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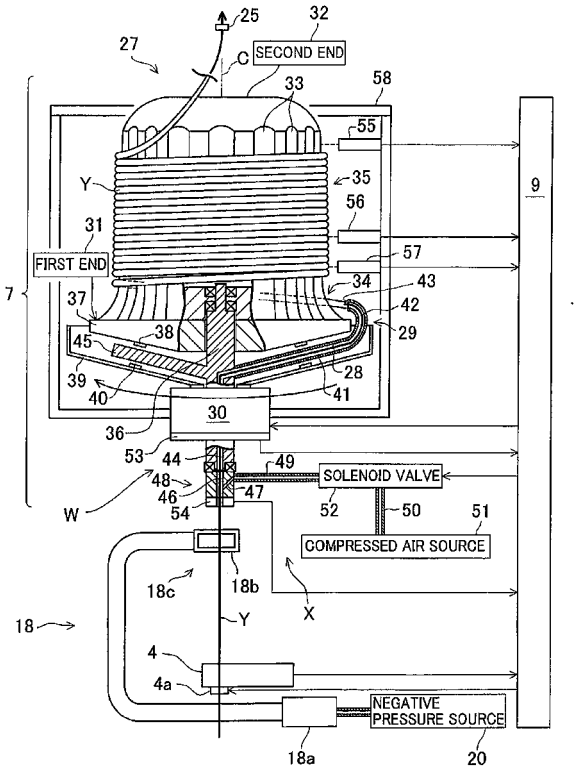
(54) YARN WINDER

(57) A technology for making it possible to continue winding while yarn jointing is carried out is provided. A yarn supplying portion 3 for unwinding a spun yarn Y from a yarn supplying bobbin B, a winding section 5 for winding the spun yarn Y to form a package P, an accumulator 7 provided between the yarn supplying portion 3 and the winding section 5 to store the spun yarn Y, and a yarn end drawing mechanism W for drawing out the yarn end of the stored spun yarn Y to the yarn supplying portion 3 side at the time of bobbin change of the yarn supplying bobbin B, yarn cutting, or yarn breakage are provided.

FIG.2



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Description

Technical Field

[0001] The present invention relates to a yarn winder (yarn winding device).

Background Art

[0002] A yarn winder forms a conical or cylindrical package such that spun yarns wound onto many yarn supplying bobbins are unwound from the bobbins and jointed with one another, while defects of these yarns are removed.

[0003] Such formation of a package by the yarn winder is carried out as follows: A spun yarn unwound from a yarn supplying bobbin receives a tension and is wound onto a rotating package after passing through components such as a yarn guide while being traversed by a traversing drum. When the yarn supplying bobbin becomes empty, a new yarn supplying bobbin replaces the empty bobbin and then yarn jointing is carried out. The yarn winding is continued with repeated bobbin change, until the package obtains a predetermined shape. As such, the yarn winder forms a single package by jointing spun yarns of a plurality of yarn supplying bobbins.

Summary of Invention

Technical Problem

[0004] In the yarn winder above, at the time of bobbin change, yarn breakage, or yarn cutting, the rotation of a package on which a yarn has already been wound is stopped or reversed, a predetermined amount of spun yarn is drawn out from the package and then yarn jointing is conducted, and eventually the package is rotated forward to resume the winding. After the forward rotation, rotation stop, and backward rotation are repeated, a part of yarn layers on the package may be disrupted. Furthermore, at the time of bobbin change, yarn breakage, or yarn cutting above, the yarn end on the package side is wound onto the package for a moment. This yarn end may drop from the end face of the package and get entangled, thereby requiring a special operation by an operator.

[0005] As an example of such a type of technology, Patent Literature 1 recites a supply device which stores yarns in advance for a process of supplying yarns to a yarn consuming machine such as a loom that uses yarns as weft. However, the yarns stored in the supply device are free from yarn defects (yarn defects) because they have already been removed by a yarn winder, and therefore such yarns do not require yarn jointing. As such, the supply device is totally different from the yarn storage section of the subject application in terms of the function.

[0006] In the meanwhile, Patent Literature 2 recites a technology of pneumatic control of yarn supply to a magazine of a yarn winder that serially wind yarns in a textile machine or the like. This magazine recited in the literature is, however, merely used for loosening a yarn to prevent a change in the yarn tension on the upstream from being communicated to the downstream. The magazine is therefore totally different from the yarn storage section of the subject application in terms of the function, in the same way as Patent Literature 1.

Citation List

Patent Literatures

[0007]

Patent Literature 1: Japanese translation of unexamined PCT publication No. 2001-516691
Patent Literature 2: Japanese Examined Patent Publication No. 48-20455

Solution to Problem and Effects

[0008] The problem to be solved by the present invention is as above. Now, means for solving this problem and its effects will be described.

[0009] According to an aspect of the present invention, a yarn winder structured as below is provided. That is to say, a yarn winder includes: a yarn supplying portion for unwinding a spun yarn from a yarn supplying bobbin; a winding section for winding the spun yarn so as to form a package; a yarn storage section which includes a yarn accumulator provided between the yarn supplying portion and the winding section to store the spun yarn as the spun yarn is wound onto the yarn accumulator; a yarn jointing section for performing a yarn jointing operation of jointing a yarn end of the spun yarn on the yarn supplying portion side with a yarn end of the spun yarn on the yarn storage section side; and a yarn end drawing mechanism for drawing out the yarn end of the spun yarn wound onto the yarn accumulator to the yarn supplying portion side, when the yarn jointing section performs the yarn jointing operation.

[0010] As such, because the yarn storage section capable of storing the spun yarn for an amount sufficient to continue the winding of the spun yarn by the winding section during the yarn jointing by the yarn jointing section is provided between the yarn jointing section and the winding section, it is possible to continue the winding of the spun yarn by the winding section during the yarn jointing at the time of bobbin change of the yarn supplying bobbin, yarn cutting, or yarn breakage. That is to say, when yarn jointing is performed at the time of bobbin change of the yarn supplying bobbin, yarn cutting, or yarn breakage, the spun yarn is continuously supplied from the yarn storage section to the winding section, and "the spun yarn on the winding section side" described above is drawn out from the yarn storage section by the yarn end drawing mechanism instead of from the package. It

is therefore possible to resolve the problem that the yarn layers of the package are disrupted after the forward rotation, rotation stop, and backward rotation are repeated to draw out the spun yarn from the package, and the above-described special operation by the operator is therefore unnecessary as the yarn end of the spun yarn Y on the winding section side where viewed from the yarn jointing section remains in the yarn storage section.

[0011] In addition to the above, the following effect is exerted. That is to say, as the frequency of repeating the forward rotation, rotation stop, and backward rotation of the package is decreased, the reduction in the power consumption is excellently achieved and it becomes possible to use a simple braking mechanism generating a relatively low braking force.

[0012] The yarn winder above is further arranged as below. That is to say, the yarn end drawing mechanism draws out the yarn end of the spun yarn wound onto the yarn accumulator to the yarn supplying portion side, by means of an airflow. According to this arrangement, since the yarn end is drawn out by the airflow, the yarn end is drawn out without causing damages to the other parts of the yarn.

[0013] The yarn winder above is further arranged as below. That is to say, the yarn end drawing mechanism includes therein a yarn passage where the spun yarn is able to run, and further includes a yarn guide unit for guiding a part of the spun yarn on the yarn supplying portion side to a predetermined winding position of the yarn accumulator. According to the arrangement above, because the yarn end drawing mechanism W has the yarn guide unit in an integrated manner, the yarn guiding at the time of the yarn winding and the yarn drawing at the time of the yarn jointing operation are carried out at optimal positions.

[0014] The yarn winder above is further arranged as below. That is to say, the predetermined winding position of the yarn accumulator where the spun yarn is guided by the yarn guide unit is, in directions in parallel to a rotation axis of the yarn accumulator, identical with a position where the yarn end drawing mechanism draws out the yarn end of the spun yarn wound onto the yarn accumulator to the yarn supplying portion side by the airflow. According to this arrangement, because in the present embodiment the winding of the yarn and the drawing out of the yarn end are carried out at the same position in the axial directions of the yarn accumulator, the yarn end is certainly drawn out as the cut yarn end exists at the wound position.

[0015] The yarn winder above is further arranged as below. That is to say, the yarn winder further includes: a gas flow generator for generating, in the yarn guide unit, a gas flow flowing from the yarn accumulator side to the yarn supplying portion side. The yarn storage section further includes: a driving unit which is arranged to rotate the yarn guide unit about the winding center axis of the yarn accumulator; and a controller for controlling the driving unit so that the yarn guide unit rotates in a direction opposite to a rotating direction at the time of storing the yarn, when the yarn end drawing mechanism draws out the yarn end of the spun yarn on the outer circumference of the yarn accumulator to the yarn jointing section side. According to the arrangement above, at the time of yarn jointing by the yarn jointing section, the yarn end of the spun yarn Y on the outer circumference of the yarn accumulator is sucked into the yarn passage of the yarn guide unit by the airflow, and drawn out to the yarn supplying portion side. Because the yarn guide unit has the function of guiding the spun yarn on the yarn supplying portion side to the outer circumference of the yarn accumulator and the function of acting as a part of the yarn end drawing mechanism, it is possible to realize the yarn winder with a simple structure. Furthermore, since the yarn path for storing the yarn is identical with the yarn path for the yarn jointing, the spun yarn Y has already been set in the yarn path for storing the yarn when the yarn jointing is completed. It is therefore possible to promptly resume the storing of the yarn after the yarn jointing.

[0016] The yarn winder above is further arranged as below. That is to say, the yarn storage section further includes: a driving unit which is arranged to rotate the yarn guide unit about the winding center axis of the yarn accumulator; and a controller for controlling the driving unit so that the yarn guide unit rotates in a direction opposite to a rotating direction at the time of storing the yarn, when the yarn end drawing mechanism draws out the yarn end of the spun yarn on the outer circumference of the yarn accumulator to the yarn jointing section side. This arrangement facilitates the yarn end of the spun yarn on the outer circumference of the yarn accumulator to be sucked into the yarn passage of the yarn guide unit.

[0017] The yarn winder above is further arranged as below. That is to say, the yarn winder further includes a drawing detection unit which is capable of detecting that the yarn end of the spun yarn wound onto the yarn storage section has been drawn to the yarn supplying portion side.

[0018] That is to say, when it is impossible to detect whether the yarn end drawing mechanism has successfully drawn out the yarn end, time redundancy is required to successfully drawing out the yarn end by the yarn end drawing mechanism. On the other hand, when the drawing detection unit above is provided, it is possible to know whether the drawing out by the yarn end drawing mechanism has successfully been done. The time required to draw out the yarn end of the spun yarn from the yarn storage section to the yarn supplying portion side is therefore shortened.

[0019] In addition to the above, the arrangement also brings about the following effect. That is to say, when the time required for drawing out is shortened, the time for interrupting the storing of the spun yarn in the yarn storage section is also shortened, with the result that the consumption of the storage amount of the spun yarn in the yarn storage section in one yarn jointing is restrained.

This facilitates the prevention of the shortage of the spun yarn in the yarn storage section at the time of yarn jointing. Furthermore, the yarn storage section may be a small accumulator capable of storing only a small amount of spun yarn, and this significantly contributes to the downsizing of the yarn winder.

[0020] The yarn winder above is further arranged as below. That is to say, the drawing detection unit is provided in the yarn storage section. Because the drawing detection unit above is provided in the yarn storage section in this way, it is possible to promptly detect that the yarn end of the spun yarn stored in the yarn storage section has been drawn out to the yarn supplying portion side by the yarn end drawing mechanism, before the yarn end is actually passed to the yarn jointing section.

[0021] The yarn winder above is further arranged as below. That is to say, the yarn storage section is capable of storing the yarn for an amount equal to or larger than an amount of the yarn wound by the winding section at a normal winding speed, during a time interval from the start of bobbin change of the yarn supplying bobbin to at least one yarn jointing by the yarn jointing section. According to this arrangement, it is possible to continue the winding at the normal winding speed by the winding section during a period from the start of the bobbin change of the yarn supplying bobbin to the completion of the yarn jointing by the yarn jointing section. The yarn winder therefore achieves high productivity. Provided that the normal winding speed of the winding section is 1200 [meters/min] and the period from the start of the bobbin change to the completion of the yarn jointing by the yarn jointing section is 6 [sec], the length of the yarn stored by the yarn storage section is 120 [meters], according to the solution above.

[0022] The yarn winder above is further arranged as below. That is to say, the yarn winder further includes: a yarn defect detection section capable of detecting a yarn defect of the spun yarn supplied from the yarn supplying portion; and a cutting member for cutting a part of the yarn on the upstream of the detected yarn defect, the yarn storage section being capable of storing the yarn for an amount equal to or larger than an amount of the yarn wound by the winding section at a normal winding speed, during a time interval from yarn cutting executed by the cutting member when the yarn defect is detected by the yarn defect detection section to at least one yarn jointing by the yarn jointing section. This arrangement makes it possible to continue the winding at the normal winding speed by the winding section during a period from the yarn cutting performed when a yarn defect is detected by the yarn defect detection section to the completion of the yarn jointing by the yarn jointing section. The yarn winder therefore achieves high productivity. Provided that the normal winding speed of the winding section is 1200 [meters/min] and the period from the yarn cutting to the completion of the yarn jointing by the yarn jointing section is 3 [sec], the length of the yarn stored by the yarn storage section is 60 [meters], according to the solution above.

[0023] The yarn winder above is further arranged as below. That is to say, the yarn storage section is capable of storing the yarn for an amount equal to or larger than an amount of the yarn wound by the winding section at a normal winding speed, during a time interval from the occurrence of yarn breakage to at least one yarn jointing by the yarn jointing section. This arrangement makes it possible to continue the winding at the normal winding speed by the winding section during a period from the occurrence of yarn breakage to the completion of the yarn jointing by the yarn jointing section. The yarn winder therefore achieves high productivity. Provided that the normal winding speed of the winding section is 1200 [meters/min] and the period from the yarn breakage to the completion of the yarn jointing by the yarn jointing section is 3 [sec], the length of the yarn stored by the yarn storage section is 60 [meters], according to the solution above.

[0024] The yarn winder above is further arranged as below. That is to say, the yarn storage section is arranged to be capable to storing the spun yarn at speed faster than the normal winding speed at which the winding section winds the spun yarn. That is to say, when the yarn jointing section performs yarn jointing, the storing of the spun yarn by the yarn storage section is interrupted and the spun yarn stored in the yarn storage section is wound by the winding section, with the result that the storage amount of the spun yarn in the yarn storage section is temporarily reduced. In this regard, the arrangement above makes it possible to recover the storage amount to the level before the interruption, after the storing of the spun yarn by the yarn storage section is resumed. It is therefore possible to restrain the storage amount of the spun yarn in the yarn storage section to be minimal (e.g., amount required for performing the yarn jointing three times), thereby the downsizing of the yarn storage section is achieved.

[0025] The yarn winder above is further arranged as below. That is to say, the yarn storage section is provided with a storage amount detector for detecting an amount of the stored spun yarn, and a controller is provided in the yarn winder to reduce winding speed at which the winding section winds the spun yarn when the amount detected by the storage amount detector becomes equal to or lower than a predetermined amount. The arrangement above makes it possible to prevent the storage amount of the spun yarn in the yarn storage section from running out, by means of simple control.

[0026] The yarn winder above is further arranged as below. That is to say, the controller gently reduces the winding speed so that yarn layers of the package are not disrupted. That is to say, as the winding speed is reduced, the yarn layers of the package may be disrupted depending on how the speed is reduced. In this regard, the disruption of the yarn layers of the package is restrained by arranging the controller as above.

[0027] The yarn winder above is further arranged as below. That is to say, the yarn accumulator includes a

first end on the yarn supplying portion side and a second end on the winding section side and has an inclined portion between the first end to the second end as the yarn accumulator is narrowed from the first end to the second end in an outer shape, and the yarn guide unit guides the part of the spun yarn on the yarn supplying portion side to the first end side of the outer circumference of the yarn accumulator. According to the arrangement above, the part of the spun yarn on the yarn supplying portion is wound onto the first end side of the outer circumference of the yarn accumulator, and this wound part of the spun yarn actively moves on the outer circumference of the yarn accumulator from the first end toward the second end on account of a winding force. For this reason, the parts of the spun yarn do not overlap each other at the guide position by the yarn guide unit and hence the spun yarn is smoothly unwound on the yarn accumulator.

[0028] The yarn winder above is further arranged as below. That is to say, the inclined portion of the yarn accumulator is constituted by at least two different slopes, and the slope on the first end side is arranged to be steeper than the slope on the second end side. With this shape, the part of the spun yarn wound on the first end side of the outer circumference of the yarn accumulator starts to move toward the second end immediately after being wound, and this movement slows down when the inclination becomes gentle. As a result, parts of the spun yarn are densely provided on the outer circumference of the yarn accumulator, and this makes it possible to achieve smooth unwinding of the spun yarn on the yarn accumulator and a large storage amount of the yarn at the same time.

[0029] The yarn winder above is further arranged as below. That is to say, the yarn accumulator includes a first end on the yarn supplying portion side and a second end on the winding section side. The yarn storage section is further provided with a conveyor that forcibly conveys the spun yarn wound onto the outer circumference of the yarn accumulator from the first end toward the second end. The yarn guide unit guides the part of the spun yarn on the yarn supplying portion side to the first end side of the outer circumference of the yarn accumulator. According to the arrangement above, the spun yarn is wound onto the first end side on the outer circumference of the yarn accumulator, and the wound spun yarn is forcibly moved from the first end toward the second end on the outer circumference of the yarn accumulator. For this reason, the parts of the spun yarn do not overlap each other at the guide position by the yarn guide unit and hence the spun yarn is smoothly unwound on the yarn accumulator.

[0030] The yarn winder above is further arranged as below. That is to say, the yarn storage section includes a plurality of rollers, a yarn winding mechanism for winding the spun yarn onto the rollers, and a roller drive motor which drives at least one of the rollers as a drive roller, the rollers being rotatably disposed so that rotation axes of the respective rollers are on a virtual circle and the rotation axes of the respective rollers are inclined with respect to directions along the virtual circle. According to the arrangement above, because the rollers on which the spun yarn is wound are inclined, the parts of the spun yarn wound on the rollers by the yarn winding mechanism are serially conveyed and move in a direction (hereinafter, transportation direction) orthogonal to the plane enclosed in the virtual circle. According to this arrangement, since the spun yarn is conveyed by the rollers, the load (friction force) on the yarn is small and hence the deterioration of the quality of the yarn is avoided.

[0031] The yarn winder above is further arranged as below. That is to say, the yarn storage section includes a rotational storage drum which is arranged to rotate so that the spun yarn is wound thereon, a motor for rotating the rotational storage drum in both directions, and a guide member for guiding the spun yarn from the yarn supplying portion side to the rotational storage drum. According to this arrangement, at the time of yarn jointing, the spun yarn wound on the rotational storage drum is drawn out to the yarn supplying portion side as the rotational storage drum is rotated in the direction opposite to the direction at the time of winding the yarn.

[0032] In addition to the above, the yarn winder above is further arranged as below. That is to say, the yarn supplying portion is provided with a yarn unwinding assisting device for lowering a regulator covering a core of the yarn supplying bobbin in sync with unwinding of the spun yarn from the yarn supplying bobbin to assist the unwinding of the spun yarn from the yarn supplying bobbin. According to this arrangement, because 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 a part of the yarn unwound from 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.

Brief Description of Drawings

[0033]

FIG. 1 is a front elevation of a winding unit.
FIG. 2 is a front elevation of an accumulator.
FIG. 3 shows the electric configuration of the winding unit.
FIG. 4 illustrates the movement of the spun yarn on the outer circumference of the accumulator.
FIG. 5 shows the start of the drawing out of a spun yarn.
FIG. 6 shows the completion of the drawing out of the spun yarn.

FIG. 7 shows the drawing out of a yarn defect of a spun yarn.
FIG. 8 is a control flow of normal winding.
FIG. 9 is a control flow at the time of yarn breakage.
FIG. 10 is a control flow for preventing yarn shortage.
FIG. 11 is a control flow at the time of yarn cutting.
FIG. 12 is a control flow at the time of bobbin change.
FIG. 13 relates to Second Embodiment of the present invention.
FIG. 14 relates to Third Embodiment of the present invention.
FIG. 15 relates to Fifth Embodiment of the present invention.
FIG. 16 relates to Sixth Embodiment of the present invention.

Description of Embodiments

<First Embodiment>

[0034] Now, the following will describe a yarn winder according to First Embodiment of the present invention with reference to figures. An automatic winder 1 (textile machine) is composed of many, for example, 60 spindles of winding units 2 (yarn winders) shown in FIG. 1, which are lined up in crosswise directions of the plane of the figure.

[0035] The main components of each winding unit 2 are: a yarn supplying portion 3 arranged to supply a spun yarn Y unwound from the yarn supplying bobbin B; a yarn clearer 4 (yarn defect detection section) which is able to detect a yarn defect (yarn defect) in the spun yarn Y supplied from the yarn supplying portion 3; a winding section 5 which winds the spun yarn Y to form a package P; and a yarn jointing section 6 which is provided between the yarn supplying portion 3 and the winding section 5 and joints the spun yarn Y on the yarn supplying portion 3 side with the spun yarn Y on the winding section 5 side at the time of bobbin change of the yarn supplying bobbin B, yarn cutting carried out when the yarn clearer 4 detects a yarn defect, or yarn breakage. Each winding unit 2 is further provided with an accumulator 7 (yarn storage section) between the yarn jointing section 6 and the winding section 5. This accumulator 7 is capable of storing a spun yarn Y for an amount equal to or larger than the amount of yarn wound by the winding section 5 during the yarn jointing by the yarn jointing section 6, in order to allow the winding section 5 to continue the winding of the spun yarn Y while the yarn jointing section 6 carries out the yarn jointing. FIG. 1 shows a frame 8 that supports the above-described components of the winding unit 2. This frame 8 contains a controller 9 (see also FIG. 3) for controlling the components.

[0036] The yarn supplying portion 3 above includes: a peg 10 which receives a yarn supplying bobbin B from an unillustrated magazine (yarn supplying bobbin holder) and supports the yarn supplying bobbin B to keep a suitable posture; a yarn unwinding assisting device 11 which assists the unwinding of the spun yarn Y from the yarn supplying bobbin B; and a yarn detector 12 which detects whether the spun yarn Y exists between the yarn unwinding assisting device 11 and the yarn jointing section 6. This yarn detector 12 is electrically connected to the controller 9 above, and sends an empty bobbin signal to the controller 9 when not detecting the spun yarn Y.

[0037] The yarn clearer 4 above is able to detect defects such as slubs and foreign matters on the spun yarn Y. The yarn clearer 4 is either an electrostatic capacity type that detects a yarn defect by comparing the quantity of the spun yarn Y with a reference value or a photoelectric type that detects a yarn defect by comparing the diameter of the spun yarn Y with a reference value. Such a yarn clearer 4 includes a yarn defect calculator 4b which calculates the length and width of a yarn defect on the spun yarn Y based on the detection result (e. g. , output voltage value) of the electrostatic-capacity type or the photoelectric type. The yarn clearer 4 is further provided with a cutter 4a (cutting member) for cutting the spun yarn Y. The cutter 4a cuts the spun yarn Y immediately after receiving a yarn cutting signal from the yarn clearer 4. Based on the arrangement above, when the yarn clearer 4 detects a yarn defect of the spun yarn Y, the yarn defect calculator 4b starts to calculate the length of this yarn defect and obtains the width of the yarn defect by calculation. The yarn clearer 4 comprehensively evaluates the calculation result (length and width of the yarn defect) of the yarn defect calculator 4b from various aspects. When it is determined that the calculation result does not fall within an evaluation reference range set by an operator, the yarn clearer 4 sends a yarn cutting signal to the cutter 4a so as to cut the spun yarn Y and sends a yarn defect detection signal to the controller 9. This yarn defect detection signal includes information of the length of the yarn defect calculated by the yarn defect calculator 4b and the information of a type of the yarn defect, which is determined based on the information of the width of the yarn defect calculated by the yarn defect calculator 4b. The controller 9 stores, in a RAM, the information of the length and type of the yarn defect obtained from the yarn clearer 4. The yarn clearer 4 above is arranged to be able to detect a yarn breakage of the spun yarn Y based on the information of the width of the yarn defect calculated by the yarn defect calculator 4b, and the yarn clearer 4 sends a yarn breakage signal to the controller 9 upon detecting a yarn breakage of the spun yarn Y.

[0038] The winding section 5 above includes a cradle 13 holding a winding bobbin Bf and a traversing drum 14 for traversing the spun yarn Y. The cradle 13 above is arranged to be able to swing between a contact state where the package P contacts the traversing drum 14 and a non-contact state. As the cradle 13 rotates in accordance with the increase in the diameter of the package P, the contact state between the package P and the traversing drum 14 is suitably adjusted. The cradle 13 above is provided with a package brake 15 (see FIG. 3) for brak-

ing the rotation of the winding bobbin Bf, whereas the traversing drum 14 is connected to a traversing drum motor 16 (see FIG. 3) for powering the rotation of the traversing drum 14. The package brake 15 and the traversing drum motor 16 are, as shown in FIG. 3, electrically connected to the controller 9, allowing the controller 9 to flexibly control the winding speed Va at which the winding section 5 winds the spun yarn Y.

[0039] As shown in FIG. 1, the winding unit 2 is further provided with a yarn end drawing mechanism W. This yarn end drawing mechanism W draws out the yarn end of the spun yarn Y, which has already been wound onto the accumulator 7, to the yarn jointing section 6 side, at the time of bobbin change of the yarn supplying bobbin B, yarn cutting carried out when the yarn clearer 4 detects a yarn defect, or yarn breakage, i.e., when yarn jointing by the yarn jointing section 6 is needed. Details of this will be given later.

[0040] The yarn jointing section 6 above includes: a splicer 17 for jointing the spun yarn Y on the yarn supplying portion 3 side with the spun yarn Y on the winding section 5 side; an upper relay pipe 18 (upper yarn end guide) that receives the spun yarn Y on the winding section 5 side from the yarn end drawing mechanism W and places the yarn Y on the splicer 17; and a lower relay pipe 19 (lower yarn end guide) which places the spun yarn Y on the yarn supplying portion 3 side on the splicer 17. The upper relay pipe 18 above is supported to be rotatable about an axis 18a, receives a negative pressure from a negative pressure source 20 shown in FIG. 2, and has a leading end where a suction port 18b for sucking the spun yarn Y is formed. Furthermore, this suction port 18b is provided with an unillustrated clamping section 18c which is able to clamp the spun yarn Y sucked into the suction port 18b by closing the suction port 18b. An upper pipe motor 21 (see FIG. 3) for powering the rotation of the upper relay pipe 18 is electrically connected to the controller 9, thereby allowing the controller 9 to flexibly control the rotation of the upper relay pipe 18. Similarly, the lower relay pipe 19 above is supported to be rotatable about an axis 19a, receives a negative pressure from the negative pressure source 20 shown in FIG. 2, and has a leading end where a suction port 19b having a clamping section 19c is formed. A lower pipe motor 22 (see FIG. 3) for powering the rotation of the lower relay pipe 19 is electrically connected to the controller 9, thereby allowing the controller 9 to flexibly control the rotation of the lower relay pipe 19. The splicer 17 is provided with a splicer motor 23 which is a power source for yarn jointing. This splicer motor 23 (see FIG. 3) is also electrically connected to the controller 9, thereby allowing the controller 9 to determine when the splicer 17 starts the yarn jointing.

[0041] As shown in FIG. 1, between the yarn detector 12 and the yarn jointing section 6 is provided a gate-type tensor 24 for providing a desired tension to the spun yarn Y. Between the accumulator 7 and the winding section 5 are provided a gate-type tensor 25 for providing a desired tension to the spun yarn Y and a waxing device 26 for waxing the spun yarn Y. The gate-type tensor 25 is on the upstream of the spun yarn Y whereas the waxing device 26 is on the downstream of the spun yarn Y.

[0042] With the arrangement above, the spun yarn Y unwound from the yarn supplying bobbin B passes through the yarn unwinding assisting device 11, the yarn detector 12, the gate-type tensor 24, and the yarn clearer 4 in this order and is eventually stored in the accumulator 7. The spun yarn Y stored in the accumulator 7 passes through the gate-type tensor 25 and the waxing device 26 in this order, and is wound by the winding section 5 to form a package P while being traversed by the traversing drum 14. At the time of bobbin change of the yarn supplying bobbin B, yarn cutting carried out when the yarn clearer 4 detects a yarn defect, or yarn breakage, a part of the spun yarn Y on the yarn supplying portion 3 side when viewed from the accumulator 7 is wound into the accumulator 7 for a moment, and at the time of the subsequent yarn jointing, the yarn end of the spun yarn Y wound into the accumulator 7 is drawn out to the yarn jointing section 6 side by the above-described yarn end drawing mechanism W.

[0043] Now, referring to FIG. 2, the structure of the accumulator 7 will be detailed.

[0044] According to the present embodiment, as main components the accumulator 7 includes: a cylindrical yarn accumulator 27 on the outer circumference of which the spun yarn Y is wound; a winding arm 29 (yarn guide unit) which has therein a yarn passage 28 where the spun yarn Y is able to run, is rotatable about the axis C of the yarn accumulator 27, and is arranged to guide a part of the spun yarn Y on the yarn supplying portion 3 side to the outer circumference of the yarn accumulator 27; and a winding arm motor 30 (driving unit) for causing the winding arm 29 to rotate about the axis C of the yarn accumulator 27.

[0045] The yarn accumulator 27 above has a first end 31 on the yarn supplying portion 3 side and a second end 32 on the winding section 5 side, and is a pipe narrowed from the first end 31 toward the second end 32 in its outer circumference. On the outer circumference of the yarn accumulator 27, grooves 33 are formed at equal intervals in the circumferential directions to extend in the directions in parallel to the axis C. More specifically, as shown in FIG. 4 (a), on the outer circumference of the yarn accumulator 27, the inclination α of the lower end portion 34 on the first end 31 side is arranged to be larger than the inclination β of the upper end portion 35 on the second end 32 side. More specifically, the inclination α of the lower end portion 34 gently changes from 2 degrees to 60 degrees with respect to the axis C. On the other hand, the inclination β of the upper end portion 35 is arranged to be 2 degrees with respect to the axis C. The lower end portion 34 is smoothly connected with the upper end portion 35. As shown in FIG. 2, the yarn accumulator 27 above is supported at a leading end (upper end) of the output shaft 36 of the winding arm motor 30 via an unillustrated bearing, and the rotation of the yarn accumu-

lator 27 with respect to the winding arm motor 30 is regulated by a magnetic coupling force between a magnet 38 adhered to a first magnet supporter 37 fixed to the first end 31 side of the yarn accumulator 27 and a magnet 40 adhered to a second magnet supporter 39 of the winding arm motor 30.

[0046] The winding arm 29 above is connected to the outer circumference of the output shaft 36 and composed of a linear portion 41 extending radially outward from the outer circumference of the output shaft 36 and a curved portion 42 which circumvents the first magnet supporter 37 and reaches the vicinity of the lower end portion 34 of the yarn accumulator 27. At the leading end of the curved portion 42 is formed an opening 43 that opposes the lower end portion 34. With this arrangement, the winding arm 29 is rotatable about the axis C of the yarn accumulator 27, between the first magnet supporter 37 and the magnet supporter 39 above. As the winding arm 29 rotates about the axis C of the yarn accumulator 27 clockwise in plan view, a part of the spun yarn Y on the yarn supplying portion 3 side, which has been introduced into the yarn passage 28 of the winding arm 29, is wound onto the outer circumference of the yarn accumulator 27. More specifically, because the opening 43 of the winding arm 29 is arranged to oppose the lower end portion 34 of the yarn accumulator 27 on the first end 31 side, a part of the spun yarn Y on the yarn supplying portion 3 side is guided by the winding arm 29 to the lower end portion 34 on the first end 31 side on the outer circumference of the yarn accumulator 27, and is wound onto this outer circumference. The yarn passage 28 of the winding arm 29 is connected to a path 44 formed in the output shaft 36. On the opposite side of the output shaft 36 from the winding arm 29, a balancer 45 is provided to be integrated with the output shaft 36.

[0047] The winding arm motor 30 is a DC brushless motor in the present embodiment and is electrically connected to the controller 9, thereby allowing the controller 9 to flexibly control the rotation speed of the winding arm 29, i.e., to flexibly control the winding speed Vb which is the speed of the spun yarn Y wound onto the yarn accumulator 27.

[0048] On the yarn clearer 4 side of the winding arm motor 30 is provided a blowdown nozzle 48. This blowdown nozzle 48 includes a yarn path 46 connected to the path 44 of the output shaft 36 and a blowdown path 47 which is connected to the yarn path 46 and is inclined from the winding arm 29 side to the upper relay pipe 18 side. To the blowdown path 47 is connected a compressed air source 51 via a connection pipe 49 and a connection pipe 50. Between the connection pipe 49 and the connection pipe 50 is provided a solenoid valve 52 which is electrically connected to the controller 9. With this arrangement, as the controller 9 opens the solenoid valve 52 so that compressed air is supplied from the compressed air source 51 to the yarn path 46 while passing through the connection pipe 50, the connection pipe 49, and the blowdown path 47 in this order, an airflow from the yarn accumulator 27 side to the upper relay pipe 18 side is formed in the yarn passage 28 of the winding arm 29, the path 44 of the output shaft 36 of the winding arm motor 30, and the yarn path 46 of the blowdown nozzle 48. According to the present embodiment, an airflow generator X (gas flow generator) for generating an airflow (gas flow) from the yarn accumulator 27 side to the yarn jointing section 6 side in the yarn passage 28 of the winding arm 29 includes at least the blowdown nozzle 48 and the compressed air source 51. Furthermore, the yarn end drawing mechanism W above includes the winding arm 29 above and the airflow generator X. That is to say, the yarn end drawing mechanism W sucks the yarn end of the spun yarn Y stored in the accumulator 7 by using the airflow generated in the winding arm 29 by the airflow generator X and draws out the spun yarn Y to the yarn jointing section 6 side (i.e. , the yarn supplying portion 3 side). More specifically, the yarn end drawing mechanism W sucks the yarn end of the spun yarn Y stored in the accumulator 7 by using the airflow generated in the winding arm 29 by the airflow generator X, and rotates the winding arm 29 in the direction opposite to the rotational direction at the time of storing the yarn, while keeping the yarn to be sucked. As such, the yarn end drawing mechanism W draws out the spun yarn Y on the outer circumference of the yarn accumulator 27 to the yarn jointing section 6 side via the yarn passage 28 of the winding arm 29.

[0049] As described above, because in the present embodiment the yarn end is drawn out by using an airflow, it is possible to draw out the yarn end without causing any damage on the yarn Y. Furthermore, because in the present embodiment the winding of the yarn Y and the drawing out of the yarn end are carried out at the same position in the axial directions of the yarn accumulator 27, the yarn end is certainly drawn out as the cut yarn end exists at the wound position.

[0050] In addition to the above, the winding arm motor 30 has a rotary encoder 53 (rotation angle detection unit) capable of detecting the rotation angle of the winding arm 29. This rotary encoder 53 is electrically connected to the controller 9. The rotary encoder 53 transmits, to the controller 9, an angle signal corresponding to the rotation angle of the winding arm 29. At the lower end of the blowdown nozzle 48 is provided a drawing sensor 54 (drawing detection unit) capable of detecting whether the yarn end of the spun yarn Y wound by the accumulator 7 has actually been drawn to the yarn jointing section 6 side by the yarn end drawing mechanism W. This drawing sensor 54 is electrically connected to the controller 9, and transmits a drawing detection signal to the controller 9 upon detecting that the yarn end of the spun yarn Y has been drawn to the yarn jointing section 6 side. From the perspective of the entire winding unit 2, the drawing sensor 54 of the present embodiment is provided in the accumulator 7 because the sensor is attached to the winding arm motor 30 of the accumulator 7 via the blowdown nozzle 48.

[0051] The accumulator 7 is further provided with a storage upper limit sensor 55, a storage lower limit sensor 56, and a storage lowest limit sensor 57 for detecting the storage amount of the spun yarn Y. These sensors 55 to 57 are supported by an accumulator attaching frame 58 which is provided for fixing the accumulator 7 to the frame 8, and are electrically connected to the controller 9 as shown in FIG. 3. The storage upper limit sensor 55 is positioned to oppose the upper end of the spun yarn Y wound on the outer circumference of the yarn accumulator 27 when the storage amount of the yarn Y in the accumulator 7 reaches 300m. Similarly, the storage lower limit sensor 56 is positioned to oppose the upper end of the spun yarn Y when the storage amount of the yarn Y in the accumulator 7 reaches 200m. Furthermore, the storage lowest limit sensor 57 is positioned to oppose the upper end of the spun yarn Y when the storage amount of the yarn Y in the accumulator 7 reaches 40m. With this arrangement, the storage upper limit sensor 55 sends a storage amount upper limit signal to the controller 9 while detecting the existence of the spun yarn Y at the opposing position. Similarly, the storage lower limit sensor 56 sends a storage amount lower limit signal to the controller 9 while detecting the existence of the spun yarn Y at the opposing position. Similarly, the storage lowest limit sensor 57 sends a storage amount lowest limit signal to the controller 9 while detecting the existence of the spun yarn Y at the opposing position. According to the present embodiment, a storage amount detector for detecting the storage amount of the spun yarn Y in the accumulator 7 includes the storage upper limit sensor 55, the storage lower limit sensor 56, and the storage lowest limit sensor 57.

[0052] This length, 300m, indicates the length longer than the length of the spun 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 spun yarn Y is less likely to occur in the accumulator 7 even if the winding of the spun yarn Y by the winding section 6 is continued while the yarn jointing is carried out.

[0053] Now, the structure of the controller 9 of the winding unit 2 will be described. That is to say, the controller 9 shown in FIG. 3 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 traversing drum motor controller 60, a winding arm motor controller 61, a drawn yarn length calculation unit 63, and an upper pipe controller 64.

[0054] The traversing drum motor controller 60 reduces the winding speed Va at which the winding section 5 winds the spun yarn Y, when the storage amount detected by the storage amount detector falls below a predetermined value. More specifically, when the storage amount lower limit signal is no longer transmitted from the storage lower limit sensor 56, the traversing drum motor controller 60 gently reduces the winding speed Va to the extent that yarn layers of the package P are not disturbed. Furthermore, when the storage amount lowest limit signal is no longer transmitted from the storage lowest limit sensor 57, the traversing drum motor controller 60 quickly reduces the winding speed Va and eventually stops the winding by the winding section 5. As such, the traversing drum motor controller 60 reduces the winding speed Va when the storage amount of the spun yarn Y in the accumulator 7 becomes low, and stops the winding by the winding section 5 when the storage amount of the spun yarn Y of the accumulator 7 becomes extremely low. A shortage of the spun yarn Y in the accumulator 7 is therefore prevented.

[0055] The winding arm motor controller 61 controls the winding arm motor 30 so that the winding arm 29 rotates in the direction opposite to the direction of the rotation at the time of storing the yarn, when the yarn end drawing mechanism W draws out the yarn end of the spun yarn Y on the outer circumference of the yarn accumulator 27 to the yarn jointing section 6 side.

[0056] The drawn yarn length calculation unit 63 calculates the drawn yarn length which indicates the length of the spun yarn Y drawn out from the accumulator 7 to the yarn jointing section 6 side by the yarn end drawing mechanism W, based on the rotation angle of the winding arm 29 detected by the rotary encoder 53 since the drawing sensor 54 detects the yarn Y. That is to say, the drawn yarn length calculation unit 63 calculates the drawn yarn length based on the diameter Phi of the yarn accumulator 27 stored in a ROM in advance and the rotation angle of the rotation of the winding arm 29 after the drawing sensor 54 detects the spun yarn Y, and stores the drawn yarn length which is the calculation result in a RAM.

[0057] The upper pipe controller 64 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 63, and rotates the upper relay pipe 18 while keeping the cramping state so as to guide the spun yarn Y which is on the winding section 5 side to the splicer 17 and places the spun yarn Y, when it is determined that the drawn yarn length reaches the yarn defect length.

[0058] 1 Now, the operation of the winding unit 2 will be described with reference to FIGs. 4 to 15.

(Start of Winding)

[0059] An operator of the automatic winder 1 shown in FIG. 1 unwinds the spun yarn Y from the yarn supplying bobbin B, places the spun yarn Y onto the yarn unwinding assisting device 11, the yarn detector 12, the yarn clearer 4, the accumulator 7, the gate-type tensor 25, and the waxing device 26, and fixes the spun yarn 7 to the winding bobbin Bf. The yarn path of the spun yarn Y in the accu-

mulator 7 is arranged as shown in FIG. 2. That is to say, the operator causes the spun yarn Y to pass through the drawing sensor 54, the yarn path 46 of the blowdown nozzle 48, the path 44 of the output shaft 36, and the yarn passage 28 of the winding arm 29 in this order. While this state is maintained, the operator draws out the spun yarn Y on the opening 43 side of the winding arm 29 and winds the yarn Y onto the yarn accumulator 27 for, for example, about five to twenty times, and then places the spun yarn Y to the waxing device 26. Although the spun yarn shown in FIG. 2 is thick for convenience of explanation, The yarn accumulator 27 in reality always store the bundle of yarn Y wound for about 600 times.

(Normal Winding)

[0060] When the winding unit 2 is powered on as shown in FIG. 8 while the state above is maintained (S300), the controller 9 starts the rotation of the traversing drum 14 so that the winding speed Va of the spun yarn Y wound by the winding section 5 is 1200m/min and starts the driving of the winding arm 29 so that the winding speed Vb of the spun yarn Y wound onto the accumulator 61 is 1500m/min (S310). As a result, as shown in FIG. 1 and FIG. 2, the bundle of the spun yarn Y wound onto the outer circumference of the yarn accumulator 27 is unwound by the winding section 5 from the upper end, and the spun yarn Y is wound to form a package P while being traversed by the traversing drum 14. At the same time, the spun yarn Y on the yarn supplying portion 3 side is, as shown in FIG. 2, guided to the lower end portion 34 of the yarn accumulator 27 by the winding arm 29, and the winding arm 29 rotates about the axis C of the yarn accumulator 27 clockwise in plan view, so that the spun yarn Y is wound onto the lower end portion of the yarn accumulator 27 on the first end 31 side. More specifically, as shown in FIG. 4(a), the guide position A of the spun yarn part Y1 guided by the winding arm 29 is arranged to oppose the lower end portion 34. The spun yarn part Y1 guided to this guide position A and wound onto the lower end portion 34 receives a winding force F which is exerted in the direction toward the axis C of the yarn accumulator 27. This winding force F and the steep inclination α of the lower end portion 34 produce a running-up force f1 which is a component of force, and the spun yarn part Y1 receiving the running-up force f1 actively moves from the first end 31 side to the second end 32 on the outer circumference of the yarn accumulator 27, as indicated by the thick arrows in FIG. 4(b). Therefore, as shown in FIG. 4 (c), even if the guide position A to which the spun yarn part Y1 is guided by the winding arm 29 is fixed to oppose the lower end portion 34, the spun yarn part Y1 moves from the first end 31 side to the second end 32 side each time the spun yarn part Y1 is guided to the guide position A, with the result that the spun yarn parts Y1 and Y0 do not overlap each other at the guide position A and hence a spun yarn part Y3 is smoothly unwound on the yarn accumulator 27. In this connection, the inclination α of the lower end portion 34 on the first end 31 side is arranged to be larger than the inclination β of the upper end portion 35 on the second end 32 side. For this reason, the spun yarn part Y1 wound onto the guide position A opposing the lower end portion 34 on the first end 31 side on the outer circumference of the yarn accumulator 27 starts to move to the second end 32 immediately after being wound, and the movement slows down as the inclination becomes gentle at the upper end portion 35. On the other hand, the spun yarn part Y2 wound on the outer circumference of the yarn accumulator 27 stays at the boundary between the lower end portion 34 and the upper end portion 35. Therefore the spun yarn part Y1 receiving a faint running-up force f1 contacts this spun yarn part Y2, and pushes up the spun yarn part Y2 and the spun yarn part Y3 to the second end 32 side as shown in FIG. 4(c). As a result, the spun yarn parts Y1 to Y3 are densely provided on the outer circumference of the yarn accumulator 27, and this makes it possible to achieve smooth unwinding of the spun yarn Y on the yarn accumulator 27 and a large storage amount of the yarn at the same time.

[0061] In the normal winding in which the spun yarn Y is wound onto the package P while the spun yarn Y is continuous from the yarn supplying portion 3 to the winding section 5, the controller 9 checks, as shown in FIG. 8, 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). When it is determined that the yarn breakage signal has been supplied (S320: YES), the controller 9 executes the control flow shown in FIG. 9 (S325), and then the process returns to the control flow shown in FIG. 8. Similarly, upon receiving the yarn defect detection signal (S330: YES), the controller 9 executes the control flow shown in FIG. 11 (S335) and then the process returns to the control flow of FIG. 8, and upon receiving the empty bobbin signal (5340: YES), the controller 9 executes the control flow shown in FIG. 12 (S345) and then the process returns to the control flow of FIG. 8.

[0062] Since the winding speed Vb is higher than the winding speed Va for a while after the start of the winding, the storage amount M of the yarn Y in the accumulator 7 increases. When the storage amount M of the yarn Y reaches 300m, the storage upper limit sensor 55 sends a storage amount upper limit signal to the controller 9. Receiving the storage amount upper limit signal from the storage upper limit sensor 55 as shown in FIG. 8 (S350: YES), the controller 9 changes the winding speed Vb from 1500m/min to 1200m/min (S360). The winding speed Va becomes identical with the winding speed Vb as a result, and the storage amount of the accumulator 7 is kept constant.

(Yarn Breakage)

[0063] Assume that yarn breakage of the spun yarn Y occurs at the gate-type tensor 24 shown in FIG. 1. In this case, a part of the spun yarn Y on the downstream of the gate-type tensor 24 is fully wound onto the yarn accumulator 27, and hence the yarn end of the spun yarn Y is wound onto the outer circumference of the lower end portion 34 of the yarn accumulator 27. At the same time, the yarn clearer 4 detects the yarn breakage and sends a yarn breakage signal to the controller 9. As shown in FIG. 8, upon receiving the yarn breakage signal from the yarn clearer 4 (S320: YES), the controller 9 executes the control flow shown in FIG. 9 (S325). That is to say, the controller 9 first of all stops rotation of the winding arm 29 (S410) while simultaneously executing a control flow for preventing yarn accumulator (detailed later) shown in FIG. 10 by means of a knownmultitask technology (S400) Subsequently, the controller 9 opens the solenoid valve 52 shown in FIG. 5 to generate an airflow from the yarn accumulator 27 side to the upper relay pipe 18 side in the yarn passage 28 of the winding arm 29 or the like, as indicated by thick arrows a and b (S420) . At the same time, the controller 9 slightly rotates the upper relay pipe 18 shown in FIG. 5 to operate the clamping section 18c, with the result that the suction port 18b is changed from the closed state to the open state. With this, as indicated by thick arrows c and d, an airflow from the suction port 18b side to the negative pressure source 20 side is formed in the upper relay pipe 18 (S420). Thereafter, the winding arm motor controller 61 controls the winding arm motor 30 to drive the winding arm 29 at a slow speed in the direction opposite to the direction of storing the yarn, i.e., anticlockwise in plan view in FIG. 5 (S430), and a drawing detection signal from the drawing sensor 54 is waited for (S440: NO). As a result, the yarn end of the spun yarn Y on the lower end portion 34 is sucked into the opening 43 of the winding arm 29, and reaches the suction port 18b of the upper relay pipe 18 via the yarn passage 28 of the winding arm 29 or the like as shown in FIG. 6. As the spun yarn Y passes through the drawing sensor 54 at this time, the drawing sensor 54 sends a drawing detection signal to the controller 9. As shown in FIG. 9, upon receiving the drawing detection signal from the drawing sensor 54 (S440: YES), the controller 9 slightly rotates the upper relay pipe 18 while continuing the low-speed rotation of the winding arm 29 so as to operate the clamping section 18c, with the result that the suction port 18b is changed from the open state to the closed state. Furthermore, the controller 9 clamps the spun yarn Y by the clamping section 18c and rotates the upper relay pipe 18 downward, so as to guide the spun yarn Y drawn out from the accumulator 7 to the splicer 17 of the yarn jointing section 6 which is on the yarn supplying portion 3 side as compared to the accumulator 7 (S450). At this stage, the length of a newly drawn part of the yarn Y drawn out from the accumulator 7 by the rotation of the upper relay pipe 18 is about 60cm. To prevent the yarn breakage of the spun yarn Y between the clamping section 18c and the yarn accumulator 27 at this time, the controller 9 synchronizes the rotation of the upper relay pipe 18 with the rotation of the winding arm 29. After the completion of the guide of the spun yarn Y to the splicer 17 by the upper relay pipe 18 (S450), the controller 9 stops the rotation of the winding arm 29 (S460). In the meanwhile, the lower relay pipe 19 sucks and captures the yarn end of the spun yarn Y around the yarn detector 12 and guides this spun yarn Y to the splicer 17, in the same manner as the upper relay pipe 18. When the part of the spun yarn Y on the accumulator 7 side and the part of the spun yarn Y on the yarn supplying portion 3 side are placed on the splicer 17, the controller 9 drives the splicer motor 23 shown in FIG. 3 to execute the yarn jointing by the splicer 17 (S470). Thereafter, the controller 9 starts, as shown in FIG. 2, to rotate the winding arm 29 clockwise in plan view (S480), and hence the normal winding state is resumed from the yarn breakage state shown in FIG. 5 (S490). The number of rotations of the winding arm 29 at this time is arranged so that the winding speed Vb is 1500m/min (S480).

(When Yarn Defect Is Detected)

[0064] In the normal winding shown in FIG. 8, upon receiving the yarn defect detection signal from the yarn clearer 4 (S330: YES), the controller 9 executes the control flow shown in FIG. 11 (S335). That is to say, the controller 9 stops the rotation of the winding arm 29 (S530) while at the same time executing a control flow for preventing yarn shortage shown in FIG. 10 by means of a known multitask technology (S500), so as to form, in the same manner as in the case of the yarn breakage, airflows in the yarn passage 28 or the like as indicated by, for example, thick arrows a, b, c, and d in FIG. 5 by controlling the solenoid valve 52 and the upper pipe motor 21 (S540). Subsequently, the winding arm motor controller 61 controls the winding arm motor 30 so that the winding arm 29 rotates at a low speed in the direction opposite to the direction at the time of storing the yarn, i.e., anticlockwise in plan view in FIG. 5 (S550), and then a drawing detection signal from the drawing sensor 54 is waited for (S560: NO). As a result, the yarn end of the spun yarn Y on the lower end portion 34 is sucked into the opening 43 of the winding arm 29, and reaches the suction port 18b of the upper relay pipe 18 via the yarn passage 28 of the winding arm 29 or the like, as shown in FIG. 6. As the spun yarn Y passes through the drawing sensor 54 at this time, the drawing sensor 54 sends a drawing detection signal to the controller 9. As shown in FIG. 11, receiving the drawing detection signal from the drawing sensor 54 (S560: YES), the drawn yarn length calculation unit 63 obtains the rotation angle of the winding arm 29 detected by the rotary encoder 53, which indicates how many angles the winding arm 29 rotates after the detection of the spun yarn Y by the drawing sensor 54 (S570), and the drawn yarn length is calculated based on this

rotation angle (S580). 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 64 is on standby until the drawn yarn length reaches the yarn defect length (S590: NO) . When the drawn yarn length reaches the yarn defect length as shown in FIG. 7 (S590: YES), the controller 9 slightly rotates the upper relay pipe 18 while continuing the low-speed rotation of the winding arm 29 so as to operate the clamping section 18c, with the result that the suction port 18b is changed from the open state to the closed state. Furthermore, the controller 9 clamps the spun yarn Y by the clamping section 18c and rotates the upper relay pipe 18 downward, so as to guide the spun yarn Y drawn out from the accumulator 7 to the splicer 17 of the yarn jointing section 6 (S600). The two-dot chain line Y6 in FIG. 7 indicates a spun yarn with a yarn defect. At this stage, the length of a newly drawn part of the spun yarn Y drawn out from the accumulator 7 by the rotation of the upper relay pipe 18 is about 60cm. To prevent the yarn breakage of the yarn Y between the clamping section 18c and the yarn accumulator 27 at this time, the controller 9 synchronizes the rotation of the upper relay pipe 18 with the rotation of the winding arm 29. After the completion of the guide of the spun yarn Y to the splicer 17 by the upper relay pipe 18 (S600), the controller 9 stops the rotation of the winding arm 29 (S610). In the meanwhile, the lower relay pipe 19 sucks and captures the yarn end of the spun yarn Y around the yarn detector 12 and guides this spun yarn Y to the splicer 17, in the same manner as the upper relay pipe 18. When the part of the spun yarn Y on the accumulator 7 side and the part of the spun yarn Y on the yarn supplying portion 3 side are placed on the splicer 17, the controller 9 drives the splicer motor 23 shown in FIG. 3 to conduct the yarn jointing by the splicer 17 (S620). Thereafter, the controller 9 starts, as shown in FIG. 2, to rotate the winding arm 29 clockwise in plan view (S630), and hence the normal winding state is resumed from the yarn breakage state shown in FIG. 5 (S640). The number of rotations of the winding arm 29 at this time is arranged so that the winding speed Vb is 1500m/min (S630).

(When Bobbin Is Changed)

[0065] Assume that the yarn supplying bobbin B becomes empty. In this case, a part of the spun yarn Y on the downstream of the gate-type tensor 24 is fully wound onto the yarn accumulator 27, and the yarn end of the spun yarn Y is wound onto the outer circumference of the lower end portion 34 of the yarn accumulator 27. At the same time, the yarn detector 12 sends an empty bobbin signal to the signal controller 9. As shown in FIG. 8, upon receiving the empty bobbin signal from the yarn detector 12 (S340: YES), the controller 9 executes the control flow show in FIG. 12 (S345). That is to say, the controller 9 exhausts the currently-attached yarn supplying bobbin B and attaches a new yarn supplying bobbin B to the peg 10 while executing the control flow for preventing yarn shortage shown in FIG. 10 by means of a known multitask technology (S700), guides the spun yarn Y of the yarn supplying bobbin B to allow the lower relay pipe 19 to be able to capture and suck the spun yarn Y (S710), and almost at the same time stops the rotation of the winding arm 29 (S720). Subsequently, in the same manner as the case of yarn breakage, the controller 9 controls the solenoid valve 52 and the upper pipe motor 21 to form an airflow in the yarn passage 28 or the like, as indicated by thick arrows a, b, c, and d in FIG. 5 (S730). Thereafter, the winding arm motor controller 61 controls the winding arm motor 30 to drive the winding arm 29 at a slow speed in the direction opposite to the direction of winding the yarn, i.e., anticlockwise in plan view (S740), and a drawing detection signal from the drawing sensor 54 is waited for (S750: NO). As a result, the yarn end of the spun yarn Y on the lower end portion 34 is sucked into the opening 43 of the winding arm 29, and reaches the suction port 18b of the upper relay pipe 18 via the yarn passage 28 of the winding arm 29 or the like, as shown in FIG. 6. As the spun yarn Y passes through the drawing sensor 54 at this time, the drawing sensor 54 sends a drawing detection signal to the controller 9. As shown in FIG. 12, upon receiving the drawing detection signal from the drawing sensor 54 (S750: YES), the controller 9 slightly rotates the upper relay pipe 18 while continuing the low-speed rotation of the winding arm 29 so as to operate the clamping section 18c, with the result that the suction port 18b is changed from the open state to the closed state. Furthermore, the controller 9 clamps the spun yarn Y by the clamping section 18c and rotates the upper relay pipe 18 downward, so as to guide the spun yarn Y drawn out from the accumulator 7 to the splicer 17 of the yarn jointing section 6 (S760). At this stage, the length of a newly drawn part of the spun yarn Y drawn out from the accumulator 7 by the rotation of the upper relay pipe 18 is about 60cm. To prevent the yarn breakage of the spun yarn Y between the clamping section 18c and the yarn accumulator 27 at this time, the controller 9 synchronizes the rotation of the upper relay pipe 18 with the rotation of the winding arm 29. After the completion of the guide of the spun yarn Y to the splicer 17 by the upper relay pipe 18 (S760), the controller 9 stops the rotation of the winding arm 29 (S770). In the meanwhile, the lower relay pipe 19 sucks and captures the yarn end of the spun yarn Y around the yarn detector 12 and guides this spun yarn Y to the splicer 17, in the same manner as the upper relay pipe 18. When the part of the spun yarn Y on the accumulator 7 side and the part of the spun yarn Y on the yarn supplying portion 3 side are placed on the splicer 17, the controller 9 drives the splicer motor 23 shown in FIG. 3 to conduct the yarn jointing by the splicer 17 (S780). Thereafter, the controller 9 starts, as shown in FIG. 2, to rotate the winding arm 29 clockwise in plan view (S790), and hence the normal winding state is resumed from the yarn breakage state

shown in FIG. 5 (S800). The number of rotations of the winding arm 29 at this time is arranged so that the winding speed Vb is 1500m/min (S790).

[0066] Now, the control flow for preventing yarn shortage will be described. In the control flow, as shown in FIG. 10, when the storage amount lower limit signal becomes no longer sent from the storage lower limit sensor 56 (S900: NO), the winding speed Va is reduced until the winding speed Va becomes lower than the 500m/min (S910: YES) so gradually that the yarn layers of the package P are not disrupted, e.g., by 100m/min in each 0.5 second (S920). As such, the traversing drum motor controller 60 reduces the winding speed Va when the amount of the spun yarn Y stored in the accumulator 7 becomes small, and this prevents the yarn shortage of the spun yarn Y in the accumulator 7. Furthermore, when the accumulator 7 resumes the storing of the spun yarn Y (S960: YES), the controller 9 increases the winding speed Va until the winding speed Va reaches 1200m/min (S970: NO), so gradually that the yarn layers of the package P are not disrupted, e.g., by 100m/min in each 0.5 second (S980). When the winding speed Va reaches 1200m/min (S970: YES), the controller 9 completes the control flow for preventing yarn shortage shown in FIG. 13 (S990). On the other hand, when the storage amount lowest limit signal becomes no longer sent from the storage lowest limit sensor 57 (S930: NO), the winding speed Va is quickly reduced until the winding speed Va becomes zero (S940: YES), e. g. , by 800m/min in each 0. 5 second, with the result that the winding is stopped (S950). This control procedure prevents yarn shortage by stopping the winding.

(Summary)

(Technical Matter 1)

[0067] As described above, according to the present embodiment, the winding unit 2 is arranged as below as shown in, for example, FIG. 1. That is to say, the winding unit 2 includes: a yarn supplying portion 3 for unwinding a spun yarn Y from a yarn supplying bobbin B and supplying the same; a yarn clearer 4 arranged to be detactable a yarn defect of the spun yarn Y supplied from the yarn supplying portion 3; a winding section 5 for winding the spun yarn Y to form a package P; and a yarn jointing section 6 which is provided between the yarn supplying portion 3 and the winding section 5 to joint a part of the spun yarn Y on the yarn supplying portion 3 side with a part of the spun yarn Y on the winding section 5 side. The winding unit 2 further includes: an accumulator 7 which is provided between the yarn jointing section 6 and the winding section 5 to be able to store the spun yarn Y for an amount equal to or larger than an amount of the yarn wound by the winding section 5 during the yarn jointing by the yarn jointing section 6; and a yarn end drawing mechanism W which draws out the yarn end of the spun yarn Y wound into the accumulator 7 to the yarn jointing section 6 side (yarn supplying portion 3 side) at the time of the yarn jointing by the yarn jointing section 6.

[0068] As such, because the accumulator 7 capable of storing the spun yarn Y for an amount sufficient to continue the winding of the spun yarn Y by the winding section 5 during the yarn jointing by the yarn jointing section 6 is provided between the yarn jointing section 6 and the winding section 5, it is possible to continue the winding of the spun yarn Y by the winding section 5 during the yarn jointing at the time of bobbin change of the yarn supplying bobbin, yarn cutting, or yarn breakage. In other words, the spun yarn Y is continuously supplied from the accumulator 7 to the winding section 5 at the time of yarn jointing, and "the spun yarn Y on the winding section 5 side" described above is drawn out from the accumulator 7 by the yarn end drawing mechanism W instead of from the package P, as shown in FIG. 5 and FIG. 6. It is therefore possible to resolve the problem that the yarn layers of the package P are disrupted after the forward rotation, rotation stop, and backward rotation are repeated to draw out the spun yarn Y from the package P, and the above-described special operation by the operator is therefore unnecessary as the yarn end of the spun yarn Y on the winding section 5 side where viewed from the yarn jointing section 6 remains in the accumulator 7.

[0069] In addition to the above, the following effect is also exerted. That is to say, as the frequency of repeating the forward rotation, rotation stop, and backward rotation of the package P is decreased, the reduction in the power consumption is excellently achieved and it becomes possible to use a simple braking mechanism generating a relatively low braking force.

(Technical Matter 2)

[0070] In addition to the above, the winding unit 2 is further arranged as below. That is to say, the yarn end drawing mechanism W draws out the yarn end of the yarn Y wound onto the yarn accumulator 27 to the yarn supplying portion 3 side by means of an airflow. According to this arrangement, since the yarn end is drawn out by the airflow, the yarn end is drawn out without causing damages to the other parts of the yarn.

(Technical Matter 3)

[0071] In addition to the above, the winding unit 2 is further arranged as below. That is to say, the yarn end drawing mechanism W includes therein a yarn passage where the yarn Y is able to run, and further includes a yarn guide unit for guiding a part of the yarn Y on the yarn supplying portion 3 side to a predetermined winding position of the yarn accumulator 27. According to the arrangement above, because the yarn end drawing mechanism W has the yarn guide unit in an integrated manner, the yarn guiding at the time of the yarn winding and the yarn drawing at the time of the yarn jointing operation are carried out at optimal positions.

(Technical Matter 4)

[0072] In addition to the above, the winding unit 2 is further arranged as below. That is to say, the accumulator 7 includes: a yarn accumulator 27 on the outer circumference of which the spun yarn Y is wound; a winding arm 29 which includes therein a yarn passage 28 where the spun yarn Y is able to run, is rotatable about the axis C of the yarn accumulator 27, and guides the spun yarn Y on the yarn supplying portion 3 to the outer circumference of the yarn accumulator 27; and an airflow generator X for generating an airflow flowing from the yarn accumulator 27 side to the yarn jointing section 6 side in the winding arm 29. The yarn end drawing mechanism W is arranged to include the winding arm 29 and the airflow generator X. According to the arrangement above, at the time of yarn jointing by the yarn jointing section 6, the yarn end of the spun yarn Y on the outer circumference of the yarn accumulator 27 is sucked into the yarn passage 28 of the winding arm 29 by the airflow, and drawn out to the yarn jointing section 6 side. Because the winding arm 29 has the function of guiding the spun yarn Y on the yarn supplying portion 3 side to the outer circumference of the yarn accumulator 27 and the function of acting as a part of the yarn end drawing mechanism W, it is possible to realize the winding unit 2 with a simple structure. Furthermore, since the yarn path for storing the yarn is identical with the yarn path for the yarn jointing, the spun yarn Y has already been set in the yarn path for storing the yarn when the yarn jointing is completed. It is therefore possible to promptly resume the storing of the yarn after the yarn jointing.

(Technical Matter 5)

[0073] In addition to the above, the winding unit 2 is further arranged as below. That is to say, the accumulator 7 is further provided with a winding arm motor 30 which rotates the winding arm 29 about the axis C of the yarn accumulator 27. In addition to the above, a winding arm motor controller 61 is further provided for controlling the winding arm motor 30 to cause the winding arm 29 to rotate in a direction opposite to the rotational direction at the time of storing the yarn, when the yarn end drawing mechanism W draws out the yarn end of the spun yarn Y on the outer circumference of the yarn accumulator 27 to the yarn jointing section 6. This arrangement facilitates the yarn end of the spun yarn Y on the outer circumference of the yarn accumulator 27 to be sucked into the yarn passage 28 of the winding arm 29.

(Technical Matter 6)

[0074] In addition to the above, preferably the winding unit 2 is further arranged as below. That is to say, the accumulator 7 is arranged to be able to store the yarn for an amount equal to or larger than an amount of the yarn wound at the normal winding speed Va by the winding section 5 during a period from the start of the bobbin change of the yarn supplying bobbin B to the completion of the yarn jointing by the yarn jointing section 6. According to this arrangement, it is possible to continue the winding at the normal winding speed Va by the winding section 5 during a period from the start of the bobbin change of the yarn supplying bobbin B to the completion of the yarn jointing by the yarn jointing section 6. The winding unit 2 therefore achieves high productivity. Provided that the normal winding speed Va of the winding section 5 is 1200 [meters/min] and the period from the start of the bobbin change to the completion of the yarn jointing by the yarn jointing section 6 is 6 [sec], the length of the yarn stored by the accumulator 7 is 120 [meters], according to the solution above. It is noted that the accumulator 7 according to the present embodiment, which is for the spun yarn of the cotton yarn number 30, is capable of storing 300 meters of yarn.

(Technical Matter 7)

[0075] In addition to the above, preferably the winding unit 2 is further arranged as below. That is to say, the accumulator 7 is capable of storing the yarn for an amount equal to or larger than an amount of the yarn wound at the normal winding speed Va by the winding section 5 during a period from the yarn cutting performed when a yarn defect is detected by the yarn clearer 4 to the completion of the yarn jointing by the yarn jointing section 6. This arrangement makes it possible to continue the winding at the normal winding speed Va by the winding section 5 during a period from the yarn cutting performed when a yarn defect is detected by the yarn clearer 4 to the completion of the yarn jointing by the yarn jointing section 6. The winding unit 2 therefore achieves high productivity. Provided that the normal winding speed Va of the winding section 5 is 1200 [meters/min] and the period from the yarn cutting to the completion of the yarn jointing by the yarn jointing section 6 is 3 [sec], the length of the yarn stored by the accumulator 7 is 60 [meters], according to the solution above. It is noted that the accumulator 7 according to the present embodiment, which is for the spun yarn of the cotton yarn number 30, is capable of storing 300 meters of yarn.

(Technical Matter 8)

[0076] In addition to the above, the winding unit 2 is further arranged as below. That is to say, the accumulator 7 is capable of storing the yarn for an amount equal to or larger than an amount of the yarn wound at the normal winding speed Va by the winding section 5 during a period from the occurrence of yarn breakage to the completion of the yarn jointing by the yarn jointing section 6. This arrangement makes it possible to continue the winding at the normal winding speed Va by the winding section 5 during a period from the occurrence of yarn breakage to the completion of the yarn jointing by the yarn jointing

section 6. The winding unit 2 therefore achieves high productivity. Provided that the normal winding speed Va of the winding section 5 is 1200 [meters/min] and the period from the occurrence of yarn breakage to the completion of the yarn jointing by the yarn jointing section 6 is 3 [sec], the length of the yarn stored by the accumulator 7 is 60 [meters], according to the solution above. It is noted that the accumulator 7 according to the present embodiment, which is for the spun yarn of the cotton yarn number 30, is capable of storing 300 meters of yarn.

(Technical Matter 9)

[0077] In addition to the above, the winding unit 2 is further arranged as below. That is to say, for example, as indicated by the step S310 in FIG. 8, the accumulator 7 is capable of storing the spun yarn Y at a speed (winding speed Vb) faster than the normal winding speed Va at which the winding section 5 winds the spun yarn Y. That is to say, when the yarn jointing section 6 performs yarn jointing, the storing of the spun yarn Y by the accumulator 7 is interrupted and the spun yarn Y stored in the accumulator 7 is wound by the winding section 5, with the result that the storage amount M of the spun yarn Y in the accumulator 7 is temporarily reduced. In this regard, the arrangement above makes it possible to recover the storage amount M to the level before the interruption, after the storing of the spun yarn Y by the accumulator 7 is resumed. It is therefore possible to restrain the storage amount M of the spun yarn Y in the accumulator 7 to be minimal (e.g., amount required for performing the yarn jointing three times), thereby the downsizing of the accumulator 7 is achieved.

(Technical Matter 10)

[0078] In addition to the above, the winding unit 2 is further arranged as below. That is to say, as shown in figures such as FIG. 2 and FIG. 3, the accumulator 7 is provided with a storage amount detector (storage upper limit sensor 55, storage lower limit sensor 56, storage lowest limit sensor 57) for detecting the storage amount M of the spun yarn Y. As shown in, for example, FIG. 10, a traversing drum motor controller 60 is further provided to reduce the winding speed Va at which the winding section 5 winds the spun yarn Y, when the storage amount M detected by the storage amount detector becomes lower than a predetermined amount. The arrangement above makes it possible to prevent the storage amount M of the spun yarn Y in the accumulator 7 from running out, by means of simple control.

(Technical Matter 11)

[0079] In addition to the above, the winding unit 2 is further arranged as below. That is to say, the traversing drum motor controller 60 gently reduces, as shown in FIG. 10 for example, the winding speed Va to the extent that the yarn layers of the package P are not disrupted. That is to say, as the winding speed Va is reduced, the yarn layers of the package P may be disrupted depending on how the speed is reduced. In this regard, the disruption of the yarn layers of the package P is restrained when the traversing drum motor controller 60 is arranged as above.

(Technical Matter 12)

[0080] In addition to the above, the winding unit 2 is further arranged as below. That is to say, as shown in FIG. 2 for example, the yarn accumulator 27 has a first end 31 on the yarn supplying portion 3 side and a second end 32 on the winding section 5 side and is narrowed from the first end 31 to the second end 32 in its outer circumference. The winding arm 29 guides the part of the spun yarn Y on the yarn supplying portion 3 side to the first end 31 side on the outer circumference of the yarn accumulator 27. According to the arrangement above, the part of the spun yarn Y on the yarn supplying portion 3 is wound onto the first end 31 side of the outer circumference of the yarn accumulator 27, and this wound part of the spun yarn Y actively moves, as shown in FIG. 4, on the outer circumference of the yarn accumulator 27 from the first end 31 toward the second end 32 on account of a winding force F. For this reason, the parts of the spun yarn Y do not overlap each other at the guide position A by the winding arm 29 and hence the spun yarn Y is smoothly unwound on the yarn accumulator 27.

(Technical Matter 13)

[0081] In addition to the above, the winding unit 2 is further arranged as below. That is to say, as shown in FIG. 4 for example, the inclination α on the first end 31 side of the outer circumference of the yarn accumulator 27 is arranged to be larger than the inclination β on the second end 32 side. With this shape, the part of the spun yarn Y wound on the first end 31 side of the outer circumference of the yarn accumulator 27 starts to move toward the second end 32 immediately after being wound, and this movement slows down when the inclination becomes gentle. As a result, parts of the spun yarn are densely provided on the outer circumference of the yarn accumulator 27, and this makes it possible to achieve smooth unwinding of the spun yarn Y on the yarn accumulator 27 and a large storage amount of the yarn at the same time.

(Technical Matter 14)

[0082] In addition to the above, the winding unit 2 of the embodiment above is further arranged as below. That is to say, a accumulator 7 capable of storing the spun yarn Y is provided between the yarn jointing section 6 and the winding section 5. A yarn end drawing mecha-

nism W is provided to draw out the yarn end of the spun yarn Y wound into the accumulator 7 to the yarn jointing section 6 side when the yarn jointing section 6 performs yarn jointing. A drawing sensor 54 capable of detecting that the yarn end of the spun yarn Y wound into the accumulator 7 has actually been drawn to the yarn jointing section 6 by the yarn end drawing mechanism W is further provided.

[0083] That is to say, when it is impossible to detect whether the yarn end drawing mechanism W has successfully been drawn out the yarn end, time redundancy is required to successfully drawing out the yarn end by the yarn end drawing mechanism W. On the other hand, when the drawing sensor 54 above is provided, it is possible to know whether the drawing out by the yarn end drawing mechanism W has successfully been done. The time required to draw out the yarn end of the spun yarn Y from the accumulator 7 to the yarn jointing section 6 side is therefore shortened.

[0084] In addition to the above, the arrangement also brings about the following effect. That is to say, when the time required for drawing out is shortened, the time for interrupting the storing of the spun yarn Y in the accumulator 7 is also shortened, with the result that the consumption of the storage amount M of the spun yarn Y in the accumulator 7 in one yarn jointing is restrained. This facilitates the prevention of the shortage of the spun yarn Y in the accumulator 7 at the time of yarn jointing. Furthermore, the accumulator 7 may be a small accumulator capable of storing only a small amount of spun yarn Y, and this significantly contributes to the downsizing of the winding unit 2.

(Technical Matter 15)

[0085] In addition to the above, the winding unit 2 is further arranged as below. That is to say, as shown in FIG. 2 for example, the drawing sensor 54 is provided in the accumulator 7. Because the drawing sensor 54 above is provided in the accumulator 7 in this way, it is possible to promptly detect that the yarn end of the spun yarn Y stored in the accumulator 7 has been drawn out to the yarn jointing section 6 side by the yarn end drawing mechanism W, before the yarn end is actually passed to the yarn jointing section 6.

(Technical Matter 16)

[0086] In addition to the above, the winding unit 2 is further arranged as below. That is to say, the accumulator 7 includes: a yarn accumulator 27 on the outer circumference of which the spun yarn Y is wound; a winding arm 29 which includes therein a yarn passage 28 where the spun yarn Y is able to run, is rotatable about the axis C of the yarn accumulator 27, and guides the spun yarn Y on the yarn supplying portion 3 to the outer circumference of the yarn accumulator 27; and a winding arm motor 30 for rotating the winding arm 29 about the axis C of the yarn accumulator 27. The yarn end drawing mechanism W draws out the spun yarn Y on the outer circumference of the yarn accumulator 27 to the yarn jointing section 6 side via the yarn passage 28 of the winding arm 29, while rotating the winding arm 29 in the direction opposite to the rotational direction at the time of storing the yarn. A rotary encoder 53 capable of detecting the rotation angle of the winding arm 29 is further provided. A drawn yarn length calculation unit 63 is further provided to calculate the drawn yarn length which indicates the length of the spun yarn Y drawn out from the accumulator 7 to the yarn jointing section 6 side by the yarn end drawing mechanism W, based on the rotation angle of the winding arm 29 detected by the rotary encoder 53 since the drawing sensor 54 detects the yarn Y. Because the drawn yarn length calculation unit 63 is provided in this way, the spun yarn Y on the outer circumference of the yarn accumulator 27 is drawn out for a sufficient length. For this reason, as shown in FIG. 11 for example, it is possible to draw out the yarn from the yarn accumulator 27 for a length equivalent to the yarn defect length detected by the yarn clearer 4.

[0087] 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 accumulator 7 between the yarn supplying bobbin B and the winding section 5, it is possible to prevent a tension change due to the traversal of the winding section 5 from being transferred to the part of the yarn unwound from the yarn supplying bobbin B. Furthermore, since the yarn unwinding from the yarn supplying bobbin is stably performed because the unwinding assist unit 11 is attached to the yarn supplying bobbin B, 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.

(Technical Matter 17)

[0088] In addition to the above, the yarn winder above is further arranged as below. That is to say, the yarn supplying portion 3 is provided with a yarn unwinding assisting device 11 for lowering a regulator covering the core of the yarn supplying bobbin B, in sync with unwinding of the yarn from the yarn supplying bobbin B to assist the unwinding of the yarn from the yarn supplying bobbin B. According to this arrangement, because the transmission of the tension of the yarn Y is blocked by providing the accumulator 7 between the yarn supplying bobbin B and the winding section 3, it is possible to prevent a tension change due to the traversal of the winding section from being transferred to the part of the yarn unwound from the yarn supplying bobbin B. Furthermore, since the yarn unwinding from the yarn supplying bobbin B is stably performed because the unwinding assist unit 11 is attached to the yarn supplying bobbin B, it is possible to prevent yarn breakage and to increase the speed of un-

winding from the yarn supplying bobbin. The efficiency in the unwinding from the yarn supplying bobbin is therefore improved.

<Second Embodiment>

[0089] Now, Second Embodiment of the present invention will be described with reference to FIG. 13. The description below predominantly deals with differences between the present embodiment and First Embodiment above to avoid redundancy.

[0090] In First Embodiment, as shown in FIG. 2, the drawing sensor 54 is provided in the accumulator 7. On the other hand, the present embodiment is arranged so that, as shown in FIG. 13, the drawing sensor 54 is provided in the yarn jointing section 6. More specifically, the drawing sensor 54 is provided at the upper relay pipe 18 of the yarn jointing section 6.

(Summary)

(Technical Matter 18)

[0091] As described above, according to the present embodiment, the winding unit 2 is arranged as below. That is to say, the drawing sensor 54 is provided in the yarn jointing section 6. According to this arrangement, the drawing sensor 54 is able to detect not only that the yarn end of the spun yarn Y stored in the accumulator 7 has been drawn to the yarn jointing section 6 side by the yarn end drawing mechanism W but also that the spun yarn Y has been correctly passed from the yarn end drawing mechanism W to the yarn jointing section 6.

(Technical Matter 19)

[0092] In addition to the above, the winding unit 2 is further arranged as below. That is to say, the yarn jointing section 6 includes: a splicer 17 for jointing a part of the spun yarn Y on the yarn supplying portion 3 side with a part of the spun yarn Y on the winding section 5 side; and an upper relay pipe 18 for receiving the part of the spun yarn Y on the winding section 5 side from the yarn end drawing mechanism W and placing the same on the splicer 17. The drawing sensor 54 is provided in the upper relay pipe 18. As such, it is rational to provide the drawing sensor 54 in a component that receives the spun yarn Y first, among the components constituting the yarn jointing section 6.

<Third Embodiment>

[0093] Now, referring to FIG. 14, Third Embodiment of the present invention will be described. The description below predominantly deals with differences between the present embodiment and First Embodiment above to avoid redundancy.

[0094] In First Embodiment, as shown in FIG. 2, the drawing sensor 54 is provided in the accumulator 7. On the other hand, the present embodiment is arranged so that the yarn clearer 4 is used as the drawing sensor 54. More specifically, the existence of the part of the spun yarn Y on the winding section 5 side is detectable by the yarn clearer 4, when the upper relay pipe 18 receives the yarn end of the spun yarn Y from the yarn end drawing mechanism W as shown in FIG. 6, the upper relay pipe 18 rotates upward as shown in FIG. 14, and the part of the spun yarn Y on the accumulator 7 side is placed onto the splicer 17 of the yarn jointing section 6 and the yarn jointing section 6 performs yarn jointing. To put it differently, the yarn path of the spun yarn Y between the splicer 17 and the accumulator 7 at the time of normal winding and the yarn path of the spun yarn Y between the splicer 17 and the accumulator 7 at the time of yarn jointing are overlapped. For this reason, as the yarn end drawing mechanism W attempts to draw out the yarn end of the spun yarn Y wound on the outer circumference of the yarn accumulator 27 for a predetermined period of time and the upper relay pipe 18 is rotated no matter whether the drawing out of the spun yarn Y from the accumulator 7 has successfully been done, it is possible, by monitoring an output signal of the yarn clearer 4, to check whether the yarn end of the spun yarn Y stored in the accumulator 7 has actually been drawn to the yarn jointing section 6 side by the yarn end drawing mechanism W.

(Summary)

(Technical Matter 20)

[0095] As described above, according to the present embodiment, the winding unit 2 is arranged as below. That is to say, when the yarn jointing section 6 performs yarn jointing, the existence of the part of the spun yarn Y on the winding section 5 side is detectable by the yarn clearer 4. This yarn clearer 4 is utilized as the drawing sensor 54 above.

<Fourth Embodiment>

[0096] Now, Fourth Embodiment of the present invention will be described. The description below predominantly deals with differences between the present embodiment and First Embodiment above to avoid redundancy.

[0097] In First Embodiment, as shown in FIG. 4 (a), the upper end portion on the second end side of the yarn accumulator has the inclination β. On the other hand, the upper end portion on the second end side of the yarn accumulator is not inclined in the present embodiment.

[0098] In addition to the above, the yarn accumulator of the present embodiment includes a plurality of beam members provided on a circle at predetermined intervals and a swing member which is provided between a pair of neighboring beam members to be movable in the radial directions of the yarn accumulator. The swing member

has a swing mechanism composed of, for example, an eccentric cam and a cam motor. As the swing mechanism drives, the bundle Y of the spun yarn Y on the upper end portion is conveyed toward the second end while keeping distances among the parts of the spun yarn Y constant, irrespective of whether neighboring parts of the spun yarn Y contact each other.

[0099] In the present embodiment, a conveyor for forcibly conveying the spun yarn Y wound onto the outer circumference of the yarn accumulator from the first end toward the second end is constituted by a plurality of beam members provided on a circle at predetermined intervals, a swing member which is provided between a pair of neighboring beam members to be movable in the radial directions of the yarn accumulator, and a swing mechanism which switches the swing member between the operating state above and a non-operating state.

(Summary)

(Technical Matter 21)

[0100] As described above, the winding unit of the present embodiment is arranged as below. That is to say, the yarn accumulator has a first end on the yarn supplying portion side and a second end on the winding section side. The accumulator is further provided with a conveyor that forcibly conveys the spun yarn Y wound onto the outer circumference of the yarn accumulator from the first end toward the second end. The winding arm guides the part of the spun yarn Y on the yarn supplying portion side to the first end side on the outer circumference of the yarn accumulator. According to the arrangement above, the spun yarn Y is wound onto the first end side on the outer circumference of the yarn accumulator, and the wound spun yarn Y is forcibly moved from the first end toward the second end on the outer circumference of the yarn accumulator. For this reason, the parts of the spun yarn Y guided by the winding arm do not overlap each other at the guide position hence the spun yarn Y is smoothly unwound on the yarn accumulator.

[0101] Furthermore, according to the arrangement above, since the bundle Y2 of the spun yarn Y on the upper end portion of the yarn accumulator is conveyed toward the second end while keeping the distance between neighboring parts of the spun yarn Y more or less constant, the storage amount M of the spun yarn Y in the accumulator is detected more accurately.

<Fifth Embodiment>

[0102] Now, referring to FIG. 15, Fifth Embodiment of the present invention will be described. The description below predominantly deals with differences between the present embodiment and First Embodiment above to avoid redundancy.

[0103] The present embodiment is identical with First Embodiment except that an accumulator 161 is provided in place of the accumulator 7. The accumulator 161 includes components such as six rollers 171 as a yarn accumulator, a base 172, a rotation plate 173, three winding assist members 174, and the winding arm 29 and the winding arm motor 30 identical with those of the accumulator 7.

[0104] The base 172 is a substantially circular plate that is supported via an unillustrated bearing at the leading end (upper end) of the output shaft 36 of the winding arm motor 30 and is provided on the upper surface of the first magnet supporter 37. The six rollers 171 are provided on the upper surface of the base 172 along a circle (i.e., along the circumference of a virtual circle; hereinafter, virtual circumferential direction), and the lower end portions thereof are pivoted on the upper surface of the base 172 whereas the upper end portions thereof are supported by the rotation plate 173. The rotation plate 173 is arranged to be rotatable about the rotation axis D of the winding arm motor 30. As the rotation plate 173 is rotated, the upper end portions of the rollers 171 supported by the rotation plate 73 move, in a virtual circumferential direction, for a distance equivalent to the same central angle. As the upper end portions of the rollers 171 are moved in the virtual circumferential direction by the rotation of the rotation plate 173, the rollers 171 are inclined in a virtual circumferential direction.

[0105] The rotation plate 173 is surrounded by a rubber ring 181 at the outer circumference. The yarn Y wound onto the rollers 171 is conveyed toward the winding section 5 through a gap between the rotation plate 173 and the rubber ring 181.

[0106] In addition to the above, to the lower surfaces of the rollers 171 are attached pulleys 182. These pulleys 182 are connected to: the speed reducer 177 that reduces the rotation speed of the winding arm motor 30 at a predetermined reduction ratio and transmits the rotation; the pulley 178a connected to the speed reducer 177; the pulley 178b connected to the pulley 178a; the pulley 178c connected to the pulley 182; and the output shaft 36 of the winding arm motor 30 via the shaft 179 connecting the pulley 178b with the pulley 178c. With this arrangement, as the winding arm motor 30 rotates, the rotation is transmitted to the pulleys 182 via the speed reducer 177, the pulley 178a to 178c, and the shaft 179, with the result that the rollers to which the pulleys 182 are attached are rotated.

[0107] In other words, in the present embodiment the winding arm motor 30 functions also as a roller drive motor for rotating the rollers 171. Note that, in the present embodiment, all of the rollers 171 may be drive rollers rotated by the winding arm motor 30, or only some of the rollers 171 are drive rollers whereas the remaining rollers may be driven rollers.

[0108] The three winding assist members 174 are attached to the base 172 to surround the lower end portions of the rollers 171 and to be away from one another at about angles of 120 degrees. The winding assist member 174 has, at a part between neighboring rollers 171, a

winding assist surface 174a for smoothly connecting the outer circumferences of the rollers 171 with each other. The lower end portions of the rollers 171 and the winding assist surface 174a form a surface that substantially continuously extends in the circumferential directions. The winding assist surface 174a is inclined inward from bottom to top, with respect to the circumferential directions.

[0109] In the present embodiment, as the winding arm motor 30 rotates the winding arm 29 anticlockwise in plan view, as shown in FIG. 15, the yarn Y is guided to the lower end portions of the rollers 171 by the winding arm 29 and wound onto the lower end portions of the rollers 171.

[0110] Although the rollers 171 are arranged to be distanced from each other, the winding assist member 174 is provided to surround the lower end portions of the rollers 171 as described above, and the lower end portions of the rollers 171 and the winding assist surface 174a form a surface extending substantially continuously along the virtual circumferential directions. The yarn Y is therefore wound across the rollers 171 and the winding assist surface 174a. For this reason, it is possible to smoothly wind the yarn Y onto the rollers 171.

[0111] Furthermore, the rollers 171 rotate at this time, and hence the yarn Y wound onto the rollers 171 by the winding arm 29 is conveyed by the rollers 171. In this connection, because the rollers 171 are inclined in the virtual circumferential directions as described above, the yarn Y conveyed by the rollers 171 moves upward (in the transportation direction). As such, since in the present embodiment the yarn Y moves upward by being conveyed by the rollers 171, the load (friction force) on the yarn Y is small when moving upward. Furthermore, as the yarn Y is conveyed on the rollers 171, the broken filaments of the yarn Y are laid down.

[0112] In addition to the above, the yarn Y wound across the lower end portions of the rollers 171 and the winding assist member 174 moves upward not only by the rotation of the drive rollers 171 but also by the inclination of the winding assist surface 174a of the winding assist member 174.

(Summary)

(Technical Matter 22)

[0113] As described above, the winding unit 2 of the present embodiment is arranged as below. That is to say, the accumulator 161 includes a plurality of rollers 171, a yarn winding mechanism for winding the yarn Y onto the rollers 171, and a winding arm motor 30 functioning as a roller drive motor which drives at least one of the rollers 171 as a drive roller, the rollers 171 being rotatably disposed so that rotation axes of the respective rollers 171 are on a virtual circle and the rotation axes of the respective rollers 171 are inclined with respect to directions along the virtual circle. According to the arrangement above, because the rollers 171 on which the spun yarn is wound are inclined, the parts of the spun yarn wound on the rollers 171 by the yarn winding mechanism are serially conveyed and move in the transportation direction, as the rollers 171 are rotated. According to this arrangement, since the yarn is conveyed by the rollers 171, the load (friction force) on the yarn is small and hence the deterioration of the quality of the yarn is avoided.

<Sixth Embodiment>

[0114] Now, referring to FIG. 16, Sixth Embodiment of the present invention will be described. The description below predominantly deals with differences between the present embodiment and First Embodiment above to avoid redundancy.

[0115] The present embodiment is identical with First Embodiment except that an accumulator 261 is provided in place of the accumulator 7. The accumulator 261 includes components such as a rotational storage drum 271, a rotational storage drum motor 272, a yarn guiding member 273, a blowdown nozzle 274, and a yarn passage forming member 275.

[0116] The rotational storage drum 271 is a drum rotated about the axis E by the rotational storage drum motor 272. The respective end portions of the drum 271 are tapered portions 271a and 271b each of which is narrowed toward the other end portion, and a part of the drum 271 between the tapered portion 271a and the tapered portion 271b is a linear portion 271c having a substantially constant diameter.

[0117] The yarn guiding member 273 is a linear pipe and is disposed so that the upper left end portion shown in FIG. 16 opposes the tapered portion 271a. With this, the yarn Y having reached the yarn guiding member 273 from the yarn supplying portion 3 side is guided to the tapered portion 271a by the yarn guiding member 273.

[0118] The blowdown nozzle 274 is attached to the right edge of the yarn guiding member 273. The blowdown nozzle 274 has the same structure as the blowdown nozzle 48 (see FIG. 2), and includes a yarn path 246 similar to the yarn path 46 (see FIG. 2) and a blowdown path 247 which is connected to a compressed air source 51 via connection pipes 49 and 50 in the same manner as the blowdown path 47 (see FIG. 2). The upper left end portion of the yarn path 246 in the figure is connected to the internal space of the yarn guiding member 273.

[0119] The yarn passage forming member 275 forms a yarn passage 228 and is provided between the suction port 18b of the upper yarn guide pipe 18 and the blowdown nozzle 274. The yarn passage 228 extends substantially vertically upward from its lower end which is immediately above the suction port 18b of the upper yarn guide pipe 18. The yarn passage 228 bends toward the upper left of FIG. 16 at its upper end portion, so that the upper end of the yarn passage 228 opposes the lower right end portion of the yarn path 246. Furthermore, a yarn drawing sensor 54 is provided at the lower end of the yarn passage forming member 275.

[0120] In the accumulator 261, as the yarn Y is guided to the tapered portion 271a by the yarn guiding member 273, the yarn Y is wound onto the tapered portion 271a by the rotation of the rotational storage drum 271 and moves rightward and upward along the slope of the tapered portion 271a, with the result that the yarn Y is stored in the rotational storage drum 271.

[0121] As such, because in the present embodiment storing the yarn Y in the rotational storage drum 271 is achieved only by simply guiding the yarn Y to a point on the tapered portion 271a, the yarn guiding member 273 is only required to guide the yarn Y to that point of the tapered portion 271a. It is therefore possible to relatively easily dispose the yarn guiding member 273 irrespective of the position and orientation of the rotational storage drum 271. For this reason, the rotational storage drum 271 can be disposed with relatively high design freedom in consideration of an unused space in the winding unit 2.

[0122] In addition to the above, at the time of yarn breakage, occurrence of yarn defect, or yarn supplying bobbin change, the solenoid valve 52 is switched to the open state so that an airflow flowing from the rotational storage drum 271 side to the upper yarn guide pipe 18 side is generated in the internal space of the yarn guiding member 273, the yarn passage 228, or the like, and the rotational storage drum 271 is rotated in the direction opposite to the direction at the time of winding the yarn Y so that the yarn end of the yarn Y on the rotational storage drum 271 is sucked into the opening of the yarn guiding member 273 and drawn out to the suction port 18b of the upper yarn guide pipe 18 via the yarn passage 228 or the like.

[0123] In this regard, as described above, because the yarn guiding member 273 guides the yarn Y to the tapered portion 271a, the yarn Y guided from the yarn guiding member 273 to the rotational storage drum 271 moves from the upper right end side toward the lower left end side with respect to the axial directions of the rotational storage drum 271. This arrangement prevents the yarn Y guided to the tapered portion 271a from moving to the upper right end side of the rotational storage drum 271 due to the inertia generated by the movement from the yarn guiding member 273 to the rotational storage drum 271. For this reason, at the time of yarn breakage, occurrence of yarn defect, or yarn supplying bobbin change, the yarn end of the yarn Y is certainly placed at around the tapered portion 271a of the rotational storage drum 271, strictly speaking, above the lower left end portion of the linear portion 271c, and hence the yarn Y is certainly sucked into the opening of the yarn guiding member 273.

(Technical Matter 23)

[0124] As described above, the winding unit 2 of the present embodiment is arranged as below. That is to say, the accumulator 261 includes a rotational storage drum 271 which rotates so that the yarn Y is wound thereon, a motor 272 for rotating the rotational storage drum 271 in both directions, and a yarn guiding member 273 for guiding the yarn Y from the yarn supplying portion 3 side to the rotational storage drum 271. According to this arrangement, at the time of yarn jointing, the yarn Y wound on the rotational storage drum 271 is drawn out to the yarn supplying portion 3 side as the rotational storage drum 271 is rotated in the direction opposite to the direction at the time of winding the yarn Y.

[0125] While preferred embodiments of the present invention have been described above, the embodiments may be modified as below.

(First Modification)

[0126] In Fourth Embodiment, a conveyor is constituted by a plurality of beam members provided on a circle at predetermined intervals, a swing member which is provided between a pair of neighboring beam members to be movable in the radial directions of the yarn accumulator, and a swing mechanism which switches the swing member between the operating state above and a non-operating state. Alternatively, the conveyor may be provided between two neighboring beam members and have a belt member running in the longitudinal directions of the beam members.

(Second Modification)

(Technical Matter 24)

[0127] In Second Embodiment, the drawing sensor 54 is provided at the upper relay pipe 18. Alternatively, the drawing sensor 54 may be provided between the accumulator 7 and the yarn jointing section 6.

(Third Modification)

[0128] In addition to the above, in First Embodiment, the part of the spun yarn Y on the downstream side is fully wound onto the yarn accumulator 27 when yarn breakage occurs, when a yarn defect is detected, or 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 29 is stopped before the spun yarn Y on the downstream side is fully wound onto the yarn accumulator 27. For example, when a yarn defect is detected, a cutter 4a cuts the spun yarn Y and at the same time the driving of the winding arm 29 is stopped. For the bobbin change, a sensor for detecting the remaining yarn amount on the yarn supplying bobbin B is attached to the yarn unwinding assisting device 11 to monitor the remaining yarn amount on the yarn supplying bobbin B. With this, the occurrence of the empty state of the yarn supplying bobbin B is detected in advance and the driving of the winding arm 29 is stopped before the spun yarn Y

on the downstream side is fully wound onto the yarn accumulator 27.

[0129] As such, by stopping the driving of the winding arm 29 before the yarn Y is fully wound onto the yarn accumulator 27, the yarn end of the spun yarn Y is stopped while the yarn end hangs down from the blowdown nozzle 48 of the accumulator 7.

[0130] Since this allows the upper relay pipe 18 to capture the yarn end hanging down from the accumulator 7, the step of drawing out the spun yarn Y by the yarn end drawing mechanism W is eliminated and hence the yarn jointing becomes more efficient. According to this arrangement, since the drawing sensor 54 is provided at the lower end of the blowdown nozzle 48, it is possible to check whether the yarn end of the spun yarn Y stored in the accumulator 7 stops in the state of being receivable by the upper relay pipe 18, i.e., whether the yarn end certainly stops in the state of hanging down from the accumulator 7 . This makes it possible to shorten the time required for drawing out the yarn end of the spun yarn Y from the yarn storage section to the yarn jointing section side.

(Fourth Modification)

[0131] In the embodiments above, the yarn end drawing mechanism W sucks the yarn end of the spun yarn Y stored in the accumulator 7 by an airflow generated in the winding arm 29 by the airflow generator X so as to draw out the yarn end to the yarn jointing section 6 side (yarn supplying portion 3 side). The yarn end drawing mechanism W may be arranged differently, e.g., the yarn end of the spun yarn Y stored in the accumulator 7 may be grabbed out by an operable arm component such as a robot arm.

Claims

1. A yarn winder comprising:

a yarn supplying portion for unwinding a spun yarn from a yarn supplying bobbin;
a winding section for winding the spun yarn so as to form a package;
a yarn storage section including a yarn accumulator which is provided between the yarn supplying portion and the winding section to store the spun yarn as the spun yarn is wound onto the yarn accumulator;
a yarn jointing section for performing a yarn jointing operation of jointing a yarn end of the spun yarn on the yarn supplying portion side with a yarn end of the spun yarn on the yarn storage section side; and
a yarn end drawing mechanism for drawing out the yarn end of the spun yarn wound onto the yarn accumulator to the yarn supplying portion side, when the yarn jointing section performs the yarn jointing operation.

2. The yarn winder according to claim 1, wherein, the yarn end drawing mechanism draws out the yarn end of the spun yarn wound onto the yarn accumulator to the yarn supplying portion side, by means of an airflow.

3. The yarn winder according to claim 2, wherein, the yarn end drawing mechanism includes therein a yarn passage where the spun yarn is able to run, and further includes a yarn guide unit for guiding a part of the spun yarn on the yarn supplying portion side to a predetermined winding position of the yarn accumulator.

4. The yarn winder according to claim 3, wherein,
the predetermined winding position of the yarn accumulator where the spun yarn is guided by the yarn guide unit is, in directions in parallel to a rotation axis of the yarn accumulator, identical with a position where the yarn end drawing mechanism draws out the yarn end of the spun yarn wound onto the yarn accumulator to the yarn supplying portion side by the airflow.

5. The yarn winder according to claim 3 or 4, further comprising:

a gas flow generator for generating, in the yarn guide unit, a gas flow flowing from the yarn accumulator side to the yarn supplying portion side.

6. The yarn winder according to claim 5, wherein,
the yarn guide unit is arranged to be rotatable about a winding center axis of the yarn accumulator and guides the part of the spun yarn on the yarn supplying portion side to the outer circumference of the yarn accumulator, and
the yarn end drawing mechanism includes the yarn guide unit and the gas flow generator.

7. The yarn winder according to claim 6, wherein, the yarn storage section further includes: a driving unit which is arranged to rotate the yarn guide unit about the winding center axis of the yarn accumulator; and a controller for controlling the driving unit so that the yarn guide unit rotates in a direction opposite to a rotating direction at the time of storing the yarn, when the yarn end drawing mechanism draws out the yarn end of the spun yarn on the outer circumference of the yarn accumulator to the yarn jointing section side.

8. The yarn winder according to any one of claims 1 to 7, further comprising a drawing detection unit which is capable of detecting that the yarn end of the spun

yarn wound onto the yarn storage section has been drawn to the yarn supplying portion side.

9. The yarn winder according to claim 8, wherein, the drawing detection unit is provided in the yarn storage section.

10. The yarn winder according to any one of claims 1 to 9, wherein, the yarn storage section is capable of storing the yarn for an amount equal to or larger than an amount of the yarn wound by the winding section at a normal winding speed, during a time interval from the start of bobbin change of the yarn supplying bobbin to at least one yarn jointing by the yarn jointing section.

11. The yarn winder according to any one of claims 1 to 9, further comprising: a yarn defect detection section capable of detecting a yarn defect of the spun yarn supplied from the yarn supplying portion; and a cutting member for cutting a part of the yarn on the upstream of the detected yarn defect, the yarn storage section being capable of storing the yarn for an amount equal to or larger than an amount of the yarn wound by the winding section at a normal winding speed, during a time interval from yarn cutting executed by the cutting member when the yarn defect is detected by the yarn defect detection section to at least one yarn jointing by the yarn jointing section.

12. The yarn winder according to any one of claims 1 to 9, wherein, the yarn storage section is capable of storing the yarn for an amount equal to or larger than an amount of the yarn wound by the winding section at a normal winding speed, during a time interval from the occurrence of yarn breakage to at least one yarn jointing by the yarn jointing section.

13. The yarn winder according to any one of claims 1 to 12, wherein, the yarn storage section is arranged to be capable to storing the spun yarn at speed faster than the normal winding speed at which the winding section winds the spun yarn.

14. The yarn winder according to any one of claims 1 to 6, wherein, the yarn storage section is provided with a storage amount detector for detecting an amount of the stored spun yarn, and a controller is provided in the yarn winder to reduce winding speed at which the winding section winds the spun yarn, when the amount detected by the storage amount detector becomes equal to or lower than a predetermined amount.

15. The yarn winder according to claim 14, wherein, the controller reduces the winding speed so that yarn layers of the package are not disrupted.

16. The yarn winder according to claim 5 or 6, wherein, the yarn accumulator includes a first end on the yarn supplying portion side and a second end on the winding section side and has an inclined portion between the first end to the second end as the yarn accumulator is narrowed from the first end to the second end in an outer circumference, and the yarn guide unit guides the part of the spun yarn on the yarn supplying portion side to the first end side of the outer circumference of the yarn accumulator.

17. The yarn winder according to claim 16, wherein, the inclined portion of the yarn accumulator is constituted by at least two different slopes, and the slope on the first end side is arranged to be steeper than the slope on the second end side.

18. The yarn winder according to any one of claims 5 to 15, wherein, the yarn storage section includes a plurality of rollers, a yarn winding mechanism for winding the spun yarn onto the rollers, and a roller drive motor which drives at least one of the rollers as a drive roller, the rollers being rotatably disposed so that rotation axes of the respective rollers are on a virtual circle and the rotation axes of the respective rollers are inclined with respect to directions along the virtual circle.

19. The yarn winder according to claim 5, 16, or 17, wherein, the yarn storage section includes a rotational storage drum which is arranged to rotate so that the spun yarn is wound thereon, a motor for rotating the rotational storage drum in both directions, and a guide member for guiding the spun yarn from the yarn supplying portion side to the rotational storage drum.

20. The yarn winder according to any one of claims 1 to 19, wherein, the yarn supplying portion is provided with a yarn unwinding assisting device for lowering a regulator covering a core of the yarn supplying bobbin in sync with unwinding of the spun yarn from the yarn supplying bobbin to assist the unwinding of the spun yarn from the yarn supplying bobbin.

FIG.1

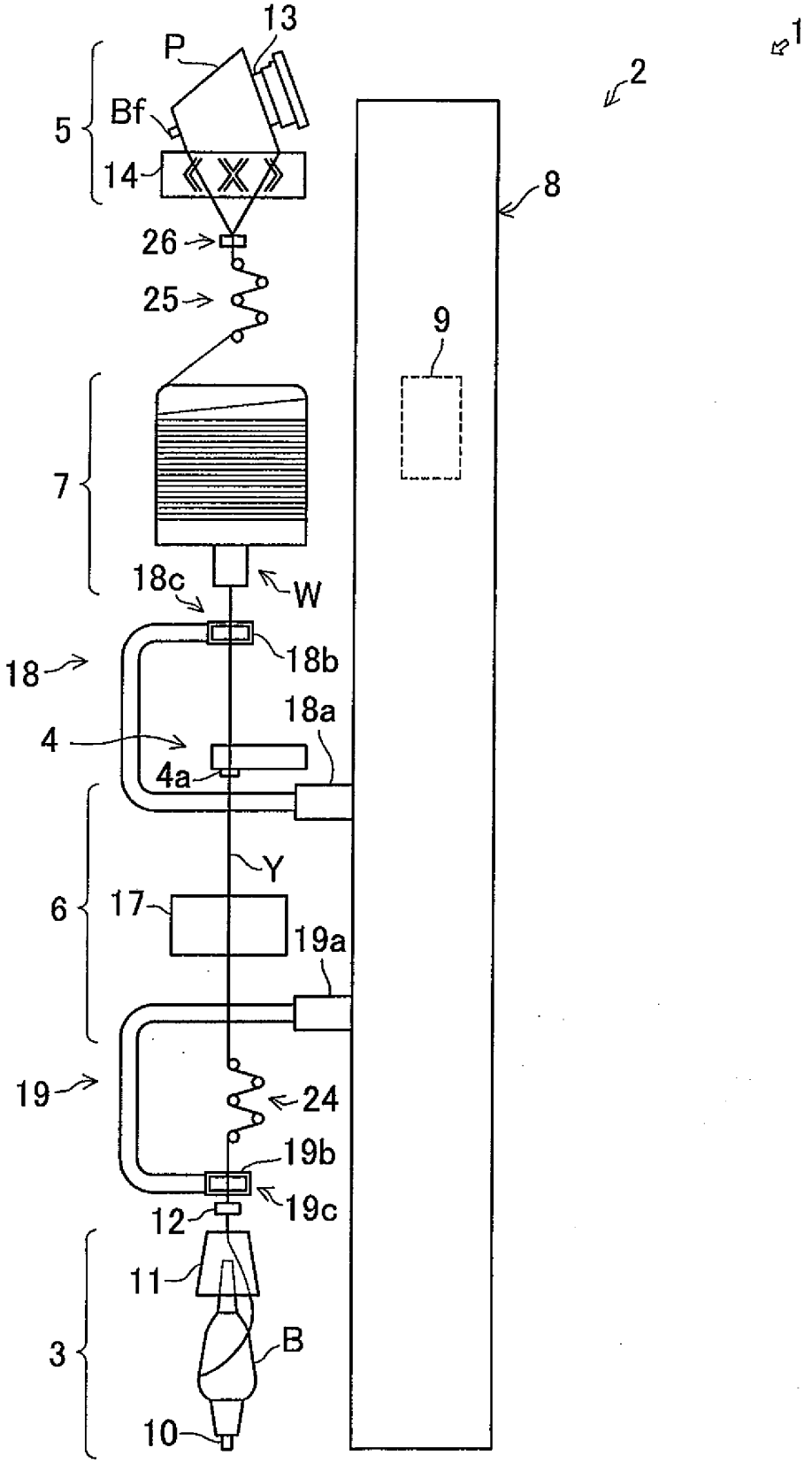

1
2
13
P
Bf
5
14
8
26
25
9
7
18c
W
18
18b
18a
4
4a
Y
6
17
19a
19
24
19b
19c
12
11
3
B
10

FIG.2

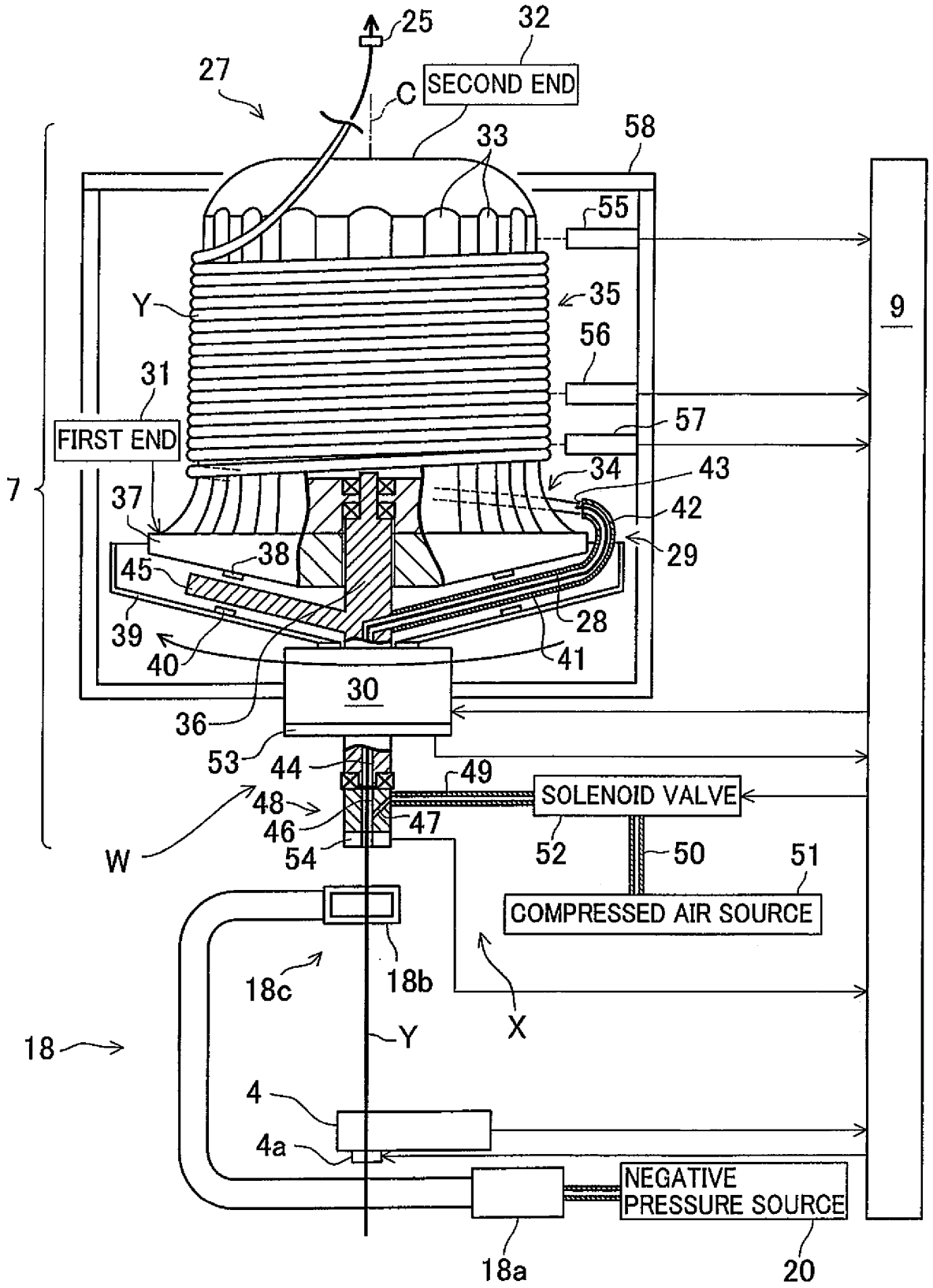

25
32
27
C
SECOND END
33
58
55
9
Y
35
56
31
FIRST END
57
34
43
7
37
42
29
38
45
28
39
40
41
30
36
53
44
49
SOLENOID VALVE
48
46
47
W
54
52
50
51
COMPRESSED AIR SOURCE
18c
18b
X
18
Y
4
4a
NEGATIVE PRESSURE SOURCE
18a
20

FIG.3

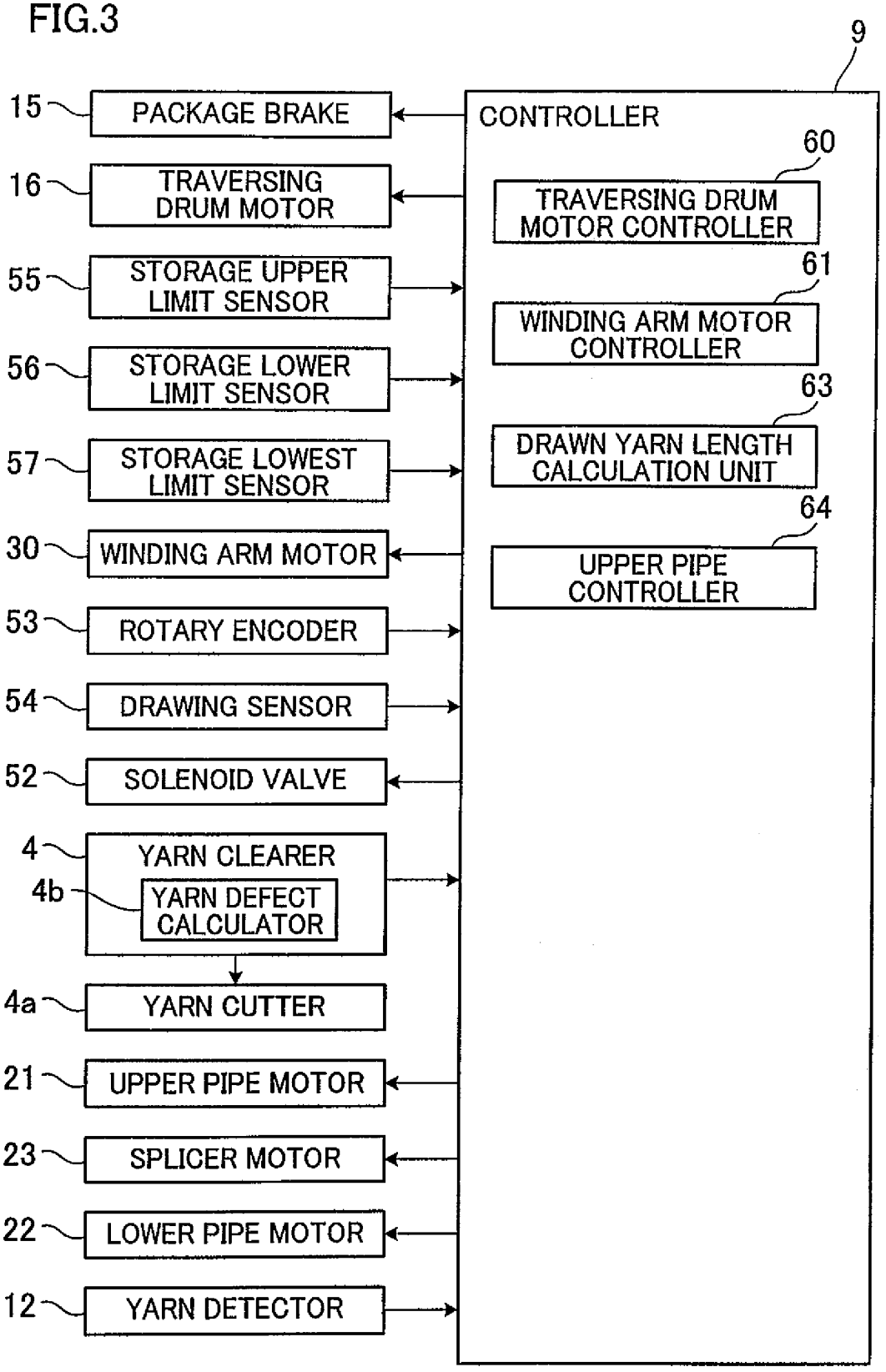

9
CONTROLLER
60
TRAVERSING DRUM MOTOR CONTROLLER
61
WINDING ARM MOTOR CONTROLLER
63
DRAWN YARN LENGTH CALCULATION UNIT
64
UPPER PIPE CONTROLLER
15
PACKAGE BRAKE
16
TRAVERSING DRUM MOTOR
55
STORAGE UPPER LIMIT SENSOR
56
STORAGE LOWER LIMIT SENSOR
57
STORAGE LOWEST LIMIT SENSOR
30
WINDING ARM MOTOR
53
ROTARY ENCODER
54
DRAWING SENSOR
52
SOLENOID VALVE
4
YARN CLEARER
4b
YARN DEFECT CALCULATOR
4a
YARN CUTTER
21
UPPER PIPE MOTOR
23
SPLICER MOTOR
22
LOWER PIPE MOTOR
12
YARN DETECTOR

FIG.4(a)

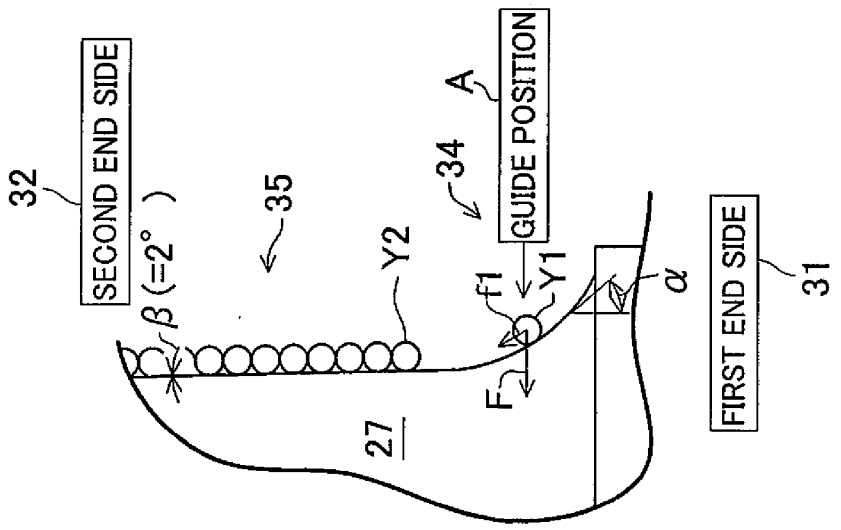


FIG.4(b)

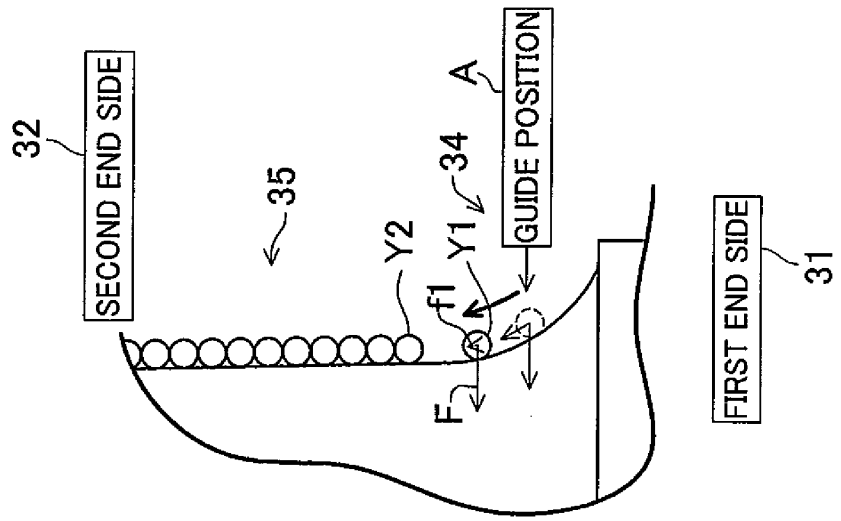


FIG.4(c)

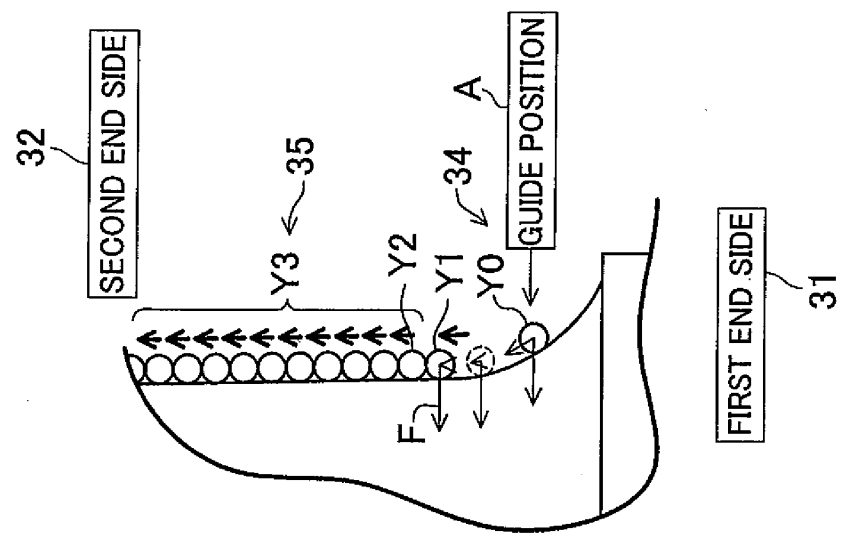


FIG.5

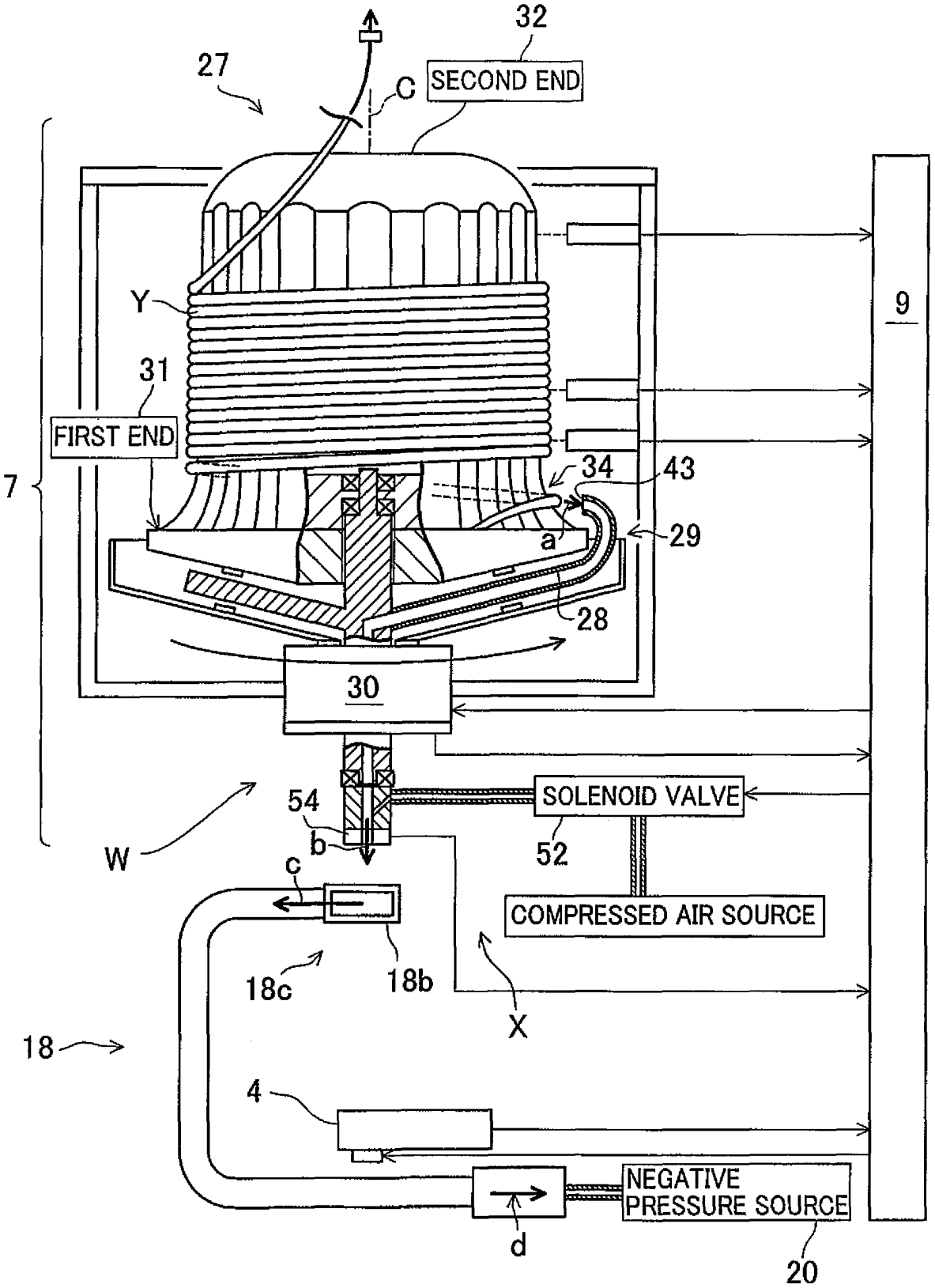

32
27
C
SECOND END
9
Y
31
FIRST END
7
34
43
a
29
28
30
54
SOLENOID VALVE
W
b
52
c
COMPRESSED AIR SOURCE
18c
18b
X
18
4
NEGATIVE
PRESSURE SOURCE
d
20

FIG.6

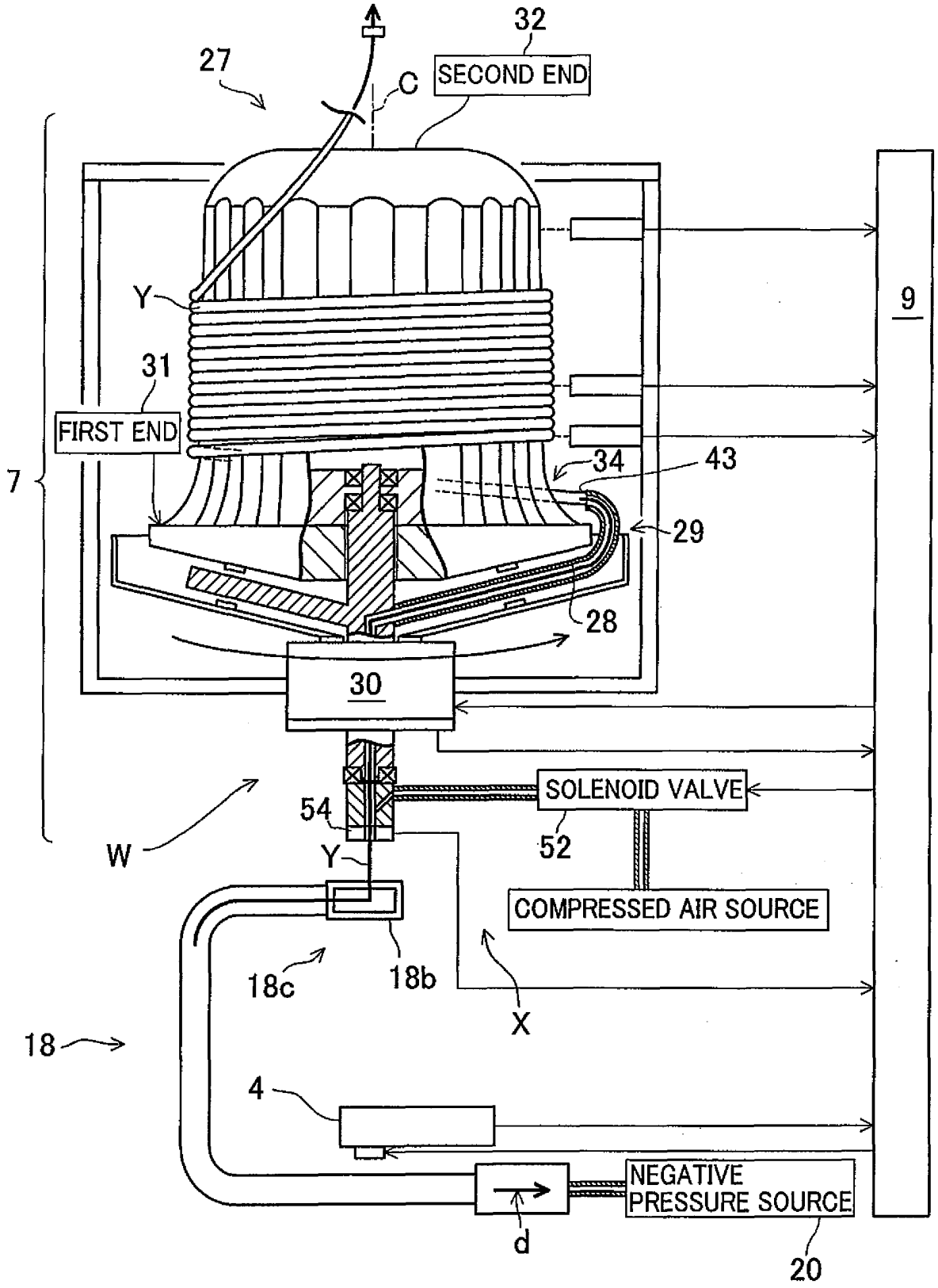

27
32
SECOND END
C
Y
31
FIRST END
7
34
43
29
28
9
30
W
54
Y
SOLENOID VALVE
52
COMPRESSED AIR SOURCE
18c
18b
X
18
4
NEGATIVE
PRESSURE SOURCE
d
20

FIG.7

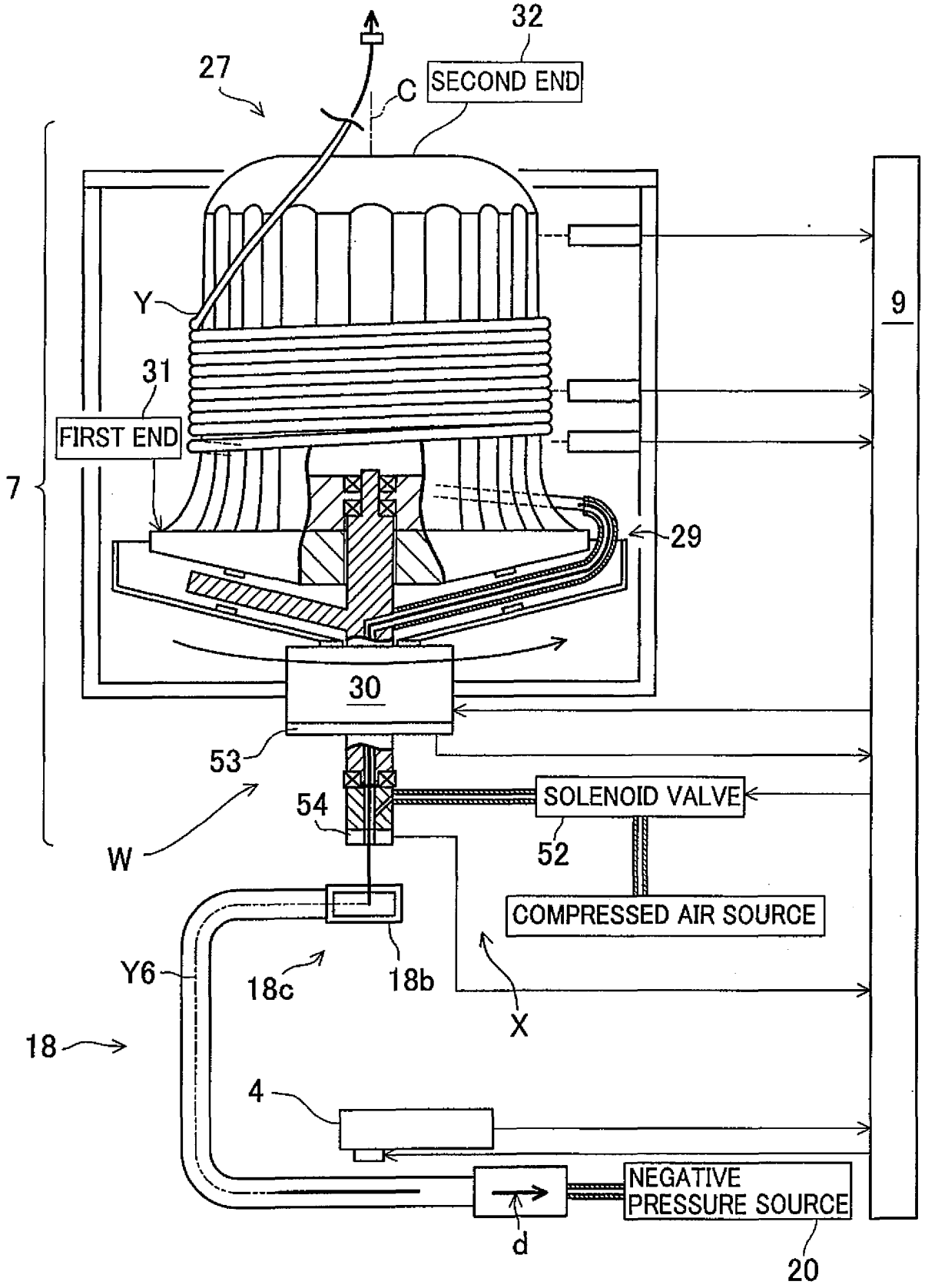

32
27
C
SECOND END
Y
9
31
FIRST END
7
29
30
53
54
SOLENOID VALVE
W
52
COMPRESSED AIR SOURCE
Y6
18c
18b
X
18
4
NEGATIVE
PRESSURE SOURCE
d
20

FIG.8

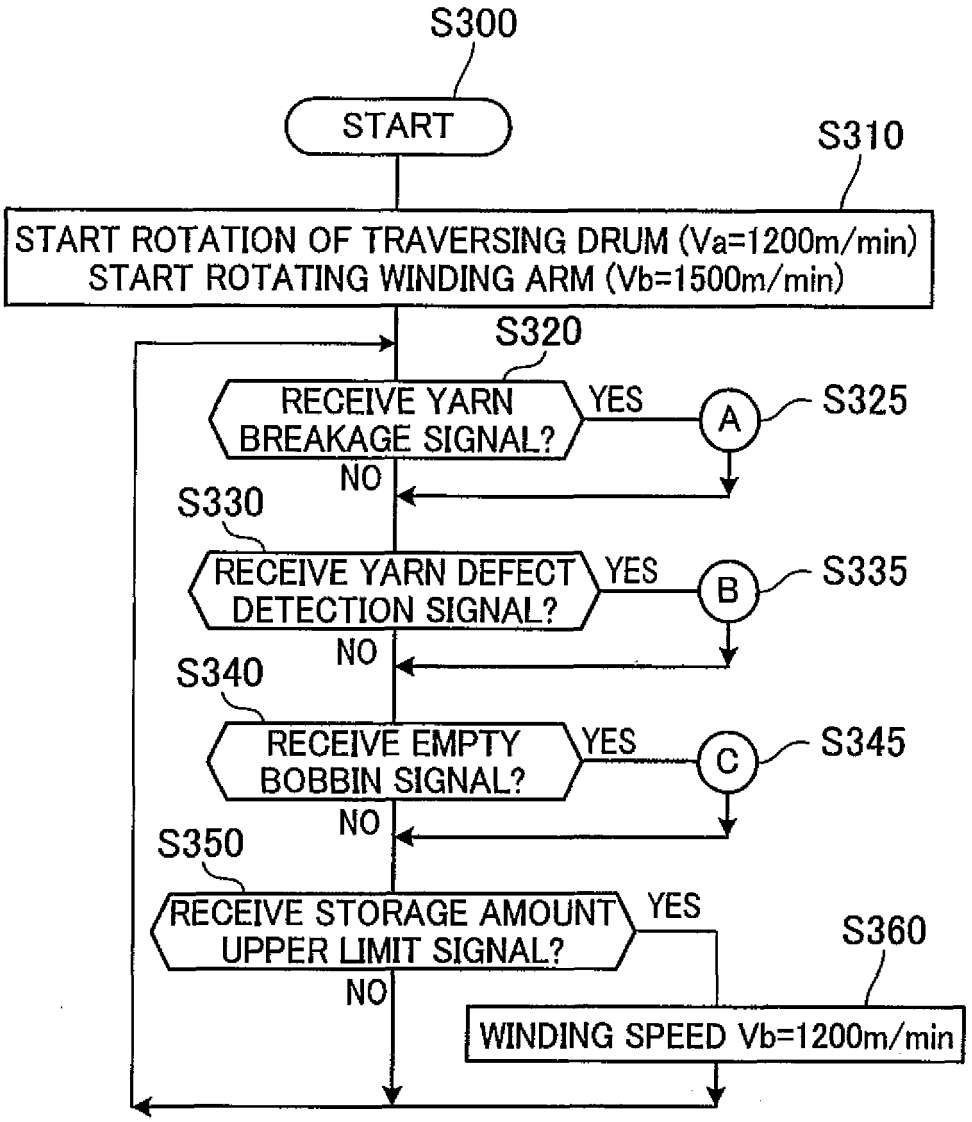

S300
START
S310
START ROTATION OF TRAVERSING DRUM (Va=1200m/min)
START ROTATING WINDING ARM (Vb=1500m/min)
S320
RECEIVE YARN BREAKAGE SIGNAL?
YES
A
S325
NO
S330
RECEIVE YARN DEFECT DETECTION SIGNAL?
YES
B
S335
NO
S340
RECEIVE EMPTY BOBBIN SIGNAL?
YES
C
S345
NO
S350
RECEIVE STORAGE AMOUNT UPPER LIMIT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

FIG.9

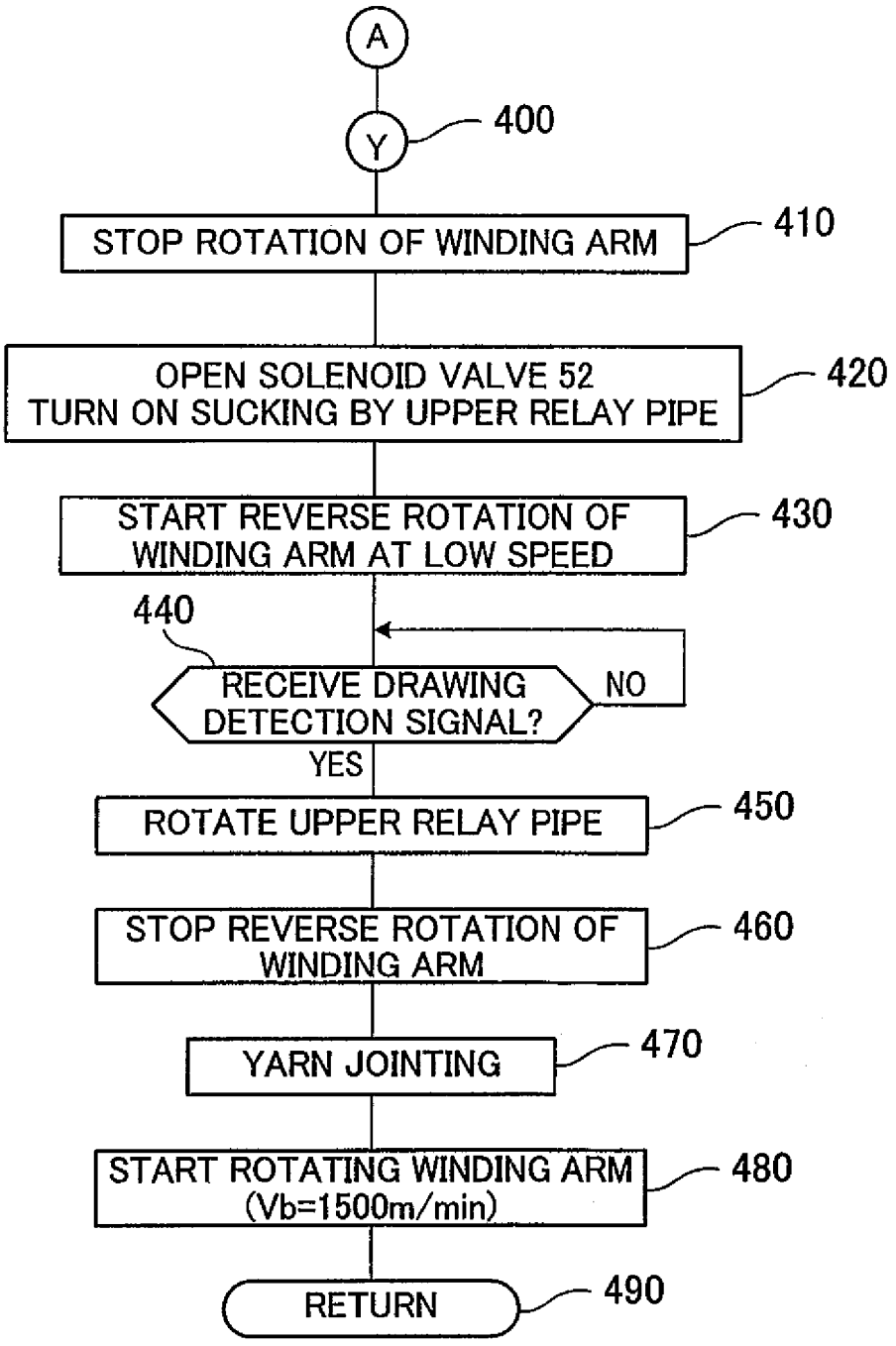

A
Y
400
STOP ROTATION OF WINDING ARM
410
OPEN SOLENOID VALVE 52
TURN ON SUCKING BY UPPER RELAY PIPE
420
START REVERSE ROTATION OF
WINDING ARM AT LOW SPEED
430
440
RECEIVE DRAWING
DETECTION SIGNAL?
NO
YES
ROTATE UPPER RELAY PIPE
450
STOP REVERSE ROTATION OF
WINDING ARM
460
YARN JOINTING
470
START ROTATING WINDING ARM
(Vb=1500m/min)
480
RETURN
490

FIG.10

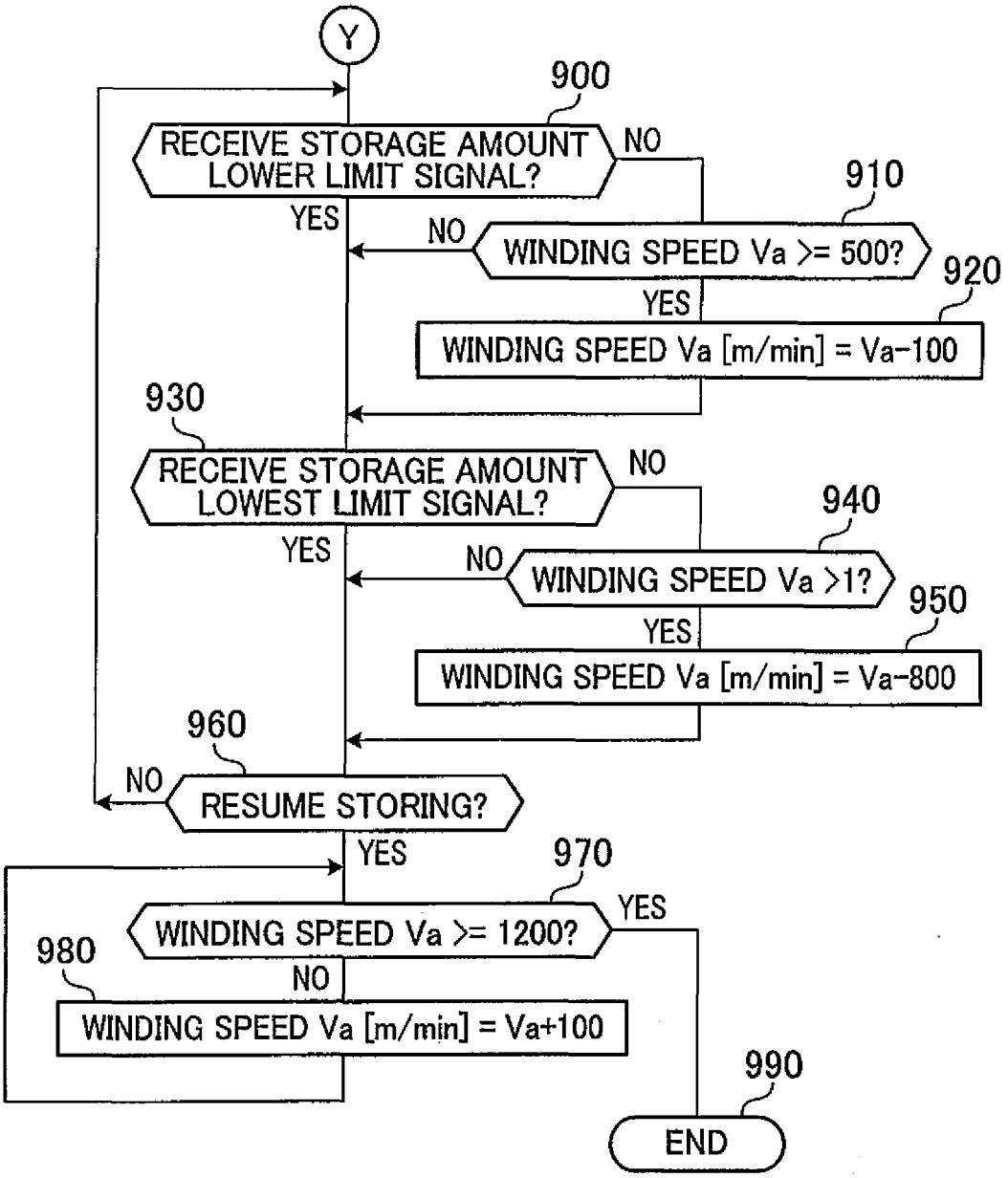

Y
900
RECEIVE STORAGE AMOUNT LOWER LIMIT SIGNAL?
NO
YES
910
NO
WINDING SPEED Va >= 500?
YES
920
WINDING SPEED Va [m/min] = Va-100
930
RECEIVE STORAGE AMOUNT LOWEST LIMIT SIGNAL?
NO
YES
940
NO
WINDING SPEED Va >1?
YES
950
WINDING SPEED Va [m/min] = Va-800
960
NO
RESUME STORING?
YES
970
WINDING SPEED Va >= 1200?
YES
980
NO
WINDING SPEED Va [m/min] = Va+100
990
END

FIG.11

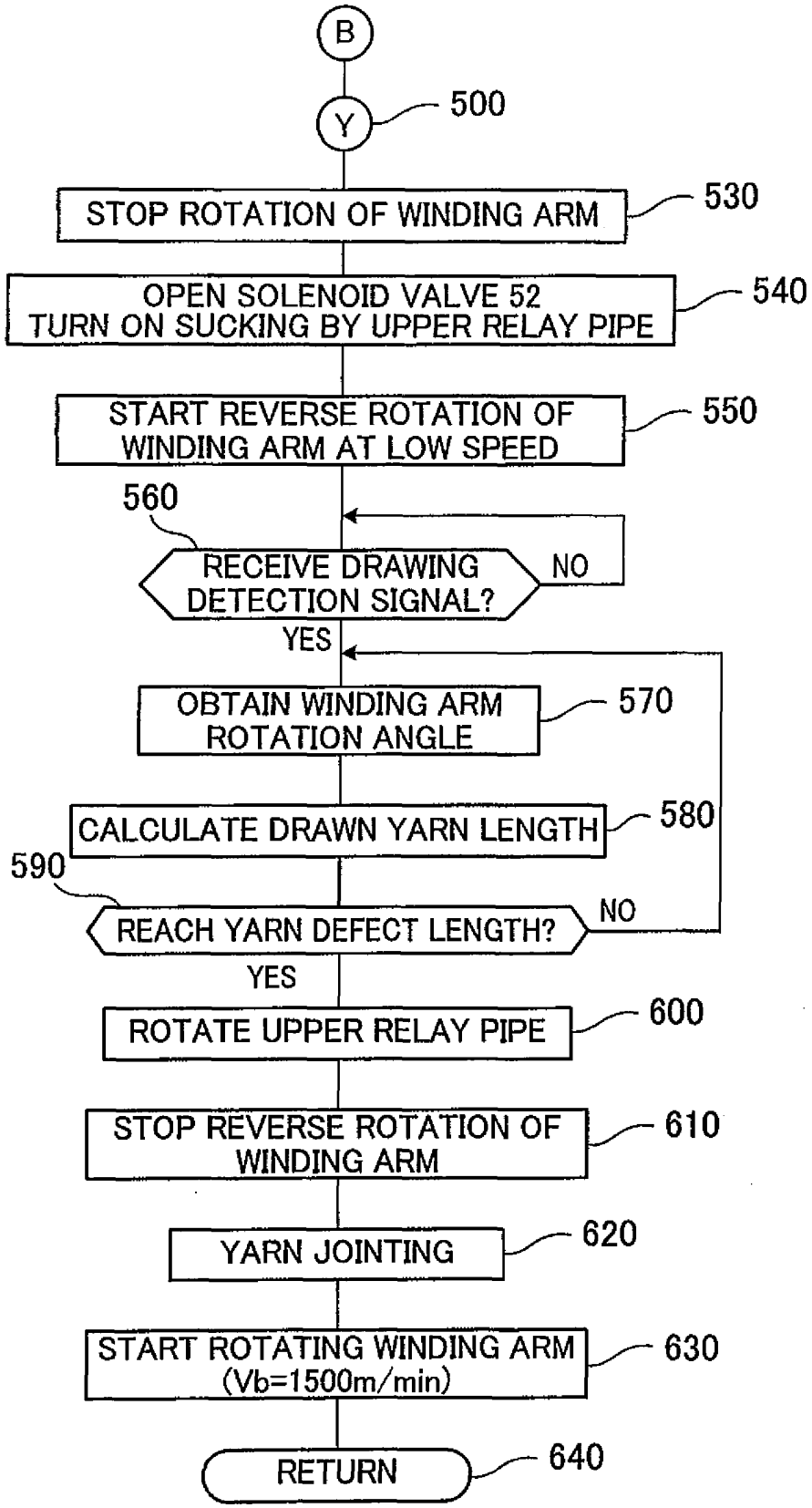

B
Y
500
STOP ROTATION OF WINDING ARM
530
OPEN SOLENOID VALVE 52
TURN ON SUCKING BY UPPER RELAY PIPE
540
START REVERSE ROTATION OF WINDING ARM AT LOW SPEED
550
560
RECEIVE DRAWING DETECTION SIGNAL?
NO
YES
OBTAIN WINDING ARM ROTATION ANGLE
570
CALCULATE DRAWN YARN LENGTH
580
590
REACH YARN DEFECT LENGTH?
NO
YES
ROTATE UPPER RELAY PIPE
600
STOP REVERSE ROTATION OF WINDING ARM
610
YARN JOINTING
620
START ROTATING WINDING ARM (Vb=1500m/min)
630
RETURN
640

FIG.12

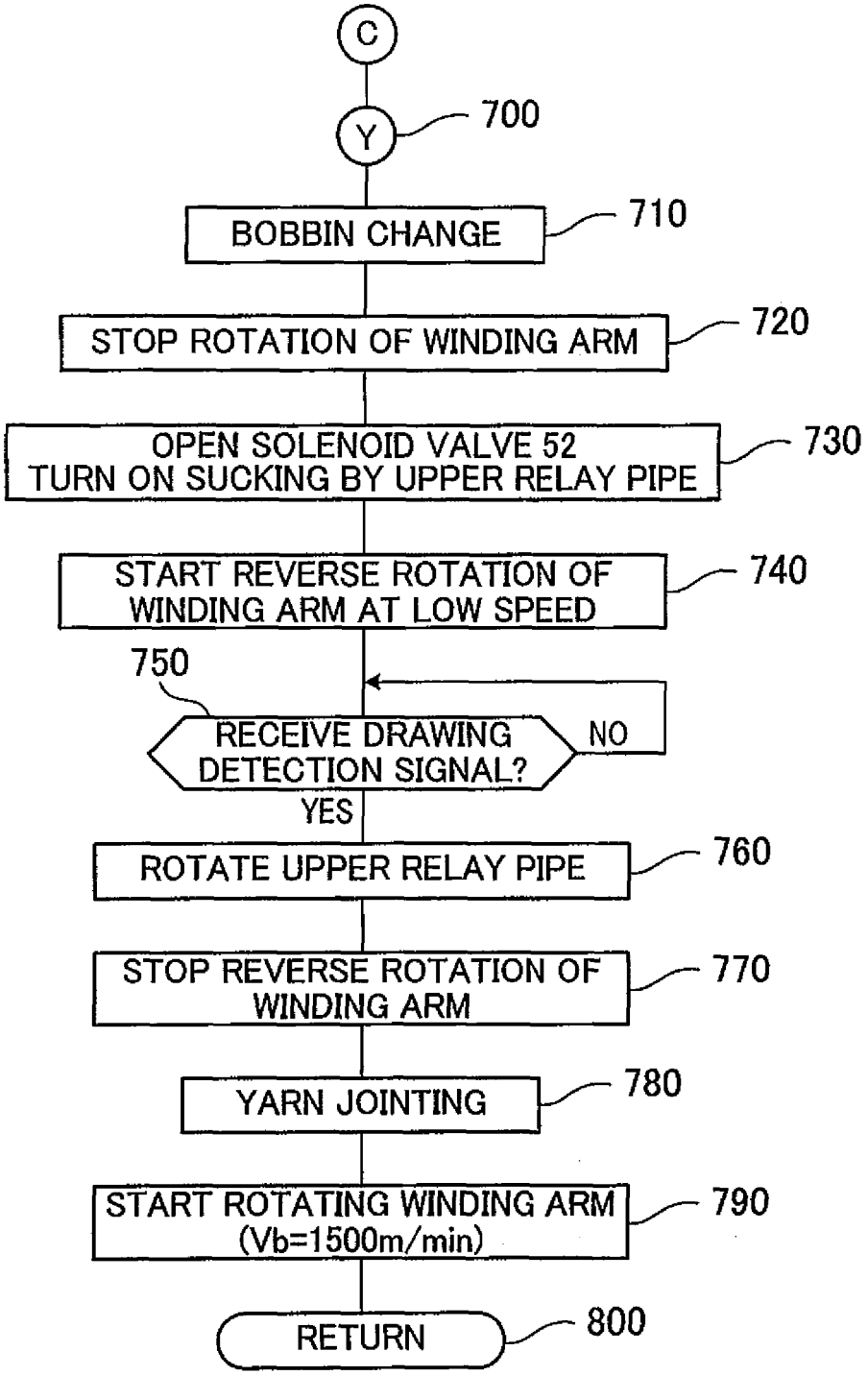

C
Y
700
BOBBIN CHANGE
710
STOP ROTATION OF WINDING ARM
720
OPEN SOLENOID VALVE 52
TURN ON SUCKING BY UPPER RELAY PIPE
730
START REVERSE ROTATION OF
WINDING ARM AT LOW SPEED
740
750
RECEIVE DRAWING
DETECTION SIGNAL?
NO
YES
ROTATE UPPER RELAY PIPE
760
STOP REVERSE ROTATION OF
WINDING ARM
770
YARN JOINTING
780
START ROTATING WINDING ARM
(Vb=1500m/min)
790
RETURN
800

FIG.13

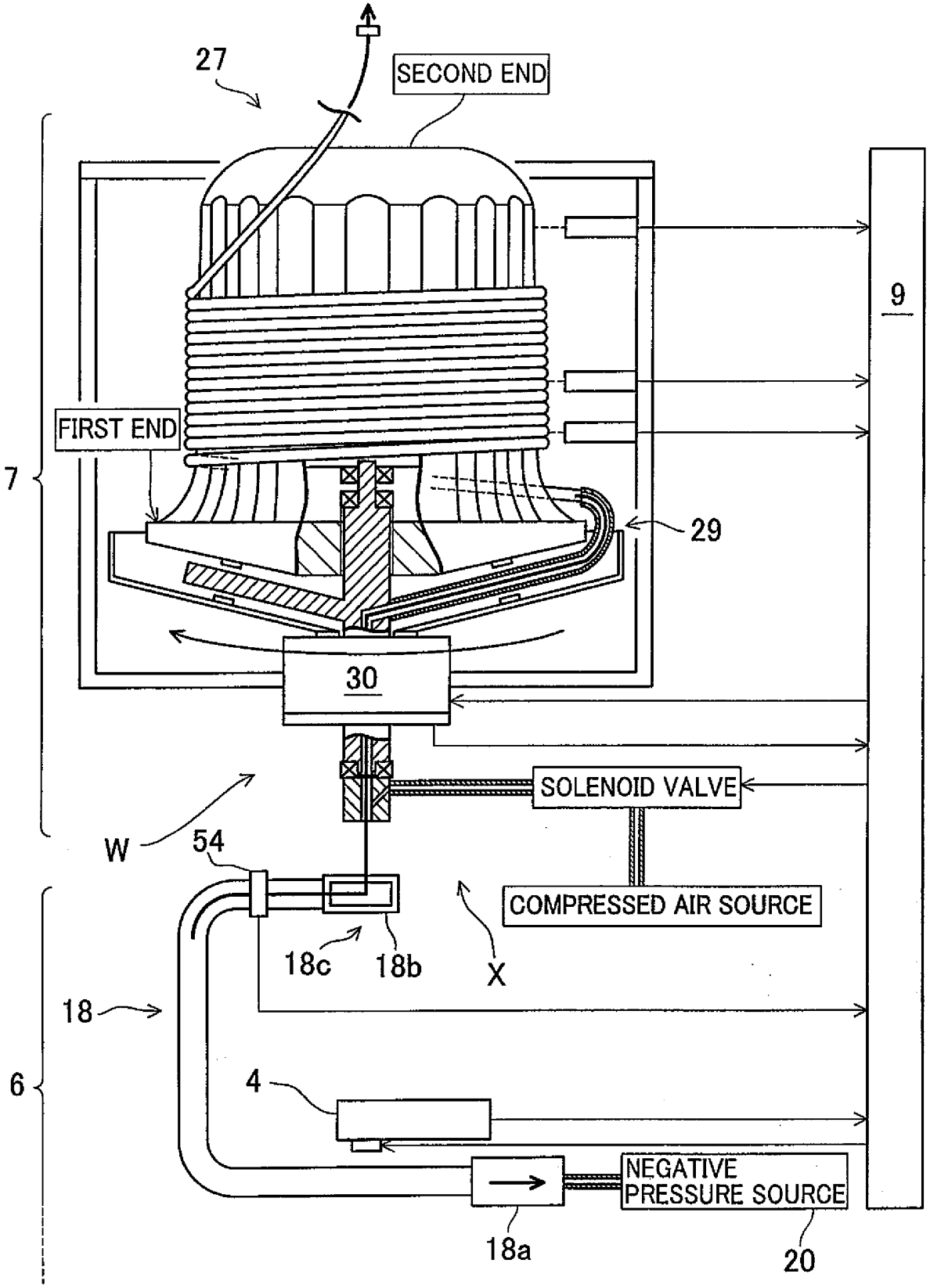

27
SECOND END
9
FIRST END
7
29
30
SOLENOID VALVE
W
54
COMPRESSED AIR SOURCE
18c
18b
X
18
6
4
NEGATIVE
PRESSURE SOURCE
18a
20

FIG.14

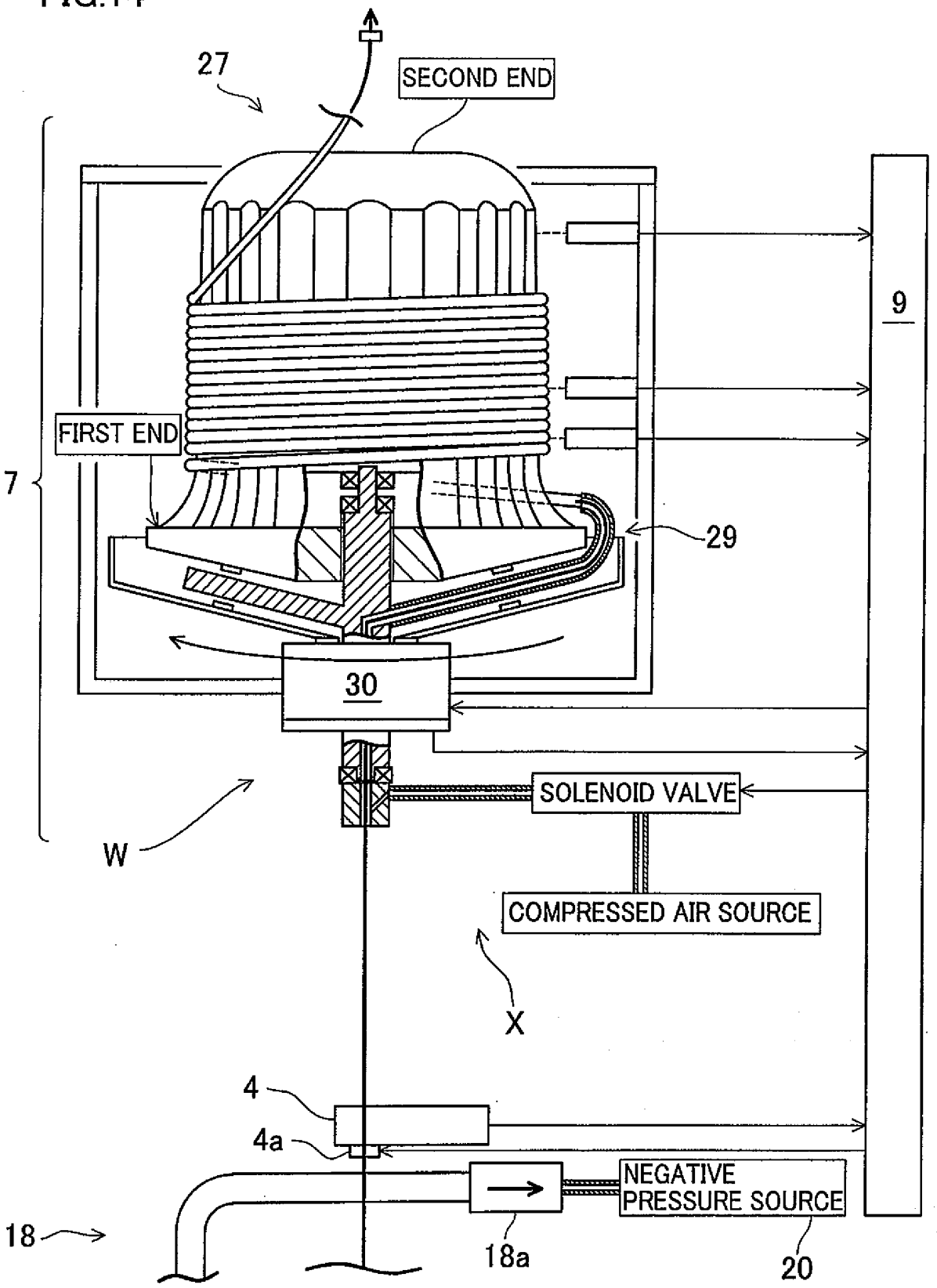

27
SECOND END
9
FIRST END
7
29
30
SOLENOID VALVE
W
COMPRESSED AIR SOURCE
X
4
4a
NEGATIVE
PRESSURE SOURCE
18
18a
20

FIG.15

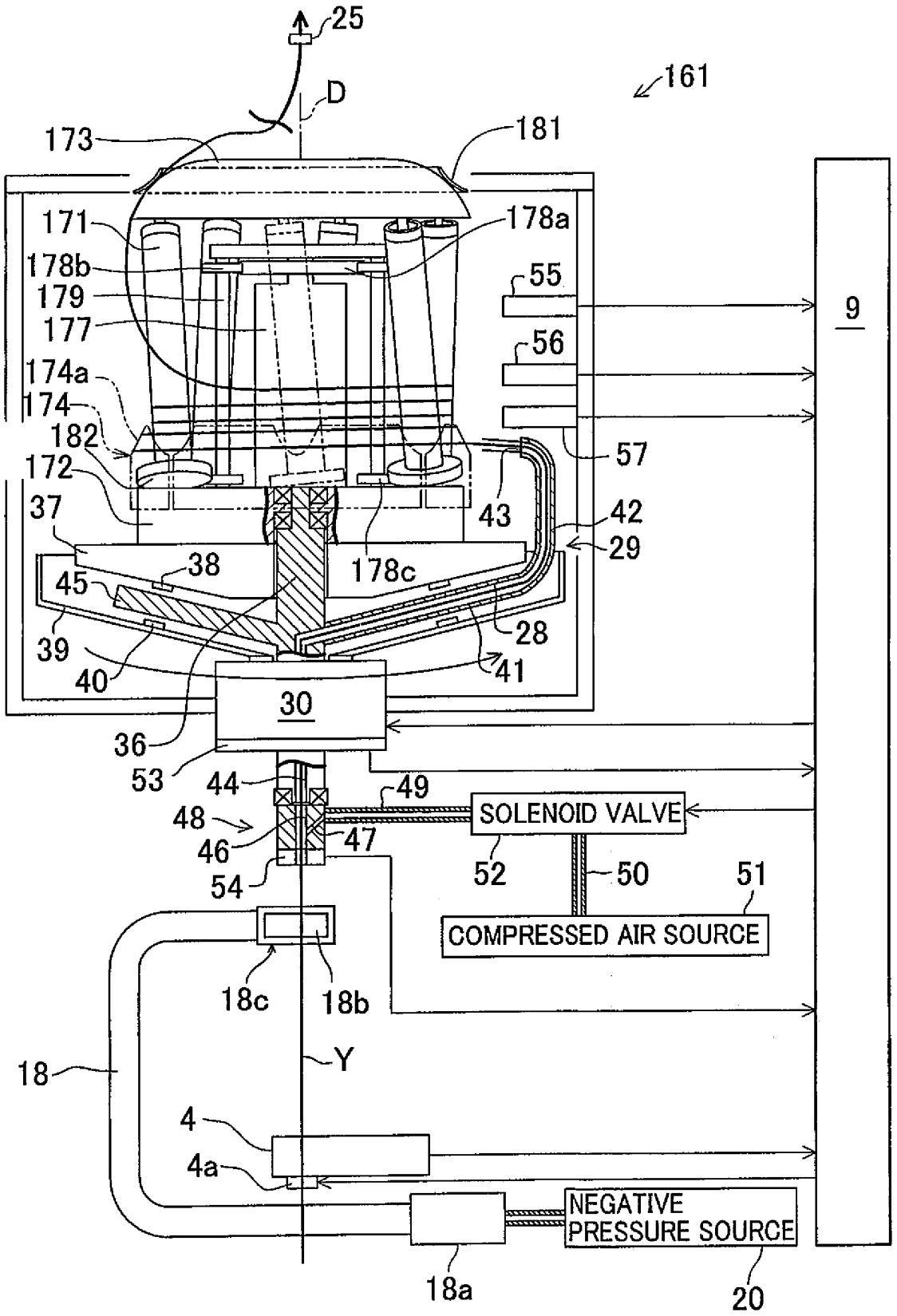
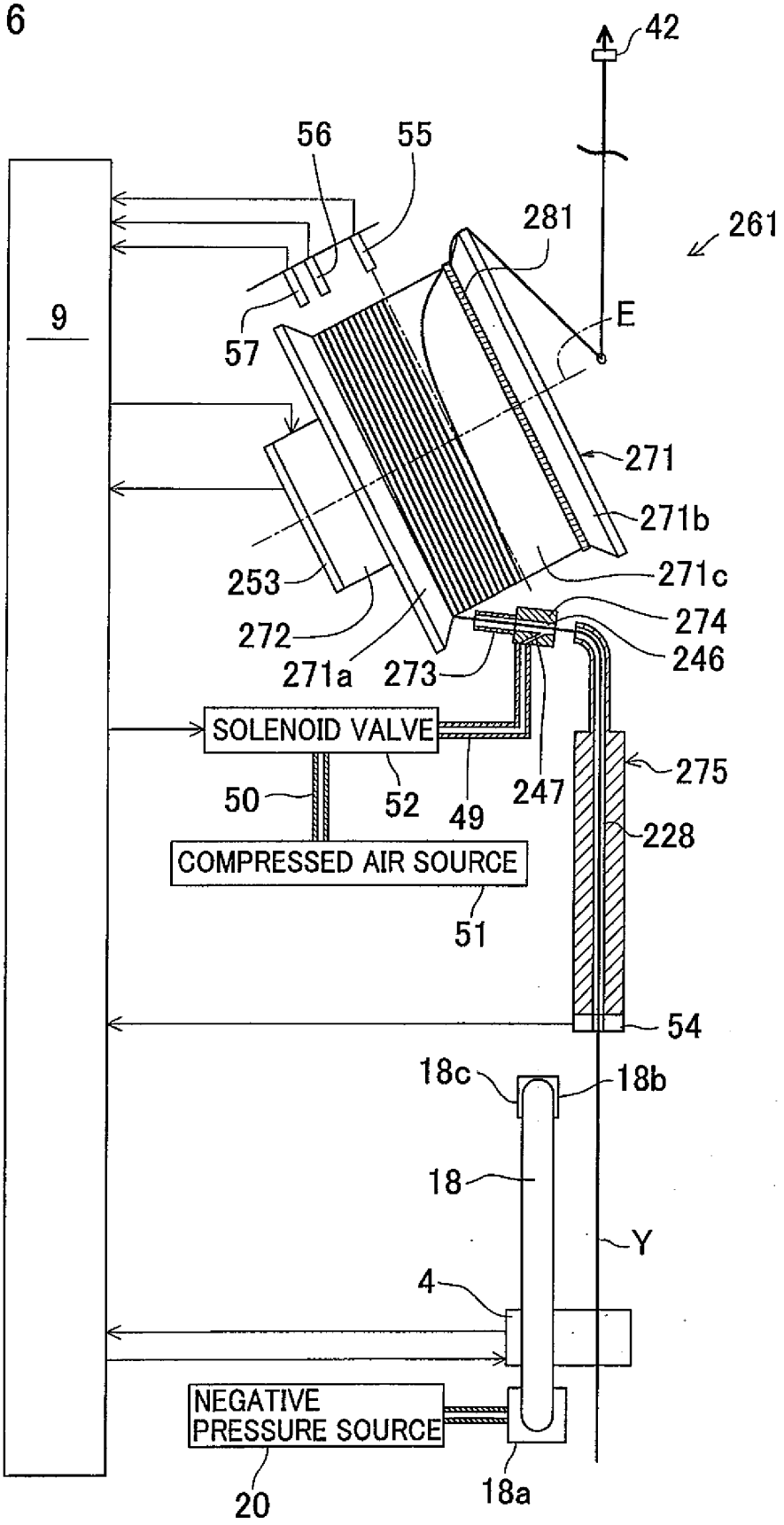

25
D
161
173
181
171
178a
178b
55
9
179
177
56
174a
174
182
57
172
37
43
42
29
38
178c
45
28
39
41
40
30
36
53
44
49
48
SOLENOID VALVE
46
47
52
50
51
54
COMPRESSED AIR SOURCE
18c
18b
18
Y
4
4a
NEGATIVE
PRESSURE SOURCE
18a
20

FIG.16


42
56
55
281
261
9
57
E
271
271b
253
271c
272
274
271a
273
246
SOLENOID VALVE
275
50
52
49
247
228
COMPRESSED AIR SOURCE
51
54
18c
18b
18
Y
4
NEGATIVE
PRESSURE SOURCE
20
18a

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2010/067115

A. CLASSIFICATION OF SUBJECT MATTER
B65H51/22(2006.01)i, *B65H63/08*(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, B65H63/08

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 2004-156185 A (Murata Machinery Ltd.), 03 June 2004 (03.06.2004), paragraphs [0018] to [0040]; fig. 1 to 6 (Family: none)	1-6,8-10, 13-18,20 7,11-12,19
Y A	JP 9-208130 A (Murata Machinery Ltd.), 12 August 1997 (12.08.1997), paragraphs [0010] to [0013]; fig. 1 & EP 787674 A2	1-6,8-10, 13-18,20 7,11-12,19
Y A	JP 6-199478 A (W. Schlafhorst AG. & Co.), 19 July 1994 (19.07.1994), paragraphs [0010] to [0012] & US 5484116 A & DE 4231958 A	8-9 1-7,10-20

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

* Special categories of cited documents:
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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
29 November, 2010 (29.11.10)	07 December, 2010 (07.12.10)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2010/067115

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 2004-277949 A (Murata Machinery Ltd.), 07 October 2004 (07.10.2004), paragraphs [0038] to [0043]; fig. 6 to 8 & EP 1460015 A1	14-15 1-13,16-20
Y A	JP 47-14429 A (Zinser Textilmaschinen GmbH), 09 August 1972 (09.08.1972), page 5, upper left column, line 10 to page 5, upper right column, line 11 & US 3749327 A & DE 2056593 A	18 1-17,19-20
Y A	JP 5-78037 A (Murata Machinery Ltd.), 30 March 1993 (30.03.1993), paragraph [0023]; fig. 3 (Family: none)	20 1-19

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2001516691 W **[0007]**
- JP 48020455 A **[0007]**