



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
25.04.2018 Bulletin 2018/17

(51) Int Cl.:
B65H 54/42 (2006.01)

(21) Application number: **17192340.2**

(22) Date of filing: **21.09.2017**

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**
Designated Extension States:
BA ME
Designated Validation States:
MA MD

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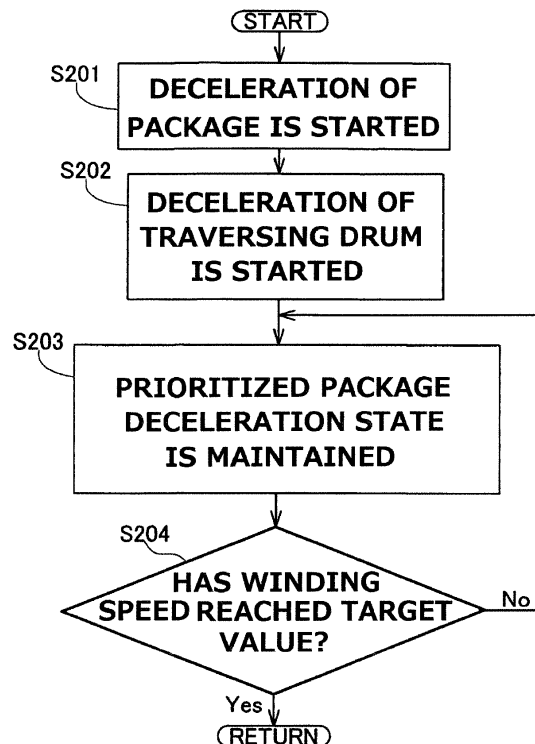
(30) Priority: **18.10.2016 JP 2016204099**

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

(57) The winding unit (2) includes a cradle (51) that supports a winding bobbin (Bm), a package rotational speed sensor (61), a traversing drum (52), a drum driving motor (62), a drum rotational speed sensor (63), a braking device (53), and a unit controlling section (15). The unit controlling section (15), when decelerating a package (100) while maintaining a state in which the package (100) and the traversing drum (52) are in contact with each other and a yarn (Y) is being wound on the package (100), controls the braking device (53) based on a detection result obtained in each of the package rotational speed sensor (61) and the drum rotational speed sensor (63) such that a circumferential speed of the package (100) is slower than a circumferential speed of the traversing drum (52).

FIG.8



Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a yarn winding device and a method of decelerating a package formed by the 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 traversing drum that rotates while being in contact with the package to rotate the package and also traverses a yarn (traversing). In addition, the disclosure explains problems arising when the yarn is decelerated in a state in which the package is being rotated by the traversing drum while the package is in contact with the traversing drum.

[0003] If the traversing drum is decelerated too fast, the deceleration of the package is delayed from that of the traversing drum, and the package may slip with respect to the traversing drum. Moreover, if the package is decelerated while winding of the yarn is being performed, because the yarn is still connected to the package, a phenomenon called stitching, in which the yarn falls off from an end of the package, can occur easily when such slippage occurs. To control such stitching arising from the cause mentioned above, the yarn winding device disclosed in Japanese Patent Application Laid-Open No. 2016-78995 has a configuration in which the traversing drum and the package are decelerated in such a manner that a difference between a circumferential speed of the traversing drum and a circumferential speed of the package is controlled to be equal to or lower than a predetermined value.

[0004] The yarn winding device disclosed in Japanese Patent Application Laid-Open No. 2016-78995 includes a roller driving source that rotationally drives the traversing drum, a package brake that brakes rotation of the package by being in contact with the package, and a controlling section that controls the roller driving source and the package brake.

[0005] When decelerating the package and the traversing drum while the yarn is in the connected state, if the package cannot be decelerated efficiently with the control of the traversing drum alone, the controlling section decelerates the package and the traversing drum in a short time by decelerating the package by using the package brake. Accordingly, the stitching arising when the sliding amount is large is prevented and an efficient deceleration control can be implemented.

[0006] Although the frequency of occurrence of the stitching can be decreased by making a sliding amount

small in the yarn winding device disclosed in Japanese Patent Application Laid-Open No. 2016-78995, that does not mean that the occurrence of the stitching during deceleration of the package can be prevented completely.

For example, during the deceleration of the package, if a winding position misalignment of a yarn occurs because of a position misalignment and the like of the package in a rotation axis direction of the package, the yarn protrudes from an end of the package that is on the other side of the end on which the winding position shifted leading to occurrence of the stitching. However, it is difficult to control such stitching in the configuration disclosed in Japanese Patent Application Laid-Open No. 2016-78995.

SUMMARY OF THE INVENTION

[0007] One object of the present invention is to surely prevent occurrence of stitching when a package is decelerated while the package is being formed.

[0008] 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 support member that supports the winding tube; a package rotational speed detecting section that detects a rotational speed of the package; a traversing drum capable of rotating by being in contact with the package thereby rotating the package while traversing the yarn; a drum driving section that rotationally drives the traversing drum; a drum rotational speed detecting section that detects a rotational speed of the traversing drum; a braking device that brakes rotation of the package; and a controlling section that controls the drum driving section and the braking device. The controlling section, when decelerating the package while maintaining a state in which the package and the traversing drum are in contact with each other and the yarn is being wound on the package, controls the braking device based on a detection result obtained in each of the package rotational speed detecting section and the drum rotational speed detecting section such that a circumferential speed of the package is slower than a circumferential speed of the traversing drum.

[0009] According to another aspect of the present invention, a package deceleration method for decelerating a package is implemented in a yarn winding device. The yarn winding device includes a support member that supports a winding tube on which a yarn from a yarn supplying section can be wound; a traversing drum that rotates while being in contact with the package that is formed by winding of the yarn on the winding tube thereby rotating the package while traversing the yarn; and a braking device that brakes rotation of the package. The package deceleration method includes, when decelerating the package while maintaining a state in which the package and the traversing drum are in contact with each other and the yarn is being wound on the package, controlling

the braking device such that a circumferential speed of the package is slower than a circumferential speed of the traversing drum.

[0010] 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 support member that supports the winding tube; a package rotational speed detecting section that detects a rotational speed of the package; a traversing drum capable of rotating by being in contact with the package thereby rotating the package while traversing the yarn; a drum driving section that rotationally drives the traversing drum; a drum rotational speed detecting section that detects a rotational speed of the traversing drum; a braking device that brakes rotation of the package; and a controlling section that controls the drum driving section and the braking device. The controlling section, when decelerating the package while maintaining a state in which the package and the traversing drum are in contact with each other and the yarn is being wound on the package, controls the braking device based on a detection result obtained in each of the package rotational speed detecting section and the drum rotational speed detecting section such that a circumferential speed of the package is slower than a circumferential speed of the traversing drum.

[0011] In the above yarn winding device, when decelerating the package while the yarn is being wound on the winding tube, the circumferential speed of the package is made slower than the circumferential speed of the traversing drum. When the circumferential speed of the package is relatively slow, a traversing width of the yarn on the package, that is, a distance for which the yarn performs one reciprocation traversing by the rotation of the traversing drum, is narrow. Accordingly, the winding position of the yarn on the package is shifted to a central portion in the traversing direction, and also a winding width of the yarn decreases. Therefore, the occurrence of the stitching when the package is decelerated while the package is being formed can be prevented surely.

[0012] In the above yarn winding device, the controlling section controls the braking device such that a difference between the circumferential speed of the package and the circumferential speed of the traversing drum is in a range of 50 m/min to 1000 m/min.

[0013] Because of excess slipping of the traversing drum and the package, a yarn breakage can occur and degree of damage to the yarn on the surface of the package can increase. Therefore, it is preferable that the difference between the circumferential speed of the package and the circumferential speed of the traversing drum, that is, a sliding amount, is in the range of 50 m/min to 1000 m/min.

[0014] The above yarn winding device further includes a holder attached to the support member and capable of rotatably holding the winding tube. The holder includes holder bodies that engage with ends of the winding tube

in a rotation axis direction. The braking device further includes a chamber to which fluid is supplied; and a resistance generating section capable of being pressed against the holder body from one side in the rotation axis direction depending on a fluid pressure in the chamber.

[0015] When the resistance generating section is pressed against the holder body from the one side in the rotation axis direction of the winding tube while the yarn is being wound on the winding tube, the winding tube and the support member and the like undergo elastic deformation. As a result, the position of the package shifts to the other side in the rotation axis direction leading to occurrence of the stitching. In the above yarn winding device, even if a winding position misalignment of the yarn occurs, because the winding width of the yarn during the deceleration is narrow, the occurrence of the stitching can be prevented.

[0016] In the above yarn winding device, the braking device further includes a fluid pressure changing section that changes a pressure of the fluid supplied to the chamber. The fluid pressure changing section provides a control such that a rate of increase of the pressure of the fluid in the chamber before the pressure of the fluid reaches an action initiation pressure at which a braking force by the resistance generating section begins to act on the package is higher than a rate of increase of the pressure of the fluid in the chamber after the pressure of the fluid has crossed the action initiation pressure.

[0017] The resistance generating section can generate a sufficient braking force when being pressed against the holder body with a force of a certain magnitude or above. That is, the effect of the deceleration operation by the resistance generating section cannot be expected until when the fluid pressure reaches a pressure of a certain value. That is, during the increase of the fluid pressure to the certain value, although no braking force acts on the holder body, the holder body is pushed in the rotation axis direction by the resistance generating section leading to the occurrence of the stitching. In the above yarn winding device, the rate of increase of the pressure of the fluid before the pressure of the fluid reaches the action initiation pressure at which the braking force by the resistance generating section begins to act on the package is higher than the rate of increase of the pressure of the fluid after the pressure of the fluid has crossed the action initiation pressure. Because of this, the pressure of the fluid supplied to the chamber reaches the action initiation pressure in a short time. Accordingly, a mismatch between a timing at which the package is pushed by the resistance generating section and a timing at which the winding width of the yarn becomes narrow because of the reason that the circumferential speed of the package is slower than the circumferential speed of the traversing drum becomes small. Accordingly, the occurrence of the stitching because of the winding position misalignment of the yarn can be prevented.

[0018] In the above yarn winding device, the controlling section first operates the braking device to start the de-

celeration of the package and thereafter controls the drum driving section to decelerate the traversing drum.

[0019] Because the traversing drum is decelerated after starting the deceleration of the package, the circumferential speed of the package can be surely made slower than the circumferential speed of the traversing drum whereby the occurrence of the stitching can be prevented. Moreover, because not only the package is decelerated by using the braking device but also the traversing drum is decelerated thereafter, an excessive increase of the sliding amount can be avoided.

[0020] The above yarn winding device further includes a yarn accumulating section arranged between the yarn supplying section and a package forming section and capable of accumulating 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 capable of joining a yarn end from the yarn supplying section and a yarn end from the yarn accumulating section to each other when the yarn is not continuous between the yarn supplying section and the yarn accumulating section. The controlling section, when the yarn joining device is performing the yarn joining, controls the drum driving section and the braking device to decelerate the traversing drum and the package.

[0021] 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 the yarn is continuous between the yarn accumulating section and the package, in the process of deceleration of the package while taking care that the yarn accumulated in the yarn accumulating section does not dry up, there are chances of occurrence of the stitching because of the winding position misalignment of the yarn. In the above yarn winding device, because the package is decelerated such that the circumferential speed of the package is slower than the circumferential speed of the traversing drum, the winding width of the yarn becomes narrow whereby the occurrence of the stitching can be prevented.

[0022] According to another aspect of the present invention, a package deceleration method for decelerating a package is implemented in a yarn winding device. The yarn winding device includes a support member that supports a winding tube on which a yarn from a yarn supplying section can be wound; a traversing drum that rotates while being in contact with the package that is formed by winding of the yarn on the winding tube thereby rotating the package while traversing the yarn; and a braking device that brakes rotation of the package. The package deceleration method includes, when decelerating the package while maintaining a state in which the package and the traversing drum are in contact with each other and the yarn is being wound on the package, controlling the braking device such that a circumferential speed of

the package is slower than a circumferential speed of the traversing drum.

[0023] In the above package deceleration method, because the circumferential speed of the package is relatively slow, a traversing width of the yarn on the package, that is, a distance for which the yarn performs one reciprocation traversing by the rotation of the traversing drum, is narrow and also a winding width of the yarn decreases. Therefore, the occurrence of the stitching when the package is decelerated while the package is being formed can be prevented surely.

[0024] In the above package deceleration method, the controlling includes controlling such that a difference between the circumferential speed of the package and the circumferential speed of the traversing drum is in a range of 50 m/min to 1000 m/min.

[0025] Like in the above yarn winding device, it is preferable that the difference between the circumferential speed of the package and the circumferential speed of the traversing drum is in the range of 50 m/min to 1000 m/min.

[0026] In the above package deceleration method, the yarn winding device further includes a holder attached to the support member and capable of rotatably holding the winding tube. The holder includes holder bodies that engage with ends of the winding tube in a rotation axis direction. The braking device further includes a chamber to which fluid is supplied; a resistance generating section capable of being pressed against the holder body from one side in the rotation axis direction depending on a fluid pressure in the chamber; and a fluid pressure changing section that changes a pressure of the fluid supplied to the chamber. The controlling includes controlling such that a rate of increase of the pressure of the fluid in the chamber before the pressure of the fluid reaches an action initiation pressure at which a braking force by the resistance generating section begins to act on the package is higher than a rate of increase of the pressure of the fluid in the chamber after the pressure of the fluid has crossed the action initiation pressure.

[0027] In the above package deceleration method, like in the above yarn winding device, even if a winding position misalignment of the yarn occurs because of the reason that the resistance generating section is pressed against the holder body, because the winding width of the yarn during the deceleration is narrow, the occurrence of the stitching can be prevented. Moreover, the pressure of the fluid supplied to the chamber reaches the action initiation pressure in a short time. Accordingly, a mismatch between a timing at which the package is pushed by the resistance generating section and a timing at which the winding width of the yarn becomes narrow because of that the circumferential speed of the package is slower than the circumferential speed of the traversing drum becomes small. Accordingly, the occurrence of the stitching because of the winding position misalignment of the yarn can be prevented.

[0028] In the above package deceleration method, the

controlling includes first operating the braking device to start the deceleration of the package and thereafter controlling a drum driving section to decelerate the traversing drum.

[0029] In the above package deceleration method like the above yarn winding device, the circumferential speed of the package can be surely made slower than the circumferential speed of the traversing drum whereby the occurrence of the stitching can be prevented. Moreover, an excessive increase of the sliding amount can be avoided.

[0030] In the above package deceleration method, the yarn winding device further includes a yarn accumulating section arranged between the yarn supplying section and a package forming section and capable of accumulating 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 capable of joining a yarn end from the yarn supplying section and a yarn end from the yarn accumulating section to each other when the yarn is not continuous between the yarn supplying section and the yarn accumulating section. The controlling includes, when the yarn joining device is performing the yarn joining, controlling the drum driving section and the braking device to decelerate the traversing drum and the package.

[0031] During the yarn joining is performed by the yarn joining device, when the yarn is continuous between the yarn accumulating section and the package, in the process of deceleration of the package, there are chances of occurrence of the stitching because of the winding position misalignment of the yarn. In the above package deceleration method like the above yarn winding device, because the package is decelerated such that the circumferential speed of the package is slower than the circumferential speed of the traversing drum, the winding width of the yarn becomes narrow whereby the occurrence of the stitching 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.

[0034] 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.

BRIEF DESCRIPTION OF THE DRAWINGS

[0035]

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 schematic view of a braking device.

FIGS. 6A and 6B are cross-sectional views of a braking cylinder and a neighboring configuration thereof.

FIG. 7 is a flowchart of a process procedure performed when a yarn breakage and the like has occurred.

FIG. 8 is a flowchart of a deceleration process.

FIGS. 9A and 9B are views for explaining a winding position misalignment of a yarn.

FIGS. 10A to 10D are graphs indicating a temporal variation of pressure and a package circumferential speed.

FIG. 11 is a block diagram of a braking device according to a variation.

FIG. 12 is a schematic side view of a winding unit according to yet another variation.

DETAILED DESCRIPTION

[0036] 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

[0037] 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.

[0038] 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 (controlling section of the present invention) of the wind-

ing 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

[0039] 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.

[0040] 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

[0041] 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.

[0042] 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

[0043] 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, a braking device 53, and the like.

[0044] 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.

[0045] Bobbin holders 56 (holder of the present invention) 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.

[0046] 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.

[0047] The traversing drum 52 is rotationally driven by a drum driving motor 62 (drum 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.

[0048] 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.

[0049] A drum rotational speed sensor 63 (drum 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.

[0050] The braking device 53 is for braking the rotation of the package 100. The details are explained later.

Yarn Accumulating Section

[0051] 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.

[0052] 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.

[0053] 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

[0054] 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 once 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

[0055] 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

[0056] 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.

[0057] 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.

[0058] 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.

[0059] 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.

[0060] 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

[0061] 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

[0062] A detailed configuration of the braking device 53 of the package forming section 12 is explained below by using FIGS. 4 to 6B. FIG. 5 is a schematic view for explaining the braking device 53. FIGS. 6A and 6B are cross-sectional views of the braking cylinder 60 and a neighboring configuration thereof. The braking device 53 includes, as shown in FIGS. 4 and 5, the braking cylinder 60, the air pressure changing section 71 (fluid pressure changing section of the present invention), and the like.

[0063] As explained above, the braking cylinder 60 is arranged inside the bobbin holder 56. The braking cylinder 60 includes, as shown in FIGS. 6A and 6B, a housing 72, a bearing sleeve 73, a rotation support member 74, and the like.

[0064] 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 (resistance generating section of the present invention) is arranged at a tip end part of the bearing sleeve 73. A 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.

[0065] 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.

[0066] 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, a solenoid valve 82, an air pressure controlling section 83, and the like. The solenoid valves 81 and 82 are normally closed 2-way solenoid valves. An input side of the solenoid valve 81 is connected to a supply port 84 connected to a compressed air source, and an output side is connected to the chamber 76 and to an input side of the solenoid valve 82. 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 is connected to an exhaust port 85 open to the outside.

[0067] The air pressure controlling section 83 opens and closes the solenoid valve 81 and the solenoid valve 82 independently. When the solenoid valve 81 is open 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 open, 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. When both the solenoid valves 81 and 82 are closed, the pressure inside the chamber 76 is maintained at the designated pressure as the compressed air is neither supplied nor discharged.

[0068] A 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 a measured value to the air pressure controlling section 83. The air pressure controlling section 83 opens and closes the solenoid valves 81 and 82 based on a detection result obtained in the pressure meter 86 to adjust the pressure of the compressed air to a predetermined value. The predetermined value is output, for example, from the unit controlling section 15.

[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. FIG. 6A depicts a state in which no compressed air is supplied to the chamber 76 or when the pressure of the compressed air supplied to the cham-

ber 76 is so low that the braking shoe 75 does not contact the holder body 58. In this state, the holder body 58 is not braked so that the holder body 58 can rotate freely with respect to the bearing sleeve 73. Moreover, at this time, the holder body 58 is biased toward the winding bobbin Bm via the shaft 78 by the action of the springs 77 and 79 of the bearing sleeve 73 and the low-pressure compressed air. As a result, the winding bobbin Bm is held so as to be rotatable.

[0070] On the other hand, when a high-pressure compressed air is supplied to the chamber 76, the bearing sleeve 73 moves toward the holder body 58 as shown in FIG. 6B. And, the braking shoe 75 is pressed from the side of the housing 72 against the holder body 58 in the rotation axis direction of the winding bobbin Bm.

[0071] When the pressure of the compressed air supplied to the chamber 76 is lower than the predetermined value, the rotation of the holder body 58 is not braked even if the braking shoe 75 has been pressed against the holder body 58. On the other hand, when the pressure is equal to or higher than the predetermined value, a frictional resistance occurs between the braking shoe 75 and the holder body 58, and the rotation of the holder body 58 is braked, and the winding bobbin Bm, which integrally rotates with the holder body 58, and the package 100 start decelerating. In the below explanation, this pressure represented by the predetermined value is referred to as an action initiation pressure. Note that the action initiation pressure can change, for example, depending on the shape and the like of the braking shoe 75.

Process Procedure Performed when Yarn Breakage and the like has Occurred

[0072] A process procedure performed by the unit controlling section 15 when a yarn breakage and the like has occurred is explained below by using FIG. 7.

[0073] 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, a 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.

[0074] 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. 7, 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 (package deceleration method of the present invention) 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.

[0075] The deceleration process is explained in detail by using FIGS. 8 to 10D. 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.

[0076] FIG. 8 is a flowchart of the deceleration process. At first, in the deceleration process, the unit controlling section 15 starts the deceleration of the package 100 (S201). The unit controlling section 15 reads from the ROM and the like a preset value of the pressure of the compressed air supplied to the chamber 76 of the braking cylinder 60, and controls the air pressure changing section 71 of the braking device 53 so as to start increasing the pressure of the compressed air supplied to the chamber 76. The preset pressure when starting the increase of the pressure is equal to the pressure when the package 100 starts deceleration, namely, is equal to the action initiation pressure.

[0077] When the pressure starts to increase, the braking shoe 75 of the braking cylinder 60 is pressed against the holder body 58 whereby the package 100 is pushed toward the small diameter side in the rotation axis direction thereof. In this process, the winding bobbin Bm and the cradle 51 undergo elastic deformation whereby the winding position of the yarn Y can shift. As shown in FIGS. 9A and 9B, when the pressure is higher (FIG. 9B) than the above-mentioned low pressure (FIG. 9A), the winding position of the yarn Y on the package 100 shifts toward the small diameter side and the yarn Y goes beyond the large diameter side of the package 100 leading to the occurrence of the stitching. The unit controlling section 15 performs the following control to prevent this.

[0078] Until the pressure reaches the action initiation pressure, the unit controlling section 15 increases a rate of increase of the pressure as high as possible. After the pressure has crossed the action initiation pressure, the

unit controlling section 15 decreases the rate of increase of the pressure.

[0079] A temporal variation of the pressure before and after the start of the deceleration of the package 100 and a temporal variation of the circumferential speed of the package 100 are explained by using FIGS. 10A to 10D. As shown in FIG. 10A, before a time point T1, that is, before the pressure starts increasing, the pressure is maintained at a pressure P1 that is a low pressure. The pressure starts increasing from the time point T1, and the pressure steeply increases from the pressure P1. At this point in time, as shown in FIG. 10B, the package 100 has not yet started deceleration. When at a time point T2 the pressure reaches a pressure P2 that is the action initiation pressure (FIG. 10A), the circumferential speed of the package 100 starts reducing (FIG. 10B). Then, the rate of increase of the pressure decreases so that the package 100 slowly decelerates. At this point in time, the circumferential speed of the package 100 is slower than the circumferential speed of the traversing drum 52. In the below explanation, this state is referred to as a prioritized package deceleration state.

[0080] Note that, after the pressure starts increasing but until the pressure reaches the action initiation pressure, the holder body 58 is pushed toward the small diameter side in the rotation axis direction by the braking shoe 75. Therefore, as shown in FIGS. 10C and 10D, if a period from the start of the increase of the pressure (time point T1) to the reaching of the pressure to the action initiation pressure (time point T2a) is long, the chances of occurrence of the stitching in the winding position misalignment of the yarn Y increase between the time points T1 and T2a. Which means that it is advantageous to start the deceleration of the package 100 as quickly as possible like in the present embodiment.

[0081] Then, the unit controlling section 15 reads a target circumferential speed of the traversing drum 52 and drives the drum driving motor 62 to start the deceleration of the traversing drum 52 (S202). In this manner, the unit controlling section 15 decelerates the package 100 first and then decelerates the traversing drum 52.

[0082] Then, the unit controlling section 15 performs a control to maintain the prioritized package deceleration state during the deceleration of the package 100 (S203). At first, the unit controlling section 15 calculates a difference (sliding amount) at the current point in time between the circumferential speed of the package 100 and the circumferential speed of the traversing drum 52. 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 stored beforehand 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, at the time point at which the deceleration is started, 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] After calculating the sliding amount, the unit controlling section 15 controls the braking device 53 such that the circumferential speed of the package 100 is maintained at a speed that is slower than the circumferential speed of the traversing drum 52. Specifically, the air pressure changing section 71 is controlled to adjust the pressure of the compressed air supplied to the chamber 76. When the sliding amount decreases, the unit controlling section 15 causes the pressure to be increased to increase the rate of the deceleration of the package 100.

[0084] In a state in which the prioritized package deceleration state has been maintained and the winding speed of the yarn Y on the package 100 is relatively slow, a traversing width of the yarn Y on the package 100, that is, a distance for which the yarn Y performs one reciprocation traversing by the rotation of the traversing drum 52, is narrow. Accordingly, the winding position of the yarn Y on the package 100 is shifted to a central portion in the traversing direction, and also a winding width of the yarn Y decreases in comparison with the same in the normal winding operation.

[0085] On the contrary, when the sliding amount increases, the unit controlling section 15 causes the pressure to be reduced to reduce the rate of the deceleration. The unit controlling section 15 maintains the prioritized package deceleration state and controls the braking device 53 such that the sliding amount is within a target range. The target range of the sliding amount is, for example, 50 m/min to 1000 m/min. Another target range of the sliding amount is, for example, 200 m/min to 400 m/min.

[0086] Subsequently, the unit controlling section 15 determines whether the winding speed of the yarn Y on the package 100 has reached the target value (S204). The unit controlling section 15 maintains the circumferential speed if the circumferential speed of the package 100 has reached the target value, but if the circumferential speed has not reached the target value, the control is returned to Step S203 thereby continuing the deceleration of the package 100 while maintaining the prioritized package deceleration state.

[0087] 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.

[0088] 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.

[0089] 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.

[0090] As explained above, when decelerating the package 100 while the yarn Y is being wound on the winding bobbin Bm, the circumferential speed of the package 100 is made slower than the circumferential speed of the traversing drum 52. When the circumferential speed of the package 100 is relatively slow, as mentioned above, the winding width of the yarn Y becomes narrow. Therefore, the occurrence of the stitching when the package is decelerated while the package is being formed can be prevented surely.

[0091] In the present embodiment, both the rotation of the package 100 and the traversing of the yarn Y are performed by the traversing drum 52. That is, the package forming section 12 does not include a traversing guide (that can independently adjust the traversing speed of the yarn Y) that is separate from of the traversing drum 52. Therefore, as explained above, the winding width of the yarn Y can be made narrow only by maintaining the prioritized package deceleration state.

[0092] Moreover, by maintaining the sliding amount within the range of 50 m/min to 1000 m/min, a yarn breakage or increase of degree of damage to the yarn on the surface of the package 100, which occurs because of excess slipping of the traversing drum 52 than the package 100, can be avoided.

[0093] Moreover, even if the winding position of the yarn Y slips off toward the small diameter side of the package 100 due to elastic deformation of the winding bobbin Bm and the cradle 51 because of the pressing of the braking shoe 75 against the holder body 58, because the winding width of the yarn Y during the deceleration

is narrow, the occurrence of the stitching can be prevented.

[0094] Moreover, the air pressure changing section 71 provides control so that the rate of increase of the pressure until the pressure of the compressed air supplied to the chamber 76 reaches the action initiation pressure is higher than the rate of increase of the pressure after the same has crossed the action initiation pressure. Because of this, the pressure of the fluid supplied to the chamber 76 reaches the action initiation pressure in a short time. Accordingly, a mismatch between a timing at which the package 100 is pushed by the braking shoe 75 and a timing at which the winding width of the yarn Y becomes narrow because of the prioritized package deceleration state becomes small. Accordingly, the occurrence of the stitching because of the winding position misalignment of the yarn can be prevented.

[0095] Moreover, because the traversing drum 52 is decelerated after starting the deceleration of the package 100, the circumferential speed of the package 100 can be surely made slower than the circumferential speed of the traversing drum 52 whereby the occurrence of the stitching can be prevented. Moreover, because not only the package 100 is decelerated by using the braking device 53 but also the traversing drum 52 is decelerated thereafter, an excessive increase of the sliding amount can be avoided.

[0096] 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 the yarn Y is continuous between the yarn accumulating section 13 and the package 100, in the process of deceleration of the package 100 while taking care that the yarn accumulated in the yarn accumulating section 13 does not dry up, there are chances of occurrence of the stitching because of the winding position misalignment of the yarn Y. However, because the package 100 is decelerated such that the circumferential speed of the package 100 is slower than the circumferential speed of the traversing drum 52, the winding width of the yarn Y becomes narrow whereby the occurrence of the stitching is prevented.

[0097] 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 cylinder 60 is not limited to the one that includes the braking shoe 75. Alternatively, the braking cylinder 60 can include a resistance generating section that can be pressed against the holder body 58 from the rotation axis direction. Alternatively, instead of such a resistance

generating section, the braking cylinder 60 can include, for example, a member that brakes the rotation of the holder body 58 by contacting the holder body 58 from above and below. Even with this configuration, when the winding position misalignment occurs because of some other cause, the occurrence of the stitching can be prevented by decelerating the package 100 like in the embodiment.

(2) The configuration of the air pressure changing section is not limited to the one explained in the embodiment. For example, as shown in FIG. 11, an air pressure changing section 92 of a braking device 91 can include a solenoid valve 93 and a supply controlling section 94. The solenoid valve 93 is a normally closed 3-way solenoid valve. The solenoid valve 93 is connected to the supply port 84, the exhaust port 85, and the chamber 76. When an electric current is supplied to the solenoid valve 93, a supply port side of the solenoid valve 93 is opened and an 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. 11. When the supply of the electric current to the solenoid valve 93 is stopped, the supply port side of the solenoid valve 93 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. 11. When decelerating the package, the supply controlling section 94 controls the solenoid valve 93 to open and close repeatedly and alternately to supply the compressed air to the chamber 76. As a result, on a time average basis, the pressure of the compressed air supplied to the chamber 76 can be kept lower than the pressure of the compressed air of the supply source to adjust a braking force acting on the package 100. The braking device 91 needs not include the pressure meter. That is, the pressure can be adjusted by controlling the opening and closing time of the solenoid valve 93.

(3) The air pressure changing section 71 needs not include the air pressure controlling section 83. The unit controlling section 15 can function as the air pressure controlling section 83 to control the air pressure changing section 71.

(4) When the yarn breakage and the like occurs, the unit controlling section 15 can start the deceleration process before starting the yarn joining process. Moreover, if the yarn joining process is completed before completion of the deceleration process, it is allowable to start acceleration of the yarn accumulating drum 41 without waiting for the completion of the deceleration process.

(5) 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.

(6) 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 the package 100 based on the detection results obtained in the pivot angle sensor and the package rotational speed sensor 61.

(7) The yarn accumulating section 13 can be omitted from the winding unit. FIG. 12 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 (5) 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 that the package 100 and the traversing drum 52 are decelerated while continuing the winding of the yarn Y. In such a case, the unit controlling section 15 narrows the winding width of the yarn Y by decelerating the package 100 and the traversing drum 52 while maintaining the prioritized package deceleration state thereby preventing the stitching.

(8) When decelerating the package 100 while winding the yarn Y, it is sufficient that the prioritized package deceleration state is maintained and it is not necessary that the difference between the circumferential speed of the package 100 and the circumferential speed of the traversing drum 52 is within the range of 50 m/min to 1000 m/min.

(9) The start of the deceleration of the traversing drum 52 needs not be after the start of the deceleration of the package 100. If a control is provided such

that the circumferential speed of the package 100 is slower than the circumferential speed of the traversing drum 52, for example, the deceleration of the traversing drum 52 and the package 100 can be started at the same time.

(10) 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.

(11) The rate of increase of the pressure before the pressure reaches the action initiation pressure needs not necessarily be higher than the rate of increase of the pressure after crossing the action initiation pressure. For example, in situations where the package 100 is heavy and the like, the rate of increase of the pressure can be maintained even after the pressure has crossed the action initiation pressure.

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

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

(14) 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 support member (74) that supports the winding tube (Bm);
 - a package rotational speed detecting section (61) that detects a rotational speed of the package (100);
 - a traversing drum (52) capable of rotating by being in contact with the package (100) thereby rotating the package (100) while traversing the yarn;
 - a drum driving section (62) that rotationally drives the traversing drum (52);
 - a drum rotational speed detecting section (63) that detects a rotational speed of the traversing drum (52);
 - a braking device (53) that brakes rotation of the package (100); and
 - a controlling section (15) that controls the drum driving section (62) and the braking device (53), **characterized in that** the controlling section (15), when decelerating the package (100) while maintaining a state in which the package (100) and the traversing drum (52) are in contact with each other and the yarn is being wound

on the package (100), controls the braking device (53) based on a detection result obtained in each of the package rotational speed detecting section (61) and the drum rotational speed detecting section (63) such that a circumferential speed of the package (100) is slower than a circumferential speed of the traversing drum (52).

2. The yarn winding device (2) as claimed in Claim 1, **characterized in that** the controlling section (15) controls the braking device (53) such that a difference between the circumferential speed of the package (100) and the circumferential speed of the traversing drum (52) is in a range of 50 m/min to 1000 m/min.
3. The yarn winding device (2) as claimed in Claim 1 or 2, further comprising
 - a holder (56) attached to the support member (74) and capable of rotatably holding the winding tube (Bm), the holder (56) including holder bodies (58) that engage with ends of the winding tube (Bm) in a rotation axis direction, and
 - the braking device (53) further includes

a chamber (76) to which fluid is supplied; and a resistance generating section (75) capable of being pressed against the holder body (58) from one side in the rotation axis direction depending on a fluid pressure in the chamber (76).

4. The yarn winding device (2) as claimed in Claim 3, **characterized in that** the braking device (53) further includes a fluid pressure changing section (71) that changes a pressure of the fluid supplied to the chamber (76), and the fluid pressure changing section (71) provides a control such that a rate of increase of the pressure of the fluid in the chamber (76) before the pressure of the fluid reaches an action initiation pressure at which a braking force by the resistance generating section (75) begins to act on the package (100) is higher than a rate of increase of the pressure of the fluid in the chamber (76) after the pressure of the fluid has crossed the action initiation pressure.
5. The yarn winding device (2) as claimed in any one of Claims 1 to 4, **characterized in that** the controlling section (15) first operates the braking device (53) to start the deceleration of the package (100) and thereafter controls the drum driving section (62) to decelerate the traversing drum (52).
6. The yarn winding device (2) as claimed in any one of Claims 1 to 5, further comprising
 - a yarn accumulating section (13) arranged between the yarn supplying section (11) and a package forming section (12) and capable of accumulating 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 capable of joining a yarn end from the yarn supplying section (11) and a yarn end from the yarn accumulating section (13) to each other when the yarn is not continuous between the yarn supplying section (11) and the yarn accumulating section (13), **characterized in that**

the controlling section (15), when the yarn joining device (33) is performing the yarn joining, controls the drum driving section (62) and the braking device (53) to decelerate the traversing drum (52) and the package (100).

7. A package deceleration method implemented in a yarn winding device (2) for decelerating a package (100),

the yarn winding device (2) including

a support member (74) that supports a winding tube (Bm) on which a yarn from a yarn supplying section (11) can be wound;

a traversing drum (52) that rotates while being in contact with the package (100) that is formed by winding of the yarn on the winding tube (Bm) thereby rotating the package (100) while traversing the yarn; and

a braking device (53) that brakes rotation of the package (100),

the package deceleration method comprising, when decelerating the package (100) while maintaining a state in which the package (100) and the traversing drum (52) are in contact with each other and the yarn is being wound on the package (100), controlling the braking device (53) such that a circumferential speed of the package (100) is slower than a circumferential speed of the traversing drum (52).

8. The package deceleration method as claimed in Claim 7, **characterized in that** the controlling includes controlling such that a difference between the circumferential speed of the package (100) and the circumferential speed of the traversing drum (52) is in a range of 50 m/min to 1000 m/min.

9. The package deceleration method as claimed in Claim 7 or 8, **characterized in that**

the yarn winding device (2) further includes a holder (56) attached to the support member (74) and capable of rotatably holding the winding tube (Bm), the holder (56) includes holder bodies (58) that engage with ends of the winding tube (Bm) in a rotation axis direction,

the braking device (53) further includes

a chamber (76) to which fluid is supplied;
a resistance generating section (75) capable of being pressed against the holder body (58) from one side in the rotation axis direction depending on a fluid pressure in the chamber (76); and
a fluid pressure changing section (71) that changes a pressure of the fluid supplied to the chamber (76), **characterized in that**

the controlling includes controlling such that a rate of increase of the pressure of the fluid in the chamber (76) before the pressure of the fluid reaches an action initiation pressure at which a braking force by the resistance generating section (75) begins to act on the package (100) is higher than a rate of increase of the pressure of the fluid in the chamber (76) after the pressure of the fluid has crossed the action initiation pressure.

10. The package deceleration method as claimed in any one of Claims 7 to 9, **characterized in that** the controlling includes first operating the braking device (53) to start the deceleration of the package (100) and thereafter controlling a drum driving section (62) to decelerate the traversing drum (52).

11. The package deceleration method as claimed in any one of Claims 7 to 10, **characterized in that** the yarn winding device (2) further includes

a yarn accumulating section (13) arranged between the yarn supplying section (11) and a package forming section (12) and capable of accumulating 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 capable of joining a yarn end from the yarn supplying section (11) and a yarn end from the yarn accumulating section (13) to each other when the yarn is not continuous between the yarn supplying section (11) and the yarn accumulating section (13), **characterized in that**

the controlling includes, when the yarn joining device (33) is performing the yarn joining, controlling the drum driving section (62) and the braking device (53) to decelerate the traversing drum (52) and the package (100).

FIG.1

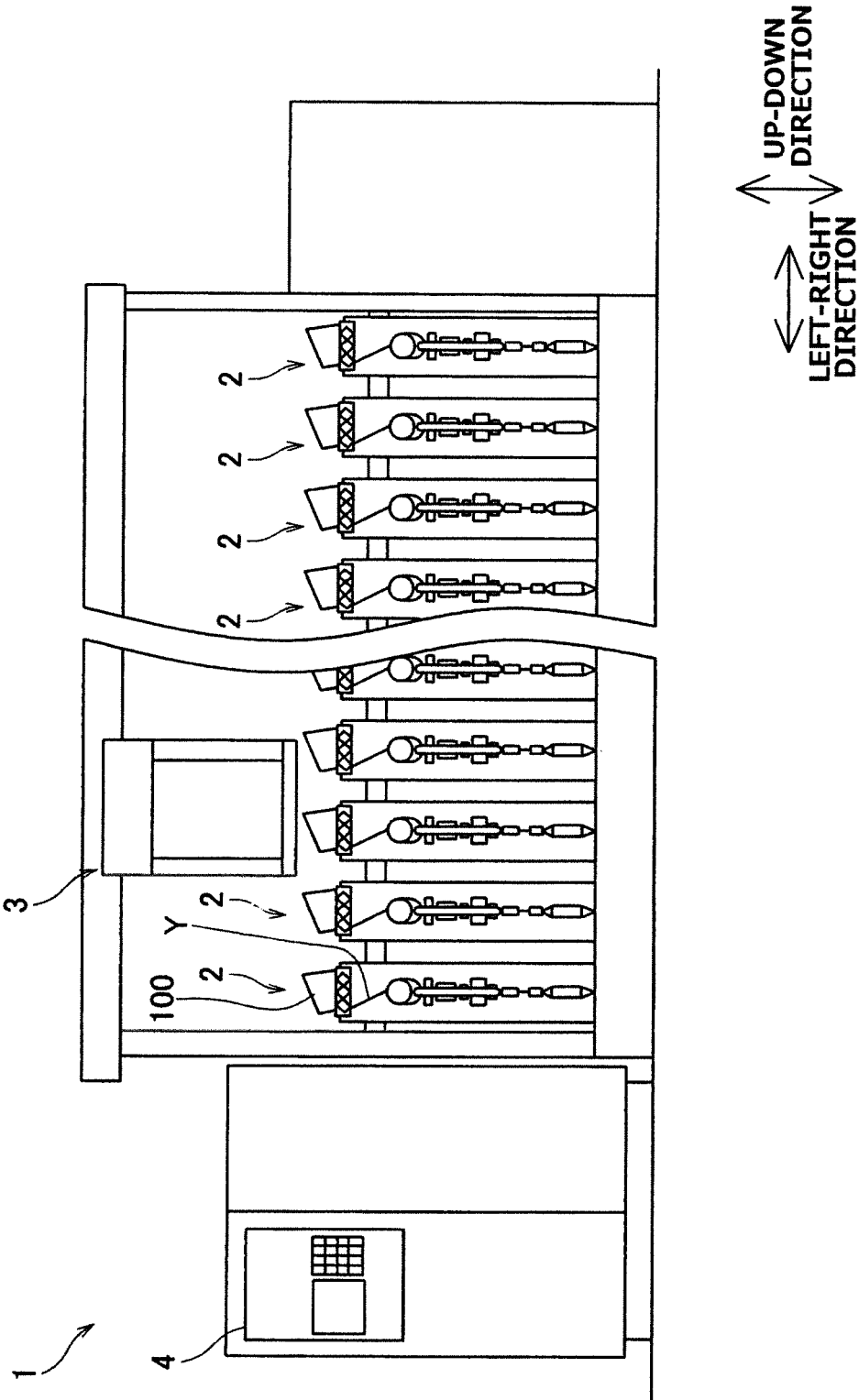


FIG.2

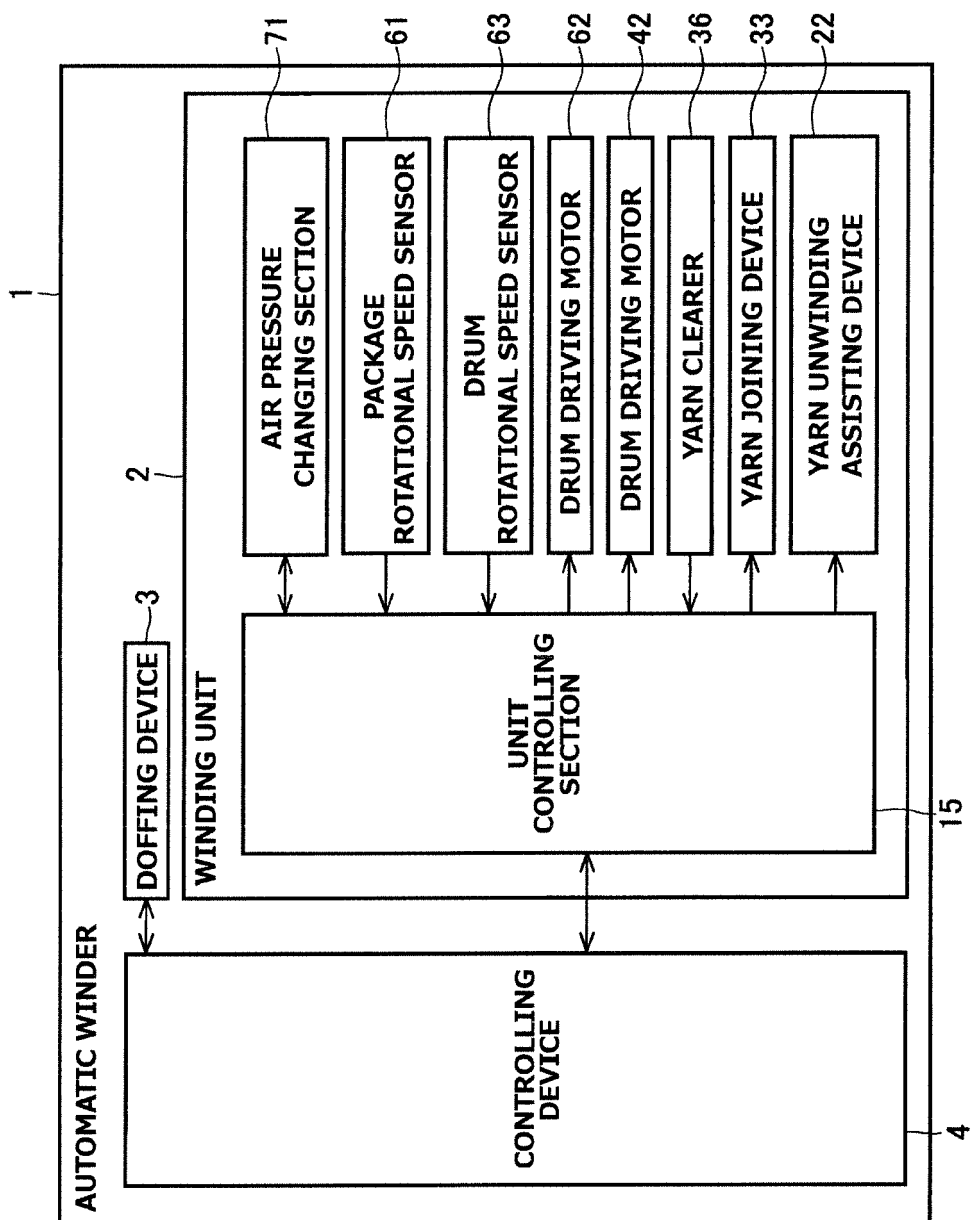
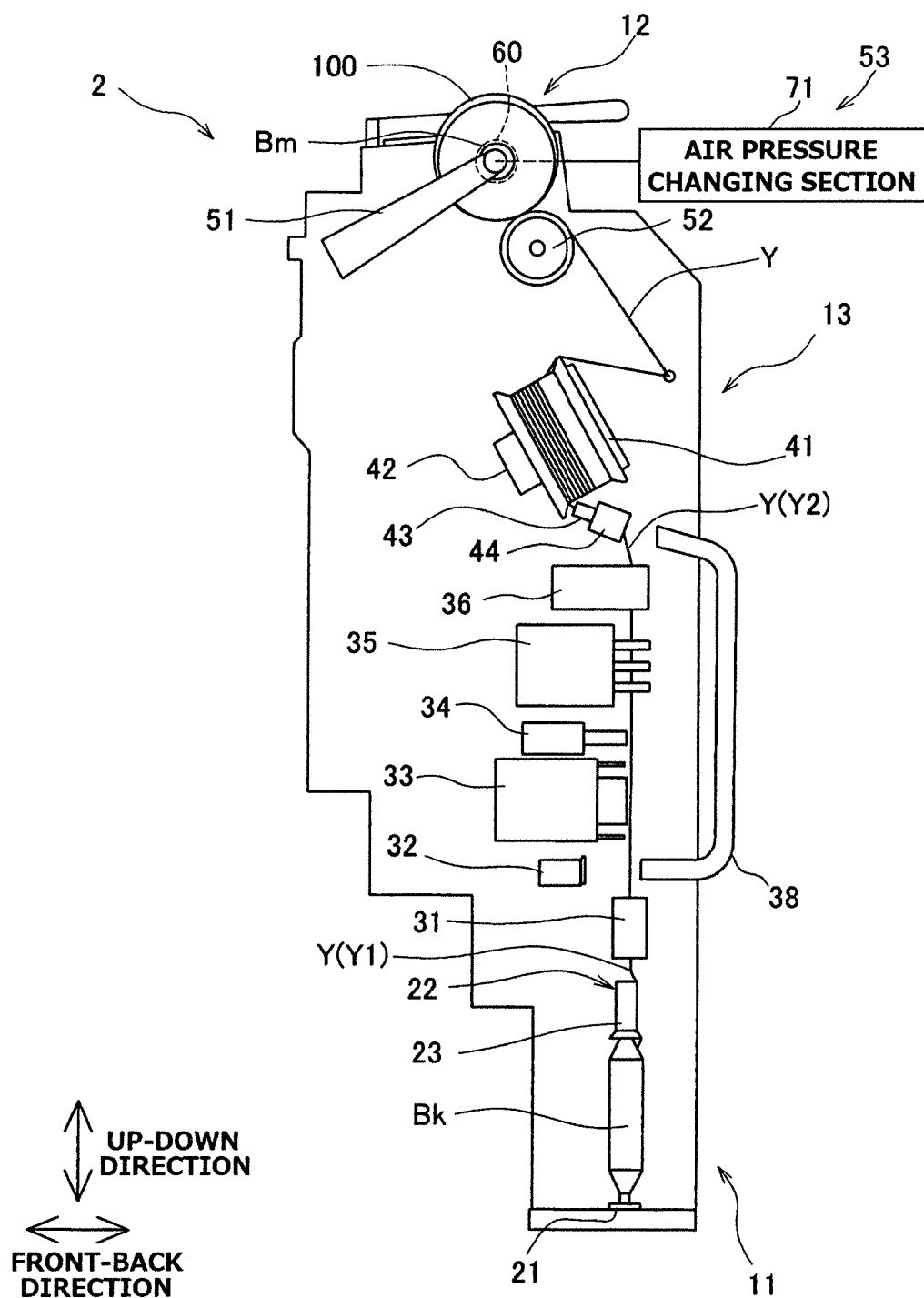
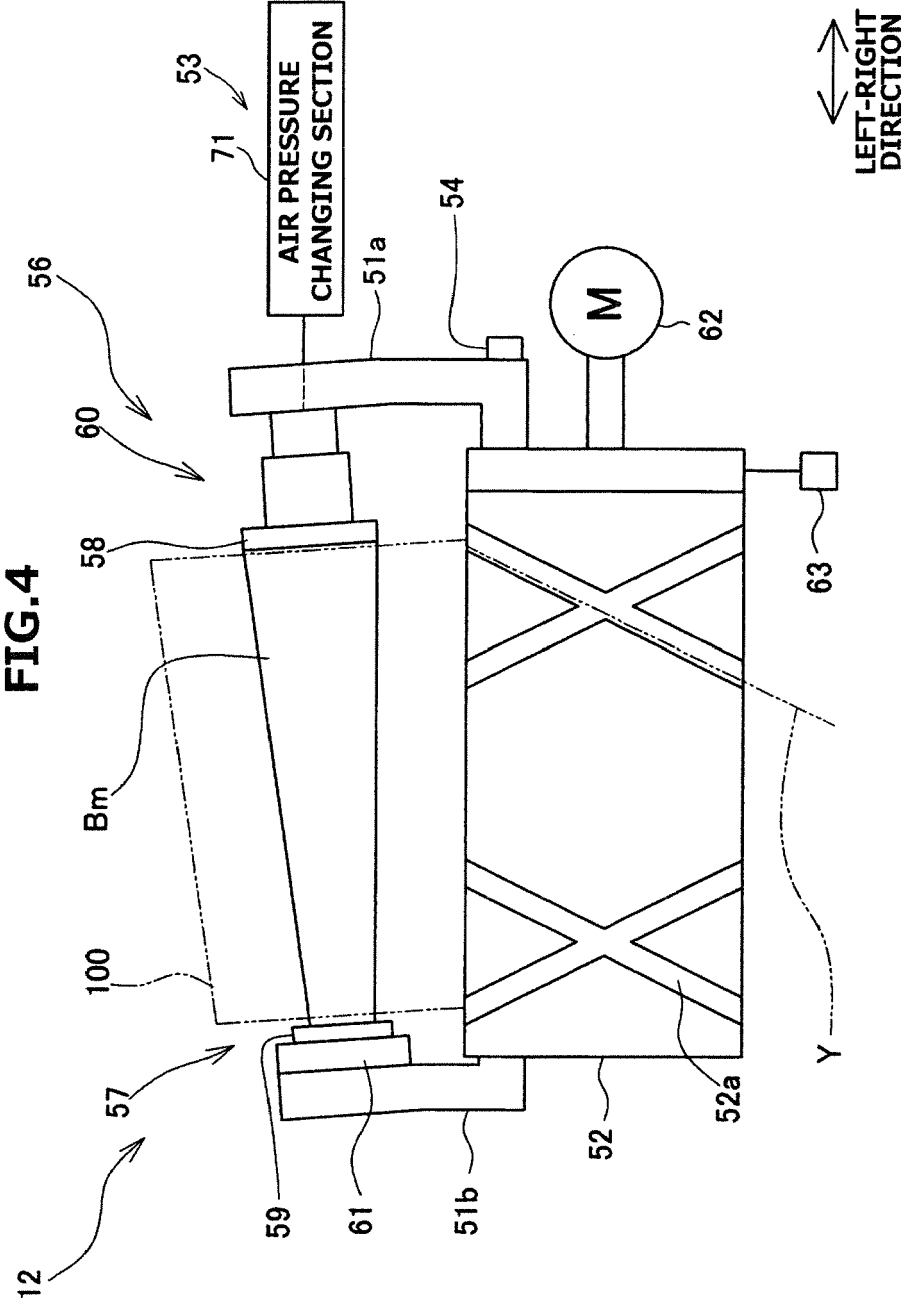


FIG.3





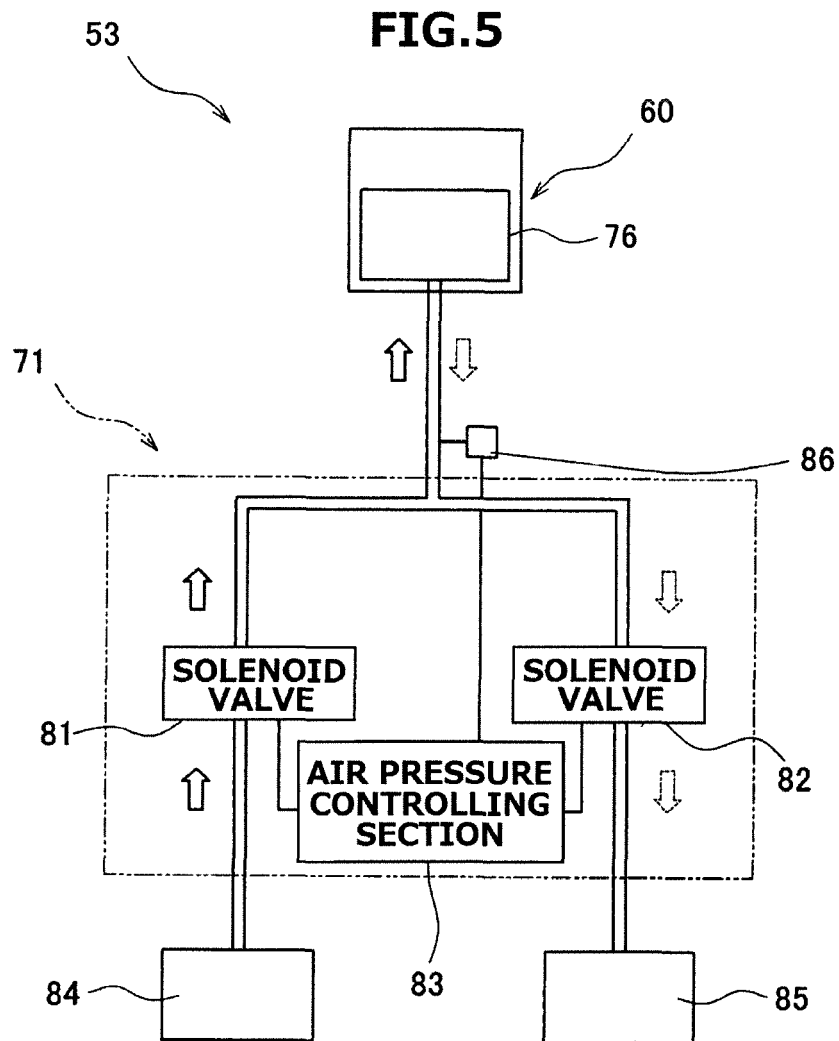


FIG.6A

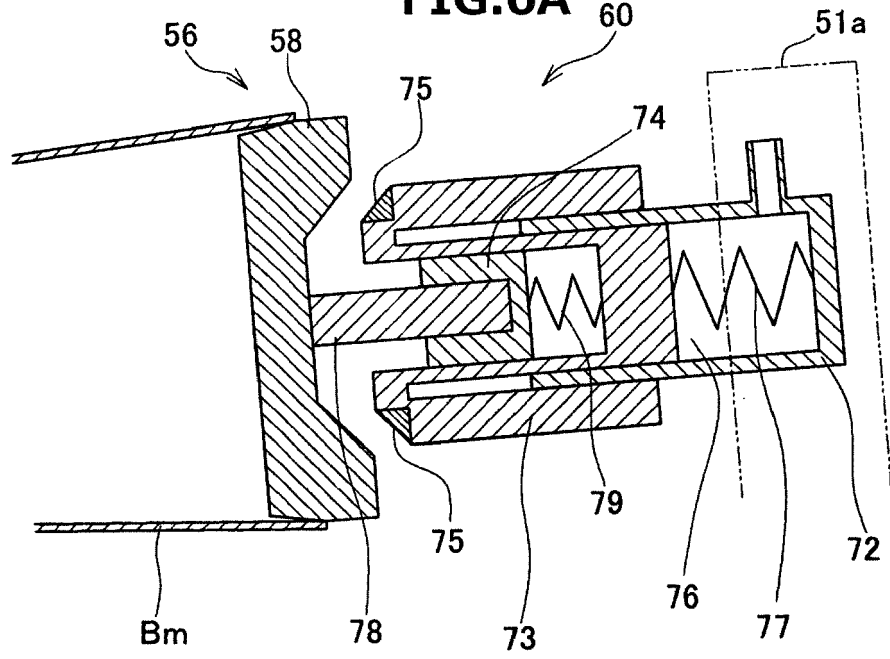


FIG.6B

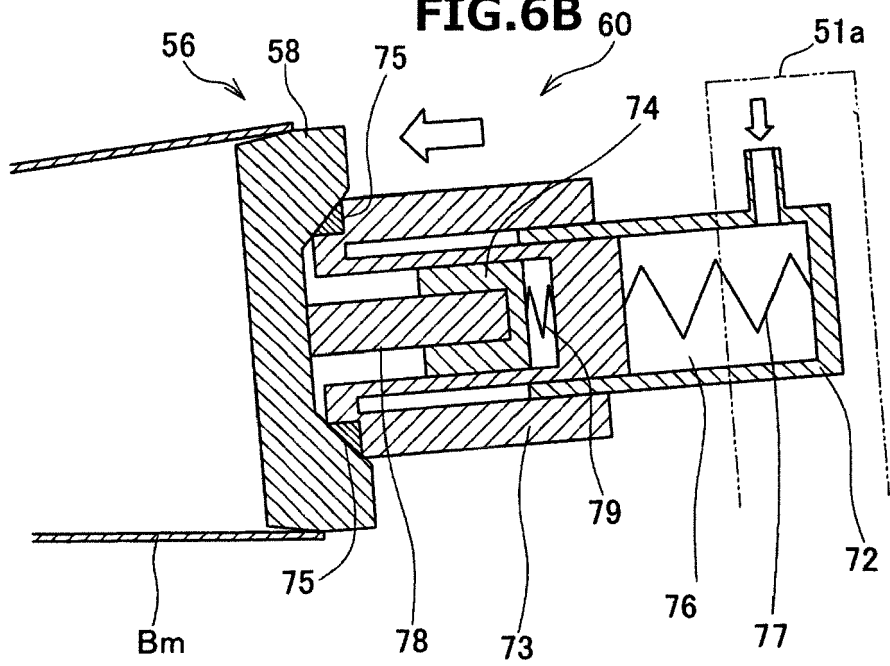


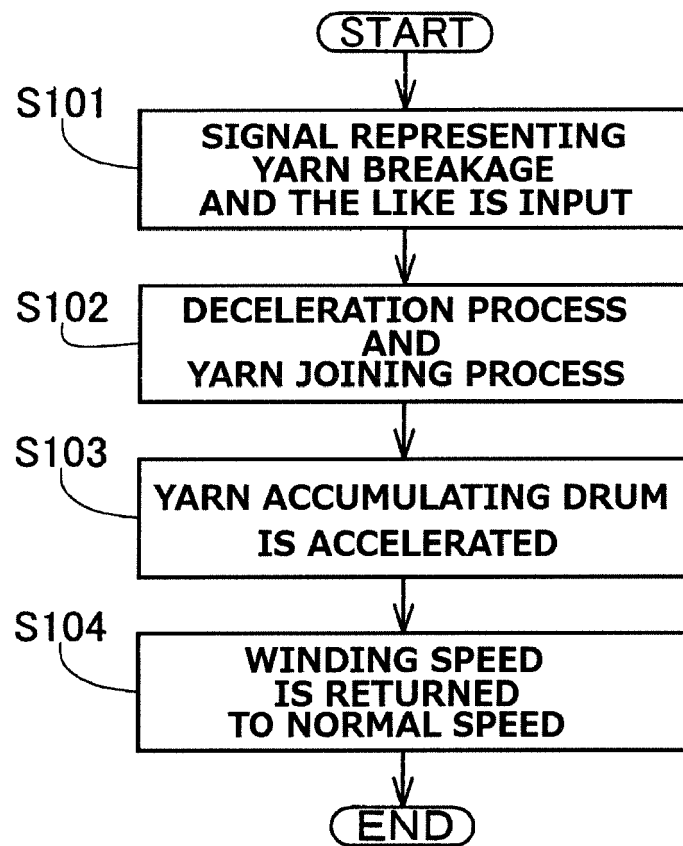
FIG.7

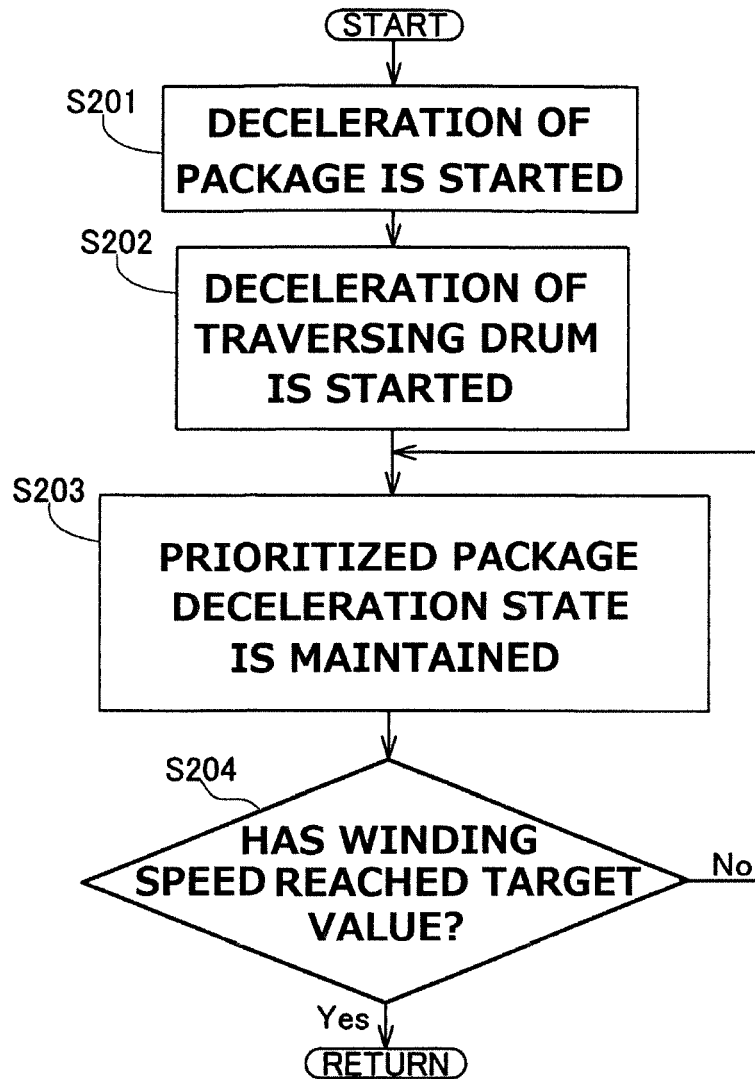
FIG.8

FIG.9A

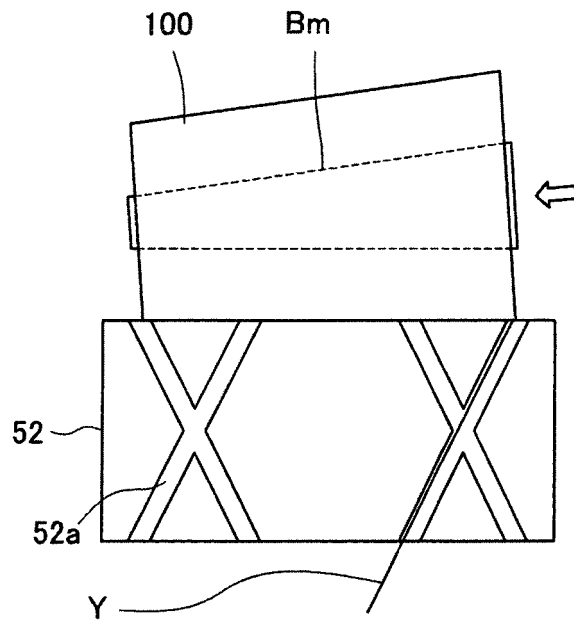


FIG.9B

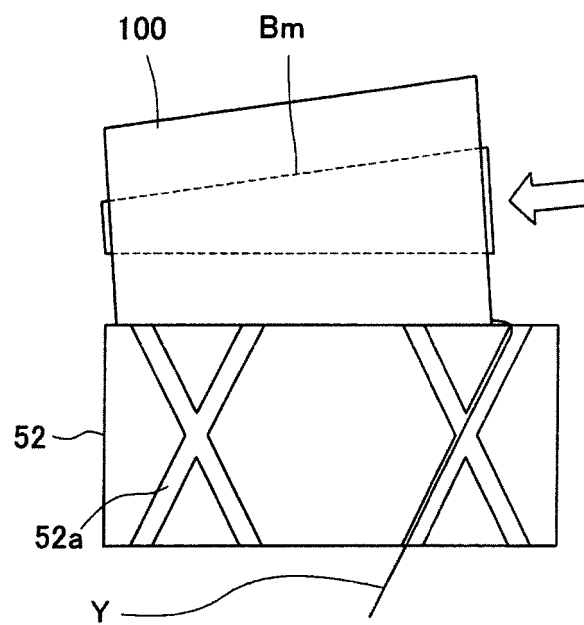


FIG.10A
PRESSURE

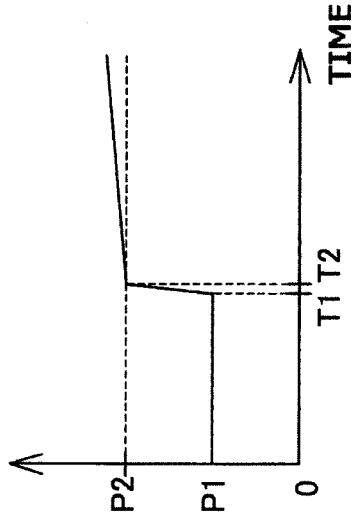


FIG.10B
PACKAGE CIRCUMFERENTIAL SPEED

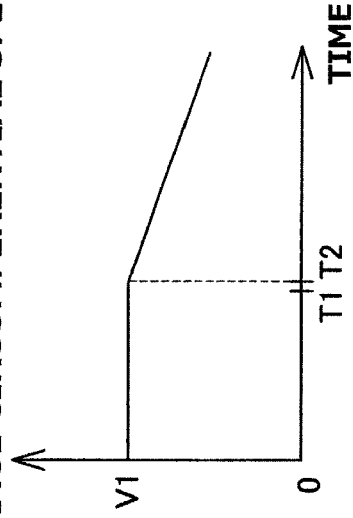


FIG.10C
PRESSURE

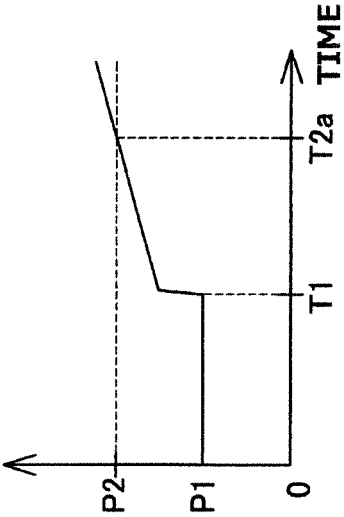


FIG.10D
PACKAGE CIRCUMFERENTIAL SPEED

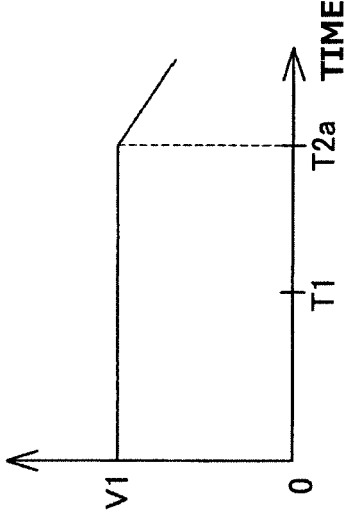


FIG.11

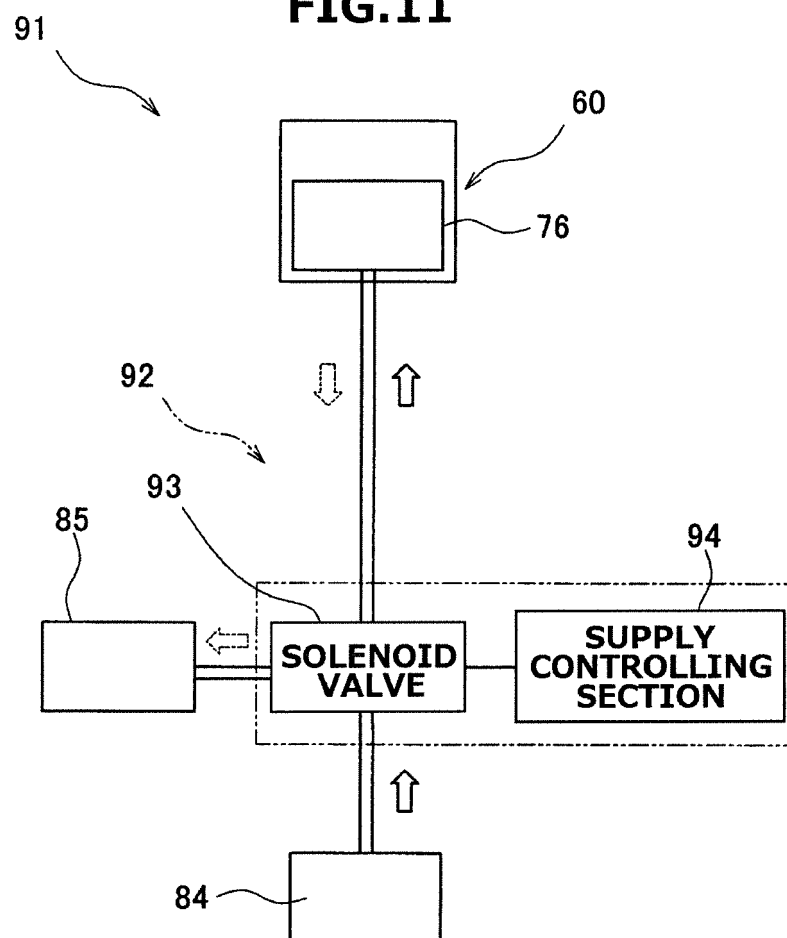
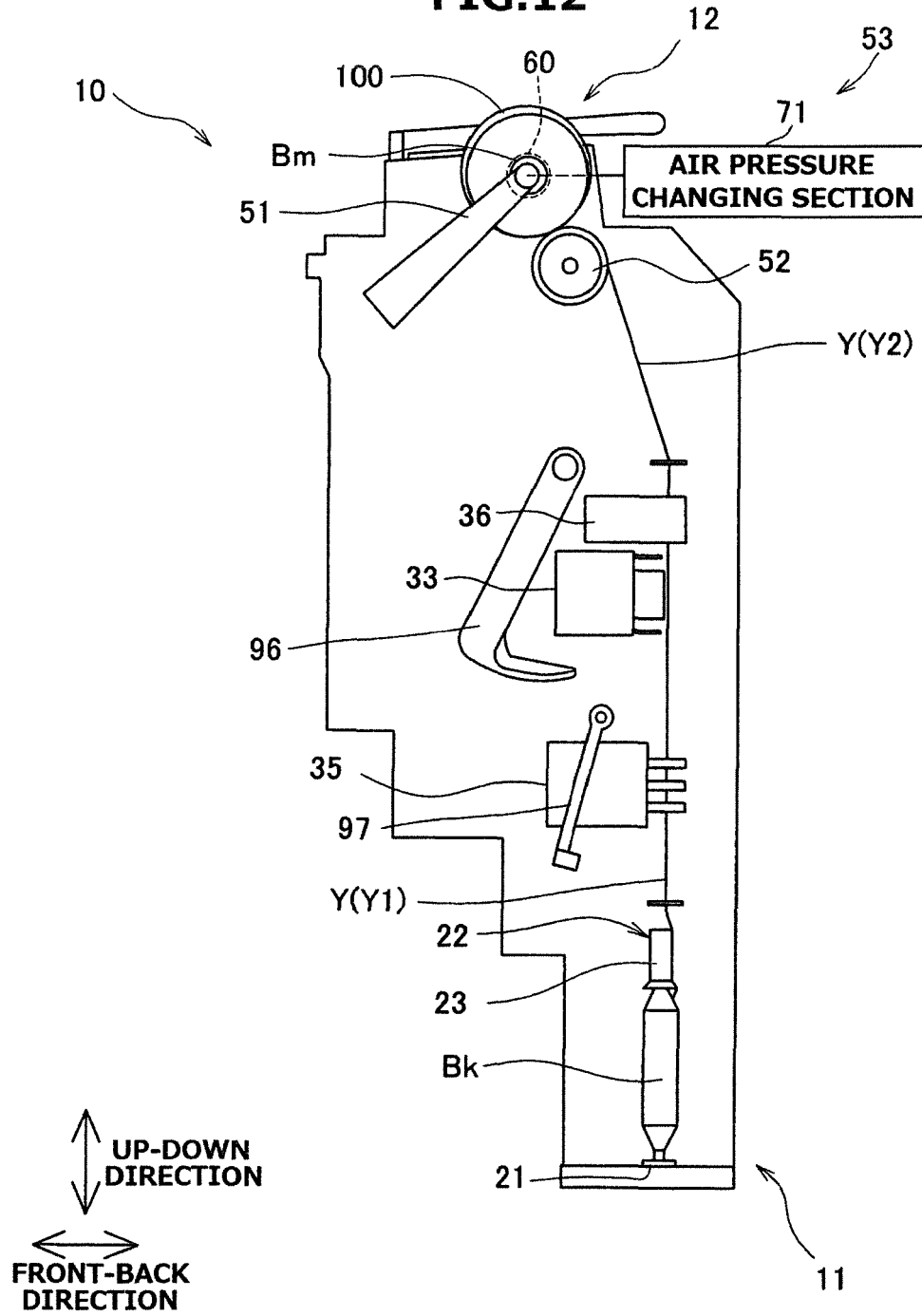


FIG.12





EUROPEAN SEARCH REPORT

Application Number
EP 17 19 2340

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