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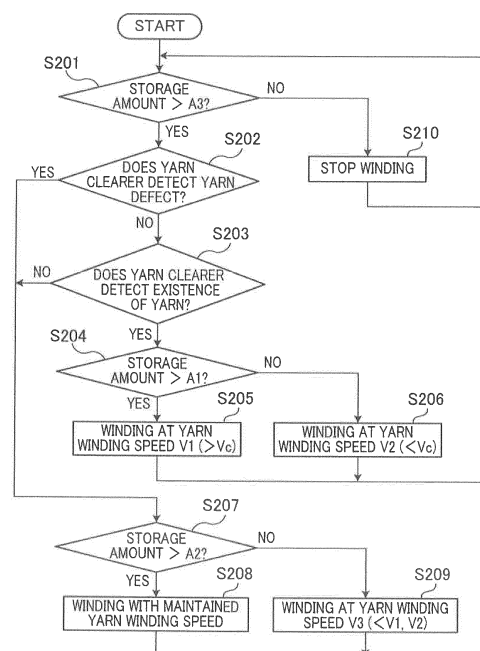
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(54) **YARN WINDING DEVICE AND YARN WINDING METHOD**

(57) In an arrangement in which a yarn unwound from a yarn supplying bobbin is temporarily stored in an unwound yarn storage and the yarn stored in the unwound yarn storage is wound to form a package, the time for yarn joining is secured without upsizing the unwound yarn storage. When the yarn is properly running (S202: NO, S203: YES), the yarn is unwound from the yarn supplying bobbin at a yarn unwinding speed V_c which is constant and maximum within a range of possible changes in the yarn unwinding speed. When the yarn storage amount is larger than A_1 (S204: YES), the yarn winding speed is set at $V_1 (>V_c)$ (S205), whereas, when the yarn storage amount is equal to or smaller than A_1 (S204: NO), the yarn winding speed is set at $V_2 (<V_c)$ (S206). When a yarn defect is detected (S202: YES) or the existence of the yarn Y becomes no longer detected (S203: NO), if the yarn storage amount is larger than $A_2 (<A_1)$ (S207: YES), the yarn winding speed is maintained (S208), and if the yarn storage amount is equal to or smaller than A_2 (S207: NO), the yarn winding speed is decreased to $V_3 (<V_1$ and $V_2)$ (S209).

FIG.5



Description

Technical Field

[0001] The present invention relates to a yarn winding device and a yarn winding method, by which a yarn unwound from a yarn supplying bobbin is wound to form a package.

Background Art

[0002] As a yarn winding device winding a yarn unwound from a yarn supplying bobbin so as to form a package, Patent Literature 1 recites a yarn winding device (winding unit) which is configured to temporarily store a yarn unwound from a yarn supplying bobbin supported by a yarn supplying bobbin supporting portion in an unwound yarn storage (yarn storage section), and wind the yarn stored in the unwound yarn storage so as to form a package. According to Patent Literature 1, in cases such as a yarn defect is detected or the yarn supplying bobbin runs out of yarn and hence the bobbin is replaced with a new yarn supplying bobbin, a part of the yarn on the yarn supplying bobbin supporting portion can be joined with a part of the yarn on the unwound yarn storage side at a yarn joining section which is provided between the yarn supplying bobbin supporting portion side and the unwound yarn storage, while the winding of the yarn stored in the unwound yarn storage is being continued.

[0003] According to Patent Literature 1, furthermore, the yarn is wound at a constant yarn winding speed, and after the completion of the yarn joining, the speed of feeding the yarn to the unwound yarn storage, i.e., the yarn unwinding speed of unwinding the yarn from the yarn supplying bobbin is temporarily increased to recover the yarn storage amount in the unwound yarn storage, which has been decreased in the yarn joining.

Citation List

Patent Literature

[0004] Patent Literature 1 Japanese Unexamined Patent Publication No. 2010-47360

Summary of Invention

Technical Problem

[0005] In the yarn winding device disclosed in Patent Literature 1, during the yarn winding, the yarn storage amount in the unwound yarn storage varies in accordance with the difference between the yarn unwinding speed at which the yarn is unwound from the yarn supplying bobbin and the yarn winding speed at which the yarn is wound onto the package. In this regard, as described above, the yarn winding speed is constant in Patent Literature 1. For this reason, to adjust the yarn stor-

age amount in the unwound yarn storage to prevent the yarn in the unwound yarn storage from overflowing and to prevent the unwound yarn storage from running out of the yarn, it is necessary to vary the yarn unwinding speed in accordance with the yarn storage amount in the unwound yarn storage.

[0006] However, adjusting the yarn storage amount in the unwound yarn storage by varying the yarn unwinding speed is disadvantageous in that the average yarn unwinding speed must be low in this case, as compared to a case where the yarn unwinding speed is set to be as high as possible. Furthermore, because the yarn supplying bobbin is typically smaller in diameter than the winding bobbin, sloughing of the yarn tends to occur when the yarn unwinding speed is significantly varied, and such sloughing often causes yarn cutting. Because of this, when the yarn storage amount of the unwound yarn storage is adjusted by varying the yarn unwinding speed, the productivity of yarn winding by the yarn winding device is low.

[0007] In addition to the above, to continue the yarn winding during the yarn joining in the yarn winding device recited in Patent Literature 1, it is necessary to arrange the yarn storage amount in the unwound yarn storage to be larger than at least the amount of yarn wound until the completion of the yarn joining. In this regard, as a yarn joining operation conducted at the yarn joining section for the yarn joining may not succeed on the first attempt, the yarn joining is achieved by repeatedly conducting the yarn joining operation each time the attempt fails.

[0008] Because of the above, the yarn storage amount in the unwound yarn storage must be larger than the amount of yarn wound while the yarn joining operation is conducted for a predetermined number of times which is more than once. For this reason, to obtain the time required to perform the yarn joining operation for the predetermined number of times, the unwound yarn storage is required to be large enough to store a sufficient amount of yarn. When the unwound yarn storage is large, the yarn winding device must be large, too.

[0009] An object of the present invention is to provide a yarn winding device and a yarn winding method, with which the productivity of yarn winding is high when a yarn is wound, at the same time a time for yarn joining or the like is sufficiently long even if the size of a unwound yarn storage is not increased.

Solution to Problem

[0010] A yarn winding device of the present invention includes: yarn supplying bobbin supporting portion configured to support a yarn supplying bobbin; an unwound yarn storage configured to unwind a yarn from the yarn supplying bobbin supported by the yarn supplying bobbin supporting portion and store the unwound yarn; a winding section configured to wind the yarn stored in the unwound yarn storage to form a package; a storage amount de-

tecting portion configured to detect a storage amount of the yarn in the unwound yarn storage; a yarn running detecting portion configured to detect whether the yarn is running between the yarn supplying bobbin supporting portion and the unwound yarn storage; and a controller configured to control a yarn winding speed of the winding section based on a detection result of each of the storage amount detecting portion and the yarn running detecting portion.

[0011] A yarn winding method of the present invention includes the steps of: unwinding a yarn from a yarn supplying bobbin; storing the unwound yarn in a unwound yarn storage; and winding the yarn stored in the unwound yarn storage so as to form a package, the running of the yarn in the space between the yarn supplying bobbin and the unwound yarn storage and a storage amount of the yarn in the unwound yarn storage being detected and the package being formed by winding the yarn at a yarn winding speed corresponding to a result of the detection.

[0012] According to the arrangements above of the present invention, when the yarn is running in the space between the yarn supplying bobbin and the unwound yarn storage, the storage amount of the yarn in the unwound yarn storage is adjustable without changing the yarn unwinding speed of unwinding the yarn from the yarn supplying bobbin, by changing the yarn winding speed in accordance with the detected storage amount of the yarn in the unwound yarn storage. As the yarn is kept unwound at a desired yarn unwinding speed in the winding of the yarn, the productivity in the winding of the yarn is improved.

[0013] Furthermore, when the yarn is not running in the space between the yarn supplying bobbin and the unwound yarn storage, the decrease in the storage amount of the yarn in the unwound yarn storage is restrained by lowering the yarn winding speed. It is therefore possible to sufficiently secure the time for the yarn joining or the like, without upsizing the unwound yarn storage. Furthermore, the downsizing of the unwound yarn storage is realized by significantly lowering the yarn winding speed.

[0014] In the present invention, the yarn winding device further includes a yarn joining section configured to perform yarn joining of a part of the yarn on the yarn supplying bobbin side with a part of the yarn on the unwound yarn storage side.

[0015] According to the present invention, it is possible to continue the winding of the yarn by winding the yarn stored in the unwound yarn storage in the winding section, while the yarn joining is being maintained at the yarn joining section. Furthermore, because the yarn winding speed is changed in accordance with the storage amount of the yarn in the unwound yarn storage, it is possible to sufficiently secure the time for the yarn joining in the yarn joining section. Furthermore, in case where a sufficient time is secured for the yarn joining in the yarn joining section, the unwound yarn storage is downsized.

[0016] In the present invention, the yarn winding device

is arranged such that the yarn running detecting portion is constituted by a yarn existence detection means configured to detect the existence of the yarn in the space between the yarn supplying bobbin supporting portion and the unwound yarn storage.

[0017] According to the present invention, the running of the yarn is detected in such a way that the yarn existence detection means detects whether the yarn exists between the yarn supplying bobbin supporting portion and the unwound yarn storage.

[0018] In the present invention, the yarn winding device is arranged such that the yarn running detecting portion is constituted by a yarn defect detection section configured to detect a yarn defect on the yarn between the yarn supplying bobbin supporting portion and the unwound yarn storage.

[0019] According to the present invention, because the yarn does not run after yarn defect is detected by the yarn defect detection section and the yarn is cut by the yarn cutter, it is possible to detect the running of the yarn by checking whether the yarn defect detection section detects yarn defect.

[0020] In the present invention, the yarn winding device is arranged such that the yarn running detecting portion is constituted by a running speed detection means configured to detect the running speed of the yarn.

[0021] According to the present invention, it is possible to detect the running of the yarn based on the running speed of the yarn detected by the speed sensor.

[0022] In the present invention, the yarn winding device is arranged such that the yarn running detecting portion is constituted by a running length detection means configured to detect the running length of the yarn.

[0023] According to the present invention, it is possible to detect the running of the yarn based on the length of the running yarn detected by the running length sensor.

[0024] In the present invention, the yarn winding device is arranged such that the unwound yarn storage includes a yarn wound portion to which the yarn is wound from one end toward the other end along one direction, and the storage amount detecting portion is disposed to oppose a part of the yarn wound portion and includes at least one sensor which is configured to detect whether the yarn exists at the part of the yarn wound portion.

[0025] According to the present invention, when the unwound yarn storage is provided with the yarn wound portion, the storage amount detecting portion may be constituted by at least one sensor opposing the yarn wound portion.

[0026] In the present invention, the yarn winding device is arranged such that, when the yarn running detecting portion detects the running of the yarn, the controller controls the unwound yarn storage so that the yarn unwinding speed of the unwound yarn storage is at a constant yarn unwinding speed, and controls the winding section so that the yarn winding speed is at a yarn winding speed which is determined based on the storage amount of the yarn detected by the storage amount detecting portion.

[0027] According to the present invention, when the running of the yarn is detected, i.e., when the storing of the yarn into the unwound yarn storage is continued, the storage amount of the yarn in the unwound yarn storage is properly maintained by unwinding the yarn from the yarn supplying bobbin at the constant yarn unwinding speed and winding the yarn at the yarn winding speed determined based on the storage amount of the yarn in the unwound yarn storage.

[0028] Furthermore, because the yarn is unwound at the constant yarn unwinding speed, the productivity in the winding of the yarn is improved.

[0029] In the present invention, the yarn winding device is arranged such that, when the yarn running detecting portion detects the running of the yarn, the controller controls the winding section to operate at a yarn winding speed V1 which is higher than the yarn unwinding speed of the unwound yarn storage, when the storage amount of the yarn detected by the storage amount detecting portion is larger than a predetermined upper limit storage amount, and controls the winding section to operate at a yarn winding speed V2 which is lower than the yarn unwinding speed when the storage amount of the yarn detected by the storage amount detecting portion is equal to or smaller than the upper limit storage amount.

[0030] In the present invention, the yarn winding method is arranged such that, when the running of the yarn is detected, if the detected storage amount of the yarn is larger than a predetermined upper limit storage amount, the yarn is wound at a yarn winding speed V1 which is higher than the yarn unwinding speed of the yarn unwound from the unwound yarn storage, and if the detected storage amount of the yarn is equal to or smaller than the upper limit storage amount, the yarn is wound at a yarn winding speed V2 which is lower than the yarn unwinding speed.

[0031] These arrangements of the present invention make it possible to keep the storage amount of the yarn in the unwound yarn storage to be close to the upper limit storage amount and prevent the yarn from overflowing from the unwound yarn storage and the unwound yarn storage from completely running out of the yarn.

[0032] In the present invention, the yarn winding device is arranged such that, when the yarn running detecting portion does not detect the running of the yarn, the controller controls the unwound yarn storage to stop the unwinding of the yarn, and controls the winding section to operate at a yarn winding speed V3 which is lower than the yarn winding speed when the yarn running detecting portion detects the running of the yarn.

[0033] In the present invention, the yarn winding method is arranged such that, when the running of the yarn is not detected, the unwinding of the yarn is stopped, and the yarn is wound at a yarn winding speed V3 which is lower than the winding speed when the running of the yarn is detected.

[0034] According to these arrangements of the invention, when the running of the yarn is not detected, the

yarn is not further stored in the unwound yarn storage, but the decrease in the storage amount of the yarn in the unwound yarn storage is minimized by lowering the yarn winding speed in such a case. This makes it possible to sufficiently secure the time for the yarn joining or the like, without upsizing the unwound yarn storage. Alternatively, in case where a sufficient time is secured for the yarn joining or the like, the unwound yarn storage is downsized.

[0035] In the present invention, the yarn winding device is arranged such that, when the yarn running detecting portion does not detect the running of the yarn, the controller controls the winding section to operate at the yarn winding speed V3 which is lower than the yarn winding speed when the yarn running detecting portion detects the running of the yarn, only when the storage amount of the yarn detected by the storage amount detecting portion is equal to or lower than a predetermined intermediate storage amount, and controls the winding section to operate at the yarn winding speed V1 or V2 which is identical with the yarn running speed when the yarn running detecting portion detects the running of the yarn, when the storage amount of the yarn detected by the storage amount detecting portion is larger than the intermediate storage amount.

[0036] According to the present invention, even when the storing of the yarn in the unwound yarn storage has been stopped, the winding of the yarn is efficiently carried out by winding the yarn at the yarn winding speed V1, V2 which is identical with the yarn winding speed when the yarn is stored in the unwound yarn storage without lowering the yarn winding speed, when the storage amount of the yarn in the unwound yarn storage is large (i.e., larger than the intermediate storage amount). Furthermore, because the yarn is wound at the same yarn winding speed V1, V2 as in the case of the storing of the yarn in the unwound yarn storage, the energy loss which occurs when the yarn winding speed is changed is restrained.

[0037] In the present invention, the yarn winding device is arranged such that the controller controls the winding section so that the winding of the yarn is stopped no matter whether the yarn running detecting portion detects the running of the yarn, when the storage amount of the yarn detected by the storage amount detecting portion is equal to or lower than a predetermined lower limit storage amount.

[0038] According to the present invention, because the winding of the yarn is stopped when the storage amount of the yarn in the unwound yarn storage becomes extremely low (i.e., lower than the lower limit storage amount), it is possible to prevent the unwound yarn storage from completely running out of yarn. This prevents, for example, the part of the yarn on the unwound yarn storage side used for the yarn joining from running out when the winding of the yarn is continued until the unwound yarn storage fully runs out of the yarn.

Advantageous Effects of Invention

[0039] According to the present invention, when the yarn is running in the space between the yarn supplying bobbin and the unwound yarn storage, the storage amount of the yarn in the unwound yarn storage is adjustable without changing the yarn unwinding speed of unwinding the yarn from the yarn supplying bobbin, by changing the yarn winding speed in accordance with the detected storage amount of the yarn in the unwound yarn storage. As the yarn is kept unwound at a desired yarn unwinding speed in the winding of the yarn, the productivity in the winding of the yarn is improved.

[0040] Furthermore, when the yarn is not running in the space between the yarn supplying bobbin and the unwound yarn storage, the decrease in the storage amount of the yarn in the unwound yarn storage is restrained by lowering the yarn winding speed. It is therefore possible to sufficiently secure the time for the yarn joining or the like, without upsizing the unwound yarn storage. Furthermore, the downsizing of the unwound yarn storage is realized by significantly lowering the yarn winding speed.

Brief Description of Drawings

[0041]

[FIG. 1] FIG. 1 is a schematic diagram of a winding unit according to the first embodiment of the present invention.

[FIG. 2] FIG. 2 is a schematic diagram of the accumulator shown in FIG. 1.

[FIG. 3] FIG. 3 is a functional block diagram of the controller shown in FIG. 1.

[FIG. 4] FIG. 4 shows a control flow of the operation of the rotational storage drum.

[FIG. 5] FIG. 5 is a control flow of the operation of the winding drum.

[FIG. 6] FIG. 6 shows a flow of operations such as yarn joining.

[FIG. 7] FIG. 7 shows an example of changes over time in the yarn winding speed, the yarn unwinding speed, and the yarn storage amount in the winding unit.

[FIG. 8] FIG. 8 is a partial enlarged view of FIG. 7.

[FIG. 9] FIG. 9 relates to the second embodiment and is equivalent to FIG. 2.

[FIG. 10] FIG. 10 is a control flow related to a modification 1 and is equivalent to FIG. 5.

[FIG. 11] FIG. 11 is a schematic diagram of a winding unit of a modification 2.

Description of Embodiments

[First Embodiment]

[0042] The following will describe a preferred first em-

bodiment of the present invention.

[0043] In an automatic winding device of the first embodiment, winding units 2 (yarn winding devices) shown in FIG. 1 are lined up in the left-right direction of the figure. Each winding unit 2 includes a yarn supplying portion 5,

a winding section 6, a yarn running detecting portion 7, a yarn jointing section 8, and an unwound yarn storage 9. **[0044]** The yarn supplying portion 5 includes a yarn supplying bobbin supporting portion 60 for supporting a yarn supplying bobbin 21, a yarn unwinding assisting device 12, and a first tension applying portion 41. Furthermore, the yarn supplying portion 5 includes an unillustrated bobbin supplier used for supplying a new yarn supplying bobbin 21 to the yarn supplying bobbin supporting portion 60. There are different types of bobbin suppliers, e.g., magazine-type suppliers and tray-type suppliers. When a spun yarn Y (which will be simply referred to as yarn Y) is fully taken out from the yarn supplying bobbin 21 placed on the yarn supplying bobbin supporting portion 60, the yarn supplying portion 5 discharges the empty bobbin supported by the yarn supplying bobbin supporting portion 60 and causes the bobbin supplier to supply a new yarn supplying bobbin 21 to the yarn supplying bobbin supporting portion 60.

[0045] The yarn unwinding assisting device 12 assists the unwinding of the yarn Y from the yarn supplying bobbin 21 by lowering a regulator 40 wrapping the core tube of the yarn supplying bobbin 21 in sync with the unwinding of the yarn Y from the yarn supplying bobbin 21. The regulator 40 contacts a balloon which is formed at an upper part of the yarn supplying bobbin 21 on account of the rotation of the yarn Y unwound from the yarn supplying bobbin 21 and the centrifugal force, so as to assist the unwinding of the yarn Y by applying a suitable tension to the balloon.

[0046] In the vicinity of the yarn unwind assisting device 12, a yarn detecting portion 37 is provided to be able to detect the existence of the yarn Y. This yarn detecting portion 37 detects that the yarn supplying bobbin 21 runs out of the yarn Y, and sends an empty bobbin signal to the controller 109.

[0047] The first tension applying portion 41 applies a predetermined tension to the running yarn Y. As the first tension applying portion 41, it is possible to use, for example, a gate-type tension applying portion in which a movable comb teeth is provided with respect to a fixed comb teeth. By this first tension applying portion 41, a predetermined tension is applied to the yarn Y stored in a later-described accumulator 61, and therefore the yarn Y stored in the accumulator 61 is neatly wound.

[0048] The winding section 6 includes an unillustrated cradle configured to be able to support the winding bobbin 22, a winding drum 24 configured to traverse the yarn Y and rotate the winding bobbin 22, and a second tension applying portion 42. The cradle is configured to be swingable to approach and move away from the winding drum 24, with the result that the package 30 contacts or move away from the winding drum 24. Furthermore, as shown

in FIG. 1, on the outer circumference of the winding drum 24 is formed a spiral-shaped spiral traversing groove 27, and the yarn Y is traversed by this spiral traversing groove 27.

[0049] The winding drum 24 is rotatably driven so as to drive the winding bobbin 22 which is provided to oppose to the winding drum 24. This winding drum 24 is driven by a winding drum motor 116 (see FIG. 3).

[0050] The second tension applying portion 42 controls the tension of the yarn Y when the yarn Y unwound from a later-described accumulator 61 of the unwound yarn storage 9 is wound onto a package. Therefore a suitable tension is applied to the yarn Y when the yarn Y taken out from the accumulator 61 is wound onto the winding bobbin 22. In the same manner as the first tension applying portion 41, a gate-type tension applying portion in which a movable comb teeth is provided with respect to a fixed comb teeth may be used as the second tension applying portion 42.

[0051] In addition to the above, a waxing device 17 is provided on the downstream of the second tension applying portion 42 to wax the running yarn Y.

[0052] The yarn running detecting portion 7 is provided with a yarn clearer 15 (yarn defect detection section). The yarn clearer 15 detects defects of the yarn Y by monitoring the thickness of the yarn Y by a suitable sensor. Yarn defects such as slub are detectable by processing signals supplied from the sensor of the yarn clearer 15. The yarn clearer 15 may also function as a sensor for simply detecting the existence of the yarn Y. In other words, in the first embodiment, the yarn clearer 15 functions as a yarn existence detection means and a yarn defect detection means of the present invention. At the upstream end of the yarn clearer 15, a cutter 16 is provided to be able to cut the yarn at a part on the upstream of yarn defect, when the yarn defect is detected.

[0053] The yarn jointing section 8 includes a yarn jointing device 14 for the yarn jointing operation, a lower yarn guide pipe 25, and an upper yarn guide pipe 26.

[0054] The yarn jointing device 14 joins the lower yarn on the yarn supplying bobbin 21 side with the upper yarn on the package 30 side (unwound yarn storage 9 side) when, for example, the running yarn is cut, yarn defect is detected, or the yarn supplying bobbin 21 runs out of the yarn Y and the yarn supplying bobbin 21 is replaced. The yarn jointing device 14 may be a mechanical-type device or a device employing fluid such as compressed air.

[0055] The lower yarn guide pipe 25 is supported to be rotatable about an axis 25a which is disposed below the yarn jointing device 14, and is rotated by a lower pipe motor 122 (see FIG. 3). At the leading end of the lower yarn guide pipe 25 is formed a suction port 25b, and the suction port 25b is provided with an unillustrated clamping section. Furthermore, the lower yarn guide pipe 25 is connected with an unillustrated negative pressure source and receives a negative pressure therefrom, and hence a suction flow for sucking the yarn Y is generated

at the suction port 25b.

[0056] The upper yarn guide pipe 26 is supported to be rotatable about an axis 26a above the yarn jointing device 14, and is rotated by an upper pipe motor 121 (see FIG. 3). At the leading end of the upper yarn guide pipe 26 is formed a suction port 26b, and this suction port 26b is provided with a clamping section 26c (see FIG. 2). Furthermore, the upper yarn guide pipe 26 is connected with a negative pressure source 120 (see FIG. 2) and receives a negative pressure therefrom, and hence a suction flow for sucking the yarn Y is generated at the suction port 26b.

[0057] The unwound yarn storage 9 is provided with the accumulator 61 configured to unwind the yarn Y from the yarn supplying bobbin 21 and store the unwound yarn Y. FIG. 2 is a schematic diagram of the accumulator 61.

[0058] As shown in FIG. 2, the accumulator 61 includes members such as a rotational storage 71, a rotational storage drum motor 72, a yarn guiding member 73, a blowdown nozzle 74, and a yarn passage forming member 75.

[0059] The rotational storage 71 is a drum rotatable about an axis C1. As described later, as the rotational storage 71 is rotated in one direction, the yarn Y is unwound from the yarn supplying bobbin 21 and the unwound yarn Y is wound onto the rotational storage 71, with the result that the yarn Y is stored in the rotational storage 71.

[0060] The both axial ends of the rotational storage 71 are formed as tapered portions 71a and 71b each of which narrows in diameter toward the other end, respectively, and the part between the tapered portion 71a and the tapered portion 71b is substantially constant in diameter to function as a linear portion 71c (yarn wound portion) on which the yarn Y is wound from one end toward the other end.

[0061] Onto the end of the linear portion 71c of the rotational storage 71 from which end the yarn winding starts, a rubber annular member 81 such as a rubber band and an O-ring is wrapped. The annular member 81 therefore rotates together with the rotational storage 71. Furthermore, as described above, because the right upper end portion of the rotational storage 71 is formed to be the tapered portion 71b, the annular member 81 does not drop off from the rotational storage 71 in the upper right direction.

[0062] The rotational storage drum motor 72 is a position controllable motor such as a DC brushless motor, a stepping motor, and a servo motor, and rotates the rotational storage 71 in either direction. Furthermore, a rotary encoder 153 is attached to the rotational storage drum motor 72 to send an angle signal corresponding to the rotation angle of the rotational storage drum motor 72 to the controller 109.

[0063] The yarn guiding member 73 is a linear pipe which is arranged so that the upper left end portion in FIG. 2 opposes the tapered portion 71a. With this, the yarn Y having reached the yarn guiding member 73 from

the yarn supplying portion 5 side is guided to the tapered portion 71a by the yarn guiding member 73.

[0064] The blowdown nozzle 74 is disposed in the right side of the yarn guiding member 73 in the figure, and includes a yarn path 146 which is connected to the internal space of the yarn guiding member 73 and a blowdown path 147 which communicates with the yarn path 146 and is inclined with the respect to the yarn path 146.

[0065] The blowdown path 147 is connected to the compressed air source 151 via a connection pipe 149 and a connection pipe 150. Between the connection pipe 149 and the connection pipe 150, a solenoid valve 152, which is electrically connected to the controller 109, is provided.

[0066] The yarn passage forming member 75 constitutes the yarn passage 128 and is provided between the suction port 26b of the upper yarn guide pipe 26 and the blowdown nozzle 74. The yarn passage 128 extends substantially straight up from its lower end that is positioned immediately above the suction port 26b of the upper yarn guide pipe 26. The upper end portion of the yarn passage 128 is bended toward the upper left in FIG. 2, so that the upper end thereof opposes the lower right end portion of the yarn path 146 of the blowdown nozzle 74.

[0067] On account of the yarn guiding member 73, the blowdown nozzle 74, and the yarn passage forming member 75 described above, when the solenoid valve 152 is opened and the compressed air in the compressed air source 151 is discharged to the yarn path 146 after passing through the connection pipe 150, the connection pipe 149, and the blowdown path 147 in this order, an airflow running from the rotational storage 71 side to the upper yarn guide pipe 26 side is formed in the internal space of the yarn guiding member 73, the yarn path 146, and the yarn passage 128. By this airflow, the yarn end of the yarn Y wound onto the rotational storage 71 is sucked, captured, and taken out to the yarn jointing section 8 side.

[0068] In regard to the above, because the yarn guiding member 73 is a pipe which is open only at the both ends and has an internal space, the air in the internal space of the yarn guiding member 73 is sucked and the air pressure in the space is significantly lowered, as the airflow is generated in the internal space of the yarn guiding member 73 by the blowdown nozzle 74. This makes it possible to strongly suck the yarn end of the yarn Y and certainly capture the yarn end of the yarn Y.

[0069] In addition to the above, at the lower end of the yarn passage forming member 75 described above, a taking-out sensor 154 is provided to detect that the yarn end of the yarn Y wound onto the accumulator 61 has been certainly taken out to the yarn jointing section 8 side. This taking-out sensor 154 is electrically connected to the controller 109. When detecting that the yarn end of the yarn Y has been taken out to the yarn jointing section 8 side, the sensor sends a drawing detection signal to the controller 109. Alternatively, because the yarn clearer 15 is able to detect the existence of the yarn Y,

the yarn clearer 15 may function as the taking-out sensor 154. In such a case, it is unnecessary to provide the taking-out sensor 154 for the detection of the taking out, in addition to the yarn clearer 15.

[0070] In addition to the above, the accumulator 61 is provided with an upper limit yarn sensor 155, an intermediate yarn sensor 156, and a lower limit yarn sensor 157, which are used for detecting the storage amount of the yarn Y. These yarn sensors 155 to 157 are positioned to oppose the upper end of the bundle of the yarn Y wound onto the rotational storage 71 when the storage amount of the yarn Y in the rotational storage 71 is A1 (upper limit storage amount, e.g., 300m), A2 (intermediate storage amount, e.g., 200m), and A3 (lower limit storage amount, e.g., 40m), respectively. It is noted that A1 above is larger than the amount of the yarn Y wound onto the winding bobbin 22 while the yarn jointing operation is executed for the predetermined more than one number of times (e.g., three times). With this arrangement, each of the yarn sensors 155 to 157 sends, to the controller 109, a signal indicating that the storage amount of the yarn Y is larger than A1, A2, or A3, while the sensor detects the existence of the yarn Y at the opposing position.

[0071] In regard to the above, in the first embodiment, in the linear portion 71c of the rotational storage 71, the range of the end of the wound yarn Y on the winding section 6 side locates (i.e., the winding width of the yarn Y on the linear portion 71c) is limited in advance to a range R1 shown in FIG. 2. Therefore, the range of the storage amount of the yarn Y in the rotational storage 71 falls between the upper limit, i.e., the storage amount (about 300m) of the yarn Y when the yarn Y is wound to the upper limit of the range R1 (the upper right end in FIG. 2) and the lower limit, i.e., the storage amount (about 40m) of the yarn Y when the yarn Y is wound to the lower limit of the range R1 (the lower left end in FIG. 2).

[0072] In the first embodiment, as described below, to keep the yarn Y stored in the rotational storage 71 to be within the range R1 above, the yarn sensors 155 to 157 detect whether the storage amount of the yarn Y in the rotational storage 71 is larger than the A1 which is the upper limit position of the range R1 of the storage amount, whether the storage amount of the yarn Y is larger than the A2 which is the intermediate position of the range R1 of the storage amount, and whether the storage amount of the yarn Y is larger than the A3 which is the lower limit position of the range R1 of the storage amount, respectively.

[0073] In regard to the above, the storage amount of the yarn Y in the rotational storage 71 when the yarn Y is stored to the upper limit of the range R1 is arranged to be smaller than the actual maximum yarn storage amount of the rotational storage 71, and hence the yarn Y does not overflow from the rotational storage 71 even when the storage amount of the yarn in the rotational storage 71 becomes temporarily larger than the A1 as described later.

[0074] Now, the controller 109 of the winding unit 2 will be described. As shown in FIG. 3, the controller 109 includes members such as a CPU (Central Processing Unit), a ROM (Read Only Memory) storing a control program executed by the CPU and data used by the control program, and the above-described RAM (Random Access Memory) which temporarily stores data when a program is executed. As the control program stored in the ROM is loaded and executed by the CPU, the control program causes the hardware such as the CPU to function as the winding drum motor controller 160, the rotational storage drum motor controller 161, the taken-out yarn length calculation unit 163, the upper pipe controller 164, and the lower pipe controller 165.

[0075] The winding drum motor controller 160 controls the rotation speed of the winding drum motor 116. The rotational storage drum motor controller 161 controls the direction and rotation speed of the rotation of the rotational storage drum motor 72.

[0076] The taken-out yarn length calculation unit 163 calculates the taken-out yarn length of the yarn Y having been taken out to the yarn jointing section 8 side from the accumulator 61 since the taking-out sensor 154 detects the yarn Y, based on the rotation angle of the rotational storage drum motor 72 detected by the rotary encoder 153.

[0077] The upper pipe controller 164 compares the yarn defect length obtained from the yarn defect detection signal with the taken-out yarn length calculated by the taken-out yarn length calculation unit 163. Once the taken-out yarn length reaches the yarn defect length, the upper pipe controller 164 swings the upper yarn guide pipe 26 while keeping it in the clamped state, so as to guide the yarn Y on the winding section 6 side to the yarn jointing device 14 and set the yarn Y to the yarn jointing device 14. The lower pipe controller 165 swings the lower yarn guide pipe 25 while keeping it in the clamped state, so as to guide the yarn Y on the yarn supplying portion 5 to the yarn jointing device 14 and set the yarn Y to the yarn jointing device 14.

[0078] Now, the operation of winding the yarn Y by the winding unit 2 will be described with reference to FIG. 4 to FIG. 7.

[0079] The operator of the automatic winding device (winding unit 2) unwinds the yarn Y from the yarn supplying bobbin 21, sets this yarn Y to the yarn unwinding assisting device 12, the yarn detecting portion 37, the first tension applying portion 41, the yarn clearer 15, the accumulator 61, the second tension applying portion 42, and the waxing device 17, and fixes the yarn Y to the winding bobbin 22. The yarn path of the yarn Y in the accumulator 61 is shown in FIG. 2. In other words, the operator causes the yarn Y to pass through the taking-out sensor 154, the yarn passage 128 of the yarn passage forming member 75, the yarn path 146 of the blow-down nozzle 74, and the internal path of the yarn guiding member 73 in this order.

[0080] In this state, the operator takes the yarn Y out

from the opening opposing the rotational storage 71 of the yarn guiding member 73 and winds the yarn Y onto the rotational storage 71 for, for example, 5 to 20 times, and then causes the yarn Y to pass through the space between the rotational storage 71 and the annular member 81, sets the yarn Y to the yarn guide 82 provided above and to the right of the rotational storage 71, and then sets the yarn Y to the second tension applying portion 42. In FIG. 2, the yarn Y is depicted as a thick yarn and the gap between neighboring parts of the yarn is wide, for convenience of explanation; however, in reality the rotational storage 71 stores a bundle of yarn Y, which is formed by winding the yarn Y for several hundreds of times with small intervals.

[0081] In this state, the rotational storage drum motor 72 and the winding drum motor 116 are driven. Because the rotational storage 71 rotates as a result, the yarn Y is unwound from the yarn supplying bobbin 21 and the unwound yarn Y is wound onto the tapered portion 71a. The yarn Y wound onto the tapered portion 71a moves toward the linear portion 71c along the surface of the tapered portion 71a, with the result that the yarn Y is wound onto the rotational storage 71 along its axis. Furthermore, as the winding drum 24 rotates, the yarn Y stored in the rotational storage 71 is unwound and is then wound onto the winding bobbin 22 which rotates together with the winding drum 24. In other words, the winding of the yarn Y starts at the winding unit 2. While the winding of the yarn Y is being carried out in the winding unit 2, the rotation speed or the like of the rotational storage 71 and the winding drum 24 is controlled in accordance with the flow illustrated in FIG. 4 and FIG. 5.

[0082] Now, the operation of the rotational storage 71 will be described. In the first embodiment, as described later, except when the rotation of the rotational storage 71 is stopped, the rotational storage 71 is rotated at a rotation speed with which the yarn unwinding speed of the yarn Y unwound from the yarn supplying bobbin 21 is at V_c which is the maximum speed within the range in which the yarn Y is properly unwound. The value V_c is determined in consideration of the material and thickness of the yarn Y to be a value with which problems such as sloughing of the yarn Y do not occur when the yarn Y is unwound from the yarn supplying bobbin 21. In the present invention, the yarn unwinding speed indicates the speed of the yarn Y unwound from the yarn supplying bobbin by the rotational storage 71.

[0083] As shown in FIG. 4, when the rotational storage 71 is rotating (S101: YES), the rotation of the rotational storage 71 is continued when the yarn clearer 15 has not detect a defect in the yarn Y (S102: NO) and the existence of the yarn Y is detected (S103: YES), i.e., when the running of the yarn Y is detected. On the other hand, when the yarn clearer 15 detects a defect in the yarn Y (S102: YES) or when the existence of the yarn Y is not detected (S103: NO), the rotation of the rotational storage 71 is stopped (S104), and the process goes back to S101.

[0084] On the other hand, when the rotation of the ro-

tational storage 71 has been stopped in, e.g., S104 above (S101: NO), the rotational storage 71 is kept in the non-rotation state until the yarn joining operation by the yarn jointing section 8 is completed (S105: NO). When the yarn joining operation by the yarn jointing section 8 is completed (S105: YES), the rotation of the rotational storage 71 is resumed (S106) and the process goes back to S101.

[0085] Now, the operation of the winding drum 24 will be described. As shown in FIG. 5, when the storage amount of the yarn Y in the rotational storage 71 is larger than A3 (lower limit storage amount), i.e., when the lower limit yarn sensor 157 has detected that the amount of stored yarn Y is larger than the prescribed lower limit (S201: YES), the rotation speed of the winding drum 24 is changed in accordance with the storage amount of the yarn Y in the rotational storage 71 if the yarn clearer 15 has not detected a defect in the yarn Y (S202: NO) and the existence of the yarn Y is detected (S203: YES), i.e., when the running of the yarn Y is detected.

[0086] More specifically, when the upper limit yarn sensor 155 has detected that the amount of stored yarn Y is larger than the prescribed upper limit, i.e., the storage amount of the yarn Y in the rotational storage 71 is larger than A1 (S204: YES), the winding drum 24 is rotated at a predetermined rotation speed with which the yarn winding speed of the yarn Y is at V1 which is higher than the yarn unwinding speed V_c , so that the winding of the yarn Y onto the winding bobbin 22 is continued (S205), and the process goes back to S201. In the present invention, the yarn winding speed indicates the speed of the yarn Y wound onto the package by the rotation of the winding drum 24.

[0087] On the other hand, when the upper limit yarn sensor 155 does not detect the existence of the yarn Y, i.e., when the storage amount of the yarn Y in the rotational storage 71 is equal to or smaller than A1 (S204: NO), the winding drum 24 is rotated at a predetermined rotation speed with which the yarn winding speed of the yarn Y is at V2 which is lower than the yarn unwinding speed V_c , so that the winding of the yarn Y onto the winding bobbin 22 is continued (S206), and the process goes back to S201.

[0088] When the yarn clearer 15 detects a defect in the yarn Y (S202: YES) or no longer detects the existence of the yarn Y (S203: NO) while the lower limit yarn sensor 157 has detected that the amount of stored yarn Y is larger than the prescribed lower limit (S201: YES), i.e., when the running of the yarn Y is not detected and the intermediate yarn sensor 156 has detected the existence of the yarn Y (S207: YES), the winding is continued with the same winding speed because the storage amount of the yarn Y in the rotational storage 71 is larger than A2 (S208). To put it differently, the winding of the yarn Y onto the winding bobbin 22 is continued at the same rotation speed as in the case where the existence of the yarn Y is detected (S203: YES), more specifically, at the rotation speed with which the yarn winding speed is at

V1 when the yarn storage amount is larger than A1 or at the rotation speed with which the yarn winding speed is V2 when the yarn storage amount is equal to or smaller than A1. Then the process goes back to S201.

[0089] On the other hand, when the storage amount of the yarn Y in the rotational storage 71 becomes equal to or lower than A2 and the intermediate yarn sensor 156 no longer detects the existence of the yarn Y (S206: NO), the rotation speed of the winding drum 24 is lowered to the extent that the yarn winding speed becomes V3 which is lower than V1 and V2 above and the winding of the yarn Y onto the winding bobbin 22 is continued (S209), and the process goes back to S201.

[0090] When the storage amount of the yarn Y in the rotational storage 71 becomes equal to or lower than A3 and the yarn sensor 157 no longer detects the existence of the yarn Y (S201: NO), the rotation of the winding drum 24 is stopped irrespective of the other conditions so that the winding of the yarn Y onto the winding bobbin 22 is stopped (S210), and the process goes back to S201.

[0091] Now, the steps of the yarn joining operation, which is carried out when, for example, the running yarn is cut, yarn defect is detected, or the yarn supplying bobbin 21 runs out of the yarn Y and the yarn supplying bobbin 21 will be described. As shown in FIG. 6, when the yarn clearer 15 detects a defect in the yarn Y (S301: YES), the cutter 16 cuts the yarn Y to remove the defective part (S302), and then the later-described yarn joining operation is conducted (S303) and the process goes back to S301 above.

[0092] When the yarn clearer 15 does not detect the existence of the yarn Y (S301: NO, S304: NO) and the yarn supplying bobbin 21 still stores the yarn Y, i.e., the yarn detecting portion 37 detects the yarn Y, it is determined that the yarn clearer 15 no longer detects the existence of the yarn Y because the running yarn Y is cut (S305: NO), and the later-described yarn joining operation is conducted (S303) and the process goes back to S301.

[0093] On the other hand, when the yarn supplying bobbin 21 has run out of the yarn Y, i.e., when the yarn detecting portion 37 does not detect the yarn Y (S305: YES), the replacement of the yarn supplying bobbin 21 is waited for (S306: NO). When the yarn supplying bobbin 21 is replaced and the yarn Y taken out from the yarn supplying bobbin 21 is detected by the yarn detecting portion 37 (S306: YES), the later-described yarn joining operation is immediately conducted (S303) and the process goes back to S301.

[0094] Now, the yarn joining operation in S303 above will be described. To conduct the yarn joining operation, to begin with, by switching the solenoid valve 152 to the open state, an airflow running from the rotational storage 71 side to the upper yarn guide pipe 26 side is formed in the internal space of the yarn guiding member 73, the yarn passage 128, or the like.

[0095] At the same time, the suction port 26b of the upper yarn guide pipe 26 is switched from the closed

state to the open state, so that an airflow running from the suction port 26b side to the negative pressure source 120 side is formed in the upper yarn guide pipe 26.

[0096] Subsequently, the rotational storage 71 is rotated at a low speed in the direction opposite to that in the winding of the yarn Y. As a result, the yarn end of the yarn Y on the rotational storage 71 is sucked into the opening of the yarn guiding member 73, and is taken out to the suction port 26b of the upper yarn guide pipe 26 via the yarn passage 128 and the like.

[0097] When the taking-out sensor 154 detects the yarn Y having been taken out, after a predetermined yarn amount is sucked out by the continuous low-speed rotation of the rotational storage 71, the suction port 26b is switched from the open state to the closed state and the clamping section 26c clamps the yarn Y, and the upper yarn guide pipe 26 is swung upward about the axis 26a. With this, the yarn Y taken out from the accumulator 61 is guided to the yarn jointing device 14 of the yarn jointing section 8.

[0098] In the meanwhile, in the same manner as the upper yarn guide pipe 26, the lower yarn guide pipe 25 sucks and captures the yarn end of the yarn Y which exists around the yarn detecting portion 37, so that this yarn Y is guided to the yarn jointing device 14. Once the part of the yarn Y on the accumulator 61 side and the part of the yarn Y on the yarn supplying portion 5 side are set to the yarn jointing device 14, the controller 109 causes the yarn jointing device 14 to execute the yarn jointing operation, and the yarn jointing operation of joining the part of the yarn Y on the yarn supplying portion 5 side with the part of the yarn Y on the accumulator 61 side is completed.

[0099] Because this yarn jointing operation by the yarn jointing device 14 may not be successfully done on the first attempt, the yarn joining is achieved by repeatedly conducting the yarn joining operation each time the attempt fails.

[0100] Now, the following will describe an example of changes in the yarn unwinding speed of the yarn Y unwound from the yarn supplying bobbin 21, the yarn winding speed of the yarn Y supplied to the winding drum 24, and the storage amount of the yarn Y in the rotational storage 71, when the winding unit 2 is driven by controlling the rotational storage 71 and the winding drum 24 as described above.

[0101] As shown in FIG. 7, because, immediately after the start of the winding, the storage amount of the yarn Y in the rotational storage 71 is smaller than A1, the upper limit yarn sensor 155 does not detect the yarn Y. The rotational storage 71 therefore rotates at a rotation speed with which the yarn unwinding speed is at Vc. In the meanwhile, the winding drum 24 rotates at a rotation speed with which the yarn winding speed is at V2 which is lower than the yarn unwinding speed Vc. On account of the difference between the yarn unwinding speed Vc and the yarn winding speed V2, the storage amount of the yarn Y in the rotational storage 71 increases over

time.

[0102] When the storage amount of the yarn Y in the rotational storage 71 exceeds A1 at a time T1, the upper limit yarn sensor 155 detects the yarn Y, and the rotation speed of the winding drum 24 is increased so that the yarn unwinding speed is increased to V1 which is higher than the yarn winding speed Vc. With this, the storage amount of the yarn Y in the rotational storage 71 decreases over time.

[0103] When the storage amount of the yarn Y in the rotational storage 71 is decreased to be equal to or lower than A1, the upper limit yarn sensor 155 no longer detects the yarn, and the rotation speed of the winding drum 24 is decreased so that the yarn winding speed becomes at V2 which is lower than the yarn unwinding speed Vc. With this, the storage amount of the yarn Y in the rotational storage 71 increases over time.

[0104] Thereafter, until a time T2 at which the yarn clearer 15 detects the existence of yarn defect, the yarn supplying bobbin 21 runs out of the yarn Y, or a part of the yarn Y between the yarn supplying bobbin 21 and the rotational storage 71 is cut and the existence of the yarn is no longer detected, the rotation speed of the winding drum 24 is repeatedly increased and decreased and the yarn winding speed of the winding drum 24 is repeatedly switched between V1 and V2. With this, the storage amount of the yarn Y in the rotational storage 71 is alternately increased and decreased and is therefore kept at an amount close to A1.

[0105] The operation between the time T1 and the time T2 above will be detailed with reference to FIG. 8. FIGs. 8(a) and 8(b) correspond to FIGs. 7 (a) and 7(c), respectively, and are enlarged views of the range between the time T1 and time T2 and its surroundings. Note that, for easier understanding, in FIGs. 8(a) and 8(b) the range corresponding to the range in FIG. 7 is elongated in the time axis direction.

[0106] As shown FIG. 8, when the upper limit yarn sensor 155 detects the yarn Y at the time T1, increase in the rotation speed of the winding drum 24 starts at a time T11 which is slightly later than the time T1. The rotation speed is then increased with a substantially constant acceleration, and the yarn winding speed reaches V1 at a time T12. The delay of the time T11 from the time T1 is a time required to start the acceleration of the winding drum motor 116 by the winding drum motor controller 160 after the upper limit yarn sensor 155 detects the yarn Y. The winding drum 24 then rotates at a constant rotation speed with which the yarn winding speed is equal to V1, until a time T13 at which the upper limit yarn sensor 155 becomes no longer detects the yarn Y.

[0107] In connection with the above, the storage amount of the yarn Y in the rotational storage 71 increases until the yarn winding speed reaches the yarn unwinding speed Vc, and decreases after the yarn winding speed exceeds the yarn unwinding speed Vc.

[0108] When the upper limit yarn sensor 155 becomes no longer detects the yarn Y at the time T13, decrease

in the rotation speed of the winding drum 24 starts at a time T14 which is slightly later than the time T13. The rotation speed is then decreased with a substantially constant acceleration, and at a time T15 the rotation speed reaches a speed with which the yarn winding speed of the yarn Y becomes equal to V2. The delay of the time T14 from the time T13 is a time required to start the decrease in the speed of the winding drum motor 116 by the winding drum motor controller 160 after the upper limit yarn sensor 155 becomes no longer detects the yarn Y. The winding drum 24 then rotates at a constant rotation speed with which the yarn winding speed is at V2, until a time T17 which is slightly later than the time T16 at which the upper limit yarn sensor 155 detects the yarn Y.

[0109] As the operation above is repeated, the storage amount of the yarn Y in the rotational storage 71 is repeatedly increased and decreased around A1, and hence the storage amount of the yarn Y in the rotational storage 71 is kept at an amount close to A1.

[0110] Subsequently, when the yarn clearer 15 detects yarn defect or no longer detects the existence of the yarn Y at a time T2, the rotation of the rotational storage 71 is stopped and the yarn unwinding speed becomes zero. Because at the time T2 the storage amount of the yarn Y in the rotational storage 71 is close to A1 and larger than A2, the yarn sensor 156 still detects the yarn Y and hence the winding drum 24 continues the winding of the yarn Y onto the winding bobbin 22 in the same way.

[0111] At this stage, because the rotation of the rotational storage 71 is stopped and the yarn Y is not further stored in the rotational storage 71, the storage amount of the yarn Y in the rotational storage 71 gradually decreases over time as the supply of the yarn Y to the winding bobbin 22 is continued. For this reason, when the yarn clearer 15 detects yarn defect or no longer detects the existence of the yarn Y while the rotation speed of the winding drum 24 is at a speed with which the yarn winding speed is V1, the winding drum 24 rotates for a short time at a rotation speed with which the yarn winding speed is at V1, and then rotates at a rotation speed with which the yarn winding speed is at V2. On the other hand, when the yarn clearer 15 detects yarn defect or no longer detects the existence of the yarn Y while the rotation speed of the winding drum 24 is at a speed with which the yarn winding speed is at V2, the winding drum 24 keeps the rotation with the rotation speed with which the yarn winding speed is at V2.

[0112] The storage amount of the yarn Y in the rotational storage 71 gradually decreases over time. When the storage amount of the yarn Y becomes equal to or lower than A2 and the yarn sensor 156 becomes no longer detects the yarn Y at a time T3, the rotation speed of the winding drum 24 is decreased so that the yarn winding speed is at V3 which is lower than V1 and V2, and the winding of the yarn Y onto the winding bobbin 22 is continued.

[0113] When the yarn joining operation is completed at a time T4, the rotation of the rotational storage 71 is

resumed and the yarn unwinding speed becomes Vc again. Furthermore, because the storage amount of the yarn Y in the rotational storage 71 has been decreased during the time length between the times T2 and T4 and is equal to or lower than A1 at the time T4, the upper limit yarn sensor 155 does not detect the yarn Y and the winding drum 24 rotates at a rotation speed with which the yarn winding speed is at V2 ($<V_c$).

[0114] With this, the storage amount of the yarn Y in the rotational storage 71 increases over time. After the storage amount of the yarn Y reaches A1, the yarn winding speed is alternately switched between V1 and V2 and the storage amount of the yarn Y is kept at an amount close to A1 in the same manner as described above.

[0115] Thereafter, when, at a time T5, the yarn clearer 15 detects yarn defect again or no longer detects the existence of the yarn Y, the rotation of the rotational storage 71 is stopped and the yarn unwinding speed becomes zero in the same manner as above, and the winding drum 24 rotates at a rotation speed with which the yarn winding speed is at V1 or V2 and the winding of the yarn Y onto the winding bobbin 22 is continued. When the storage amount of the yarn Y in the rotational storage 71 becomes equal to or lower than A2 at a time T6, the rotation speed is decreased to change the yarn winding speed to V3.

[0116] When the yarn joining operation is completed at a time T7, the rotation of the rotational storage 71 is resumed and the yarn unwinding speed becomes Vc again in the same manner as above, and the winding drum 24 rotates at a rotation speed with which the yarn winding speed is at V2 ($<V_c$).

[0117] In the example shown in FIG. 7, the time length between the time point at which the yarn clearer 15 becomes no longer detects the yarn Y for the second time and the time point at which the yarn clearer 15 detects the yarn Y again, i.e., the time length between the times T5 and T7 is longer than the time length for the first time, i.e., the time length between the times T2 and T4. Such a difference occurs due to, for example, a difference in the reason of stopping the unwinding of the yarn Y from the yarn supplying bobbin 21 and a difference in the time required for the yarn joining operation.

[0118] More specifically, the aforesaid time length is short when, for example, the reason to stop the unwinding of the yarn Y from the yarn supplying bobbin 21 is either the detection of yarn defect by the yarn clearer 15 or the non-detection of the existence of the yarn Y by the yarn clearer 15 due to the cutting of the running yarn Y, and the number of times of repeating the yarn jointing operation until the yarn joining is successfully done is small.

[0119] On the other hand, the time length is long when, for example, the reason to stop the unwinding of the yarn Y from the yarn supplying bobbin 21 is the running out of the yarn Y in the yarn supplying bobbin 21 that requires the replacement of the yarn supplying bobbin 21 or the number of times of repeating the yarn jointing operation until the yarn joining is successfully done is large.

[0120] In addition to the above, when, after the time T7, the yarn clearer 15 detects yarn defect or no longer detects the existence of the yarn Y at a time T8 before the storage amount of the yarn Y in the rotational storage 71 becomes larger than A2, the rotation of the rotational storage 71 is stopped and the yarn unwinding speed V becomes zero in the same manner as above. Because at the time T8 the storage amount of the yarn Y in the rotational storage 71 is equal to or lower than A2, the intermediate yarn sensor 156 does not detect the yarn Y, and the rotation speed of the winding drum 24 is immediately decreased to a speed with which the yarn winding speed is at V3, and the winding of the yarn Y onto the winding bobbin 22 is continued.

[0121] The yarn joining operation is then completed, and thereafter a similar operation is continued.

[0122] According to the first embodiment described above, when the yarn clearer 15 detects yarn defect or no longer detects the existence of the yarn Y, the rotation speed of the winding drum 24 is lowered and the yarn winding speed is lowered when the storage amount of the yarn Y in the rotational storage 71 is small (i.e., not higher than A2). This makes it possible to restrain the decrease in the storage amount of the yarn Y in the rotational storage 71 on account of the winding of the yarn Y onto the winding bobbin 22. The winding of the yarn Y onto the winding bobbin 22 can therefore be continued even if the unwinding of the yarn Y from the yarn supplying bobbin 21 has been stopped and the yarn Y is not further stored in the rotational storage 71. Thanks to this, the time required for conducting the yarn joining operation is sufficiently secured without upsizing the rotational storage 71. Alternatively, the rotational storage 71 is downsized while securing a predetermined time length for the yarn joining operation.

[0123] Moreover, even if the yarn clearer 15 detects yarn defect or no longer detects the existence of the yarn Y, the winding of the yarn Y is continued without decreasing the rotation speed of the winding drum 24, i.e., the yarn winding speed of the yarn Y wound onto the winding bobbin 22, when the storage amount of the yarn Y in the rotational storage 71 is large (i.e., larger than A2). The winding of the yarn Y is therefore efficiently done. Furthermore, because the yarn winding speed is unchanged in this case, the energy loss caused by a change in the yarn winding speed is avoided.

[0124] In addition to the above, when the yarn clearer 15 does not detect yarn defect and detects the existence of the yarn Y, the winding drum 24 is rotated at a rotation speed with which the yarn winding speed is at V1 which is higher than the yarn unwinding speed Vc to decrease the storage amount of the yarn Y in the rotational storage 71, when the storage amount of the yarn Y in the rotational storage 71 is larger than A1. On the other hand, when the storage amount of the yarn Y in the rotational storage 71 is equal to or lower than A1, the winding drum 24 is rotated at a rotation speed with which the yarn winding speed is at V2 which is lower than the yarn unwinding

speed Vc, so that the storage amount of the yarn Y in the rotational storage 71 is increased. This makes it possible to keep the storage amount of the yarn Y in the rotational storage 71 to be close to A1.

[0125] In connection with the above, the storage amount of the yarn in the rotational storage 71 may be adjusted in a manner different from that in the first embodiment. That is to say, the yarn winding speed of the yarn Y wound onto the winding bobbin 22 is kept constant, and the rotation speed of the rotational storage 71, i.e., the yarn unwinding speed of the yarn Y unwound from the yarn supplying bobbin 21 is changed in accordance with the storage amount of the yarn in the rotational storage 71.

[0126] However, when the yarn unwinding speed of the yarn Y unwound from the yarn supplying bobbin 21 is changed, an average yarn unwinding speed is low as compared to the case where the yarn Y is unwound from the yarn supplying bobbin 21 at the maximum yarn unwinding speed Vc.

[0127] Furthermore, in the winding unit 2 of the first embodiment, significant increase or decrease in the yarn unwinding speed of the yarn Y unwound from the yarn supplying bobbin 21 is not preferable, because such a change may cause the aforesaid problem such as sloughing of the yarn Y. Such sloughing increases the frequency of yarn breakage, thereby decreasing the production efficiency.

[0128] Because of the above, the productivity of the winding of the yarn Y onto the winding bobbin 22 in the winding unit 2 is significantly low when the yarn unwinding speed is changed, as compared to the case where the yarn winding speed is changed. In other words, when the storage amount of the yarn Y in the rotational storage 71 is adjusted by changing the yarn unwinding speed, the productivity of the winding of the yarn Y onto the winding bobbin 22 is very low.

[0129] For this reason, in order to maximally avoid the decrease in the yarn unwinding speed of the yarn Y unwound from the yarn supplying bobbin 21, which should not be changed significantly, the first embodiment is arranged so that the rotational storage 71 is rotated at a constant rotation speed so that the yarn unwinding speed is at Vc which is the maximum speed within the range in which the yarn Y is properly unwound from the yarn supplying bobbin 21, and the storage amount of the yarn Y in the rotational storage 71 is adjusted by changing the rotation speed of the winding drum 24, i.e., the yarn winding speed of the yarn Y wound onto the winding bobbin 22 in accordance with the storage amount of the yarn Y in the rotational storage 71. The productivity of the winding of the yarn Y onto the winding bobbin 22 is therefore high in the winding unit 2.

[0130] When the storage amount of the yarn Y in the rotational storage 71 becomes smaller than A3, the rotation of the winding drum 24 is stopped irrespective of the other conditions, so as to stop the winding of the yarn Y onto the winding bobbin 22. It is therefore possible to

prevent the rotational storage 71 from completely running out of the yarn Y. This prevents, for example, the part of the yarn Y on the accumulator 61 side used for the yarn joining from running out when the winding of the yarn Y is continued until the rotational storage 71 fully runs out of the yarn Y.

[Second Embodiment]

[0131] Now a preferred second embodiment of the present invention will be described. The second embodiment is substantially identical with the first embodiment except that the structure of an unwound yarn storage 209 is different from that of the unwound yarn storage 9 of the first embodiment. The following will focus on the structure of the unwound yarn storage 209, and other features identical with those of the first embodiment may not be explained.

[0132] As shown in FIG. 9, the unwound yarn storage 209 of the second embodiment is provided with an accumulator 261. This accumulator 261 includes members such as six rollers 271, a base 272, a rotation plate 273, a winding arm 275, and a winding arm motor 276.

[0133] The base 272 is a substantially circular plate, and is supported at the leading end of the output shaft 236 of the winding arm motor 276 via an unillustrated bearing. The six rollers 271 (yarn wound portions) are lined up on the upper surface of the base 272 to form a circle thereon. The lower end of each roller is pivoted on the upper surface of the base 272, whereas the upper end of the roller is supported by the rotation plate 273.

[0134] The rotation plate 273 is arranged to be rotatable about the axis C2 of the winding arm motor 276. As the rotation plate 273 is rotated, the upper ends of the rollers 271 supported by the rotation plate 273 are circumferentially moved for distances equivalent to the same central angles. As the upper ends of the rollers 271 are circumferentially moved by the rotation of the rotation plate 273, the rollers 271 are circumferentially inclined.

[0135] The outer circumference of the rotation plate 273 is wrapped by the rubber ring 281, and the yarn Y wound onto the rollers 271 passes through the gap between the rotation plate 273 and the rubber ring 281 and is sent toward the winding section 6, as described later. In this connection, because the yarn Y is sandwiched between the rotation plate 273 and the rubber ring 281 and conveyed in the gap therebetween, the broken filaments of the yarn Y are laid down. Furthermore, because the yarn Y is sandwiched between the rotation plate 273 and the rubber ring 281, it is possible to prevent the occurrence of a balloon in the yarn Y which is unwound from the rollers 271 and is running toward the winding section 6.

[0136] In the second embodiment, all of the rollers 271 may be drive rollers rotated by a winding arm motor 276, or only some of the rollers 271 are drive rollers and the other rollers are driven rollers rotated in accordance with the movement of the wound yarn Y.

[0137] The winding arm 275 is provided for unwinding the yarn Y from the yarn supplying bobbin 21 and guiding the yarn Y to the lower end portion of the roller 271. This winding arm 275 has therein a yarn passage 228 in which the yarn Y is able to run, and is arranged to be rotatable about an axis C2. The winding arm 275 is connected to the outer circumference of the output shaft 236, and is constituted by a linear portion 241 extending radially outward from the outer circumference of the output shaft 236 and a curved portion 242 which circumvents the base 272 and reaches the vicinity of the lower end portions of the rollers 271.

[0138] At the leading end of the curved portion 242 is formed an opening 243 that opposes the lower end portions of the rollers 271. In this arrangement, the winding arm 275 is arranged to be rotatable about an axis C2. As the winding arm 275 rotates about the axis C2 anticlockwise in plan view, as described below, the yarn Y on the yarn supplying portion 5 side, which has been guided into the yarn passage 228 of the winding arm 275, is wound onto the lower end portions of the six rollers 271.

[0139] The winding arm motor 276 is a position controllable motor such as a DC brushless motor, a stepping motor, and a servo motor. This motor is electrically connected to the controller 109, and the controller 109 controls the rotation speed of the winding arm 275, i.e., the winding speed of the yarn Y onto the roller 271.

[0140] Below the winding arm motor 276 is provided a yarn passage 244 which is connected to the yarn passage 228 of the winding arm 275. Below the yarn passage 244 is provided a blowdown nozzle 248 which is identical with the above-described blowdown nozzle 74 (see FIG. 1).

[0141] At the lower end of the blowdown nozzle 248, a taking-out sensor 254 is provided to be able to detect that the yarn end of the yarn Y wound into the accumulator 261 has actually been taken out to the yarn joining section 8 side. This taking-out sensor 254 is electrically connected to the controller 109 and sends a drawing detection signal to the controller 109 upon detection of the taking out of the yarn end of the yarn Y to the yarn joining section 8 side.

[0142] In the accumulator 261, as shown in FIG. 9, the range of the end (upper end) of the yarn Y wound onto the rollers 271 on the winding section 6 side is set at a range R2, and yarn sensors 155 to 157 identical with those in the first embodiment are provided to correspond to the range. Each of these yarn sensors 155 to 157 detects whether the storage amount of the yarn Y in the accumulator 261 is larger than A1, A2, or A3.

[0143] Now, the operation of the winding unit of the second embodiment will be described. In the same manner as in the first embodiment, the second embodiment is arranged so that, as shown in FIG. 4 and FIG. 5, the yarn unwinding speed of the yarn Y unwound from the yarn supplying bobbin 21 and the yarn winding speed of the yarn Y onto the winding bobbin 22 and the like are controlled based on whether the yarn clearer 15 detects

yarn defect, whether the yarn clearer 15 detects the existence of the yarn Y, and the storage amount of the yarn Y in the accumulator 261, and the yarn joining operation or the like is conducted in the same manner as shown in FIG. 6.

[0144] In the meanwhile, in the second embodiment, while the yarn Y is unwound from the yarn supplying bobbin 21 by rotating the winding arm 275 as described above, the unwound yarn Y is wound onto the rollers 271 and onto a winding assist member 274 provided to surround the rollers 271, across the rollers 271 and the winding assist member 274. In this regard, toward the upper end, a winding assist surface 274a which is the outer circumference of the winding assist member 274 is inclined to approach the center of the circle on which the rollers 271 are provided. The wound yarn Y is moved upward along the winding assist surface 274a when it is on the winding assist surface 274a. After leaving the winding assist surface 274a and wound onto the rollers 271, the yarn Y is conveyed by the inclined rollers 271 and moved upward. As a result, the yarn Y is wound onto the six rollers 271 along the axis C2.

[0145] In addition to the above, in the second embodiment, whether the winding arm 275 is rotating is determined in S101 in FIG. 4, the rotation of the winding arm 275 is stopped in S104, and the rotation of the winding arm 275 is resumed in S106. Furthermore, in the second embodiment, in the yarn joining in S303 in FIG. 6, the yarn Y is taken out by rotating the winding arm 275 in the direction opposite to the direction of the rotation at the time of the winding of the yarn Y.

[0146] Now, modifications of the first and second embodiments will be described. It is noted that features identical with those of the first and second embodiments may not be explained again.

[0147] In the first and second embodiments, the running of the yarn Y between the yarn supplying portion 5 and the accumulator 61, 261 is detected by checking the existence of the yarn Y by the yarn clearer 15. The disclosure, however, is not limited to this arrangement. For example, a sensor (speed sensor) configured to detect the speed of the running yarn Y or a sensor (running length sensor) configured to detect the length of the running yarn Y is provided between the yarn supplying portion 5 and the accumulator 61, 261, and the running of the yarn Y is detected by the sensor.

[0148] When the yarn Y is properly running, the speed or length of the yarn Y detected by the sensor falls within a predetermined range. When, for example, the running yarn Y is cut, the yarn Y is cut by the cutter 16 as yarn defect is detected, or the yarn supplying bobbin 21 runs out of the yarn Y, the speed or length of the yarn Y detected by the sensor is decreased, and becomes zero in the end, i.e., goes out of the predetermined range. Therefore the running of the yarn Y is detectable by checking whether the speed or length of the yarn Y detected by the sensor falls within the predetermined range.

[0149] In the first and second embodiments, the wind-

ing of the yarn Y onto the winding bobbin 22 is continued by maintaining the yarn winding speed when the storage amount of the yarn Y is larger than A2, even if the yarn clearer 15 detects yarn defect or no longer detects the existence of the yarn Y. The disclosure, however, is not limited to this arrangement. For example, in a modification (modification 1), the intermediate yarn sensor 156 (see FIG. 2) for detecting whether the storage amount of the yarn Y is larger than A2 is not provided, and as shown in FIG. 10, the yarn winding speed is decreased to V3 irrespective of the storage amount of the yarn Y when the yarn Y is cut by the cutter 16 (S202: YES) or the yarn clearer 15 no longer detects the yarn Y (S203: NO) (S401).

[0150] In this case, the efficiency in the winding of the yarn Y is worse than the efficiency in the first embodiment, when the storage amount of the yarn Y is larger than A2 while the unwinding of the yarn Y from the yarn supplying bobbin 21 has been stopped. However, in this modification, the time length of the continuation of the winding of the yarn Y while the unwinding of the yarn Y from the yarn supplying bobbin 21 has been stopped is longer than the time lengths in the first and second embodiments, and hence the length of time for the yarn joining operation or the like is long. Alternatively, the rotational storage 71 and the roller 271 are further downsized as compared to the first and second embodiments, when the time for the yarn joining operation is identical with those in the first and second embodiments.

[0151] Furthermore, the yarn winding speed may be controlled only in the normal yarn winding, i.e., when no yarn defect is detected (S202: NO) and the existence of the yarn Y is detected, and the winding of the yarn Y may be continued at the same yarn winding speed without lowering the same either when yarn defect is detected (S202: YES) or the existence of the yarn Y becomes no longer detected (S203: NO). In this case, however, while the productivity of the yarn winding is improved in the normal yarn winding, the rotational storage 71 must be upsized to sufficiently secure the time for conducting the yarn joining operation.

[0152] In the first and second embodiments, the storage amount of the yarn Y in the accumulator 61, 261 is adjusted by setting the yarn winding speed at V1 which is higher than the yarn unwinding speed Vc when the storage amount of the yarn Y in the accumulator 61, 261 is larger than A1 while the running of the yarn is detected, and setting the yarn winding speed at a constant speed V2 which is lower than the yarn unwinding speed Vc when the storage amount of the yarn Y is equal to or lower than A1. The control for adjusting the storage amount of the yarn Y, however, is not limited to this arrangement.

[0153] For example, the yarn winding speed is changed to be lower than V2 when the storage amount of the yarn Y in the accumulator 61, 261 is small (such as equal to or smaller than A2), e.g., immediately after the start of the winding of the yarn Y by the winding unit 2 and immediately after the completion of the yarn joining,

and the yarn winding speed is returned to V2 after the storage amount of the yarn Y exceeds A2. This makes it possible to promptly increase the storage amount of the yarn Y when the storage amount of the yarn Y in the accumulator 61, 261 is small.

[0154] Furthermore, a sensor which is able to continuously detect the storage amount of the yarn Y in the accumulator 61, 261 may be provided in place of the yarn sensors 155 to 157, and the storage amount of the yarn Y may be adjusted by increasing the yarn winding speed in accordance with the increase in the detected storage amount of the yarn Y.

[0155] Alternatively, the above-described control of the yarn winding speed is not conducted in the normal yarn winding, and the control of the yarn winding speed is conducted only when yarn defect is detected (S202: YES) or when the existence of the yarn Y becomes no longer detected (S203: NO). In this case, however, while the time for performing the yarn joining operation is sufficiently secured without upsizing the rotational storage 71, it is necessary to change the yarn unwinding speed in the normal yarn winding, and hence the productivity of the yarn winding is low.

[0156] In addition to the above, in the first embodiment, the yarn Y is unwound from the yarn supplying bobbin 21 by the rotation of the rotational storage 71 and the unwound yarn Y is stored by winding the same onto the rotational storage 71, whereas, in the second embodiment, the yarn Y is unwound from the yarn supplying bobbin 21 by the rotation of the winding arm 275, and the unwound yarn Y is stored by winding the same on the rollers 271 which are circumferentially lined up. In this regard, the arrangement for unwinding the yarn Y from the yarn supplying bobbin 21 and the arranged for storing the unwound yarn Y may be differently arranged.

[0157] To unwind the yarn Y from the yarn supplying bobbin 21, for example, a dedicated arrangement to do so is provided in the vicinity of the yarn supplying portion 5, in addition to the arrangement for winding the yarn Y (such as the rotational storage 71 and the winding arm 275).

[0158] Furthermore, the yarn Y may be stored in such a way that the yarn Y unwound from the yarn supplying bobbin 21 is wound, by the winding arm 275, onto a member which is neither the rotational storage 71 nor the rollers 271, such as a substantially cylindrical member which does not actively rotate. Furthermore, the unwound yarn storage may not be provided with the yarn wound portion to which the yarn Y is wound. For example, a case having a yarn storage space therein is provided, and the yarn Y unwound from the yarn supplying bobbin 21 is introduced into and stored in this space.

[0159] While in the embodiment above the part of the yarn Y on the accumulator side and the part of the yarn Y on the yarn supplying bobbin 21 side are set to the yarn joining device 14 in the yarn joining operation by using the lower yarn guide pipe 25 and the upper yarn guide pipe 26, the disclosure is not limited to this arrange-

ment.

[0160] According to a modification (modification 2), as shown in FIG. 11, the lower yarn guide pipe 25, the upper yarn guide pipe 26, the yarn passage forming member 75 and the like of the first embodiment are not provided, and an upper yarn capturing unit 301, a guide member 302, a lower yarn blowing up unit 303, and a yarn trap 304 are provided in place of these members. FIG. 11 further illustrates a magazine-type bobbin supplying unit 305 as a bobbin supplier for supplying the yarn supplying bobbin 21.

[0161] The upper yarn capturing unit 301 is provided immediately above the first tension applying portion 41 to be connected to an unillustrated negative pressure source. The guide member 302 is a substantially cylindrical member and extends between the upper yarn capturing unit 301 and the blowdown nozzle 74 to circumvent the yarn path of the yarn Y in the normal winding. The guide member 302 has a slit 302a at the left end part of the member in the figure. The slit 302a extends along the entire length thereof.

[0162] The lower yarn blowing up unit 303 is provided immediately below the first tension applying portion 41. The lower yarn blowing up unit 303 is connected to an unillustrated compressed air source so as to generate an upward airflow. The yarn trap 304 is provided between the yarn joining device 14 and the yarn clearer 15 to be able to suck the yarn Y and is connected to an unillustrated negative pressure source.

[0163] In the same manner as in the first embodiment above, when, for example, the running yarn is cut, yarn defect is detected, or the yarn supplying bobbin 21 is replaced as the yarn supplying bobbin 21 runs out of the yarn Y, an airflow is generated at the blowdown nozzle 74, and hence the yarn end of the yarn Y wound onto the rotational storage 71 is sucked and blown away from the blowdown nozzle 74 toward the guide member 302. The yarn end blown to the guide member 302 is, as indicated by the dashed line, is guided along the wall surface on the right side of the guide member 302 in the figure and reaches a position opposing the upper yarn capturing unit 301. The upper yarn capturing unit 301 captures the guided yarn end by sucking the same. As the yarn end is sucked by the upper yarn capturing unit 301, the part of the yarn Y inside the guide member 302 is pulled and taken out from the slit 302a to the outside of the guide member 302, and is set to the yarn joining device 14.

[0164] On the other hand, the lower yarn blowing up unit 303 blows the part of the yarn Y on the yarn supplying bobbin 21 upward, and the yarn trap 304 sucks and captures the yarn blown up by the lower yarn blowing up unit 303. The part of the yarn Y on the yarn supplying bobbin 21 side is pulled as the part is sucked by the lower yarn blowing up unit 303, and is therefore set to the yarn joining device 14.

[0165] In the modification 2, in the same manner as above, the part of the yarn Y on the accumulator 61 side and the part of the yarn Y on the yarn supplying bobbin

21 side are set to the yarn jointing device 14, and then the yarn joining is conducted by the yarn jointing device 14 in the same manner as in the first embodiment above.

[0166] In addition to the above, because the guide member 302 extends to circumvent the yarn path of the yarn Y in the normal winding, the yarn Y does not contact the guide member 302 in the normal winding, and hence the deterioration in the quality of the yarn Y is prevented.

[0167] In this case, the yarn end sucked from the rotational storage 71 by the blowdown nozzle 74 is guided to the upper yarn guide unit 301 by the guide member 302. The positional relationship between the blowdown nozzle 74 and the upper yarn guide unit 301 is therefore relatively freely changeable by changing the direction, length, shape or the like of the guide member 302. In other words, the degree of freedom of the layout of the blowdown nozzle 74 and the upper yarn guide unit 301 is high.

[0168] When the part of the yarn Y on the accumulator 61 side and the part of the yarn Y on the yarn supplying bobbin 21 side are set to the yarn jointing device 14 as described above, the yarn Y is promptly set to the yarn jointing device 14 because setting the yarn Y to the yarn jointing device 14 does not involve any mechanical operations such as the swinging of the lower yarn guide pipe 25 and the upper yarn guide pipe 26 as in the first embodiment, and hence the time required to complete the yarn joining operation is short.

[0169] In addition to the above, while in the embodiments above the yarn Y wound onto the winding bobbin 22 is traversed by the spiral traversing groove 27 formed on the winding drum 24, the yarn Y may be traversed in such a way that the yarn Y which is placed and is immediately before wound onto the winding bobbin 22 is traversed by an arm-type traverse unit that reciprocates crosswise.

Reference Signs List

[0170]

2	WINDING UNIT
6	WINDING SECTION
9	UNWOUND YARN STORAGE
14	YARN JOINTING DEVICE
15	YARN CLEARER
21	YARN SUPPLYING BOBBIN
60	YARN SUPPLYING BOBBIN SUPPORT- ING PORTION
61	ACCUMULATOR
71	ROTATIONAL STORAGE DRUM
155 to 157	YARN SENSORS
209	UNWOUND YARN STORAGE
261	ACCUMULATOR
271	ROLLER
275	WINDING ARM

Claims

1. yarn winding device comprising:

5 a yarn supplying bobbin supporting portion configured to support a yarn supplying bobbin;
an unwound yarn storage configured to unwind a yarn from the yarn supplying bobbin supported by the yarn supplying bobbin supporting portion and store the unwound yarn;
10 a winding section configured to wind the yarn stored in the unwound yarn storage to form a package;
a storage amount detecting portion configured to detect a storage amount of the yarn in the unwound yarn storage;
15 a yarn running detecting portion configured to detect whether the yarn is running between the yarn supplying bobbin supporting portion and the unwound yarn storage; and
a controller configured to control a yarn winding speed of the winding section based on a detection result of each of the storage amount detecting portion and the yarn running detecting portion.

2. The yarn winding device according to claim 1, further comprising

30 a yarn jointing section configured to perform yarn joining of a part of the yarn on the yarn supplying bobbin side with a part of the yarn on the unwound yarn storage side.

3. The yarn winding device according to claim 1 or 2, wherein, the yarn running detecting portion is constituted by a yarn existence detection means configured to detect the existence of the yarn in the space between the yarn supplying bobbin supporting portion and the unwound yarn storage.

4. The yarn winding device according to claim 1 or 2, wherein, the yarn running detecting portion is constituted by a yarn defect detection section configured to detect a yarn defect on the yarn between the yarn supplying bobbin supporting portion and the unwound yarn storage.

5. The yarn winding device according to claim 1 or 2, wherein, the yarn running detecting portion is constituted by a running speed detection means configured to detect the running speed of the yarn.

6. The yarn winding device according to claim 1 or 2, wherein, the yarn running detecting portion is constituted by a running length detection means configured to detect the running length of the yarn.

7. The yarn winding device according to any one of

claims 1 to 6, wherein,
the unwound yarn storage includes a yarn wound
portion to which the yarn is wound from one end to-
ward the other end along one direction, and
the storage amount detecting portion is disposed to
oppose a part of the yarn wound portion and includes
at least one sensor which is configured to detect
whether the yarn exists at the part of the yarn wound
portion.

8. The yarn winding device according to any one of
claims 1 to 7, wherein,
when the yarn running detecting portion detects the
running of the yarn,
the controller controls the unwound yarn storage so
that the yarn unwinding speed of the unwound yarn
storage is at a constant yarn unwinding speed, and
controls the winding section so that the yarn winding
speed is at a yarn winding speed which is determined
based on the storage amount of the yarn detected
by the storage amount detecting portion.

9. The yarn winding device according to claim 8, where-
in, when the yarn running detecting portion detects
the running of the yarn,
the controller controls the winding section to operate
at a yarn winding speed V1 which is higher than
the yarn unwinding speed of the unwound yarn stor-
age, when the storage amount of the yarn detected
by the storage amount detecting portion is larger
than a predetermined upper limit storage amount,
and controls the winding section to operate at a yarn
winding speed V2 which is lower than the yarn un-
winding speed when the storage amount of the yarn
detected by the storage amount detecting portion is
equal to or smaller than the upper limit storage
amount.

10. The yarn winding device according to claim 8 or 9,
wherein, when the yarn running detecting portion
does not detect the running of the yarn, the controller
controls the unwound yarn storage to stop the un-
winding of the yarn,
and controls the winding section to operate at a yarn
winding speed V3 which is lower than the yarn wind-
ing speed when the yarn running detecting portion
detects the running of the yarn.

11. The yarn winding device according to claim 9 or 10,
wherein, when the yarn running detecting portion
does not detect the running of the yarn,
the controller controls the winding section to operate
at the yarn winding speed V3 which is lower than the
yarn winding speed when the yarn running detecting
portion detects the running of the yarn, only when
the storage amount of the yarn detected by the stor-
age amount detecting portion is equal to or lower
than a predetermined intermediate storage amount,

and

controls the winding section to operate at the yarn
winding speed V1 or V2 which is identical with the
yarn running speed when the yarn running detecting
portion detects the running of the yarn, when the
storage amount of the yarn detected by the storage
amount detecting portion is larger than the interme-
diate storage amount.

12. The yarn winding device according to any one of
claims 1 to 11, wherein,
the controller controls the winding section so that the
winding of the yarn is stopped no matter whether the
yarn running detecting portion detects the running
of the yarn, when the storage amount of the yarn
detected by the storage amount detecting portion is
equal to or lower than a predetermined lower limit
storage amount.

13. A yarn winding method comprising the steps of:

unwinding a yarn from a yarn supplying bobbin;
storing the unwound yarn in a unwound yarn
storage; and
winding the yarn stored in the unwound yarn
storage so as to form a package,
the running of the yarn in the space between the
yarn supplying bobbin and the unwound yarn
storage and a storage amount of the yarn in the
unwound yarn storage being detected and the
package being formed by winding the yarn at a
yarn winding speed corresponding to a result of
the detection.

14. The yarn winding method according to claim 13,
wherein, when the running of the yarn is detected,
if the detected storage amount of the yarn is larger
than a predetermined upper limit storage amount,
the yarn is wound at a yarn winding speed V1 which
is higher than the yarn unwinding speed of the yarn
unwound from the unwound yarn storage, and
if the detected storage amount of the yarn is equal
to or smaller than the upper limit storage amount,
the yarn is wound at a yarn winding speed V2 which
is lower than the yarn unwinding speed.

15. The yarn winding method according to claim 13 or
14, wherein, when the running of the yarn is not de-
tected,
the unwinding of the yarn is stopped, and
the yarn is wound at a yarn winding speed V3 which
is lower than the winding speed when the running of
the yarn is detected.

FIG.1

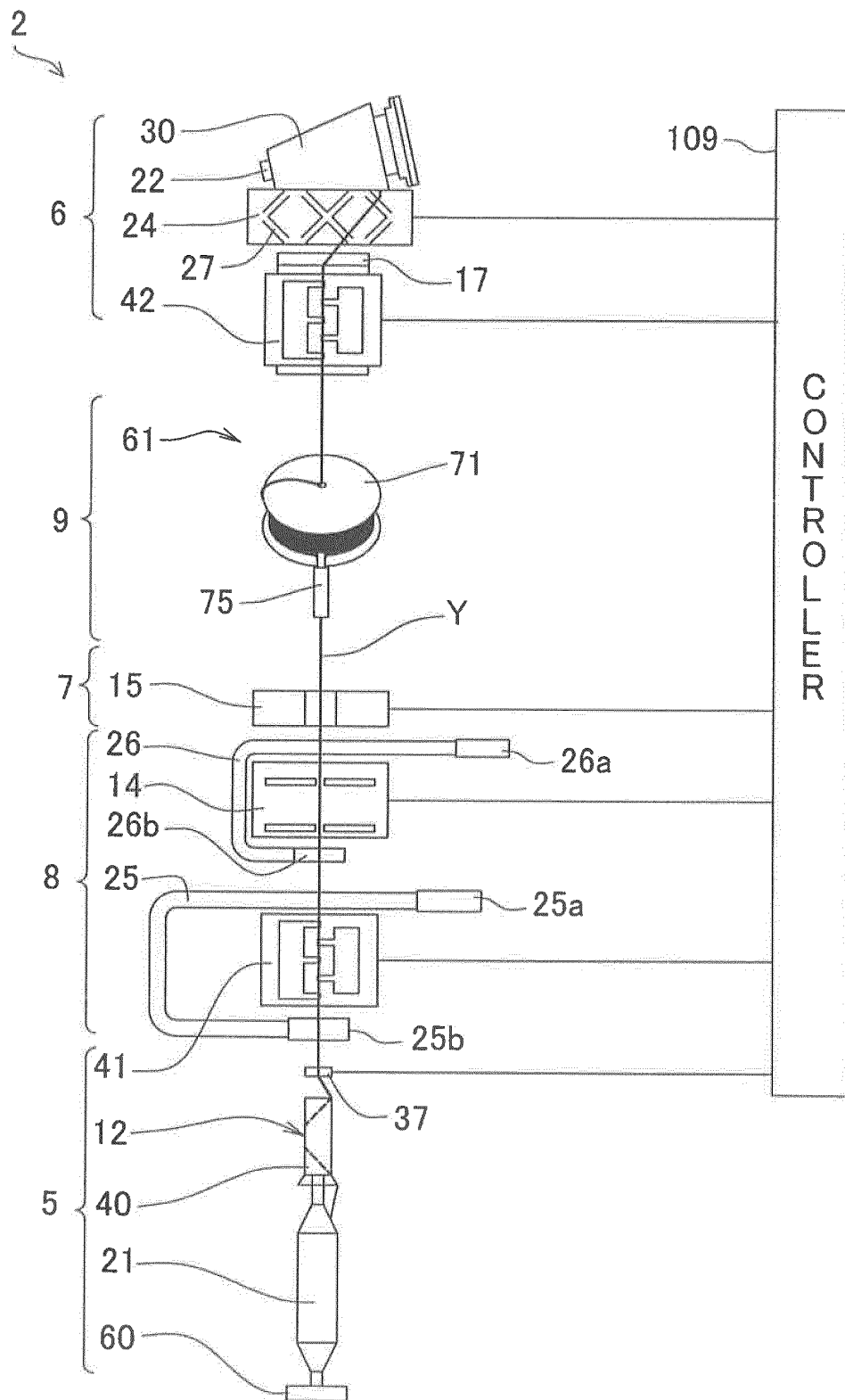


FIG. 2

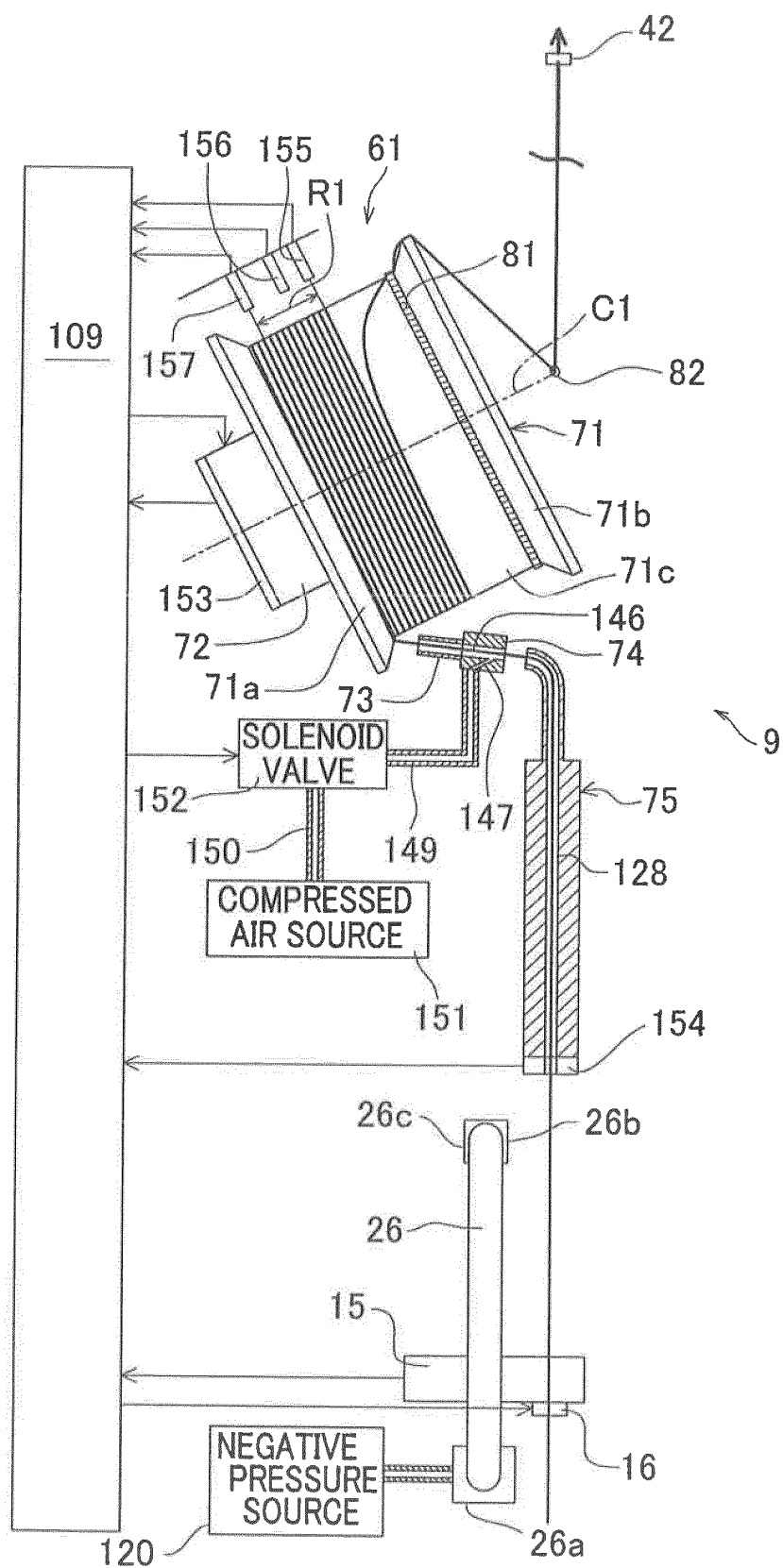


FIG.3

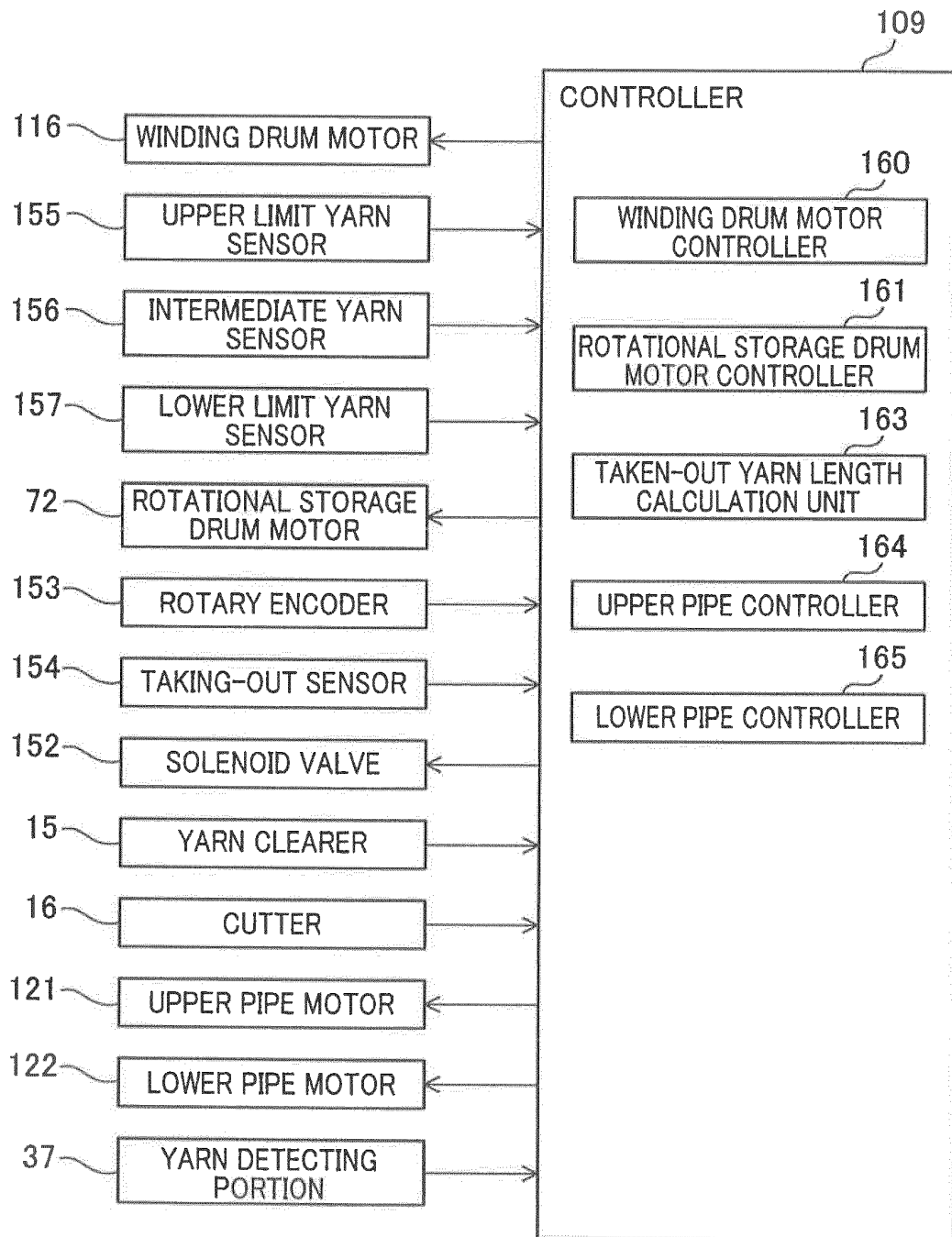


FIG.4

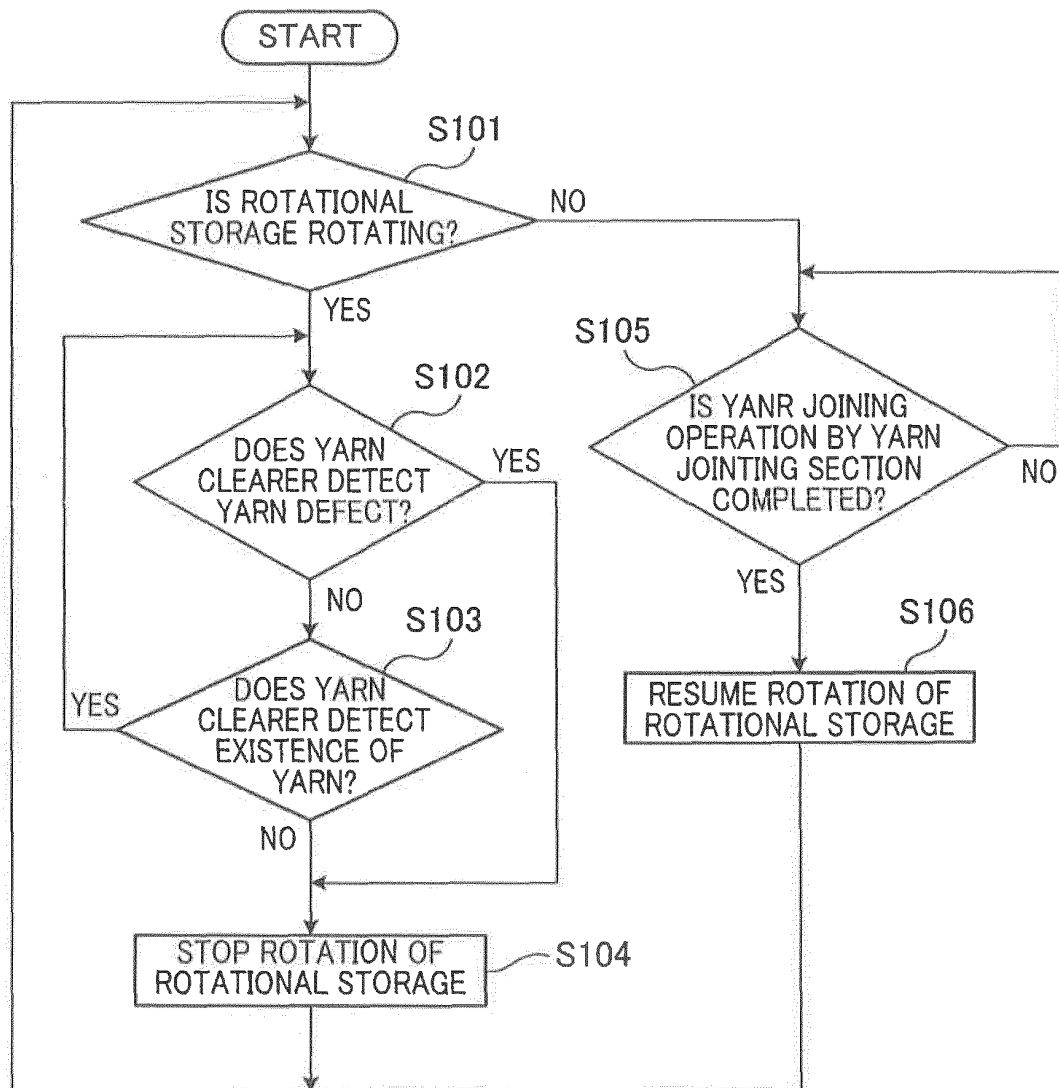


FIG.5

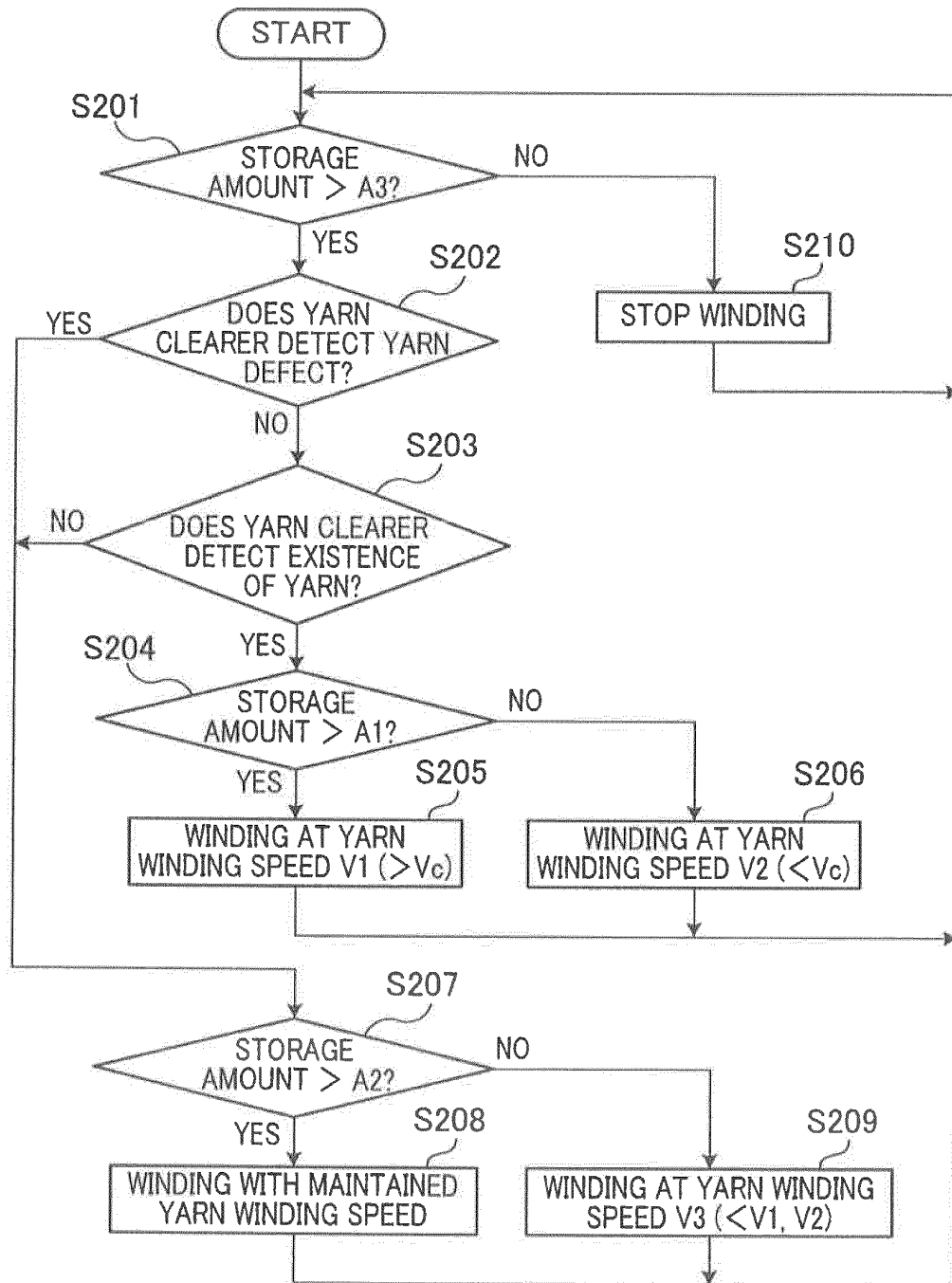


FIG.6

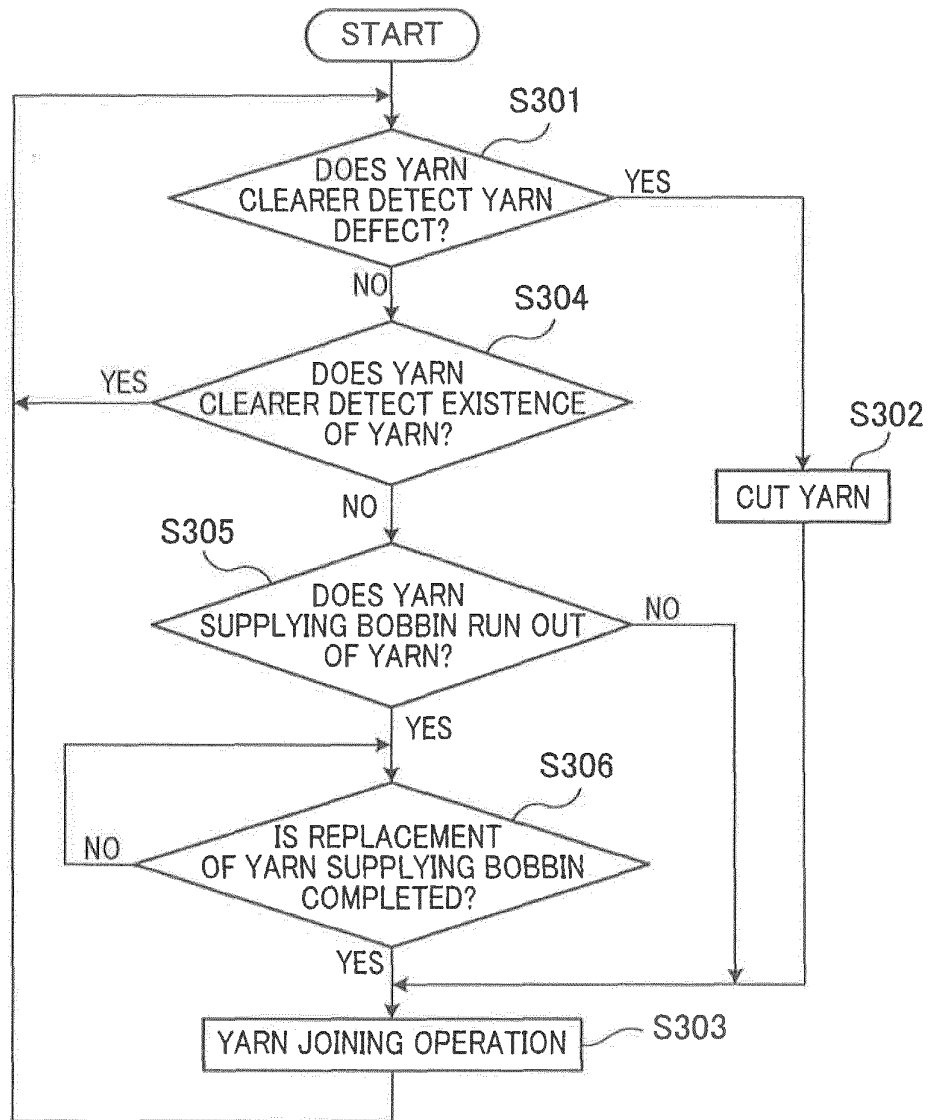


FIG.7(a)

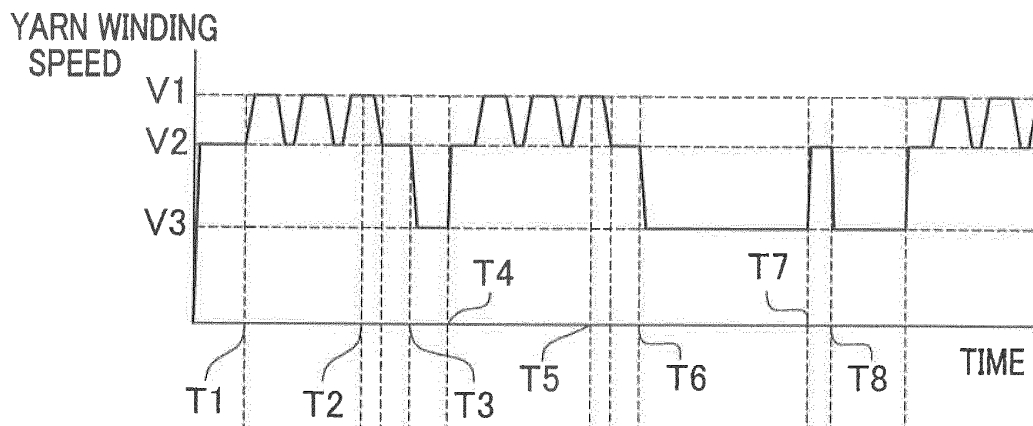


FIG.7(b)

YARN UNWINDING SPEED

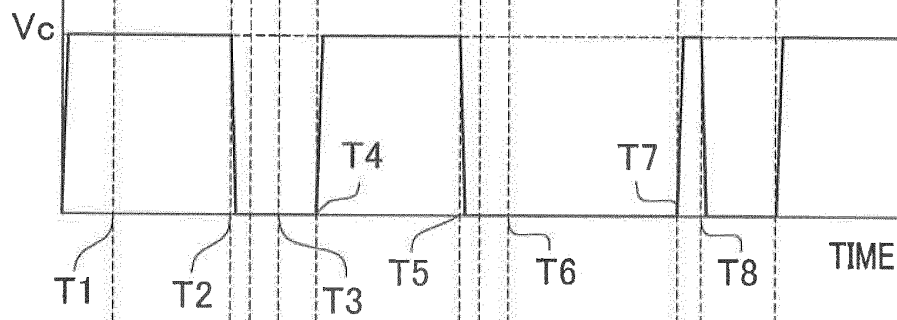
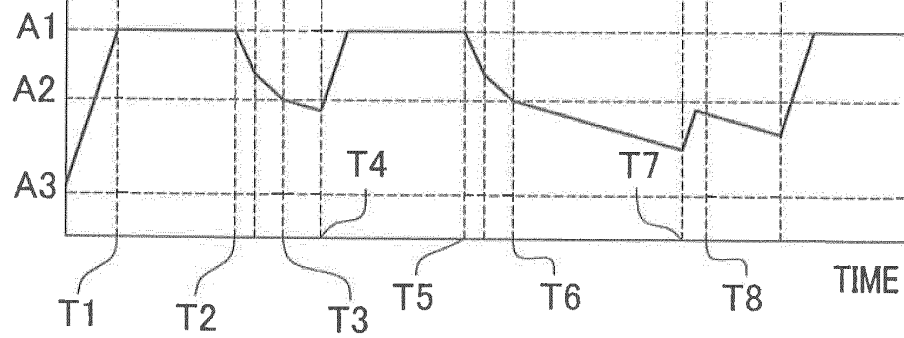


FIG.7(c)

YARN STORAGE AMOUNT



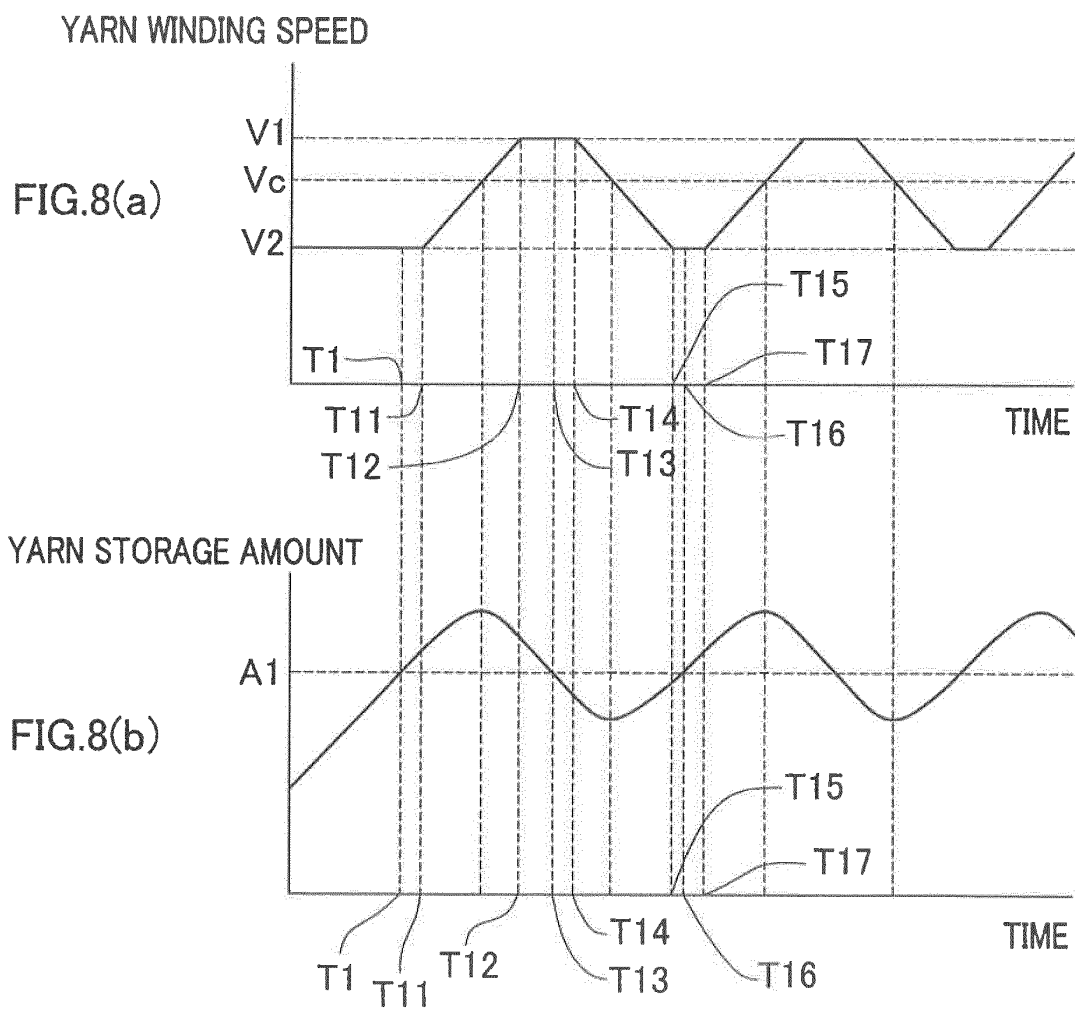


FIG.9

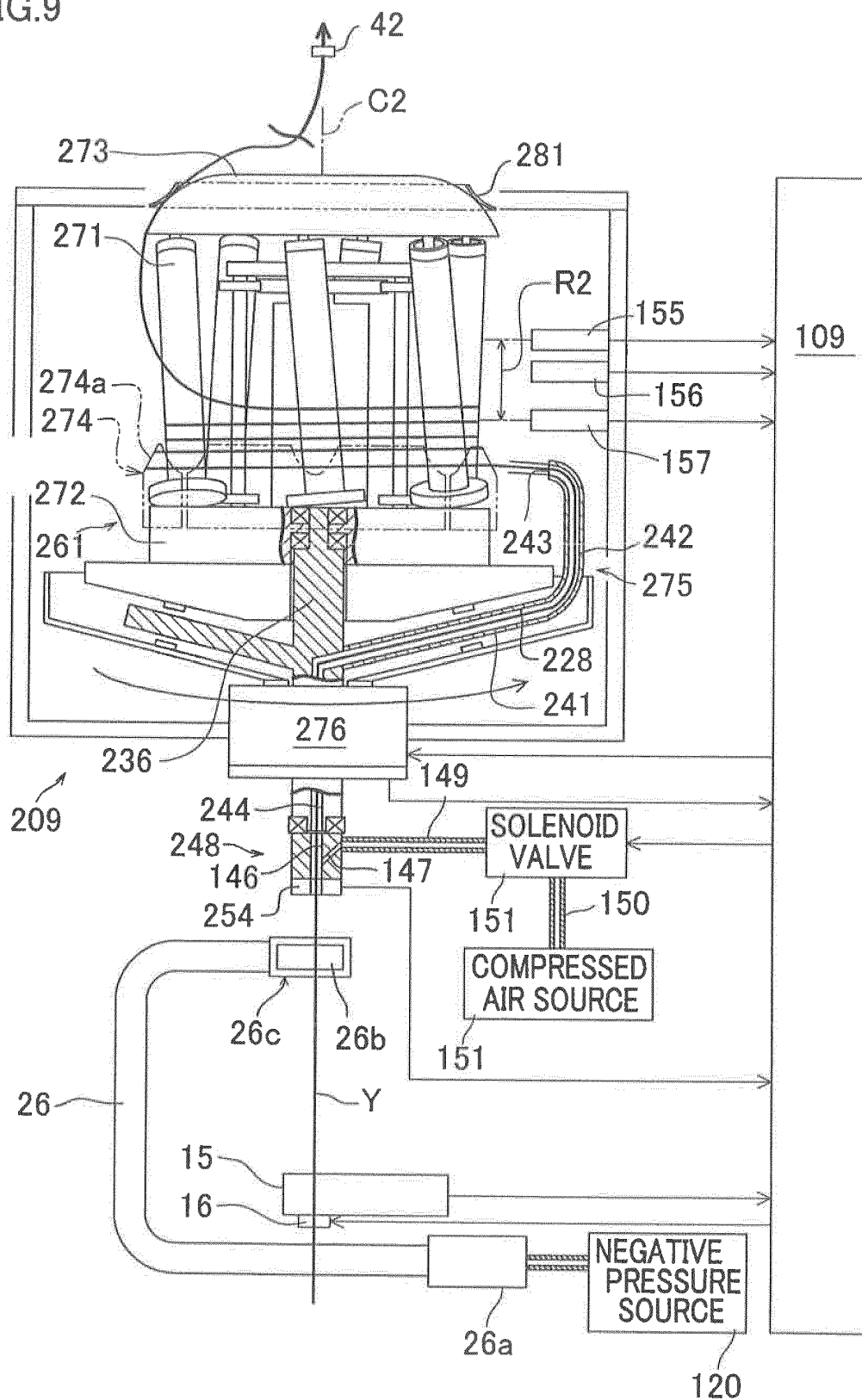


FIG.10

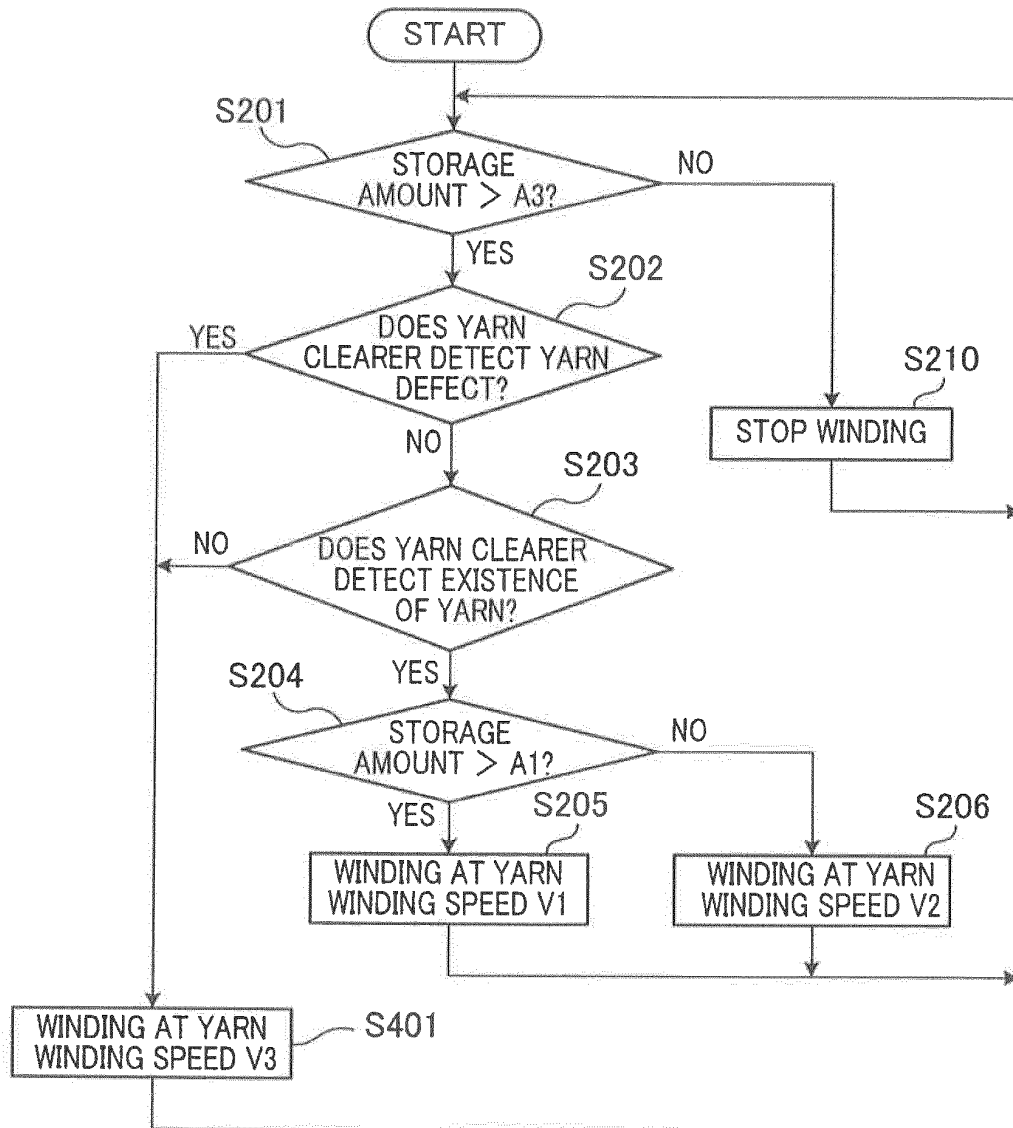
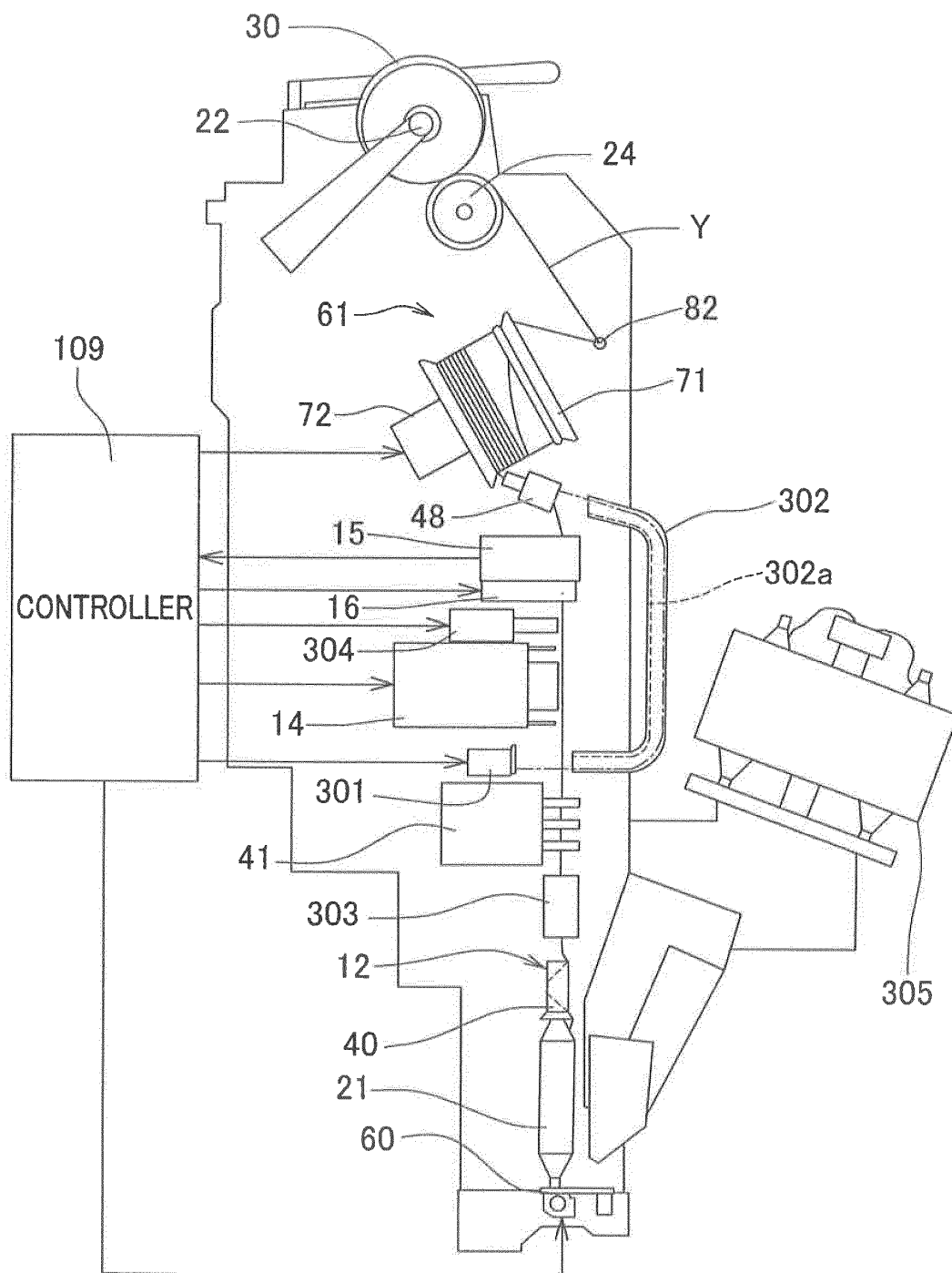


FIG.11



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2012/053447

A. CLASSIFICATION OF SUBJECT MATTER

B65H54/22 (2006.01) i, B65H51/20 (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)

B65H54/22, B65H51/20

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	1996-2012
Kokai Jitsuyo Shinan Koho	1971-2012	Toroku Jitsuyo Shinan Koho	1994-2012

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.
X	JP 2010-149977 A (Murata Machinery Ltd.), 08 July 2010 (08.07.2010), paragraphs [0032], [0060] to [0075] & EP 2202192 A2	1-9, 12-15
A	JP 2010-89908 A (Murata Machinery Ltd.), 22 April 2010 (22.04.2010), paragraphs [0043] to [0049] & EP 2189557 A1	1-15

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

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"&" document member of the same patent family

Date of the actual completion of the international search
23 March, 2012 (23.03.12)Date of mailing of the international search report
03 April, 2012 (03.04.12)Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

Facsimile No.

Telephone No.

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

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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