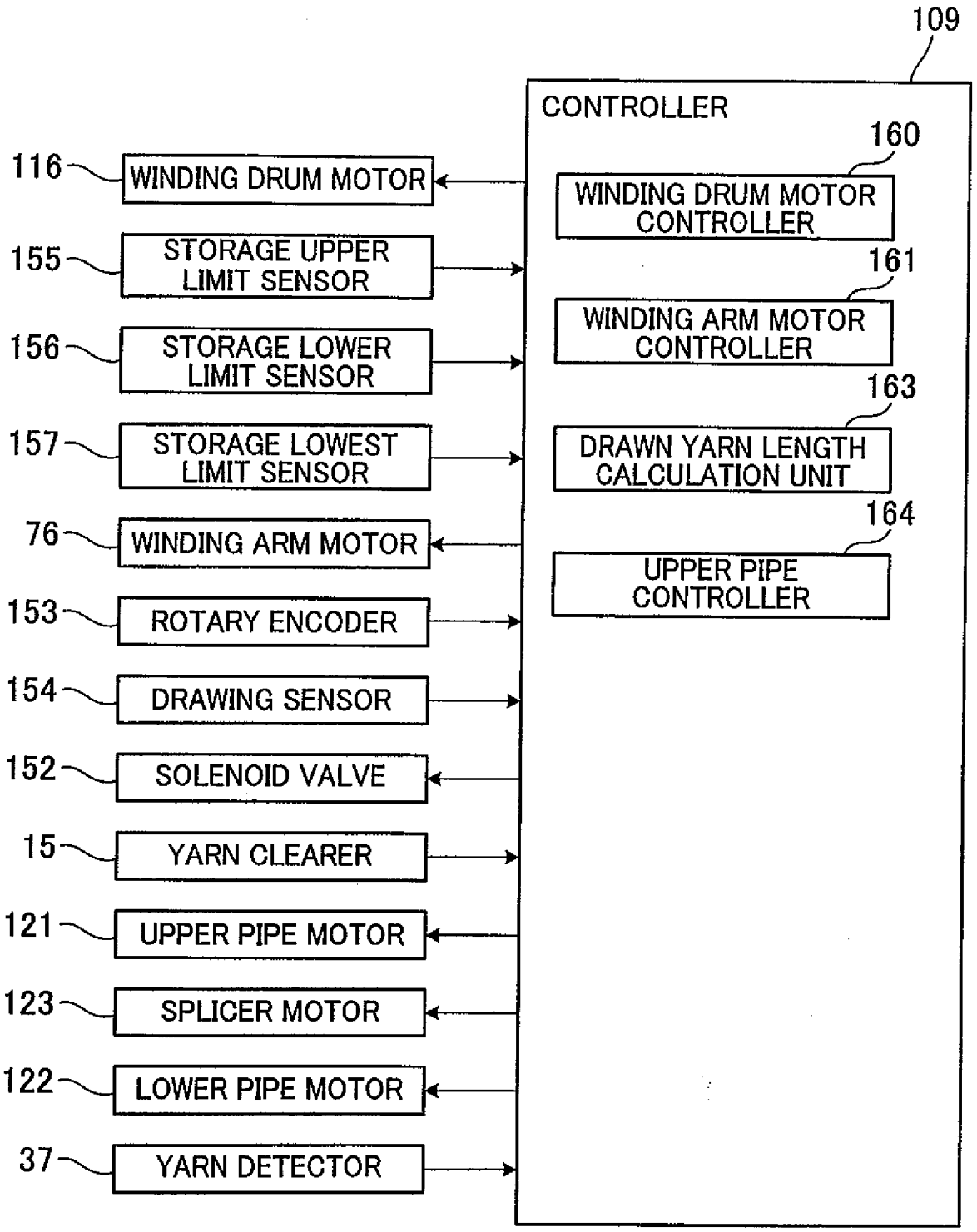

109
CONTROLLER
160
WINDING DRUM MOTOR CONTROLLER
161
WINDING ARM MOTOR CONTROLLER
163
DRAWN YARN LENGTH CALCULATION UNIT
164
UPPER PIPE CONTROLLER
116
WINDING DRUM MOTOR
155
STORAGE UPPER LIMIT SENSOR
156
STORAGE LOWER LIMIT SENSOR
157
STORAGE LOWEST LIMIT SENSOR
76
WINDING ARM MOTOR
153
ROTARY ENCODER
154
DRAWING SENSOR
152
SOLENOID VALVE
15
YARN CLEARER
121
UPPER PIPE MOTOR
123
SPLICER MOTOR
122
LOWER PIPE MOTOR
37
YARN DETECTOR

FIG.5

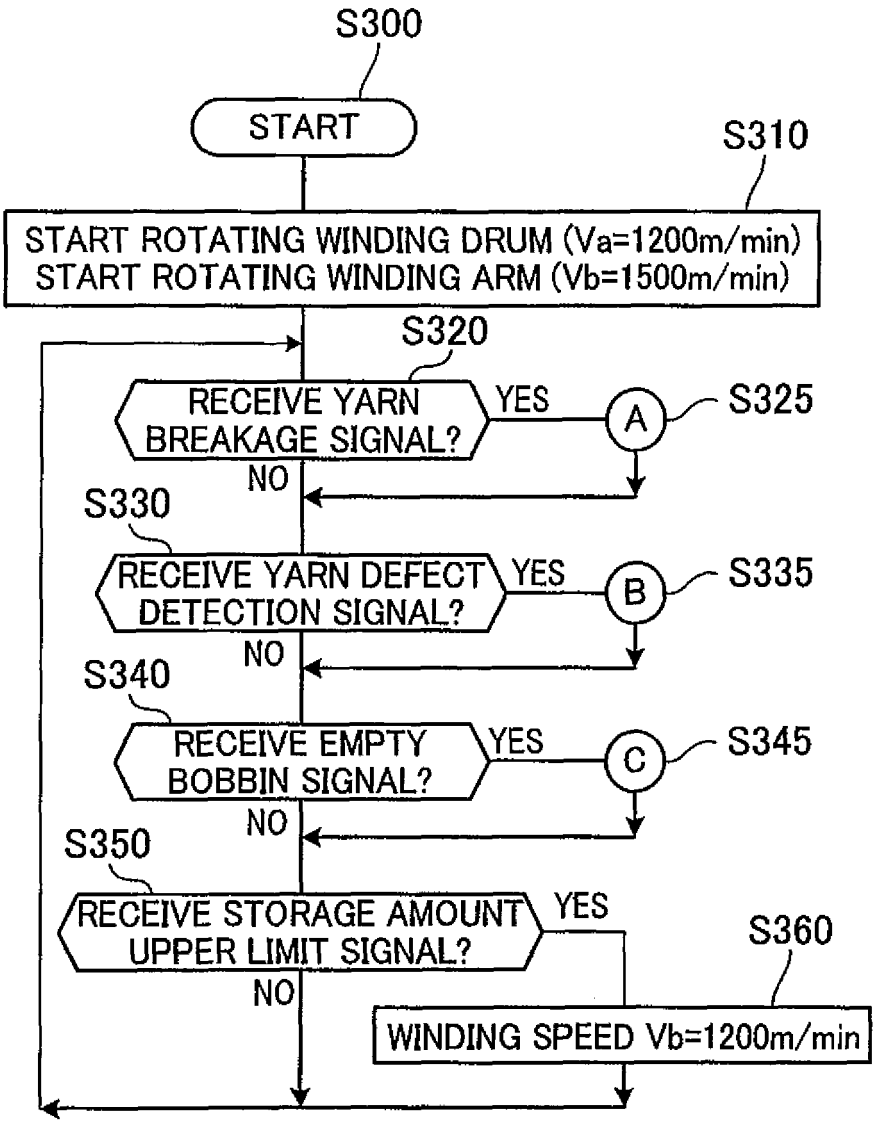

S300
START
S310
START ROTATING WINDING DRUM (Va=1200m/min)
START ROTATING WINDING ARM (Vb=1500m/min)
S320
RECEIVE YARN BREAKAGE SIGNAL?
YES
A
S325
NO
S330
RECEIVE YARN DEFECT DETECTION SIGNAL?
YES
B
S335
NO
S340
RECEIVE EMPTY BOBBIN SIGNAL?
YES
C
S345
NO
S350
RECEIVE STORAGE AMOUNT UPPER LIMIT SIGNAL?
YES
S360
NO
WINDING SPEED Vb=1200m/min

FIG.6(a)

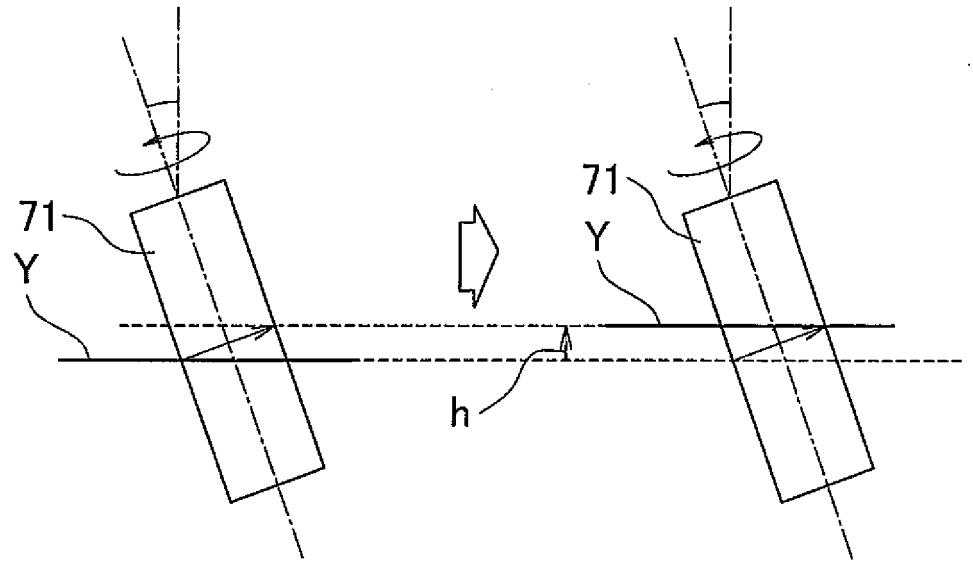


FIG.6(b)

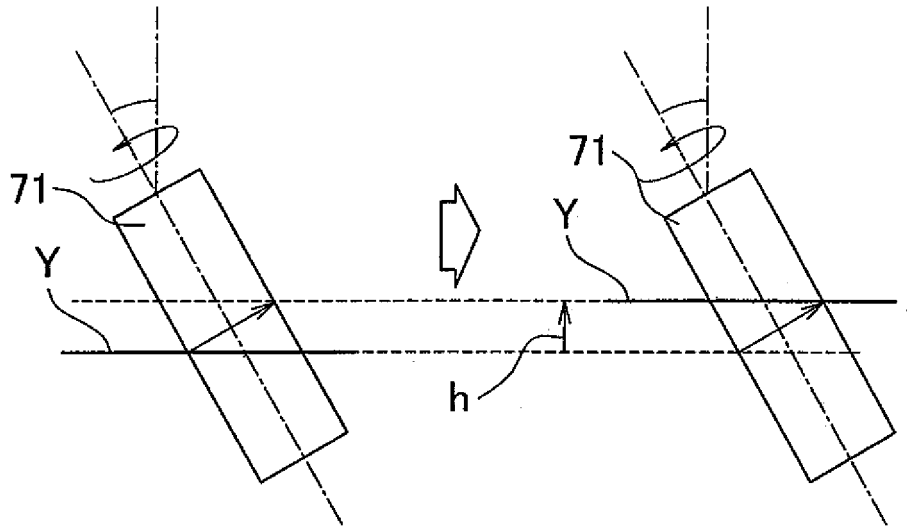


FIG.7

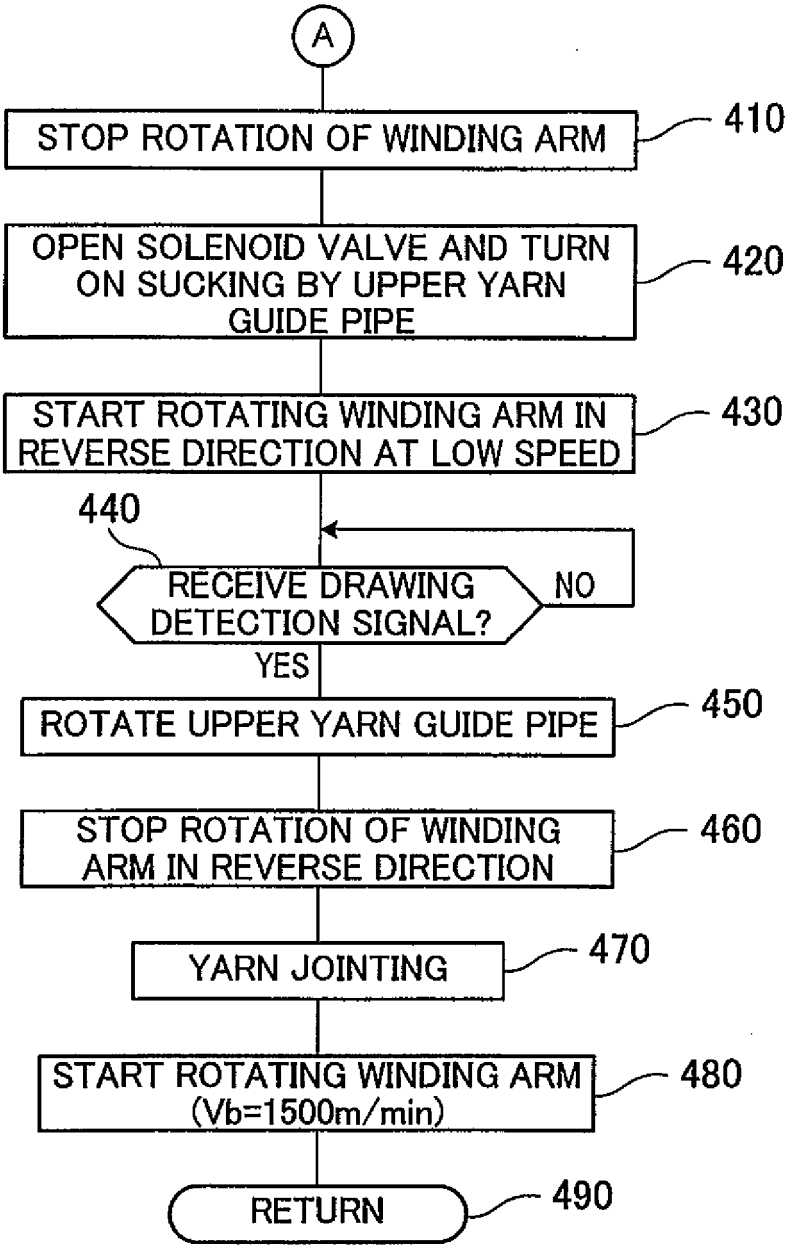

A
STOP ROTATION OF WINDING ARM
410
OPEN SOLENOID VALVE AND TURN ON SUCKING BY UPPER YARN GUIDE PIPE
420
START ROTATING WINDING ARM IN REVERSE DIRECTION AT LOW SPEED
430
440
RECEIVE DRAWING DETECTION SIGNAL?
NO
YES
ROTATE UPPER YARN GUIDE PIPE
450
STOP ROTATION OF WINDING ARM IN REVERSE DIRECTION
460
YARN JOINTING
470
START ROTATING WINDING ARM (Vb=1500m/min)
480
RETURN
490

FIG.8

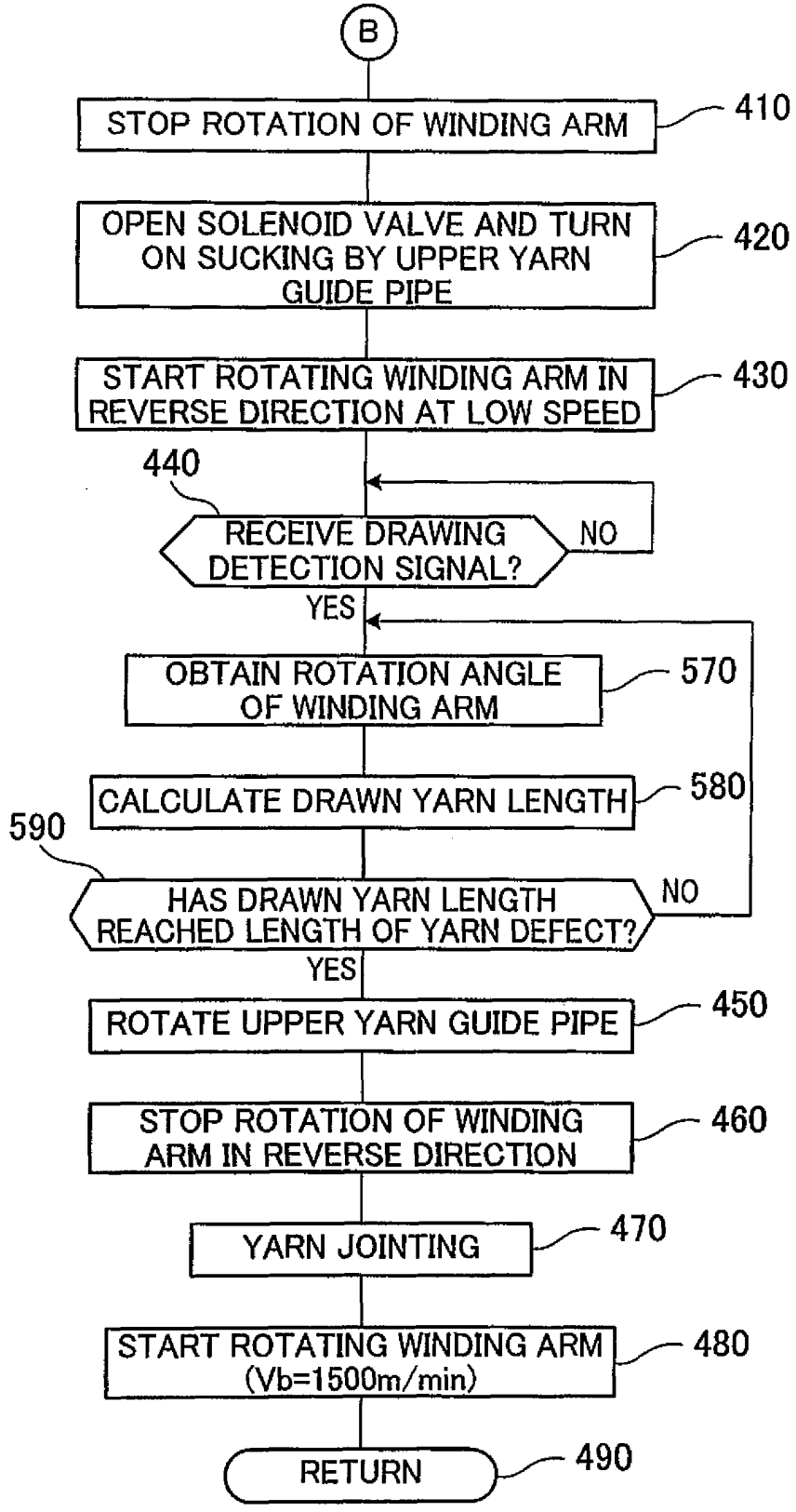
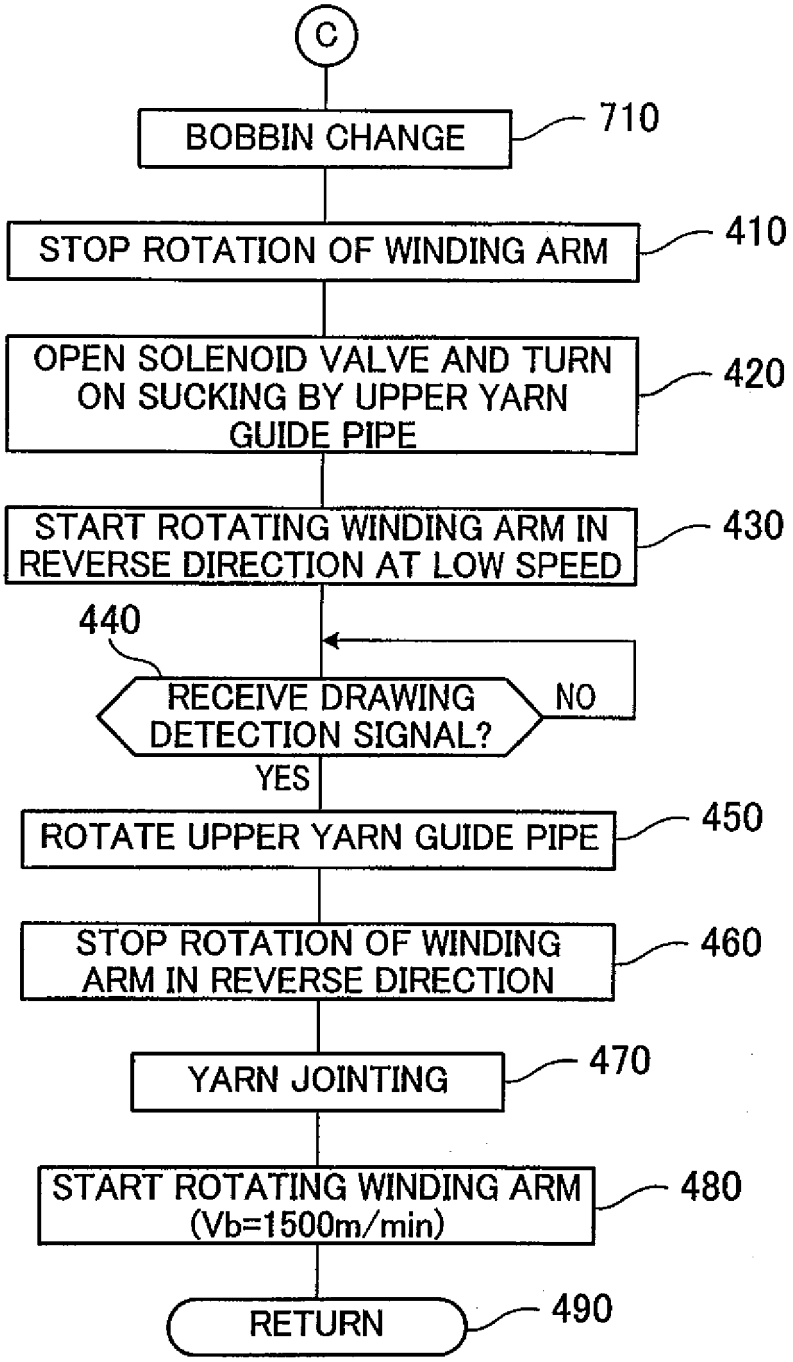

B
STOP ROTATION OF WINDING ARM
410
OPEN SOLENOID VALVE AND TURN ON SUCKING BY UPPER YARN GUIDE PIPE
420
START ROTATING WINDING ARM IN REVERSE DIRECTION AT LOW SPEED
430
440
RECEIVE DRAWING DETECTION SIGNAL?
NO
YES
OBTAIN ROTATION ANGLE OF WINDING ARM
570
CALCULATE DRAWN YARN LENGTH
580
590
HAS DRAWN YARN LENGTH REACHED LENGTH OF YARN DEFECT?
NO
YES
ROTATE UPPER YARN GUIDE PIPE
450
STOP ROTATION OF WINDING ARM IN REVERSE DIRECTION
460
YARN JOINTING
470
START ROTATING WINDING ARM (Vb=1500m/min)
480
RETURN
490

FIG.9


C
BOBBIN CHANGE
710
STOP ROTATION OF WINDING ARM
410
OPEN SOLENOID VALVE AND TURN ON SUCKING BY UPPER YARN GUIDE PIPE
420
START ROTATING WINDING ARM IN REVERSE DIRECTION AT LOW SPEED
430
440
RECEIVE DRAWING DETECTION SIGNAL?
NO
YES
ROTATE UPPER YARN GUIDE PIPE
450
STOP ROTATION OF WINDING ARM IN REVERSE DIRECTION
460
YARN JOINTING
470
START ROTATING WINDING ARM (Vb=1500m/min)
480
RETURN
490

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2010/067113

A. CLASSIFICATION OF SUBJECT MATTER
B65H51/22(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B65H51/22

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2010
Kokai Jitsuyo Shinan Koho	1971-2010	Toroku Jitsuyo Shinan Koho	1994-2010

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 47-14429 A (Zinser Textilmaschinen GmbH), 09 August 1972 (09.08.1972), page 2, upper right column, line 18 to page 6, upper right column, line 16 & DE 2056593 A & US 3749327 A	1-5,9-10,15 6-8,11-14
Y A	CD-ROM of the specification and drawings annexed to the request of Japanese Utility Model Application No. 99743/1991(Laid-open No. 42262/1993) (Murata Machinery Ltd.), 08 June 1993 (08.06.1993), paragraphs [0010] to [0023]; fig. 1 to 2 & US 5377923 A & DE 4221559 A	1-5,9-10,15 6-8,11-14

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 November, 2010 (26.11.10)	07 December, 2010 (07.12.10)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2010/067113

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 117693/1983(Laid-open No. 26465/1985) (Toho Denki Kabushiki Kaisha), 22 February 1985 (22.02.1985), page 3, line 5 to page 6, line 19; fig. 1A, 1B, 1C (Family: none)	1-15
A	JP 5-162923 A (Tsudakoma Corp.), 29 June 1993 (29.06.1993), paragraphs [0005] to [0017]; fig. 1 (Family: none)	1-15

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2004156186 A **[0008]**
- US 3314621 A **[0008]**