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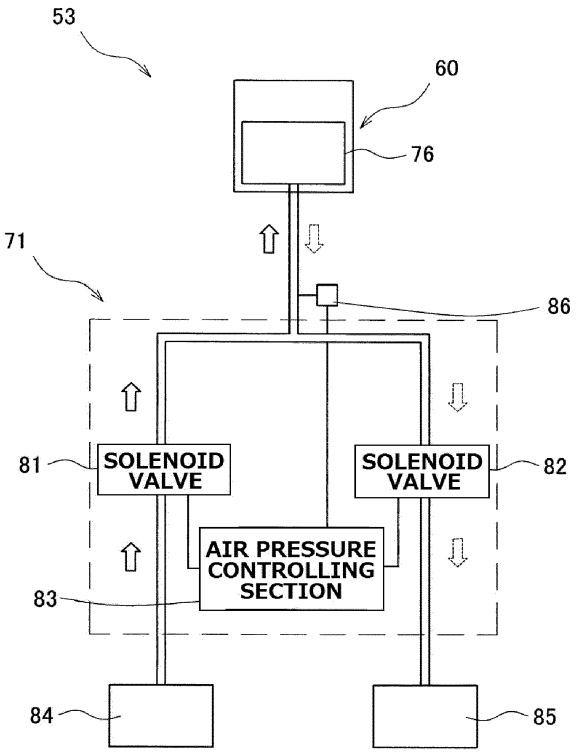
(54) YARN WINDING DEVICE

(57) A winding unit (2) includes a braking device (53) that includes a braking shoe (75) that brakes a package (100), a chamber (76) that operates the braking shoe, and a changing section (71) that changes a pressure of fluid supplied to the chamber. The changing section includes a first valve (81) arranged between a supply port (84) and the chamber, a second valve (82) arranged between the chamber and an exhaust port (85), and a controlling section (83) that opens and closes the valves independently. The pressure can be increased, decreased, or maintained at a constant value by appropriately operating the first valve and the second valve. Accordingly, the pressure can be adjusted at a given time, and the magnitude of the braking force acting on the package can be changed at a given time.

FIG.5



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

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

2. Description of the Related Art

[0002] A yarn winding device that forms a package by winding on a winding tube a yarn supplied from a yarn supplying section is disclosed in Japanese Patent Application Laid-Open No. 2016-78995. Specifically, the disclosed yarn winding device includes a contact roller that rotates while being in contact with the package to rotate the package, and a roller driving source that drives the contact roller. Also, a configuration that directly brakes the rotation of the package is disclosed.

[0003] The yarn winding device includes a rotary holder that rotates integrally with the winding tube, a package brake that brakes the rotary holder by using a pressure of compressed air, a solenoid valve that switches between supply and no-supply of the compressed air to the package brake, and a controlling unit that opens / closes the solenoid valve. The package brake includes a braking piston that brakes the rotation of the rotary holder and a housing that is a chamber to which the compressed air is supplied. When the compressed air is not supplied, the brake does not operate on the package and the package can rotate freely. When the controlling unit controls the solenoid valve to supply the compressed air to the chamber, the braking piston moves and contacts the rotary holder, and the package decelerates by frictional resistance between the braking piston and the rotary holder.

[0004] Japanese Patent Application Laid-Open No. 2010-37083 discloses a yarn winding device including a package brake, a solenoid valve, and a controlling unit similar to Japanese Patent Application Laid-Open No. 2016-78995. The controlling unit controls the solenoid valve to alternately repeat supply and exhaust of compressed air.

[0005] With such an operation, the so-called pumping brake is realized thereby gradually applying a braking force on the package to stop the rotation of the package. Note that, a ratio of an open duration and a closed duration of the solenoid valve is constant from a time point at which the package starts decelerating until a time point at which the package stops.

SUMMARY OF THE INVENTION

[0006] There is a requirement to exert a complicated control on the deceleration of the package while monitoring an amount of the yarn on the package, variations in the circumferential speed of the package, and the like. In the yarn winding device disclosed in Japanese Patent Application Laid-Open No. 2016-78995, however, a pressure inside the chamber cannot be controlled as desired as the operation involves simply switching with the solenoid valve the supply and no-supply of the compressed air.

[0007] In the yarn winding device disclosed in Japanese Patent Application Laid-Open No. 2010-37083, a pressure inside the chamber can be changed by alternately repeating the supply and no-supply of the compressed air; however, this does not mean that the ratio between the open duration and the closed duration of the solenoid valve is changed during the deceleration of the package. That is, the pressure inside the chamber cannot be changed to a desired value during the deceleration of the package.

[0008] One object of the present invention is to make it possible to adjust a pressure of fluid supplied to a chamber to a desired value at a given time during deceleration of a package thereby making it possible to change a magnitude of a braking force acting on the package at a given time.

[0009] According to one aspect of the present invention, a yarn winding device that unwinds a yarn from a yarn supplying section capable of supplying the yarn and winds the yarn on a winding tube to form a package includes a braking device. The braking device includes a braking member that brakes rotation of the package; a chamber that operates the braking member by a pressure of fluid inside thereof; and a fluid pressure changing section that changes the pressure of the fluid supplied to the chamber. The fluid pressure changing section includes a first valve arranged between the chamber and a fluid supply port connected to a fluid supply source; a second valve arranged between the chamber and a fluid discharge port; and a fluid pressure controlling section that opens and closes the first valve and the second valve independently.

[0010] According to another aspect of the present invention, a yarn winding device that unwinds a yarn from a yarn supplying section that supplies the yarn and winds the yarn on a winding tube to form a package includes a braking device. The braking device includes a braking member that brakes rotation of the package; a chamber that operates the braking member by a fluid pressure inside thereof; a supply switching valve arranged between the chamber and a fluid supply port connected to a fluid supply source; and a supply controlling section that controls opening and closing of the supply switching valve. The supply controlling section causes the opening and closing of the supply switching valve to be performed repeatedly alternately while changing at least one between an open duration and a closed duration of the supply switching valve.

[0011] The above and other objects, features, advantages and technical and industrial significance of this invention will be better understood by reading the following detailed description of presently preferred embodiments

of the invention, when considered in connection with the accompanying drawings.

[0012] According to one aspect of the present invention, a yarn winding device that unwinds a yarn from a yarn supplying section capable of supplying the yarn and winds the yarn on a winding tube to form a package includes a braking device. The braking device includes a braking member that brakes rotation of the package; a chamber that operates the braking member by a pressure of fluid inside thereof; and a fluid pressure changing section that changes the pressure of the fluid supplied to the chamber. The fluid pressure changing section includes a first valve arranged between the chamber and a fluid supply port connected to a fluid supply source; a second valve arranged between the chamber and a fluid discharge port; and a fluid pressure controlling section that opens and closes the first valve and the second valve independently.

[0013] The first valve is for supplying the fluid from the fluid supply port to the chamber. The second valve is for discharging the fluid from the chamber to the fluid discharge port. When the first valve is opened and the second valve is closed, the pressure of the fluid supplied to the chamber increases. When the first valve is closed and the second valve is opened, the pressure decreases. Because these valves can be operated independently by the control of the fluid pressure controlling section, the pressure can be maintained at a constant value by closing both the valves. With this configuration, the magnitude of the pressure of the fluid supplied to the chamber can be adjusted to a desired magnitude at a given time during the deceleration of the package. Accordingly, the magnitude of the braking force acting on the package can be changed at a given time.

[0014] In the above yarn winding device, the braking device can further include a pressure detecting section that detects the pressure of the fluid supplied from the fluid pressure changing section to the chamber. The fluid pressure controlling section controls the first valve and the second valve based on the pressure detected by the pressure detecting section so that the pressure of the fluid supplied to the chamber is equal to a designated pressure.

[0015] The first valve and the second valve are controlled by the fluid pressure controlling section based on the pressure detected by the pressure detecting section such that the pressure of the fluid supplied to the chamber is maintained at the designated pressure. Accordingly, the pressure can be adjusted to the designated pressure, and the braking force acting on the package can be changed.

[0016] In the above yarn winding device, the designated pressure is sequentially input into the fluid pressure controlling section from outside.

[0017] The designated pressure is input into the fluid pressure controlling section from outside from time to time. That is, the magnitude of the designated pressure can be changed at a given time while the package is decelerating. Accordingly, the magnitude of the braking force acting on the package can be changed appropriately depending on the situation at a given time.

[0018] In the above yarn winding device, the braking device can further include a supply switching valve arranged between the chamber and the first valve of the fluid pressure changing section; and a supply controlling section that controls opening and closing of the supply switching valve.

[0019] The supply and no-supply of the fluid from the fluid pressure changing section to the chamber can be switched by performing the opening and closing of the supply switching valve. As a result, the fluid supplied from the fluid pressure changing section can be supplied to the chamber after changing the pressure thereof. Accordingly, the braking force acting on the package can be changed further finely.

[0020] In the above yarn winding device, the supply controlling section causes the opening and closing of the supply switching valve to be performed repeatedly alternately.

[0021] Because the opening and closing of the supply switching valve is performed alternately repeatedly, the supply and no-supply of the fluid to the chamber is performed alternately repeatedly. As a result, the pressure of the fluid supplied to the chamber decreases below the pressure of the fluid supplied from the fluid pressure changing section. Accordingly, the braking force can be applied on the package more gradually than when only the fluid pressure changing section is used.

[0022] In the above yarn winding device, the supply controlling section changes at least one between an open duration and a closed duration of the supply switching valve.

[0023] Because at least one between the open duration and the closed duration of the supply switching valve is changed by the supply controlling section, the pressure of the fluid supplied to the chamber from the fluid pressure changing section can be adjusted. Accordingly, the braking force acting on the package can be changed further finely.

[0024] According to another aspect of the present invention, a yarn winding device that unwinds a yarn from a yarn supplying section that supplies the yarn and winds the yarn on a winding tube to form a package includes a braking device. The braking device includes a braking member that brakes rotation of the package; a chamber that operates the braking member by a fluid pressure inside thereof; a supply switching valve arranged between the chamber and a fluid supply port connected to a fluid supply source; and a supply controlling section that controls opening and closing of the supply switching valve. The supply controlling section causes the opening and closing of the supply switching valve to be performed repeatedly alternately while changing at least one between an open duration and a closed duration of the supply switching valve.

[0025] When the opening and closing of the supply

switching valve are performed repeatedly alternately, the supply and no-supply of the fluid to the chamber are performed repeatedly alternately. As a result, the pressure of the fluid supplied to the chamber decreases below the pressure of the fluid inside the fluid supply source. Moreover, by changing at least one between the open duration and the closed duration, the pressure of the fluid supplied to the chamber can be adjusted to a desired pressure at a given time during the deceleration of the package. Accordingly, the braking force acting on the package can be changed at a given time.

[0026] The above yarn winding device can further include a contact roller that rotates the package by rotating while being in contact with the package; a roller driving section that rotationally drives the contact roller; a package rotational speed detecting section that detects a rotational speed of the package; a contact roller rotational speed detecting section that detects a rotational speed of the contact roller; and a winding controlling section that controls the braking device and the roller driving section. The winding controlling section, when decelerating the package that is in contact with the contact roller while maintaining a state in which the yarn is being wound on the package, controls the braking device and the roller driving section so that a difference in a circumferential speed of the package and a circumferential speed of the contact roller falls within a predetermined range based on a detection result obtained in the package rotational speed detecting section and a detection result obtained in the contact roller rotational speed detecting section.

[0027] At a timing and the like at which the package becomes fully wound, for example, there may be a situation that necessitates the package to be decelerated while being in contact with the contact roller and continuing the winding of the yarn. In such a situation, stitching, outer layer disorder of the package, and the like may occur if the difference in the circumferential speed of the package and the circumferential speed of the contact roller is large. In the present invention, during the deceleration of the package, the pressure of the fluid supplied to the chamber can be adjusted to a desired pressure at a given time, and the braking force acting on the package can be changed at a given time, so that the difference in the circumferential speeds of the package and the contact roller can be made small, and various issues can be prevented.

[0028] The above yarn winding device can further include a yarn accumulating section arranged between the yarn supplying section and the package forming section and that accumulates the yarn supplied from the yarn supplying section; and a yarn joining device arranged between the yarn supplying section and the yarn accumulating section and that joins a yarn end from the yarn supplying section and a yarn end from the yarn accumulating section when the yarn is discontinuous between the yarn supplying section and the yarn accumulating section. The winding controlling section controls the braking device and the roller driving section to decelerate the package and the contact roller while the yarn is being joined by the yarn joining device.

[0029] When the yarn becomes discontinuous between the yarn supplying section and the yarn accumulating section due to occurrence of the yarn breakage and the like, the formation of the package is continued by pulling the yarn accumulated in the yarn accumulating section while the yarn joining is performed by the yarn joining device. In this case, when decelerating the package so that the yarn accumulated in the yarn accumulating section does not dry up, while the yarn is continuous between the yarn accumulating section and the package, stitching, outer layer disorder of the package, and the like may occur if the difference in the circumferential speed of the package and the circumferential speed of the contact roller is large. In the present invention, during the deceleration of the package, the pressure of the fluid supplied to the chamber can be adjusted to a desired pressure at a given time, and the braking force acting on the package can be changed at a given time, so that the above-mentioned difference in the circumferential speeds can be made small, and various issues can be prevented.

[0030] In the above yarn winding device, the braking device changes the pressure of the fluid supplied to the chamber so that the lesser the amount of the yarn on the package is the weaker a braking force acts on the package.

[0031] The braking force acting on the package can be made smaller in proportion to the weight of the package. Accordingly, excessive deceleration of the package can be prevented.

[0032] In the above explanation, the meaning of "a plurality of" also includes "a predetermined number of".

[0033] Although the invention has been explained with respect to specific embodiments for a complete and clear disclosure, the appended claims are not to be thus limited but are to be construed as embodying all modifications and alternative constructions that may occur to one skilled in the art that fairly fall within the scope of the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0034]

FIG. 1 is a front view of an automatic winder according to one embodiment of the present invention.
FIG. 2 is a block diagram of an electrical configuration of the automatic winder.
FIG. 3 is a schematic side view of a winding unit.
FIG. 4 is a front view of a package forming section.
FIG. 5 is a block diagram of a braking device.
FIG. 6 is a cross-sectional view of a braking cylinder and a neighboring configuration thereof.
FIG. 7 is a graph indicating a temporal variation of a pressure of compressed air supplied to a chamber by an air pressure changing section.

FIG. 8 is a flowchart of a process procedure performed when a yarn breakage and the like has occurred.
FIGS. 9A and 9B are graphs indicating a temporal variation of the pressure of the compressed air supplied to the chamber.
FIG. 10 is a block diagram of a braking device according to a variation.
FIGS. 11A to 11D are explanatory drawings showing timings of opening and closing and the like of a solenoid valve.
FIG. 12 is a block diagram of a braking device according to another variation.
FIGS. 13A to 13C are explanatory drawings showing a temporal variation and the like of the pressure of the compressed air.
FIG. 14 is a block diagram of a braking device according to yet another variation.
FIG. 15 is a schematic side view of a winding unit according to yet another variation.

DETAILED DESCRIPTION

[0035] Exemplary embodiments of the present invention are explained below with reference to FIGS. 1 to 9B. Note that, as shown in FIG. 1, a direction along which a plurality of winding units is arranged is taken as a left-right direction and a direction in which the gravity acts is taken as an up-down direction. Moreover, a direction orthogonal to the left-right direction and the up-down direction is taken as a front-back direction.

Schematic Configuration of Automatic Winder

[0036] At first, a schematic configuration of an automatic winder 1 is explained by using FIGS. 1 and 2. FIG. 1 is a front view of the automatic winder 1 according to the present embodiment. FIG. 2 is a block diagram of an electrical configuration of the automatic winder 1. The automatic winder 1 includes a plurality of winding units 2 (yarn winding device of the present invention), a doffing device 3, a controlling device 4, and the like.

[0037] The winding units 2 are arranged along the left-right direction. Each of the winding units 2 forms a package 100 by winding on a winding bobbin Bm (winding tube of the present invention) a yarn Y unwound from a yarn supplying bobbin Bk. The doffing device 3 is arranged above the winding units 2 so as to be movable in the left-right direction. Upon receiving a fully-wound signal from a given winding unit 2, the doffing device 3 moves above that winding unit 2 and performs operations of removing the fully wound package 100, mounting an empty winding bobbin Bm in the winding unit 2, and the like. The controlling device 4, as shown in FIG. 2, is electrically connected to a later-explained unit controlling section 15 (winding controlling section of the present invention) of the winding unit 2 and a not-shown controlling section of the doffing device 3. The controlling device 4 performs communication with these controlling sections.

Winding Unit

[0038] A configuration of the winding unit 2 is explained below by using FIGS. 2 to 4. FIG. 3 is a schematic side view of the winding unit 2. FIG. 4 is a front view of a later-explained package forming section 12. The winding unit 2, as shown in FIGS. 2 and 3, includes a yarn supplying section 11, the package forming section 12, a yarn accumulating section 13, a yarn joining device 33 and a yarn clearer 36 arranged between the yarn supplying section 11 and the yarn accumulating section 13, the unit controlling section 15, and the like.

Yarn Supplying Section

[0039] The yarn supplying section 11 is for supplying the yarn Y that has been wound on the yarn supplying bobbin Bk, and it is arranged at a lower end of the winding unit 2. As shown in FIG. 3, the yarn supplying section 11 includes a yarn supplying bobbin supporting member 21.

[0040] The yarn supplying bobbin supporting member 21 supports the yarn supplying bobbin Bk such that the yarn supplying bobbin Bk stands substantially vertical. The yarn supplying bobbin supporting member 21 discharges an empty yarn supplying bobbin Bk. After the empty yarn supplying bobbin Bk is discharged, a new yarn supplying bobbin Bk is supplied from a not-shown bobbin supplying device to the yarn supplying bobbin supporting member 21.

Package Forming Section

[0041] The package forming section 12 is for forming the package 100 by winding the yarn Y on the winding bobbin Bm, and it is arranged at an upper end of the winding unit 2. As shown in FIGS. 3 and 4, the package forming section 12 includes a cradle 51 (support member of the present invention), a traversing drum 52 (contact roller of the present invention), a braking device 53, and the like.

[0042] The cradle 51 has, as shown in FIG. 4, a pair of cradle arms 51a and 51b. The cradle arms 51a and 51b are supported so as to be pivotable around an axis 54. The cradle arms 51a and 51b pivot so as to move toward or away from the traversing drum 52.

[0043] Bobbin holders 56 and 57 are attached to tip ends of the cradle arms 51a and 51b, respectively, for rotatably holding the winding bobbin Bm. The bobbin holders 56 and 57 have holder bodies 58 and 59, respectively, that engage with respective ends of the winding bobbin Bm in a rotation axis direction of the winding bobbin Bm. In the present embodiment, the cradle 51 is configured such that a cone-shaped winding bobbin Bm can be mounted thereon. The holder body 58 is arranged on a large diameter side and the holder body 59 is arranged on a small diameter side of the winding bobbin Bm, and

the holder bodies 58 and 59 rotate integrally with the winding bobbin Bm.

[0044] A later-explained braking cylinder 60 is arranged inside the bobbin holder 56. A package rotational speed sensor 61 (package rotational speed detecting section of the present invention) is arranged near the bobbin holder 57. The package rotational speed sensor 61 detects a rotational speed of the package 100 and outputs the detected value to the unit controlling section 15.

[0045] The traversing drum 52 is rotationally driven by a drum driving motor 62 (roller driving section of the present invention). When the traversing drum 52 rotates while the package 100 is in contact with the traversing drum 52, the winding bobbin Bm and the package 100 follow this rotation.

[0046] A traversing groove 52a is formed on an outer peripheral surface of the traversing drum 52. When the traversing drum 52 with the yarn Y entered inside the traversing groove 52a is rotated, the yarn Y can be caused to traverse with a predetermined width.

[0047] A drum rotational speed sensor 63 (contact roller rotational speed detecting section of the present invention) is arranged near the traversing drum 52. The drum rotational speed sensor 63 detects a rotational speed of the traversing drum 52 and outputs the detected value to the unit controlling section 15.

[0048] The braking device 53 is for braking the rotation of the package 100. The details are explained later.

Yarn Accumulating Section

[0049] The yarn accumulating section 13 is for temporarily accumulating the yarn Y unwound from the yarn supplying bobbin Bk. The yarn accumulating section 13 is arranged below the package forming section 12. As shown in FIG. 3, the yarn accumulating section 13 includes a yarn accumulating drum 41, a drum driving motor 42, a yarn guiding member 43, and an upper yarn blowdown device 44.

[0050] The yarn accumulating drum 41 is a substantially cylindrical member. The yarn Y is accumulated by winding the yarn Y on an outer peripheral surface of the yarn accumulating drum 41. The drum driving motor 42 rotationally drives the yarn accumulating drum 41. The yarn guiding member 43 is a tubular member. One end of the yarn guiding member 43 is arranged so as to oppose an end of the yarn accumulating drum 41 along a rotation axis direction of the yarn accumulating drum 41. The yarn Y travels from the yarn supplying section 11 to the yarn guiding member 43 and inside the yarn guiding member 43, and the yarn Y is guided to the yarn accumulating drum 41. The upper yarn blowdown device 44 is arranged adjacent to the yarn guiding member 43. The upper yarn blowdown device 44 is connected to a compressed air source. The upper yarn blowdown device 44 blows down the yarn Y of the upper part (yarn Y on the yarn accumulating section 13 side) during yarn joining explained later.

[0051] When the drum driving motor 42 rotationally drives the yarn accumulating drum 41, the yarn Y is guided to the yarn accumulating drum 41 by the yarn guiding member 43, and the yarn Y is wound around the outer peripheral surface of the yarn accumulating drum 41. The wound yarn Y is pulled from the yarn accumulating drum 41 and wound on the package 100 when the drum driving motor 62 of the package forming section 12 rotates the traversing drum 52 and the package 100. In this manner, because the yarn Y has been accumulated in the yarn accumulating section 13, for example, when the later-explained yarn joining is performed, the yarn Y can be pulled from the yarn accumulating section 13, and the package forming section 12 can continue a winding operation of the yarn Y.

Yarn Joining Device

[0052] As shown in FIG. 3, the yarn joining device 33 is arranged between the yarn supplying section 11 and the yarn accumulating section 13. When the yarn Y becomes discontinuous between the yarn supplying section 11 and the yarn accumulating section 13, the yarn joining device 33 performs the yarn joining of the yarn Y from the yarn supplying section 11 (hereinafter, "lower yarn Y1") and the yarn Y from the yarn accumulating section 13 (hereinafter, "upper yarn Y2"). As the situations in which the yarn Y becomes discontinuous, when a yarn breakage has occurred due to excessive tension, when the yarn is cut because of occurrence of a yarn defect, when replacing the yarn supplying bobbin Bk, and the like can be mentioned. A device that uses compressed air, for example, can be used as the yarn joining device 33. The yarn joining device 33 jets compressed air on the lower yarn Y1 and the upper yarn Y2 to untwist yarn ends of both the yarns. Thereafter, the yarn joining device 33 again jets the compressed air on both the yarn ends to perform the yarn joining by intertwining the yarn ends together.

Yarn Clearer

[0053] As shown in FIG. 3, the yarn clearer 36 is arranged between the yarn supplying section 11 and the yarn accumulating section 13. The yarn clearer 36 monitors a thickness of the yarn Y and the like to detect a yarn defect. A not-shown cutter is arranged near the yarn clearer 36 for cutting the yarn Y. When a yarn breakage occurs or when the bobbin is replaced, the yarn clearer 36 detects absence of the yarn Y and outputs to the unit controlling section 15 a detection signal representing the detection of absence of the yarn Y. On the other hand, upon detecting the yarn defect, the cutter immediately cuts the yarn Y, and the yarn clearer 36 outputs to the unit controlling section 15 a detection signal representing the detection of the yarn defect.

Configuration Between Yarn Supplying Section and Yarn Accumulating Section

[0054] The winding unit 2 includes various structural components, other than the yarn joining device 33 and the yarn clearer 36 mentioned above, between the yarn supplying section 11 and the yarn accumulating section 13. That is, as shown in FIG. 3, a yarn unwinding assisting device 22, a lower yarn blowup device 31, an upper yarn catching device 32, a lower yarn catching device 34, a tension applying device 35, and the like are arranged between the yarn supplying section 11 and the yarn accumulating section 13 in this order from bottom to top. In the present embodiment, the yarn joining device 33 is arranged between the upper yarn catching device 32 and the lower yarn catching device 34, and the yarn clearer 36 is arranged above the tension applying device 35.

[0055] The yarn unwinding assisting device 22 is arranged above the yarn supplying section 11. The yarn unwinding assisting device 22 includes a regulating member 23. The yarn unwinding assisting device 22 causes the regulating member 23 to contact from above the yarn Y unwound from the yarn supplying bobbin Bk to prevent bulging of the yarn Y by a centrifugal force generated during unwind.

[0056] The lower yarn blowup device 31 is connected to a compressed air source. The lower yarn blowup device 31 blows up the lower yarn Y1. The upper yarn catching device 32 is connected to a negative pressure source. The upper yarn catching device 32 catches by suction the upper yarn Y2. The lower yarn catching device 34 is connected to a negative pressure source. The lower yarn catching device 34 catches by suction the lower yarn Y1 blown up by the lower yarn blowup device 31. The tension applying device 35 includes, for example, fixed comb teeth and movable comb teeth. The tension applying device 35 applies a predetermined tension to the yarn Y.

[0057] Along the up-down direction, a tubular yarn guiding member 38 is arranged from the position of the upper yarn catching device 32 to the position of the upper yarn blowdown device 44. An opening on an upper end of the yarn guiding member 38 opposes the upper yarn blowdown device 44 and an opening on a lower end thereof opposes the upper yarn catching device 32. A not-shown slit is formed in a longitudinal direction on a side wall of the yarn guiding member 38.

[0058] When the yarn Y is cut by the yarn clearer 36, the yarn joining operation explained below is performed by the yarn joining device 33, the yarn accumulating section 13, and the like. At first, the rotation of the drum driving motor 42 of the yarn accumulating section 13 is stopped to stop the rotation of the yarn accumulating drum 41. Then, the lower yarn Y1 generated by cutting of the yarn by the yarn clearer 36 is caught by suction by the lower yarn catching device 34, and the lower yarn Y1 is guided to the yarn joining device 33. Moreover, the upper yarn blowdown device 44 pulls the upper yarn Y2 that has adhered to the surface of the yarn accumulating drum 41 to blow down toward the yarn guiding member 38. The blown down upper yarn Y2 is guided from the opening on the upper end to the opening on the lower end of the yarn guiding member 38. By the upper yarn catching device 32 catching by suction the yarn end of the upper yarn Y2, the upper yarn Y2 is taken out of the slit of the yarn guiding member 38 and guided to the yarn joining device 33. The yarn joining device 33 performs the yarn joining of the lower yarn Y1 and the upper yarn Y2 guided thereto.

Unit Controlling Section

[0059] The unit controlling section 15 includes a CPU (Central Processing Unit), a ROM (Read Only Memory), a RAM (Random Access Memory), and the like. The unit controlling section 15 controls various structural components by using the CPU based on computer programs stored in the ROM. Specifically, the unit controlling section 15 controls reception of a signal from the yarn clearer 36, the drum rotational speed sensor 63, the package rotational speed sensor 61, a later-explained air pressure changing section 71 and the like, and the operation of the yarn unwinding assisting device 22, the yarn joining device 33, the drum driving motor 42, the drum driving motor 62, the air pressure changing section 71, and the like.

Detailed Configuration of Braking Device

[0060] A detailed configuration of the braking device 53 of the package forming section 12 is explained below by using FIGS. 4 to 6. FIG. 5 is a schematic view of the braking device 53. FIG. 6 is a schematic cross-sectional view of the braking cylinder 60 and a neighboring configuration thereof. The braking device 53 includes, as shown in FIG. 5, the braking cylinder 60, the later-explained air pressure changing section 71 (fluid pressure changing section of the present invention) that changes a pressure of the compressed air supplied to a chamber 76 of the braking cylinder 60, a pressure meter 86 (pressure detecting section of the present invention), and the like.

[0061] As explained above, the braking cylinder 60 is arranged inside the bobbin holder 56. As shown in FIG. 6, the braking cylinder 60 has a housing 72, a bearing sleeve 73, a rotation support member 74, and the like.

[0062] The housing 72 is attached to a tip end part of the cradle arm 51a. The bearing sleeve 73 is fit in the housing 72 so as to be movable but not rotatable. A braking shoe 75 (braking member of the present invention) is arranged at a tip end part of the bearing sleeve 73. The chamber 76 is formed by an inner wall of the housing 72 and the bearing sleeve 73. The chamber 76 has an opening through which the compressed air can be supplied to the chamber 76. A spring 77 that biases the bearing sleeve 73 toward the holder body 58 is arranged between the housing 72 and the bearing sleeve 73.

[0063] The rotation support member 74 is arranged inside the bearing sleeve 73. A shaft 78 is attached to the holder body 58. The rotation support member 74 supports the shaft 78 so as to be rotatable. A spring 79 that biases the rotation support member 74 toward the holder body 58 is arranged between the bearing sleeve 73 and the rotation support member 74.

[0064] The air pressure changing section 71 is for changing the pressure of the compressed air supplied to the chamber 76 of the braking cylinder 60. As shown in FIG. 5, the air pressure changing section 71 includes a solenoid valve 81 (first valve of the present invention), a solenoid valve 82 (second valve of the present invention), an air pressure controlling section 83 (fluid pressure controlling section of the present invention), and the like.

[0065] Both the solenoid valves 81 and 82 are normally closed 2-way solenoid valves. The solenoid valve 81 is arranged between a supply port 84 (fluid supply port of the present invention) and the chamber 76. The supply port 84 is connected to the compressed air source (fluid supply source of the present invention). An input side of the solenoid valve 81 is connected to the supply port 84 and an output side is connected to the chamber 76 and an input side of the solenoid valve 82. The solenoid valve 82 is arranged between the chamber 76 and an exhaust port 85 (fluid discharge port of the present invention) open to the outside. The input side of the solenoid valve 82 is connected to the chamber 76 and to the output side of the solenoid valve 81, and an output side thereof is connected to the exhaust port 85. The air pressure controlling section 83 opens and closes the solenoid valve 81 and the solenoid valve 82 independently. One or more designated pressures is input into the air pressure controlling section 83, for example, from the unit controlling section 15 and the like.

[0066] The solenoid valve 81 switches between supply and no-supply of the compressed air from the supply port 84 to the chamber 76. The solenoid valve 82 switches between discharge and no-discharge of the compressed air from the exhaust port 85. When the solenoid valve 81 is opened and the solenoid valve 82 is closed, the compressed air flows as shown with a continuous-line arrow in FIG. 5. In this state, the compressed air is supplied from the supply port 84 to the chamber 76 whereby the pressure of the compressed air inside the chamber 76 increases. In contrast, when the solenoid valve 81 is closed and the solenoid valve 82 is opened, the compressed air flows as shown with a dotted-line arrow in FIG. 5. In this state, the compressed air is discharged from the chamber 76 to the exhaust port 85, and the pressure inside the chamber 76 decreases. Because the solenoid valves 81 and 82 are operated independently by the air pressure controlling section 83, by closing both the solenoid valves 81 and 82, the pressure inside the chamber 76 is maintained at the designated pressure as the compressed air is neither supplied nor discharged.

[0067] The pressure meter 86 is arranged between the solenoid valve 81 and the chamber 76. The pressure meter 86 measures the pressure of the compressed air supplied to the chamber 76 and outputs the measured value to the air pressure controlling section 83. The air pressure controlling section 83 controls the solenoid valves 81 and 82 based on the pressure measured by the pressure meter 86 such that the pressure inside the chamber 76 is maintained at the designated pressure.

[0068] A temporal variation of the pressure controlled by the air pressure changing section 71 is explained by using FIG. 7. In FIG. 7, an initial pressure is indicated by a pressure P0. The designated pressure is input into the air pressure controlling section 83 by the unit controlling section 15 and the like from time to time. At a time point T0, for example, when a pressure P1, which is higher than the pressure P0, is input as the designated pressure from the unit controlling section 15 and the like, the air pressure controlling section 83 opens the solenoid valve 81 and closes the solenoid valve 82 whereby the pressure inside the chamber 76 increases and reaches the pressure P1. At a time point T1, when a pressure P2, which is lower than the pressure P1, is input as the designated pressure, the air pressure controlling section 83 closes the solenoid valve 81 and opens the solenoid valve 82 whereby the pressure inside the chamber 76 decreases and reaches the pressure P2. At a time point T2, when a different designated pressure is input, the air pressure controlling section 83 similarly controls the solenoid valves 81 and 82 and changes the pressure inside the chamber 76. In this manner, the pressure of the compressed air supplied to the chamber 76 is adjusted by the air pressure changing section 71 at a given time to a desired pressure that is equal to or lower than a pressure Pmax of the compressed air source.

[0069] In the above configuration, depending on the pressure of the compressed air supplied to the chamber 76, the bearing sleeve 73 moves along the rotation axis direction of the winding bobbin Bm. That is, the bearing sleeve 73 moves toward the holder body 58 of the bobbin holder 56 when the pressure increases, and the bearing sleeve 73 moves away from the holder body 58 when the pressure decreases. When no compressed air is supplied to the chamber 76, or when the pressure of the compressed air is so low that the braking shoe 75 does not contact the holder body 58, the holder body 58 is not braked and it can freely rotate with respect to the bearing sleeve 73. In this case, the holder body 58 is biased toward the winding bobbin Bm via the shaft 78 by the springs 77 and 79 and the low-pressure compressed air. As a result, the winding bobbin Bm is held so as to be rotatable.

[0070] In contrast, when a high-pressure compressed air is supplied to the chamber 76, the bearing sleeve 73 moves toward the holder body 58, and the braking shoe 75 contacts the holder body 58. As a result, a frictional resistance occurs between the braking shoe 75 and the holder body 58, and the rotation of the holder body 58 is braked. The winding bobbin Bm, which integrally rotates with the holder body 58, and the package 100 decelerate.

A magnitude of a braking force that decelerates the rotation of the package 100 varies based on a magnitude of the frictional force occurring between the braking shoe 75 and the holder body 58, and the magnitude of this frictional force varies based on the pressure of the compressed air inside the chamber 76.

[0071] As explained above, the pressure of the compressed air supplied to the chamber 76 can be adjusted at a given time by the air pressure changing section 71 to a desired pressure that is equal to or lower than the pressure of the compressed air source. Accordingly, the magnitude of the braking force acting on the package 100 can be changed at a given time.

[0072] Moreover, the solenoid valves 81 and 82 are controlled by the air pressure controlling section 83 based on the pressure measured by the pressure meter 86 such that the pressure of fluid supplied to the chamber 76 is maintained at the designated pressure. Therefore, the pressure can be adjusted to the designated pressure, and the braking force acting on the package 100 can be changed.

[0073] The designated pressure is input into the air pressure controlling section 83 by the unit controlling section 15 and the like from time to time, and the magnitude of the designated pressure can be changed at a given time while the package 100 is decelerating. Accordingly, the magnitude of the braking force acting on the package 100 can be changed appropriately depending on the situation.

[0074] As explained above, the pressure inside the chamber 76 can be controlled to a desired pressure by the braking device 53 according to the present embodiment by changing the pressure of the compressed air supplied from the air pressure changing section 71 to the chamber 76. By using this braking device 53, when decelerating the package 100, the deceleration can be performed appropriately depending on the situation such as the variations in a circumferential speed of the package 100, thereby allowing prevention of quality degradation of the package 100, for example. As one example, a case of performing a deceleration control on the package 100 when performing the yarn joining after occurrence of a yarn breakage and the like is explained below.

[0075] As mentioned above, the winding unit 2 includes the yarn accumulating section 13 so that, when performing the yarn joining, the yarn joining can be performed while continuing the winding of the yarn Y by using the yarn Y accumulated in the yarn accumulating section 13. However, if the yarn joining fails by any chance, because the yarn Y accumulated in the yarn accumulating section 13 may dry up, a control is performed to decelerate the package 100 during the yarn joining thereby suppressing the consumption of the yarn Y in the yarn accumulating section 13.

[0076] On this occasion, it is desirable to reduce the winding speed of the package 100 as quick as possible; however, if the deceleration is too quick, the yarn on the surface of the package 100 may be damaged due to slipping between the traversing drum 52 and the package 100, or stitching may occur, leading to the quality degradation of the package 100. Therefore, in the below explained method, the package 100 is appropriately decelerated without degrading the quality of the package 100 to the utmost by controlling the pressure inside the chamber 76 with the braking device 53.

Series of Control Performed by Unit Controlling Section at the time of Occurrence of Yarn Breakage and the like

[0077] A series of control performed in a deceleration process of the package 100 by the unit controlling section 15 at the time of the occurrence of the yarn breakage and the like is explained below by using FIGS. 8 and 9.

[0078] It is assumed that the unit controlling section 15 has driven the drum driving motor 62 to rotate the traversing drum 52 while the package 100 and the traversing drum 52 are in contact with each other whereby some yarn Y has been wound on the package 100. Moreover, the low-pressure compressed air is being supplied to the chamber 76 of the braking cylinder 60 so that the package 100 is not braked. That is, the circumferential speed of the package 100 and a circumferential speed of the traversing drum 52 are almost equal. Moreover, the unit controlling section 15 is controlling the drum driving motor 42 to rotate the yarn accumulating drum 41 to keep an appropriate amount of the accumulated yarn Y in the yarn accumulating section 13. A yarn winding operation performed under these conditions is referred to as a normal winding operation below. In the normal winding operation, the circumferential speeds of the package 100 and the traversing drum 52 are 1500 m/min, for example.

[0079] During the normal winding operation, when the yarn Y becomes discontinuous between the yarn supplying section 11 and the yarn accumulating section 13 due to occurrence of a yarn breakage, a yarn cut, a need for the bobbin replacement, and the like, as shown in FIG. 8, a signal representing the yarn breakage and the like is output from the yarn clearer 36, and the signal is input into the unit controlling section 15 (S101). At this time, in the winding unit 2 according to the present embodiment, the pulling of the yarn Y from the yarn accumulating section 13 and the winding of the yarn Y on the package 100 are continued while performing a later-explained yarn joining process. However, when doing so, in parallel with the yarn joining process, the deceleration process of the package 100 and the traversing drum 52 to reduce the winding speed of the yarn Y is performed (S102) so that the yarn Y accumulated in the yarn accumulating section 13 does not dry up.

[0080] The deceleration process is explained below in detail. When continuing the winding of the yarn Y on the package 100 while performing the yarn joining process, the unit controlling section 15 causes the package 100 and the traversing drum 52 to decelerate thereby temporarily reducing the winding speed of the yarn Y so that the yarn Y accumulated in the yarn accumulating section

13 does not dry up. Specifically, it is necessary to reduce the circumferential speeds of the package 100 and the traversing drum 52, for example, from 1500 m/min to 300 m/min.

[0081] The unit controlling section 15 reads a target circumferential speed of the traversing drum 52 and controls the drum driving motor 62 to start the deceleration of the traversing drum 52. Simultaneously with this, the unit controlling section 15 reads a designated pressure at the time of start of the deceleration and outputs the designated pressure to the air pressure changing section 71. The air pressure controlling section 83 supplies the compressed air to the chamber 76 based on the input designated pressure, and starts the deceleration of the package 100.

[0082] During the deceleration of the package 100 and the traversing drum 52, the unit controlling section 15 calculates a difference (sliding amount) in the circumferential speed of the package 100 and the circumferential speed of the traversing drum 52 at a given time. The circumferential speed of the traversing drum 52 is calculated based on the detection result obtained in the drum rotational speed sensor 63 and a diameter of the traversing drum 52 previously stored in the ROM and the like. The circumferential speed of the package 100 is controlled based on the detection result obtained in the package rotational speed sensor 61 and the detection result obtained in the drum rotational speed sensor 63. More particularly, when deceleration has just begun, a ratio between the detection result obtained in the package rotational speed sensor 61 and the detection result obtained in the drum rotational speed sensor 63 is calculated. For this ratio, it is assumed that the circumferential speed of the package 100 and the circumferential speed of the traversing drum 52 are equal, and the deceleration control is performed based on this ratio while taking into account the sliding amount.

[0083] FIGS. 9A and 9B are graphs indicating examples of a temporal variation of the pressure of the compressed air supplied to the chamber 76 after starting the deceleration of the package 100. The initial pressure, which is the pressure before the start of the deceleration, is the pressure P0 that is the low pressure mentioned above. The pressure after the deceleration process starts is higher than the pressure P0. During the deceleration process, the unit controlling section 15 outputs the designated pressure to the air pressure controlling section 83 from time to time and controls the air pressure changing section 71 so that the sliding amount at a given time falls within a predetermined range. That is, if the deceleration of the package 100 is excessive, the designated pressure is reduced to reduce the deceleration, and if the deceleration of the package 100 is insufficient, the designated pressure is increased to increase the deceleration. Because the pressure is adjusted by the air pressure changing section 71 to a desired pressure that is equal to or lower than the pressure Pmax at a given time, such a control is possible.

[0084] Note that, the magnitude of the designated pressure can change depending on the amount of the yarn on the package 100. When the package 100 is light and if the braking force applied by the braking device 53 is too large, the package 100 may be decelerated excessively. As explained earlier, the unit controlling section 15 outputs the designated pressure for which the sliding amount falls within the predetermined range. Therefore, if the package 100 is light, the designated pressure is generally relatively low (see FIG. 9A). In contrast, if the package 100 is heavy, the designated pressure is generally relatively high (see FIG. 9B). Based on the designated pressure, the air pressure controlling section 83 changes the pressure so that the lesser the amount of the yarn of the package 100 is the weaker the braking force acts on the package 100.

[0085] While performing the above sliding amount control, the unit controlling section 15 determines whether the winding speed of the yarn Y onto the package 100 has reached a target value. If the circumferential speed of the package 100 has reached the target value, the unit controlling section 15 maintains the circumferential speed. If the circumferential speed of the package 100 has not reached the target value, the deceleration process is continued.

[0086] Note that, in a situation in which drying up of the yarn Y on the yarn accumulating section 13 is anticipated even after assuming that the deceleration process is performed, the unit controlling section 15 controls the braking device 53 and the drum driving motor 62 so as to stop the package 100 and the traversing drum 52.

[0087] In parallel with the deceleration process, the unit controlling section 15 performs the yarn joining process. The unit controlling section 15 controls the drum driving motor 42 so as to stop the yarn accumulating drum 41. Thereafter, as mentioned above, the unit controlling section 15 guides the lower yarn Y1 and the upper yarn Y2 to the yarn joining device 33 and controls the yarn joining device 33 to perform the yarn joining. Even while the yarn joining process is being performed, the unit controlling section 15 drives the drum driving motor 62 to rotate the traversing drum 52 and the package 100 whereby the pulling of the yarn Y from the yarn accumulating section 13 and the winding of the yarn Y on the package 100 are continued. However, in this case, the amount of the accumulated yarn Y decreases as the yarn accumulating drum 41 is not rotating.

[0088] Subsequently, the unit controlling section 15 controls the drum driving motor 42 to rotate the yarn accumulating drum 41 and restarts the accumulation of the yarn Y in the yarn accumulating section 13. To increase the decreased yarn Y in the yarn accumulating section 13 as quickly as possible, the unit controlling section 15 accelerates the yarn accumulating drum 41 to rotate it at a rotational speed that is faster than the same in the normal winding operation (S103). Finally, the unit controlling section 15 controls the drum driving motor 62 to accelerate the traversing drum 52 so that the winding speed

of the yarn Y is returned to the same in the normal winding operation (S104). On this occasion, the rotational speed of the yarn accumulating drum 41 is also returned to the rotational speed in the normal winding operation.

[0089] As explained above, in the present invention, during the deceleration of the package 100, the pressure of the compressed air supplied to the chamber 76 can be adjusted to a desired pressure at a given time, and the braking force acting on the package 100 can be changed at a given time. Therefore, while the package 100 and the traversing drum 52 are in contact with each other, and the package 100 and the traversing drum 52 are to be decelerated in the state in which the yarn is continuous and the yarn Y is being wound, the difference in the circumferential speeds of the package 100 and the traversing drum 52 can be made small by decelerating the traversing drum 52 with maximum efficiency and causing the package 100 to follow. Accordingly, issues such as stitching, yarn breakage, and the like can be prevented.

[0090] When the yarn Y becomes discontinuous between the yarn supplying section 11 and the yarn accumulating section 13 due to occurrence of the yarn breakage and the like, the formation of the package 100 is continued by pulling the yarn Y accumulated in the yarn accumulating section 13 while the yarn joining is performed by the yarn joining device 33. In this case, when decelerating the package 100 so that the yarn accumulated in the yarn accumulating section 13 does not dry up, while the yarn is continuous between the yarn accumulating section 13 and the package 100, stitching, outer layer disorder of the package, and the like may occur if the difference in the circumferential speed of the package 100 and the circumferential speed of the traversing drum 52 is large. In the present invention, during the deceleration of the package 100, the pressure of the compressed air supplied to the chamber 76 can be adjusted to a desired pressure at a given time, and the braking force acting on the package 100 can be changed at a given time, so that the above-mentioned difference in the circumferential speeds can be controlled easily, and various issues can be prevented.

[0091] Because the braking force acting on the package 100 can be made smaller in proportion to the weight of the package 100, excessive deceleration of the package 100 can be prevented.

[0092] Variations that are different from the above embodiment are explained below. The same reference numerals have been attached to the structural components that are the same as those of the above embodiment and the explanation thereof has been omitted appropriately.

(1) The configuration of the braking device can be changed. In FIG. 10, a braking device 91 includes a solenoid valve 87 (supply switching valve of the present invention) and a supply controlling section 88 in replacement of the air pressure changing section 71 of the above embodiment.

The solenoid valve 87 is a normally closed 3-way solenoid valve. The solenoid valve 87 is arranged between the chamber 76 and the supply port 84 and the exhaust port 85. A supply port side of the solenoid valve 87 is connected to the supply port 84. An exhaust port side of the solenoid valve 87 is connected to the exhaust port 85. A cylinder port side of the solenoid valve 87 is connected to the chamber 76. The supply controlling section 88 controls ON / OFF (opening and closing) of the solenoid valve 87. Data relating to opening and closing timings of the solenoid valve 87 is output, for example, from the unit controlling section 15. When an electric current is supplied to the solenoid valve 87 (ON state), the supply port side of the solenoid valve 87 is opened and the exhaust port side is closed. In this state, the compressed air is supplied from the supply port 84 to the chamber 76 as shown with a continuous-line arrow in FIG. 10. When the supply of the electric current to the solenoid valve 87 is stopped (OFF state), the supply port side of the solenoid valve 87 is closed and the exhaust port side is opened. In this state, the compressed air is discharged from the chamber 76 to the exhaust port 85 as shown with a dotted-line arrow in FIG. 10.

A temporal variation of the pressure of the compressed air supplied to the chamber 76 during the deceleration process is explained by using FIGS. 11A to 11D. A plurality of sets of setting data relating to the switching timings between opening and closing of the solenoid valve 87 within a certain period is stored in the ROM and the like of the unit controlling section 15. FIG. 11A shows an example of setting data in the form of a graph in which switching between ON / OFF is repeated alternately twice within a period A, and an ON duration (open duration of the present invention) is shorter than an OFF duration (closed duration of the present invention). In contrast, FIG. 11B shows setting data in the form of a graph in which the ON duration is longer than the OFF duration. When the setting data such as that shown in FIG. 11B is read, because the ON duration thereof is longer than that of the setting data shown in FIG. 11A, the pressure increases easily. Note that, the period A is a short period of the order of, for example, 0.1 second. It is needless to say that the setting data is not limited to the above-mentioned data. For example, the ON duration and the OFF duration can be equal. Moreover, the first ON duration and the second ON duration can be different. The number of times of repetition needs not be two.

During the deceleration of the package 100 and the traversing drum 52, the unit controlling section 15 calculates a difference in the circumferential speeds of both at a given time, and based on the difference in the circumferential speeds at the current time point, reads the most appropriate setting data relating to the switching timing of ON / OFF of the solenoid

valve 87. For example, as shown in FIG. 11C, assume that three sets of the setting data respectively having a different ratio of the ON duration and the OFF duration are read sequentially. When such setting data are input sequentially from the unit controlling section 15 into the supply controlling section 88, the supply controlling section 88 repeats alternately the opening and closing of the solenoid valve 87 while changing the ON duration and the OFF duration based on the setting data. As a result, the pressure shows a temporal variation in a range that is equal to or lower than the pressure Pmax as shown in FIG. 11D. Accordingly, although a fine pressure adjustment cannot be performed like when the air pressure changing section 71 is used, unlike in the conventional pumping brake control, a feedback is performed during the deceleration of the package 100 based on the difference in the circumferential speeds and the magnitude of the pressure can be adjusted to a desired magnitude at a given time. Accordingly, the braking force acting on the package 100 can be changed at a given time.

(2) Configuration of a braking device can be added. As shown in FIG. 12, a braking device 92 further includes the supply controlling section 88 and the solenoid valve 87 arranged between the chamber 76 and the solenoid valve 81 of the air pressure changing section 71. With regard to the flow of the compressed air in the air pressure changing section 71, like in FIG. 5, the supply thereof is shown with a continuous-line arrow and the exhaust thereof is shown with a dotted-line arrow. With regard to the flow of the compressed air due to the opening and closing of the solenoid valve 87, the supply thereof is shown with a solid black arrow and the exhaust thereof is shown with a dotted-line hatched arrow.

A temporal variation of the pressure of the compressed air supplied to the chamber 76 during the deceleration process is explained by using FIGS. 13A to 13C. FIG. 13A is a graph indicating the temporal variation of the pressure of the compressed air (pressure of the compressed air between the solenoid valve 81 and the solenoid valve 87) supplied from the air pressure changing section 71. FIG. 13B shows setting data in the form of a graph that includes ON / OFF switching timings of the solenoid valve 87. The ratio and the change of the ON duration and the OFF duration are the same as those in FIG. 11C. That is, even in this variation, the ON duration and the OFF duration of the solenoid valve 87 are fed back based on the difference in the circumferential speeds of the package 100 and the traversing drum 52. When the setting data are sequentially input from the unit controlling section 15 into the supply controlling section 88, the supply controlling section 88 repeats alternately the opening and closing of the solenoid valve 87 while changing the ON duration and the OFF duration based on the setting data.

FIG. 13C is a graph indicating a result of the temporal variation of the pressure of the compressed air supplied to the chamber 76 after being passed through the solenoid valve 87. A two-dot chain line shows the pressure of the compressed air supplied from the air pressure changing section 71 same as that shown in FIG. 13A. Because the opening and closing of the solenoid valve 87 is performed alternately repeatedly, the pressure of the compressed air inside the chamber 76 decreases below the pressure of the compressed air supplied from the air pressure changing section 71. Moreover, because the ON duration and the OFF duration of the solenoid valve 87 are changed, the pressure of the compressed air supplied from the air pressure changing section 71 to the chamber 76 can be adjusted. Accordingly, the braking force acting on the package 100 can be changed further finely.

In this variation, the ratio between the ON duration and the OFF duration of the solenoid valve 87 can be held constant during the deceleration process. Moreover, the solenoid valve 87 can be a 2-way solenoid valve that switches between supply and no-supply of the compressed air to the chamber 76.

(3) Configuration of still another braking device can be used. As shown in FIG. 14, a braking device 93 includes an air pressure switching unit 94 in replacement of the air pressure changing section 71 of the braking device 92 shown in FIG. 12. The air pressure switching unit 94 is connected to the supply port 84. Moreover, the air pressure switching unit 94 is connected to a supply port 95 connected to a compressed air source having a pressure lower than a pressure of the compressed air source connected to the supply port 84. The air pressure switching unit 94 can switch between a relatively high-pressure compressed air from the supply port 84 and a relatively low-pressure compressed air from the supply port 95 as the compressed air to be supplied to the solenoid valve 87. The air pressure switching unit 94 is controlled by the unit controlling section 15. When the compressed air is supplied from the supply port 84, the compressed air flows as shown with a continuous-line arrow in FIG. 14. In contrast, when the compressed air is supplied from the supply port 95, the compressed air flows as shown with a continuous-line hatched arrow.

In this configuration, when applying a weak braking force to the package 100, for example, when decelerating a light small winding-diameter package 100, the unit controlling section 15 controls the air pressure switching unit 94 to perform switching so that the compressed air is supplied from the supply port 95. In addition, the supply controlling section 88 controls the solenoid valve 87, as mentioned above, to alternately repeat the ON / OFF of the solenoid valve 87. With this configuration, although a fine pressure adjustment cannot be performed like when the air

pressure changing section 71 is used, the pressure can be adjusted more finely than when only the solenoid valve 87 is used as mentioned in the variation (1). Note that, the number of the supply ports is not limited to two. More fine adjustment can be performed by increasing the number of the supply ports.

(4) In the braking devices 91 to 93, only one between the ON duration and the OFF duration of the solenoid valve 87 can be changed.

(5) The pressure meter 86 can be omitted from the braking devices 53, 91, 92, and 93. For example, a table indicating a relation between the designated pressures and the opening and closing timings of each of the solenoid valves can be stored previously in the ROM and the like of the unit controlling section 15. Alternatively, a computer program to calculate the opening and closing timing from the designated pressure can be previously loaded in the unit controlling section 15.

(6) The designated pressure can be input into the air pressure controlling section 83 from an external device, such as the controlling device 4, other than the unit controlling section 15. Alternatively, an operator can input the designated pressure.

(7) The air pressure changing section 71 need not include the air pressure controlling section 83, and the unit controlling section 15 can function as an air pressure controlling section to control the air pressure changing section 71. The braking devices 91 to 93 need not include the supply controlling section 88, and the unit controlling section 15 can function as a supply controlling section to control the solenoid valve 87.

(8) During the deceleration process, along with the control of the braking device 53, the unit controlling section 15 can control the drum driving motor 62 to perform fine adjustment of the circumferential speed of the traversing drum 52 so that the sliding amount falls within a predetermined range.

(9) The package forming section 12 can include a not-shown lift-up cylinder that pivots the cradle 51. That is, when it is necessary to suddenly stop the package 100 and the traversing drum 52, it is allowable to have a configuration in which the cradle 51 is pivoted to separate the package 100 from the traversing drum 52.

(10) A not-shown pivot angle sensor for detecting a pivot angle of the cradle arms 51a and 51b and outputting the detected value to the unit controlling section 15 can be arranged on the axis 54 and the like of the cradle 51. That is, because the detection result obtained in the pivot angle sensor changes as the cradle arms 51a and 51b pivot depending on the package diameter, the unit controlling section 15 can calculate the circumferential speed of and the amount of yarn on the package 100 based on the detection results obtained in the pivot angle sensor and the package rotational speed sensor 61.

(11) The yarn accumulating section 13 can be omitted from a winding unit. FIG. 15 shows a winding unit 10 that does not include the yarn accumulating section 13. The winding unit 10 includes, as a configuration for guiding the yarn Y to the yarn joining device 33, an upper yarn catching-guiding member 96 having a mouth for sucking and catching the upper yarn Y2 from the package forming section 12, a lower yarn catching-guiding member 97 having a suction port for sucking and catching the lower yarn Y1 from the yarn supplying section 11, and the like. During the yarn joining, the lower yarn Y1 and the upper yarn Y2 are guided to the yarn joining device 33 by the upper yarn catching-guiding member 96 and the lower yarn catching-guiding member 97, respectively.

When performing the yarn joining in the winding unit 10, the unit controlling section 15 controls the lift-up cylinder mentioned in the variation (9) to pivot the cradle 51, and after the package 100 is separated from the traversing drum 52, the package 100 and the traversing drum 52 are stopped. In this manner, in the winding unit 10, the package 100 is not decelerated during the yarn joining like in the above embodiment. However, at a timing and the like at which the package 100 becomes fully wound, for example, there may be a situation that necessitates the package 100 and the traversing drum 52 to be decelerated while continuing the winding of the yarn Y. In such a situation, because the braking force acting on the package 100 can be adjusted as desired, the sliding amount can be made small. Accordingly, issues such as stitching, yarn breakage, and the like can be prevented.

(11) The package 100 can be rotated by a configuration other than the traversing drum 52. For example, the package 100 can be rotationally driven by rotating a contact roller that has no traversing groove, and the yarn Y can be traversed by using a traversing guide that is independent of the contact roller.

(12) The yarn joining device 33 is not limited to the one that uses the compressed air but can be one that uses a mechanical structure, for example.

(13) Fluid other than the compressed air, such as oil, can be supplied to the chamber 76.

(14) The winding bobbin Bm is not limited to the cone type but can be a cheese type (tube type).

(15) The application of the present invention is not limited to the winding unit 2 but it can be applied to a yarn winding device such as a spinning unit (for example, see Japanese Patent Application Laid-Open No. 2013-253353). In this case, the air spinning device and the like that generates a spun yarn is equivalent to the yarn supplying section 11.

Claims

1. A yarn winding device (2) that unwinds a yarn from a yarn supplying section (11) capable of supplying the yarn and winds the yarn on a winding tube (Bm) to form a package (100),
the yarn winding device (2) comprising a braking device (53) including

a braking member (75) that brakes rotation of the package (100) ;
a chamber (76) that operates the braking member (75) by change of a pressure of fluid; and
a fluid pressure changing section (71) that changes the pressure of the fluid supplied to the chamber (76), wherein

the fluid pressure changing section (71) includes

a first valve (81) arranged between the chamber (76) and a fluid supply port (84) connected to a fluid supply source;
a second valve (82) arranged between the chamber (76) and a fluid discharge port (85); and
a fluid pressure controlling section (83) that opens and closes the first valve (81) and the second valve (82) independently.

2. The yarn winding device (2) as claimed in Claim 1, wherein
the braking device (53) further includes a pressure detecting section (86) that detects the pressure of the fluid supplied from the fluid pressure changing section (71) to the chamber (76), and
the fluid pressure controlling section (83) controls the first valve (81) and the second valve (82) based on the pressure detected by the pressure detecting section (86) so that the pressure of the fluid supplied to the chamber (76) is equal to a designated pressure.

3. The yarn winding device (2) as claimed in Claim 2, wherein the designated pressure is sequentially input into the fluid pressure controlling section (83) from outside.

4. The yarn winding device (2) as claimed in any one of Claims 1 to 3, wherein the braking device (53) further includes
a supply switching valve (87) arranged between the chamber (76) and the first valve (81) of the fluid pressure changing section (71); and
a supply controlling section (88) that controls opening and closing of the supply switching valve (87).

5. The yarn winding device (2) as claimed in Claim 4, wherein the supply controlling section (88) causes the opening and closing of the supply switching valve (87) to be performed repeatedly alternately.

6. The yarn winding device (2) as claimed in Claim 5, wherein the supply controlling section (88) changes at least one between an open duration and a closed duration of the supply switching valve (87).

7. A yarn winding device (2) that unwinds a yarn from a yarn supplying section (11) that supplies the yarn and winds the yarn on a winding tube (Bm) to form a package (100),
the yarn winding device (2) comprising a braking device (53) including

a braking member (75) that brakes rotation of the package (100) ;
a chamber (76) that operates the braking member (75) by a fluid pressure inside thereof;
a supply switching valve (87) arranged between the chamber (76) and a fluid supply port (84) connected to a fluid supply source; and
a supply controlling section (88) that controls opening and closing of the supply switching valve (87), wherein

the supply controlling section (88) causes the opening and closing of the supply switching valve (87) to be performed repeatedly alternately while changing at least one between an open duration and a closed duration of the supply switching valve (87).

8. The yarn winding device (2) as claimed in any one of Claims 1 to 7, further comprising
a contact roller (52) that rotates the package (100) by rotating while being in contact with the package (100);
a roller driving section (62) that rotationally drives the contact roller (52);
a package rotational speed detecting section (61) that detects a rotational speed of the package (100);
a contact roller rotational speed detecting section (63) that detects a rotational speed of the contact roller (52); and
a winding controlling section (15) that controls the braking device (53) and the roller driving section (62), wherein
the winding controlling section (15), when decelerating the package (100) that is in contact with the contact roller (52) while maintaining a state in which the yarn is being wound on the package (100), controls the braking device (53) and the roller driving section (62) so that a difference in a circumferential speed of the package (100) and a circumferential speed of the contact roller (52) falls within a predetermined range based on a detection result obtained in the package rotational speed detecting section (61) and a detection result obtained in the contact roller rotational speed detecting section (63).

9. The yarn winding device (2) as claimed in Claim 8, further comprising
a yarn accumulating section (13) arranged between the yarn supplying section (11) and the package forming section (12) and that accumulates the yarn supplied from the yarn supplying section (11); and
a yarn joining device (33) arranged between the yarn supplying section (11) and the yarn accumulating section (13) and that joins a yarn end from the yarn supplying section (11) and a yarn end from the yarn accumulating section (13) when the yarn is discontinuous between the yarn supplying section (11) and the yarn accumulating section (13), wherein
the winding controlling section (15) controls the braking device (53) and the roller driving section (62) to decelerate the package (100) and the contact roller (52) while the yarn is being joined by the yarn joining device (33).

10. The yarn winding device (2) as claimed in any one of Claims 1 to 9, wherein the braking device (53) changes the pressure of the fluid supplied to the chamber (76) so that the lesser the amount of the yarn on the package (100) is the weaker a braking force acts on the package (100).

FIG.1

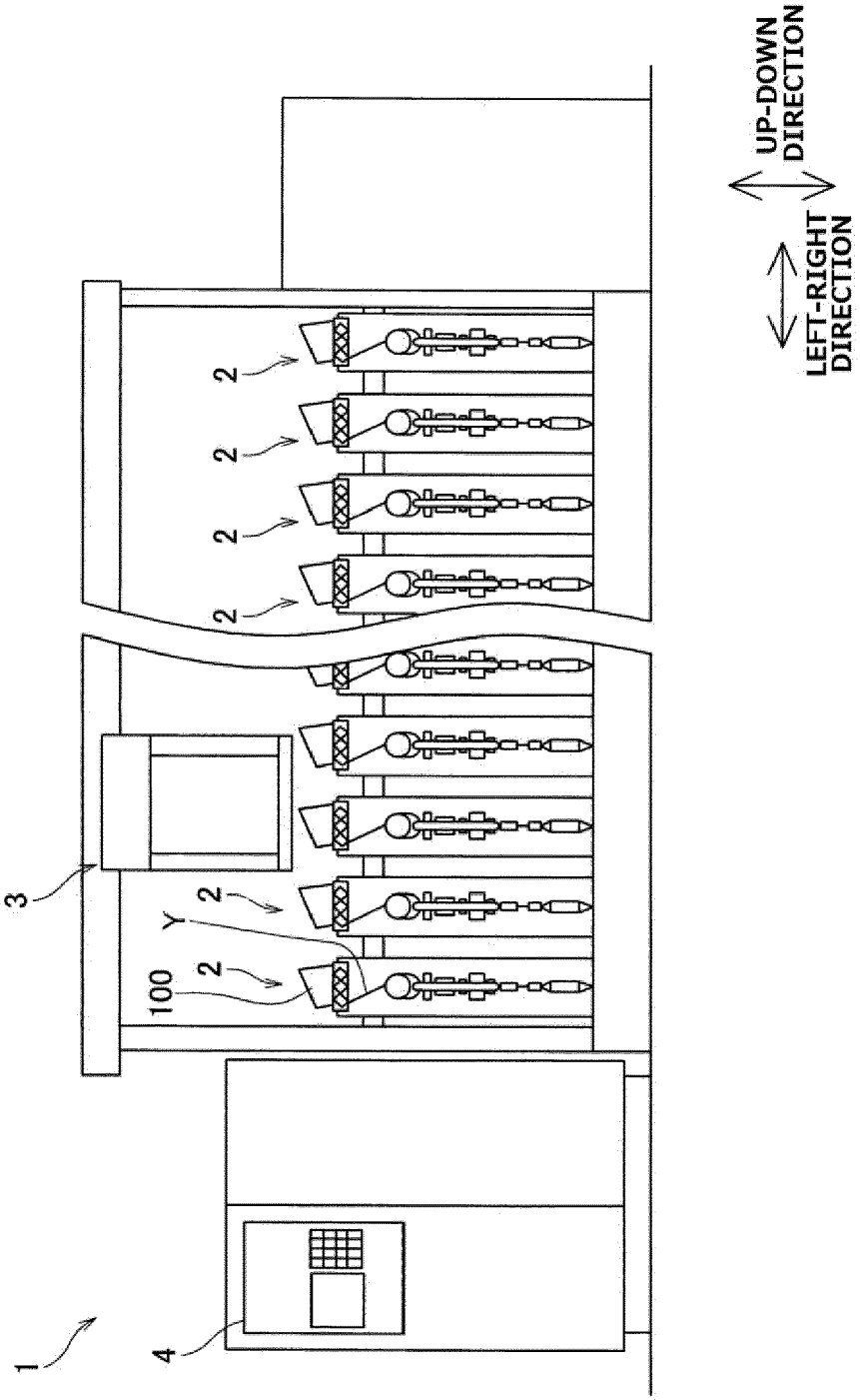


FIG.2

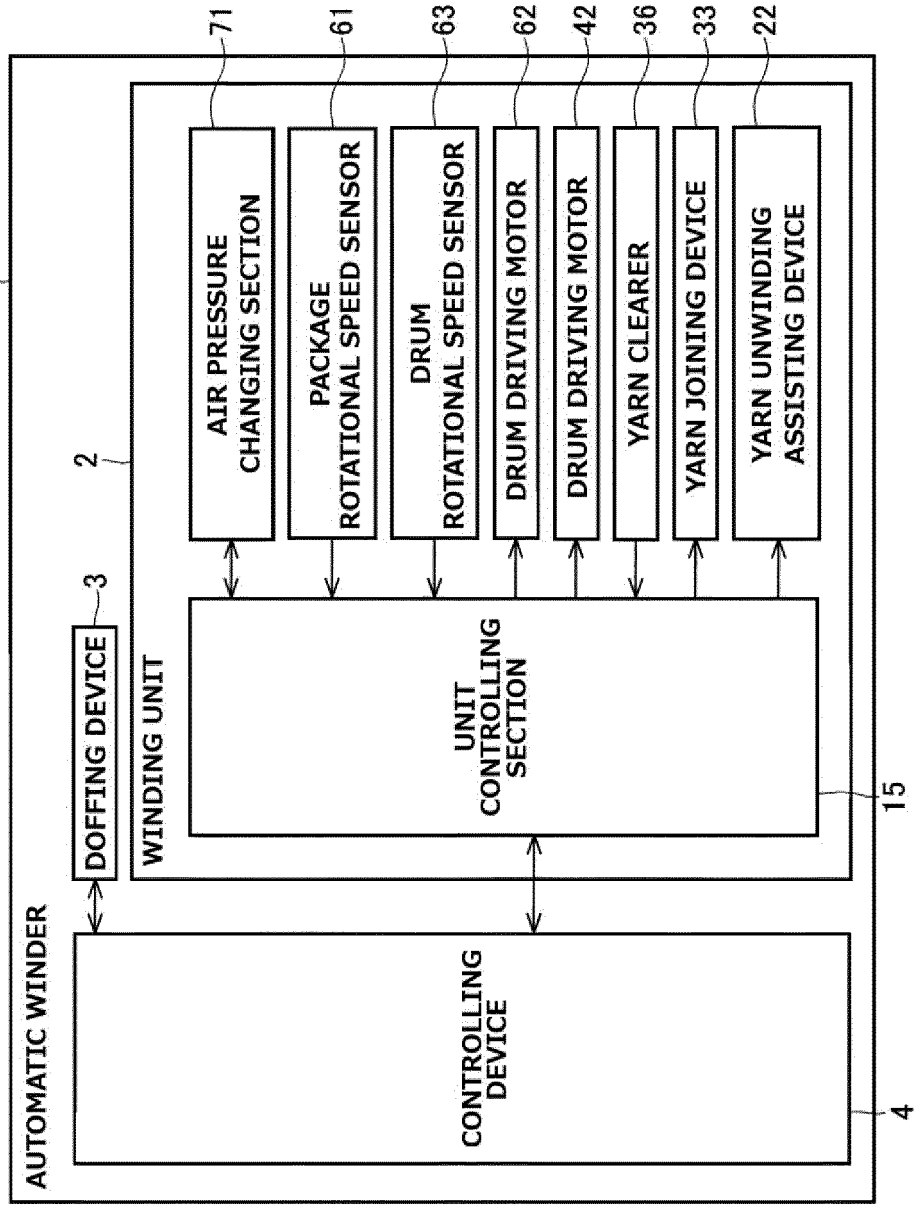

1
AUTOMATIC WINDER
2
WINDING UNIT
3
DOFFING DEVICE
AIR PRESSURE CHANGING SECTION
71
PACKAGE ROTATIONAL SPEED SENSOR
61
DRUM ROTATIONAL SPEED SENSOR
63
DRUM DRIVING MOTOR
62
DRUM DRIVING MOTOR
42
YARN CLEARER
36
YARN JOINING DEVICE
33
YARN UNWINDING ASSISTING DEVICE
22
UNIT CONTROLLING SECTION
15
CONTROLLING DEVICE
4

FIG.3

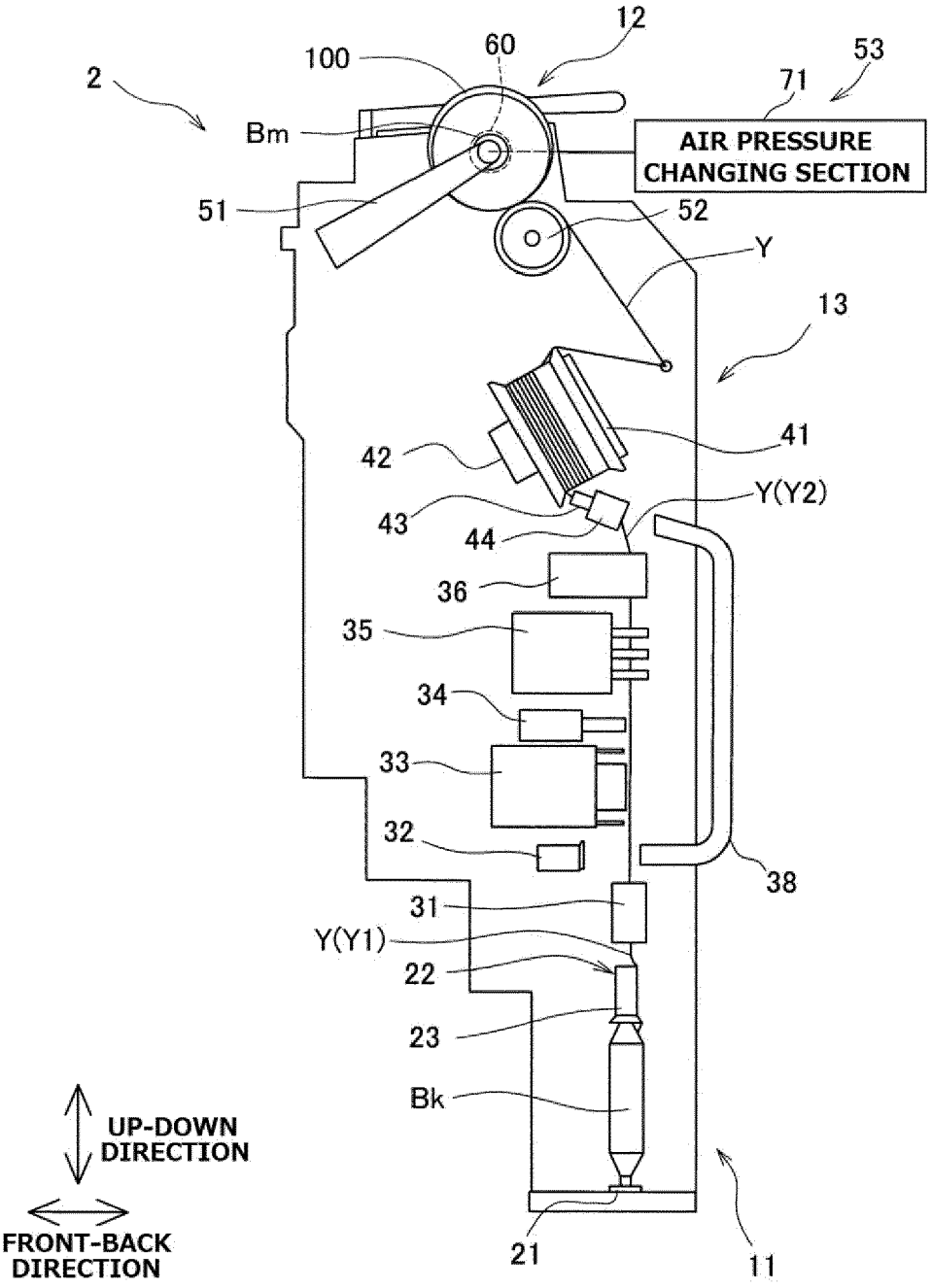

12
100
60
53
2
71
Bm
AIR PRESSURE CHANGING SECTION
51
52
Y
13
41
42
Y(Y2)
43
44
36
35
34
33
32
38
31
Y(Y1)
22
23
Bk
UP-DOWN DIRECTION
FRONT-BACK DIRECTION
21
11

FIG.4

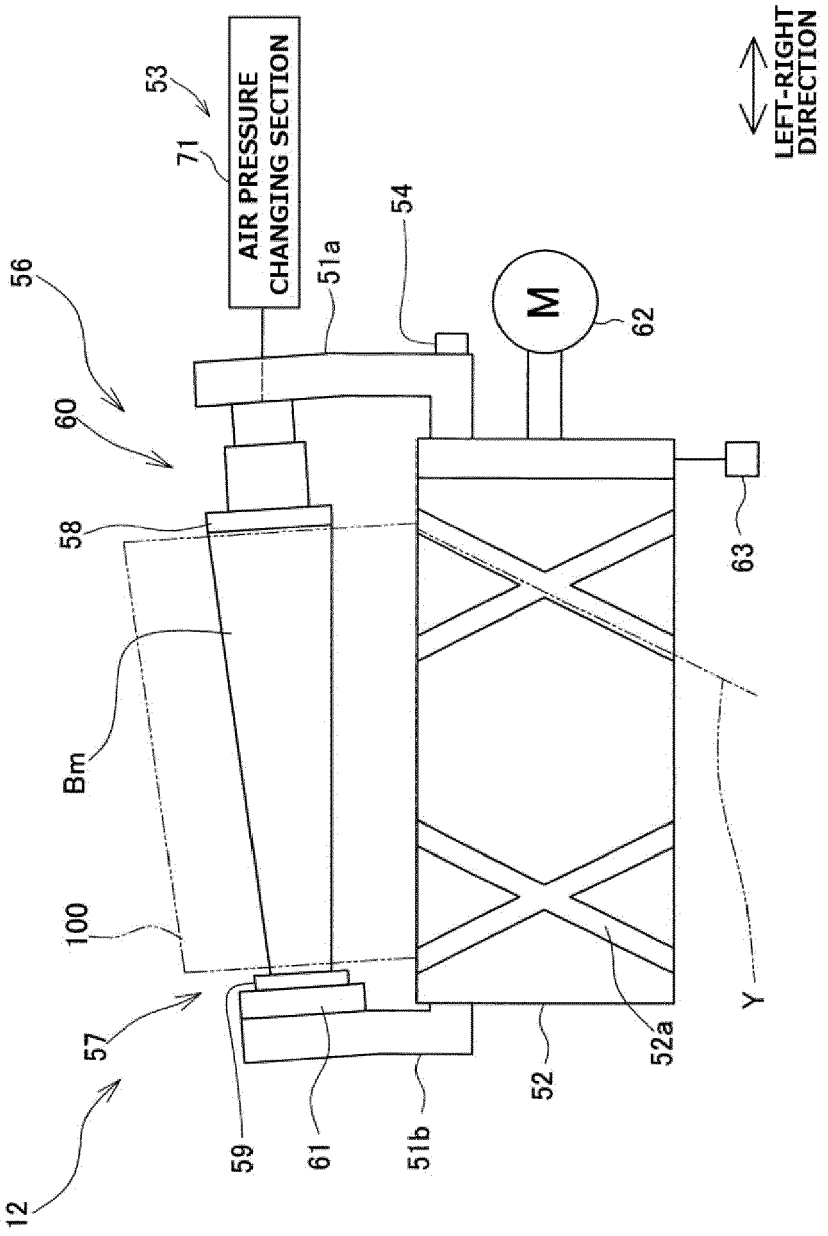

AIR PRESSURE CHANGING SECTION
53
71
54
51a
56
60
M
62
58
63
Bm
100
57
59
61
51b
52
52a
Y
12
LEFT-RIGHT DIRECTION

FIG.5

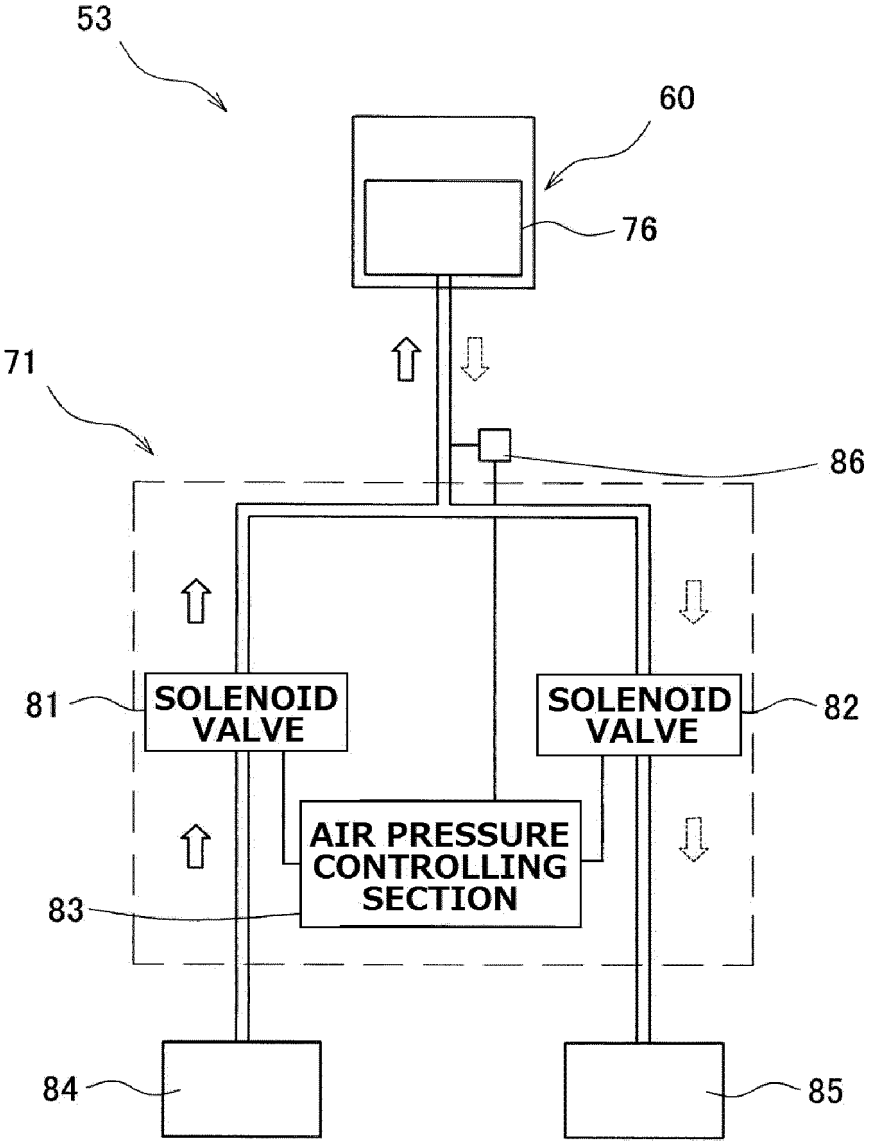

53
60
76
71
86
81
SOLENOID VALVE
SOLENOID VALVE
82
AIR PRESSURE CONTROLLING SECTION
83
84
85

FIG.6

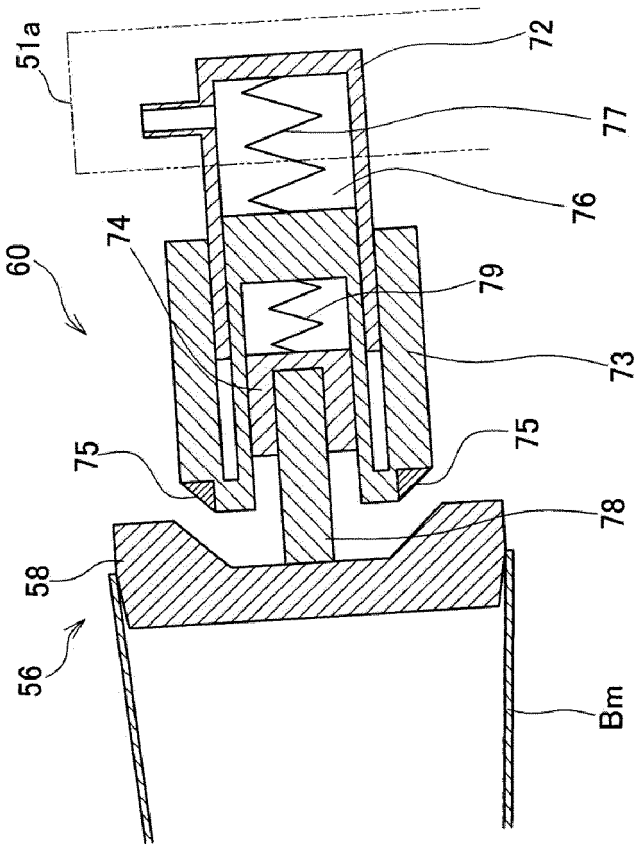


FIG.7

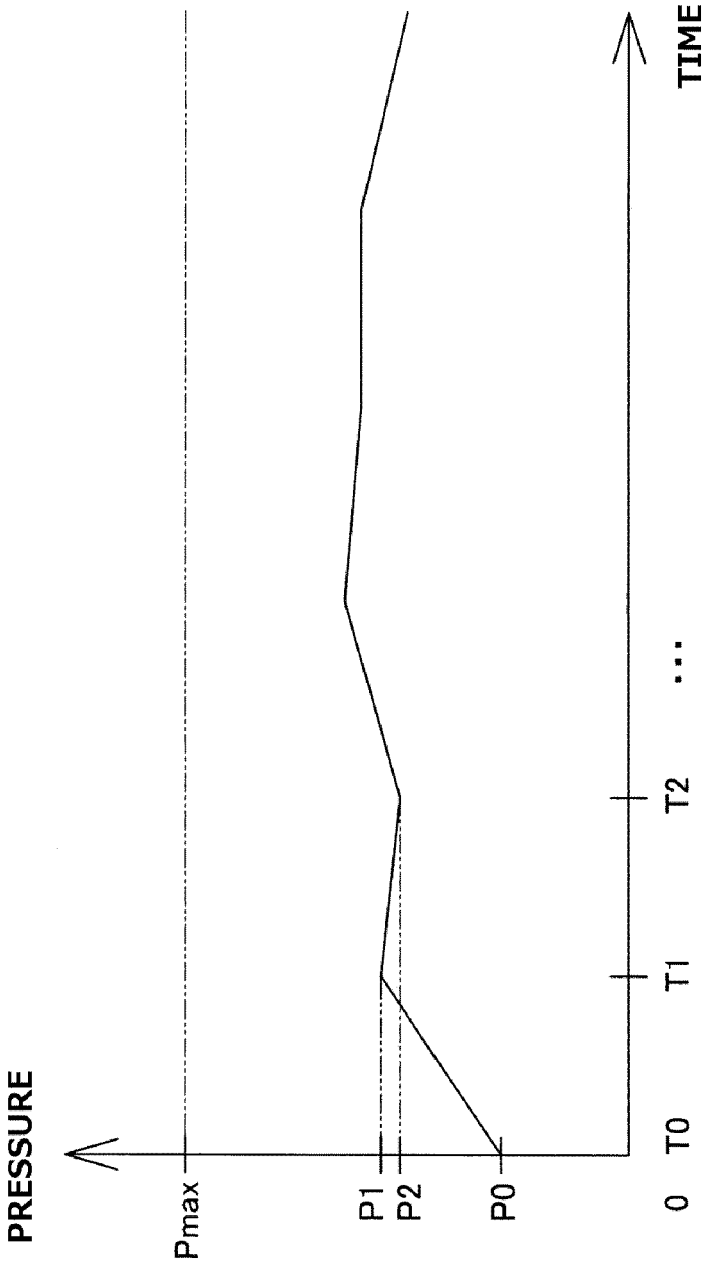


FIG.8

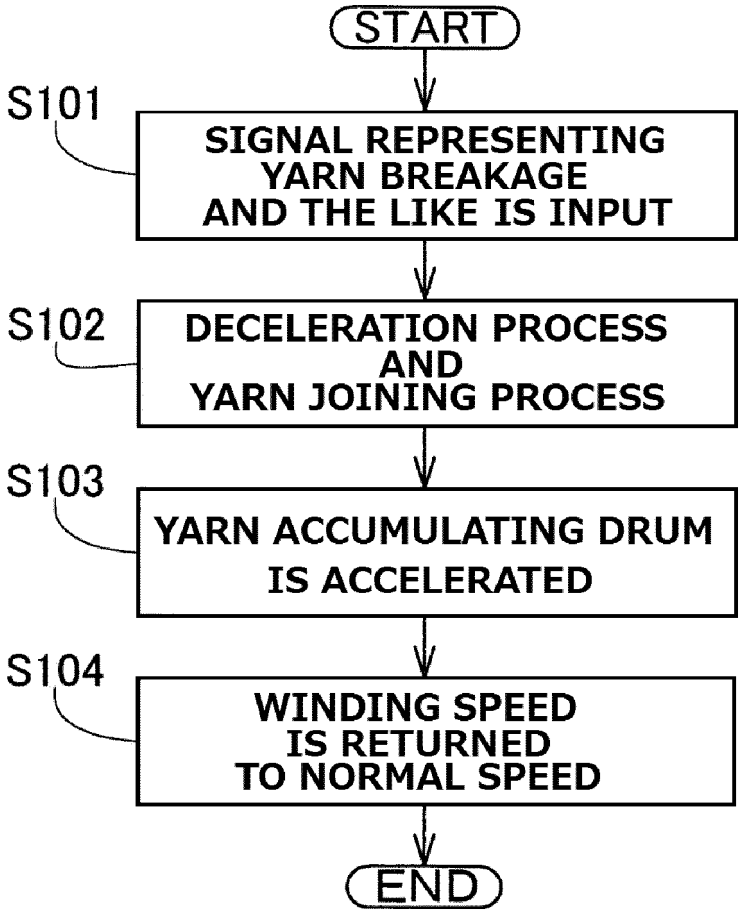

START
S101
SIGNAL REPRESENTING YARN BREAKAGE AND THE LIKE IS INPUT
S102
DECELERATION PROCESS AND YARN JOINING PROCESS
S103
YARN ACCUMULATING DRUM IS ACCELERATED
S104
WINDING SPEED IS RETURNED TO NORMAL SPEED
END

FIG.9A

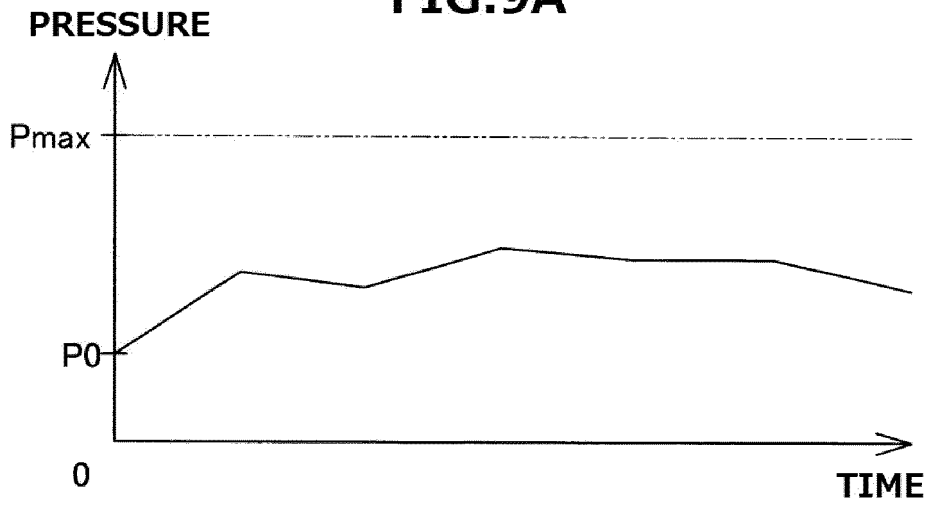


FIG.9B

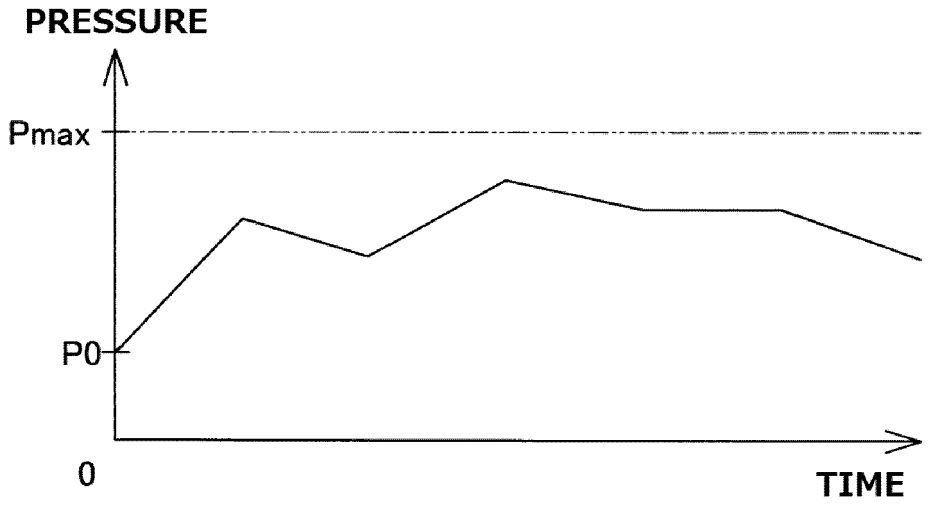


FIG.10

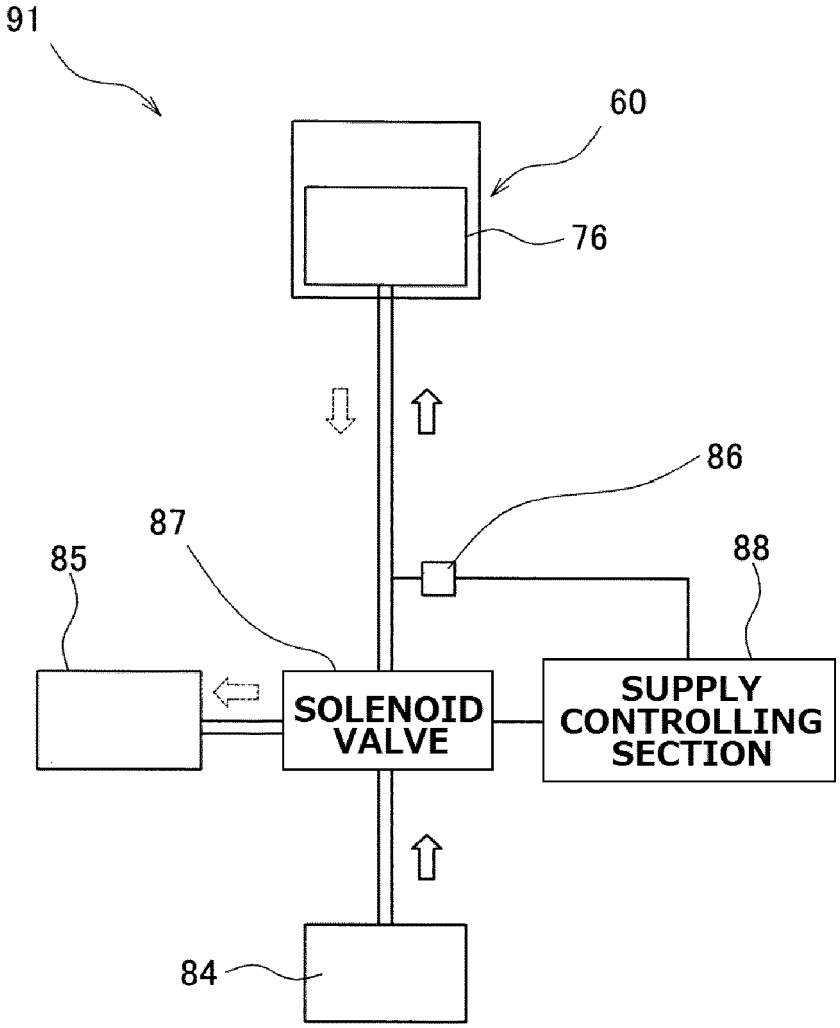

91
60
76
86
87
88
85
SOLENOID VALVE
SUPPLY CONTROLLING SECTION
84

FIG.11A

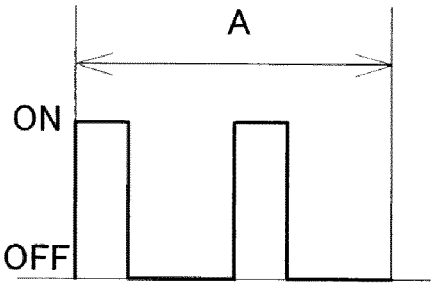


FIG.11B

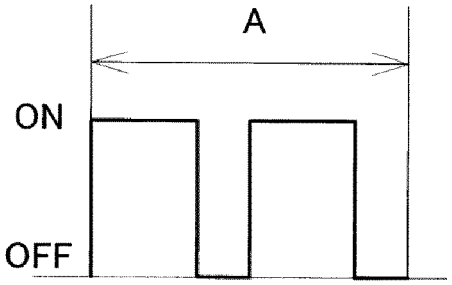


FIG.11C

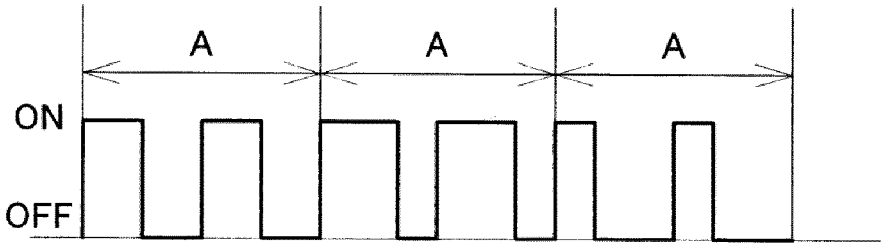


FIG.11D

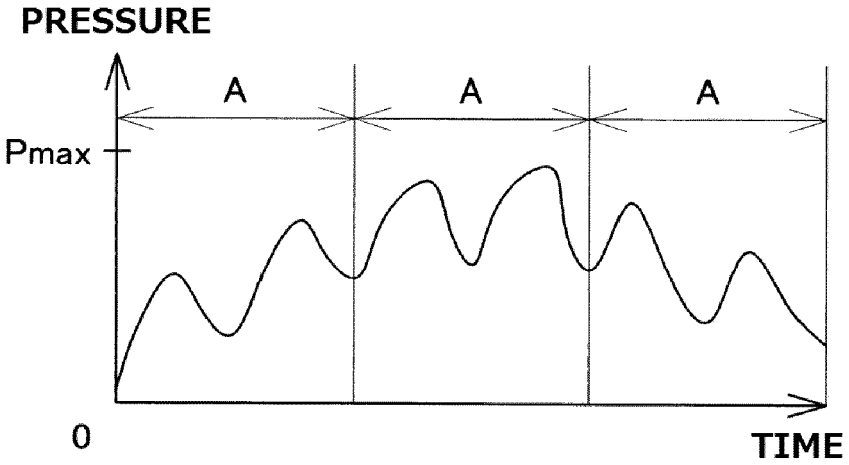


FIG.12

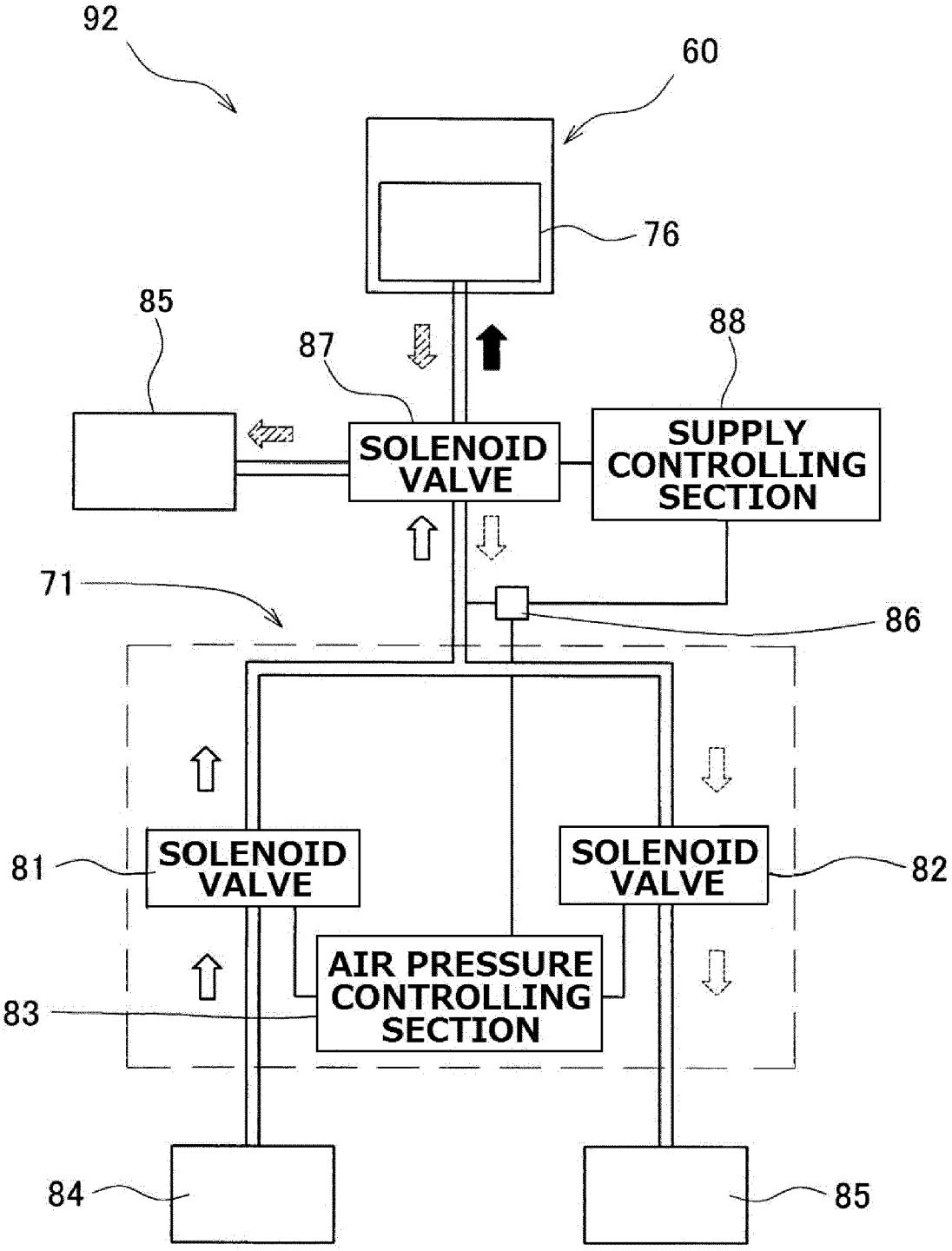

92
60
76
85
87
88
SOLENOID VALVE
SUPPLY CONTROLLING SECTION
71
86
81
SOLENOID VALVE
SOLENOID VALVE
82
AIR PRESSURE CONTROLLING SECTION
83
84
85

FIG.13A

FIG.13B

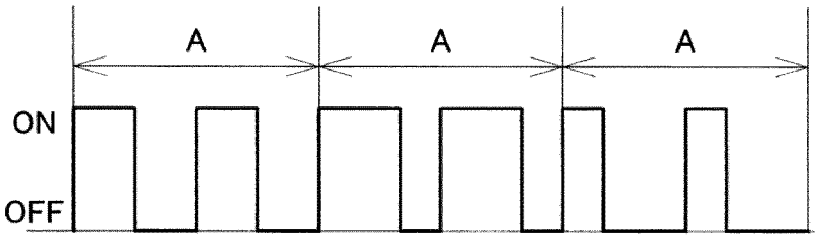


FIG.13C

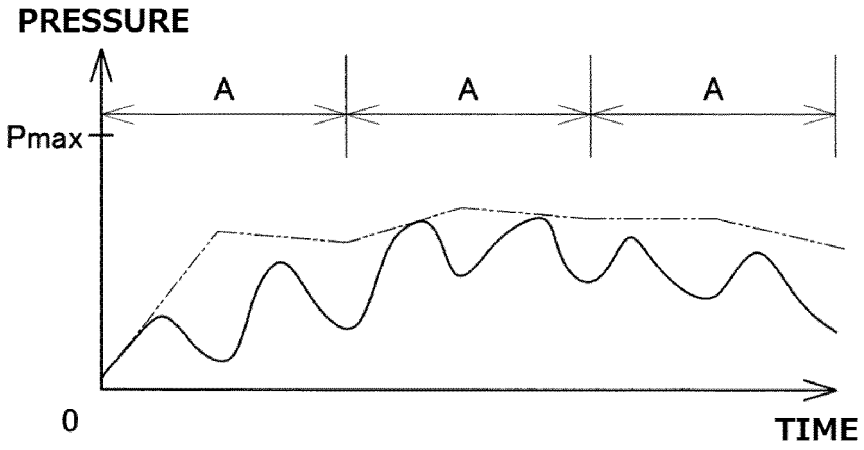


FIG.14

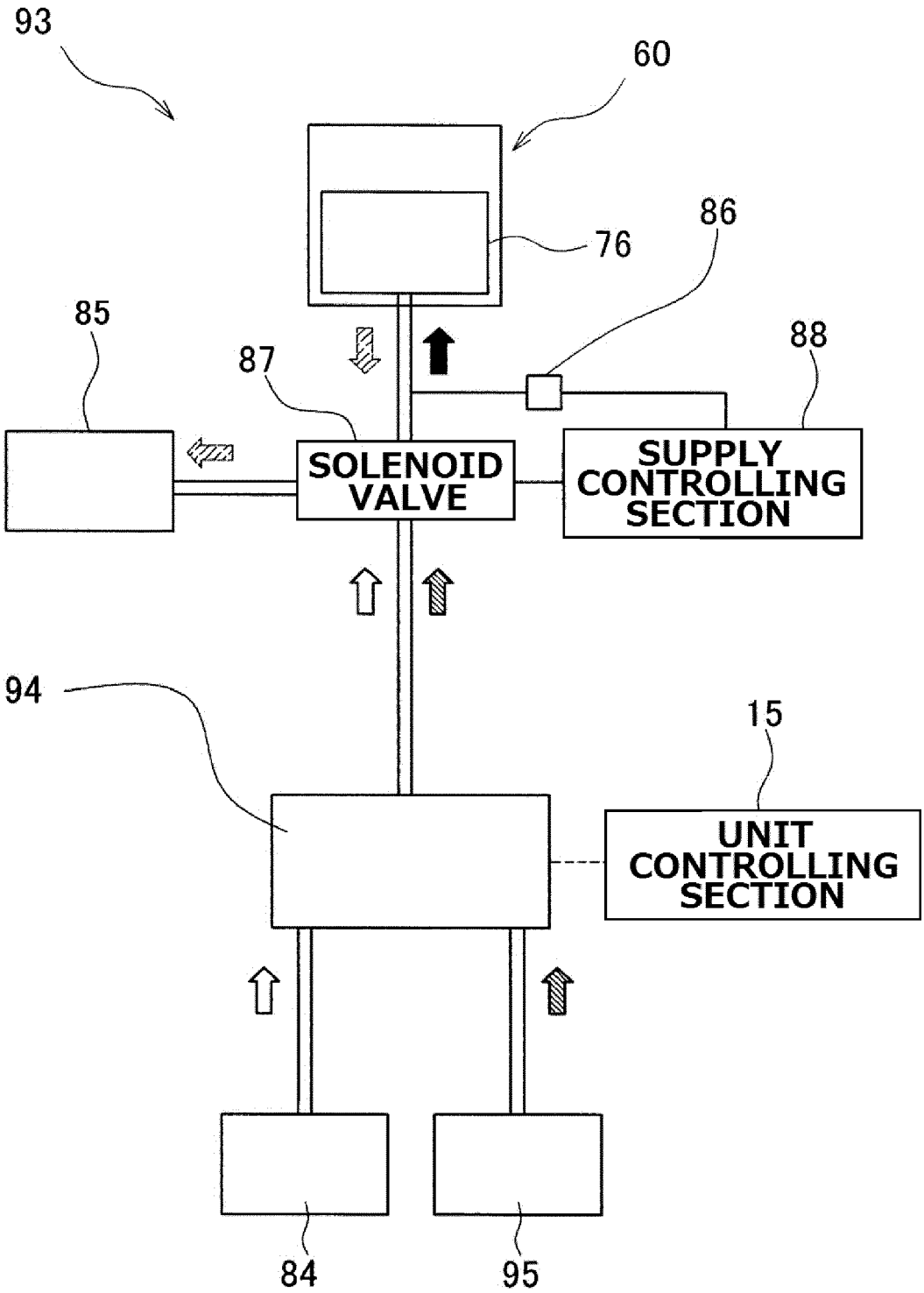
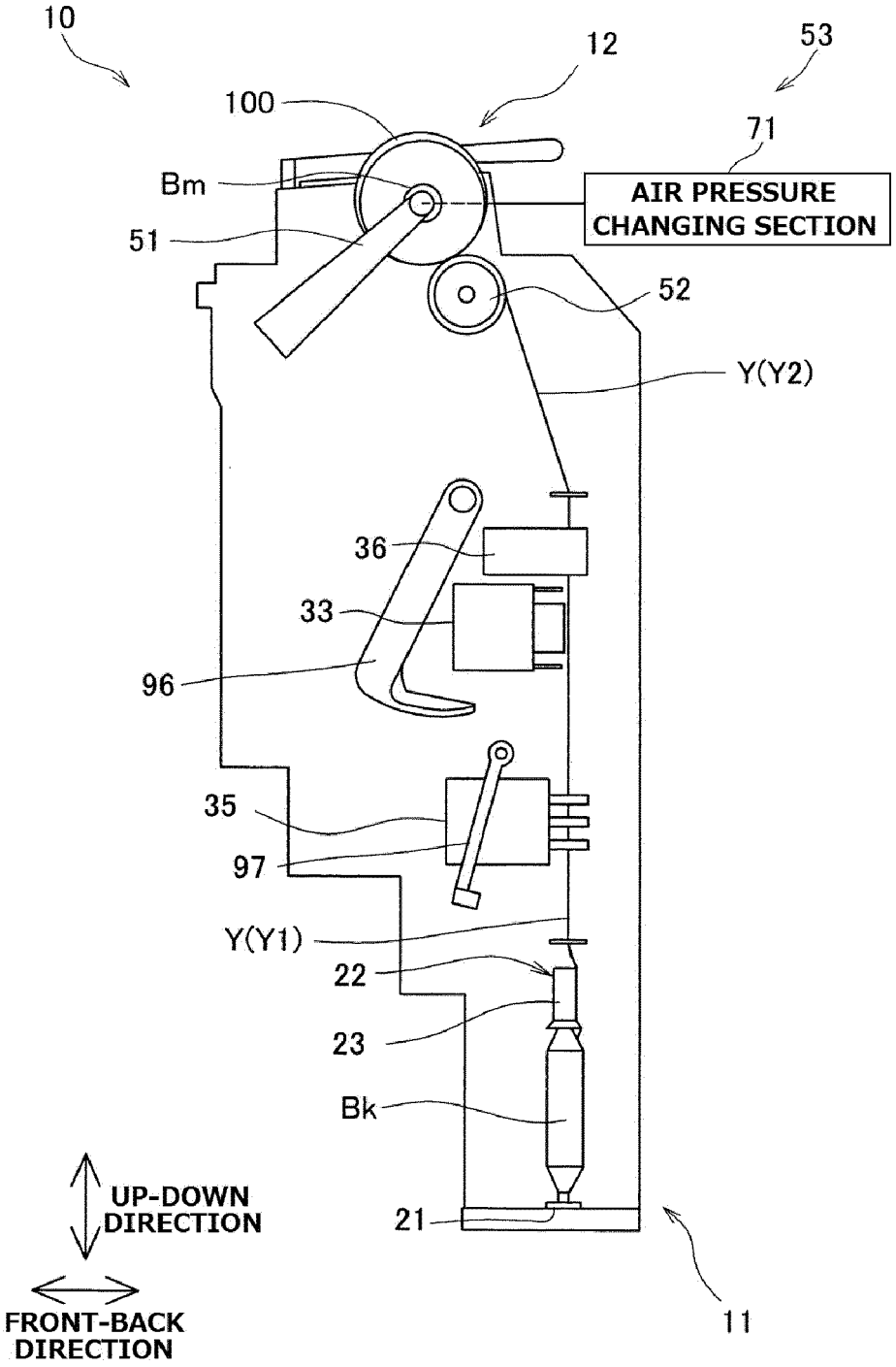

93
60
76
86
85
87
88
SOLENOID VALVE
SUPPLY CONTROLLING SECTION
94
15
UNIT CONTROLLING SECTION
84
95

FIG.15


10
12
53
100
71
Bm
AIR PRESSURE CHANGING SECTION
51
52
Y(Y2)
36
33
96
35
97
Y(Y1)
22
23
Bk
21
11
UP-DOWN DIRECTION
FRONT-BACK DIRECTION

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EUROPEAN SEARCH REPORT

Application Number
EP 17 19 0815

DOCUMENTS CONSIDERED TO BE RELEVANT

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X,D	JP 2010 037083 A (MURATA MACHINERY LTD) 18 February 2010 (2010-02-18)	7	INV.
Y	* paragraphs [0034], [0036], [0045], [0046], [0051], [0062] - [0064]; figures *	8-10	B65H54/74 B65H54/42 B65H54/553

Y,D	JP 2016 078995 A (MURATA MACHINERY LTD) 16 May 2016 (2016-05-16) * figures * & EP 3 009 387 A1 (MURATA KIKAI KK) 20 April 2016 (2016-04-20) * paragraph [0068] *	8-10	

X	DE 10 2009 004615 A1 (OERLIKON TEXTILE GMBH & CO KG [DE]) 22 July 2010 (2010-07-22) * paragraphs [0018], [0039]; figures *	7	

A	EP 2 161 232 A2 (MURATA MACHINERY LTD [JP]) 10 March 2010 (2010-03-10) * paragraph [0065]; figure 9 *	1-10	
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	26 February 2018	Lemmen, René

CATEGORY OF CITED DOCUMENTS

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26-02-2018

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- JP 2016078995 A **[0002] [0004] [0006]**
- JP 2010037083 A **[0004] [0007]**
- JP 2013253353 A **[0092]**