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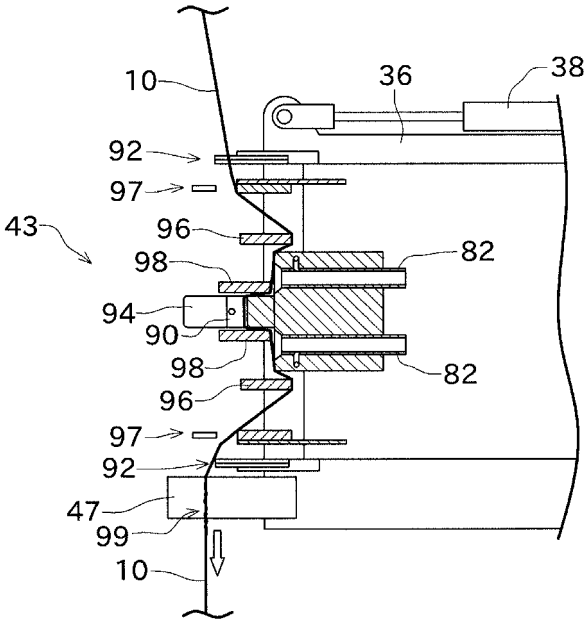
(54) Apparatus for joining a yarn, and yarn winding machine and unit including same

(57) A yarn joining device (43) is adapted to perform a yarn joining operation to join a spun yarn (10) between a spinning device and a package. A yarn-path regulating member (yarn guiding levers 96 and yarn controlling levers 98) is adapted to move between a position of making contact with the spun yarn (10) to bend the spun yarn (10) and a position of releasing the spun yarn (10) . A control section is adapted to control the yarn-path regulating member to make contact with the spun yarn (10) to bend the spun yarn (10) during the yarn joining operation, and to maintain bending of the spun yarn (10) after completion of the yarn joining operation and until at least winding of the spun yarn (10) by the winding device is started.

FIG. 12



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a yarn joining device arranged in a yarn winding machine or unit.

2. Description of the Related Art

[0002] There is known a yarn winding machine adapted to wind a yarn around a bobbin to form a package. This type of yarn winding machine includes, for example, a spinning machine disclosed in Japanese Unexamined Patent Publication No. 2010-77576. The spinning machine includes a spinning device adapted to produce a spun yarn by twisting a fiber bundle, and a winding device adapted to wind the spun yarn produced by the spinning device around the bobbin to form a package.

[0003] The spinning machine disclosed in Japanese Unexamined Patent Publication No. 2010-77576 includes a yarn joining cart adapted to connect (join) a yarn from the spinning device and a yarn from the package when the spun yarn between the spinning device and the package is disconnected. The yarn joining cart includes a yarn joining device adapted to connect the yarn from the spinning device and the yarn from the package. The yarn joining cart includes a suction pipe adapted to catch the yarn from the spinning device and guide the yarn to the yarn joining device, and a suction mouth adapted to catch the yarn from the package and guide the yarn to the yarn joining device.

[0004] A detailed structure of the yarn joining device is described, for example, in Japanese Unexamined Patent Publication No. 2001-199637. The yarn joining device described in Japanese Unexamined Patent Publication No. 2001-199637 includes a yarn guiding lever adapted to guide the yarn and regulate the yarn. As illustrated in FIG. 4 and the like of Japanese Unexamined Patent Publication No. 2001-199637, the yarn to be joined by the yarn joining device is regulated by the yarn guiding lever to be bent. After completion of a yarn joining operation, the yarn guiding lever is released to free the yarn.

[0005] Since the yarn path is bent during the yarn joining operation, the spun yarn between the spinning device and the package is longer than during a normal winding. Therefore, when the yarn guiding lever is released after the yarn joining operation is completed, the lengthened spun yarn slackens. As a result, the slackened or kinked yarn may be wound into a package.

[0006] If the yarn is slackened, the slackened yarn may get caught at a surrounding member. For example, the spinning machine described in Japanese Unexamined Patent Publication No. 2010-77576 has a rotating slack eliminating roller arranged between the spinning device and the winding device. If the yarn slackens when the winding is resumed, the yarn may get entangled around the rotating slack eliminating roller. The winding device of the spinning machine disclosed in Japanese Unexamined Patent Publication No. 2010-77576 includes a reciprocating traverse guide. If the yarn slackens when the winding is resumed, the slackened yarn may get caught at the traverse guide, and a yarn breakage may occur.

BRIEF SUMMARY OF THE INVENTION

[0007] An object of the present invention is to provide an approach which eliminates slackening of a yarn generated when a yarn joining operation is completed, e.g. in a yarn winding machine or unit.
This object is achieved by an apparatus in accordance with claim 1, a yarn winding machine in accordance with claim 2, and a yarn winding unit in accordance with claim 11.
An apparatus for joining a yarn according to an aspect of the present invention includes a yarn joining device adapted to perform a yarn joining operation to join the yarn, a yarn-path regulating member adapted to move between a position where the yarn-path regulating member makes contact with the yarn to bend the yarn and a position where the yarn-path regulating member releases the yarn, and a control section adapted to control the yarn-path regulating member to make contact with the yarn to bend the yarn during the yarn joining operation, and to control the yarn-path regulating member to maintain bending of the yarn after completion of the yarn joining operation and until at least winding of the yarn is started.

[0008] A yarn winding machine according to one aspect of the present invention includes a winding section, a yarn supplying section, a yarn joining device, a yarn-path regulating member, and a control section. The winding section is adapted to wind a yarn into a package. The yarn supplying section is adapted to supply the yarn to the winding section. The yarn joining device is adapted to perform a yarn joining operation to join the yarn between the yarn supplying section and the package. The yarn-path regulating member is adapted to move between a position where the yarn-path regulating member makes contact with the yarn to bend the yarn and a position where the yarn-path regulating member releases the yarn. The control section is adapted to control the yarn-path regulating member to make contact with the yarn to bend the yarn during the yarn joining operation, and to control the yarn-path regulating member to maintain bending of the yarn after completion of the yarn joining operation and until at least winding of the yarn by the winding section is started.

[0009] By starting the winding of the yarn while the yarn path is regulated by the yarn-path regulating member, the yarn can be prevented from slackening immediately after the completion of the yarn joining operation. A start of the winding of the yarn refers to a start of rotating the package in a direction of winding the yarn.

[0010] The above yarn winding machine includes a

joint monitoring device adapted to inspect a quality of a yarn-joint formed by the yarn joining operation performed by the yarn joining device. After the completion of the yarn joining operation performed by the yarn joining device, and until the yarn-joint passes at least the joint monitoring device, the control section controls the yarn-path regulating member to maintain the bending of the yarn.

[0011] Accordingly, the joint monitoring device can inspect the yarn-joint while the yarn path is regulated by the yarn-path regulating member. Since the yarn does not slacken when the joint monitoring device inspects the yarn-joint, inspection accuracy of the yarn-joint can be improved.

[0012] The above yarn winding machine further includes a clamping section adapted to clamp the yarn during the yarn joining operation performed by the yarn joining device. The control section controls the clamping section to release the clamped yarn after the completion of the yarn joining operation performed by the yarn joining device, and controls the winding section to start winding of the yarn while controlling the yarn-path regulating member to maintain the bending of the yarn.

[0013] When the yarn clamped by the clamping section is released, the yarn can travel and the winding of the yarn can be resumed. By continuing the regulation of the yarn path by the yarn path regulating member at the start of the winding, the yarn can be prevented from slackening.

[0014] In the above yarn winding machine, the yarn supplying section is preferably an air-jet spinning device adapted to twist a fiber bundle by whirling airflow to produce a spun yarn.

[0015] Since a speed of producing the spun yarn is high in the air-jet spinning device, the spinning of the spinning device is easily influenced by a fluctuation of the yarn path. Therefore, by preventing the slackening of the spun yarn immediately after the completion of the yarn joining operation, the quality of the produced spun yarn can be improved.

[0016] In the above yarn winding machine, after the completion of the yarn joining operation performed by the yarn joining device, and until at least the winding of the yarn by the winding section is started, the control section preferably controls the yarn-path regulating member to stop while bending the yarn, and thereafter to move a position to release the yarn.

[0017] By once stopping the yarn-path regulating member, the yarn-path regulating member can reliably maintain the bending of the yarn. As a result, the yarn can be reliably prevented from slackening.

[0018] In the above yarn winding machine, when moving the yarn-path regulating member from the position where the yarn-path regulating member bends the yarn to the position where the yarn-path regulating member releases the yarn, the control section preferably controls the yarn-path regulating member to move under a speed in which the yarn-path regulating member can maintain the bending of the yarn.

[0019] When releasing the yarn, the yarn-path regulating member is moved slowly. Accordingly, the yarn-path regulating member can be moved while the yarn path is regulated by the yarn-path regulating member. As a result, the yarn can be prevented from slackening when the yarn-path regulating member releases the yarn.

[0020] The above yarn winding machine further includes a yarn accumulating device arranged between the yarn supplying section and the winding section in a travelling direction of the yarn and adapted to temporarily accumulate the yarn by winding the yarn around an outer periphery of a rotating yarn accumulating roller. The yarn joining device performs the yarn joining operation between the yarn accumulating device and the winding section in the travelling direction of the yarn.

[0021] In the above yarn winding machine, the slackening of the yarn during the yarn joining operation can be prevented, and the yarn can be prevented from being entangled around the rotating yarn accumulating roller. Therefore, the yarn can be appropriately accumulated by the yarn accumulating device.

[0022] The above yarn winding machine preferably includes a traverse device adapted to traverse the yarn by a reciprocating traverse guide before the yarn is wound into the package.

[0023] In the above yarn winding machine, since the slackening of the yarn during the yarn joining operation can be prevented, the slackened yarn can be prevented from being caught at the reciprocating traverse guide and causing the yarn breakage. Therefore, the yarn can be appropriately traversed by the traverse device.

[0024] The above yarn winding machine further includes a plurality of winding units and a yarn joining cart. The yarn winding unit includes the yarn supplying section and the winding section. The yarn joining cart includes the yarn joining device, and the yarn joining cart is provided capable of travelling along the plurality of the yarn winding units, to stop near a yarn winding unit in which the yarn is disconnected, and to perform the yarn joining operation by the yarn joining device to the yarn winding unit.

[0025] By providing the yarn joining cart that travels with the yarn joining device mounted thereto, a structure of the entire yarn winding machine can be simplified and a cost can be reduced as compared to the structure in which the yarn joining device is provided for each yarn winding unit.

[0026] According to another aspect of the present invention, a yarn winding unit includes a winding section, a yarn supplying section, a yarn joining device, a yarn-path regulating member, and a control section. The winding section is adapted to wind a yarn into a package. The yarn supplying section is adapted to supply the yarn to the winding section. The yarn joining device is adapted to perform a yarn joining operation to join the yarn between the yarn supplying section and the package. The yarn-path regulating member is adapted to move between a position where the yarn-path regulating member

makes contact with the yarn to bend the yarn and a position where the yarn-path regulating member releases the yarn. The control section is adapted to control the yarn-path regulating member to make contact with the yarn to bend the yarn during the yarn joining operation, and to control the yarn-path regulating member to maintain bending of the yarn after the completion of the yarn joining operation and until at least the winding of the yarn by the winding section is started.

[0027] By resuming the winding of the yarn while the yarn path is regulated by the yarn-path regulating member, the yarn can be prevented from slackening immediately after the completion of the yarn joining operation.

BRIEF DESCRIPTION OF THE DRAWINGS

[0028]

FIG. 1 is a front view illustrating an overall structure of a fine spinning machine according to one embodiment of the present invention;

FIG. 2 is a side view of a spinning unit and a yarn joining cart;

FIG. 3 is a cross-sectional view of a spinning device;

FIG. 4 is a side view illustrating a state in which a yarn breakage occurred in the spinning unit;

FIG. 5 is a side view illustrating a state of sucking and catching the spun yarn with a yarn catching section of the yarn joining cart;

FIG. 6 is a side view illustrating a state in which the spun yarn is guided by the yarn catching section of the yarn joining cart;

FIG. 7 is a side view illustrating a state in which the yarn joining device is advanced to a yarn joining position;

FIG. 8 is a cross-sectional side view of the yarn joining device when the yarn is clamped by a clamping section;

FIG. 9 is a cross-sectional side view of the yarn joining device illustrating a state in which the yarn ends are untwisted;

FIG. 10 is a cross-sectional side view of the yarn joining device illustrating a state in which the yarn ends are twisted;

FIG. 11 is a side view illustrating a state immediately after winding of the spun yarn is resumed after a yarn joining operation is completed;

FIG. 12 is a cross-sectional side view of the yarn joining device illustrating a state in which a yarn-joint is passed through a joint monitoring device; and

FIG. 13 is a cross-sectional side view of the yarn joining device illustrating a state in which a yarn is slackened when a yarn path is not regulated by a yarn-path regulating member.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0029] A fine spinning machine as a yarn winding machine according to one embodiment of the present invention will be described with reference to the drawings. A fine spinning machine (spinning machine) 1 illustrated in FIG. 1 includes a plurality of spinning units (yarn winding units) 2 arranged in line, a yarn joining cart 3, a blower box 80, and a motor box 5.

[0030] A negative pressure source (not illustrated) or the like for supplying negative pressure to each spinning unit 2 is arranged in the blower box 80. A common drive source (not illustrated) for the spinning units 2 is arranged in the motor box 5.

[0031] As illustrated in FIG. 2, each spinning unit 2 includes a draft device 7, a spinning device (yarn supplying section) 9, a yarn accumulating device 12, and a winding device (winding section) 13 arranged in this order from upstream to downstream. Each spinning unit 2 is adapted to spin a fiber bundle 8 fed from the draft device 7 by the spinning device 9 to produce a spun yarn 10, and winds the spun yarn 10 around a bobbin 48 with the winding device 13. The bobbin 48 wound with the spun yarn 10 is referred to as a package 45. "Upstream" and "downstream" respectively refer to upstream and downstream in a travelling direction of the fiber bundle 8 and the spun yarn 10 during a normal winding. The normal winding refers to a state in which the spun yarn 10 between the spinning device 9 and the winding device 13 is in continuation and the package 45 is rotatably driven at a substantially constant peripheral speed so that the spun yarn 10 is wound at a substantially constant speed.

[0032] The draft device 7 is arranged in proximity to an upper end of a frame 6 of the fine spinning machine 1. The draft device 7 includes four draft rollers, i.e., a back roller 16, a third roller 17, a middle roller 19 provided with a rubber apron belt 18, and a front roller 20 in this order from the upstream. Each draft roller is rotatably driven at a predetermined rotation speed. The draft device 7 includes opposing rollers arranged to face the draft rollers. The draft device 7 sandwiches and transports a sliver 15, which is a raw material of the fiber bundle 8, between the rotating draft rollers and the opposing rollers opposing the draft rollers. The draft device 7 drafts the sliver 15 to a predetermined width to obtain the fiber bundle 8.

[0033] The spinning device 9 is arranged immediately downstream of the front roller 20. The fiber bundle 8 drafted by the draft device 7 is supplied to the spinning device 9. The spinning device 9 applies a twist to the fiber bundle 8 supplied from the draft device 7 to produce the spun yarn 10. The spun yarn 10 produced by the spinning device 9 is wound by the winding device 13, to be described later. Therefore, the spinning device 9 is the yarn supplying section adapted to supply the spun yarn 10 to the winding device 13.

[0034] In the fine spinning machine 1 of the present embodiment, an air-jet spinning device which uses whirl-

ing airflow to apply the twist to the fiber bundle 8 is adopted as the spinning device 9. As illustrated in FIG. 3, the spinning device 9 includes a nozzle block 35, a hollow guide shaft body 23, and a fiber guiding section 22.

[0035] A spinning chamber 26 is formed between the nozzle block 35 and the hollow guide shaft body 23. An air injecting nozzle 27 adapted to inject air into the spinning chamber 26 is formed in the nozzle block 35. A yarn introducing port 21 for introducing the fiber bundle 8 into the spinning chamber 26 is formed in the fiber guiding section 22. The air injecting nozzle 27 is adapted to inject the air into the spinning chamber 26 to generate whirling airflow.

[0036] The fiber bundle 8 supplied from the draft device 7 is guided into the spinning chamber 26 by the fiber guiding section 22 having the yarn introducing port 21. In the spinning chamber 26, the twist is applied to the fiber bundle 8 that is swung around the periphery of the hollow guide shaft body 23 by the whirling airflow, and the spun yarn 10 is produced. The twisted spun yarn 10 is passed through a yarn passage 29 formed at an axial center of the hollow guide shaft body 23, and fed to an outside of the spinning device 9 from a yarn exit (not illustrated) on the downstream of the hollow guide shaft body 23.

[0037] A needle-like guide needle 22a is arranged in the yarn introducing port 21. A tip-end of the guide needle 22a is directed towards the spinning chamber 26. The fiber bundle 8 introduced from the yarn introducing port 21 is guided into the spinning chamber 26 so as to be wound around the guide needle 22a. Accordingly, a state of the fiber bundle 8 introduced into the spinning chamber 26 can be stabilized. Since the fiber bundle 8 is guided so as to be wound around the guide needle 22a, even if a twist is applied to the fibers in the spinning chamber 26, the twist is prevented from being propagated to the upstream of the fiber guiding section 22. Accordingly, the twist applied by the spinning device 9 is prevented from influencing the draft device 7. However, the guide needle 22a may be omitted, and a downstream end of the fiber guiding section 22 may function as the guide needle 22a.

[0038] As illustrated in FIG. 2, the winding device 13 is arranged downstream of the spinning device 9. The winding device 13 includes a cradle arm 71, a winding drum 72, and a traverse device 75.

[0039] The winding drum 72 is rotatably driven in one direction at a prescribed rotation speed. The cradle arm 71 can rotatably support the bobbin 48 for winding the spun yarn 10. The cradle arm 71 is supported to be swingable about a supporting shaft 73. When the cradle arm 71 is swung about the supporting shaft 73 while supporting the bobbin 48 (or the package 45 formed by winding the spun yarn 10 around the bobbin 48), the outer periphery of the bobbin 48 (or the package 45) makes contact with or is located away from the winding drum 72. By causing the outer periphery of the bobbin 48 (or the package 45) to make contact with the rotatably-driven winding drum 72, the bobbin 48 (or the package 45) is rotated in one direction accompanying the rotation of the winding drum 72, and the spun yarn 10 can be wound around the bobbin 48 (or the package 45). In the following description, a direction in which the winding drum 72 rotates the package 45 is referred to as a "winding direction". The winding drum 72 of the winding device 13 in each spinning unit 2 is rotatably driven simultaneously by the common drive source (not illustrated) for the plurality of spinning units 2. Accordingly, the package 45 can be rotated simultaneously at the same peripheral speed in the plurality of spinning units 2, and thus the spun yarn 10 can be wound simultaneously.

[0040] The traverse device 75 includes a traverse guide 76 capable of being engaged with the spun yarn 10. The traverse guide 76 is reciprocated in a direction parallel to an axial direction of the winding drum 72 by a driving means (not illustrated). The driving means is arranged in the motor box 5. The winding drum 72 is rotatably driven while reciprocating the traverse guide 76 engaged with the spun yarn 10, and the spun yarn 10 is wound into the package 45 while being traversed.

[0041] The yarn accumulating device 12 is arranged between the spinning device 9 and the winding device 13. As illustrated in FIG. 2, the yarn accumulating device 12 includes a yarn accumulating roller 14, and an electric motor 25 for rotatably driving the yarn accumulating roller 14.

[0042] The yarn accumulating roller 14 can have a prescribed amount of the spun yarn 10 wound around an outer peripheral surface thereof to temporarily accumulate the spun yarn 10. When the yarn accumulating roller 14 is rotated at a predetermined rotation speed with the spun yarn 10 wound around the outer peripheral surface of the yarn accumulating roller 14, the spun yarn 10 can be pulled out at a predetermined speed from the spinning device 9 and transported towards the downstream. Since the yarn accumulating device 12 can temporarily accumulate the spun yarn 10 on the outer peripheral surface of the yarn accumulating roller 14, the yarn accumulating device 12 functions as one type of buffer between the spinning device 9 and the winding device 13. Accordingly, a drawback (e.g., slackening of the spun yarn 10 or the like) when a spinning speed in the spinning device 9 and a winding speed in the winding device 13 do not match for some reason can be resolved.

[0043] Yarn quality measuring equipment 59 is arranged at a position between the spinning device 9 and the yarn accumulating device 12. The spun yarn 10 spun by the spinning device 9 is passed through the yarn quality measuring equipment 59 before being wound by the yarn accumulating device 12. The yarn quality measuring equipment 59 monitors a thickness of the travelling spun yarn 10 with a capacitance sensor (not illustrated). When a yarn defect (area where abnormality is found in thickness or the like of the spun yarn 10) of the spun yarn 10 is detected, the yarn quality measuring equipment 59 transmits a yarn defect detection signal to a unit controller (not illustrated). The yarn quality measuring equipment

59 is not limited to the capacitance sensor and may be a light transmissive sensor. The yarn quality measuring equipment 59 may detect a foreign substance contained in the spun yarn 10 as a yarn defect.

[0044] A cutter (not illustrated) is arranged in proximity to the yarn quality measuring equipment 59. When the yarn defect of the spun yarn 10 is detected by the yarn quality measuring equipment 59, the cutter immediately cuts the spun yarn 10. Instead of using the cutter, the spinning unit 2 may stop the supply of air to the spinning device 9 and cut the spun yarn 10 by interrupting the production of the spun yarn 10.

[0045] As illustrated in FIG. 1, the frame 6 of the fine spinning machine 1 includes a yarn joining cart travelling rail 41 along a direction in which the spinning units 2 are arranged. The yarn joining cart 3 travels on the yarn joining cart travelling rail 41. Accordingly, the yarn joining cart 3 can travel among the plurality of spinning units 2.

[0046] As illustrated in FIG. 1 and FIG. 2, the yarn joining cart 3 includes a yarn joining device 43, a yarn catching section (a suction pipe 44 and a suction mouth 46), a joint monitoring device (a yarn-joint monitoring device) 47, a reverse-rotation driving mechanism 49, and a moving means 30. The yarn joining cart 3 includes a cart control section (not illustrated) for controlling each component of the yarn joining cart 3.

[0047] The suction pipe 44 and the suction mouth 46 can respectively swing vertically with an axis as a center. The suction pipe 44 generates suction airflow at a tip-end thereof to suck and catch the spun yarn 10 fed from the spinning device 9 (see FIG. 5). The suction mouth 46 generates suction airflow at a tip-end thereof to suck and catch the spun yarn 10 from the package 45 supported by the winding device 13 (see FIG. 5). The suction pipe 44 and the suction mouth 46 swing while keeping the sucked and caught spun yarn 10 to guide the spun yarn 10 to a position facing a front side (left side of FIG. 6) of the yarn joining device 43 (a state of FIG. 6) . Operations of the suction pipe 44 and the suction mouth 46 are controlled by the cart control section.

[0048] The yarn joining device 43 can perform the yarn joining operation (join) of the spun yarn 10 from the spinning device 9 guided by the suction pipe 44 and the spun yarn 10 from the package 45 guided by the suction mouth 46. The yarn joining device 43 is configured as a splicer device adapted to form a yarn-joint by applying a twist to the yarn ends with the whirling airflow. The yarn joining device 43 is not limited thereto, and may be a mechanical knotter, for example. Formation of the yarn-joint by the yarn joining device 43 is controlled by the cart control section. When the yarn joining cart 3 stops at the spinning unit 2, the yarn joining device 43 is located between the winding device 13 and the yarn accumulating device 12 in the travelling direction of the spun yarn 10.

[0049] The moving means 30 can move the yarn joining device 43 in a direction of advancing towards or receding from the yarn path during the normal winding (travelling path of the spun yarn 10, vertical direction in plane of drawing in FIG. 2). The yarn joining device 43 carries out the yarn joining operation at a position located close to the yarn path during the normal winding (e.g., a position illustrated in FIG. 7). The position of the yarn joining device 43 at this time is referred to as a "yarn joining position". When the yarn joining operation is not carried out, the yarn joining device 43 is retreated to a position located away from the yarn path during the normal winding (e.g., a position illustrated in FIG. 2). The position of the yarn joining device 43 at this time is referred to as a "retreated position".

[0050] The moving means 30 includes a rail 37 and an air cylinder 38. The rail 37 is arranged in a cart main body of the yarn joining cart 3. The rail 37 has a linear elongate form. The rail 37 is arranged such that a longitudinal direction thereof is along a direction substantially orthogonal to the yarn path during the normal winding (front and back direction of the spinning unit 2, left and right direction in plane of drawing in FIG. 2). The yarn joining device 43 is attached to a supporting bracket 36. The supporting bracket 36 is supported by the rail 37, and is movable along the longitudinal direction of the rail 37. Therefore, the yarn joining device 43 attached to the supporting bracket 36 is movable in a direction substantially orthogonal to the yarn path during the normal winding.

[0051] The air cylinder 38 is a movement driving source for driving the yarn joining device 43 along the rail 37. One end of the air cylinder 38 is attached to the cart main body of the yarn joining cart 3, and the other end is attached to the supporting bracket 36. By extending and contracting the air cylinder 38, the yarn joining device 43 can be linearly moved in the direction along the rail 37 (direction orthogonal to the yarn path during the normal winding). The extending and contracting operation of the air cylinder 38 is controlled by the cart control section.

[0052] Next, a structure of the yarn joining device 43 will be described in detail with reference to FIG. 10. As illustrated in FIG. 10, the yarn joining device 43 includes a yarn joining nozzle 94, clamping sections 97, a yarn-path regulating member (yarn guiding levers 96 and yarn controlling levers 98), cutters 92, and untwisting pipes 82.

[0053] The yarn joining nozzle 94 is arranged on a front side of a main body of the yarn joining device 43. A yarn joining hole 90, through which the spun yarn 10 can be passed, is formed in the yarn joining nozzle 94. An injection port (not illustrated) for injecting compressed air is formed on an inner side of the yarn joining hole 90. By injecting the compressed air into the yarn joining hole 90 from the injection port, the yarn joining nozzle 94 generates the whirling airflow inside the yarn joining hole 90.

[0054] The yarn joining device 43 includes two untwisting pipes 82. The two untwisting pipes 82 are formed in an elongate cylindrical shape. The longitudinal direction of the two untwisting pipes 28 is arranged to be parallel to each other in a front and back direction of the yarn joining device 43. The two untwisting pipes 82 are arranged in line in a direction substantially parallel to the

yarn travelling direction, and each untwisting pipe 82 has one end opened to the front side of the yarn joining device 43. An air injecting hole is formed in each of the untwisting pipes 82 for generating an airflow directed towards a rear side (side opposite to the yarn path) by injecting the compressed air to the inner side of the untwisting pipes 82.

[0055] The yarn joining nozzle 94 and the untwisting pipes 82 are fixedly arranged on the main body of the yarn joining device 43. Therefore, when the moving means 30 moves the yarn joining device 43, the yarn joining nozzle 94 and the untwisting pipes 82 integrally move with the main body of the yarn joining device 43.

[0056] The yarn path regulating member (the yarn guiding levers 96 and the yarn controlling levers 98) is a lever-like member swingably arranged in the main body of the yarn joining device 43. However, in FIG. 8 to FIG. 10 and FIG. 12, only the cross-sections of the yarn guiding levers 96 and the yarn controlling levers 98 are illustrated. The yarn guiding levers 96 and the yarn controlling levers 98 are arranged capable of regulating the yarn path of the spun yarn 10 by making contact with the spun yarn 10. FIG. 8 and the like illustrate a state in which the yarn path is regulated by the yarn guiding levers 96 and the yarn controlling levers 98. The yarn guiding levers 96 and the yarn controlling levers 98 can be swung to a position of not making contact with the spun yarn 10. Accordingly, the spun yarn 10 regulated by the yarn guiding levers 96 and the yarn controlling levers 98 can be released.

[0057] One clamping section 97 is arranged above and below the yarn joining nozzle 94, respectively, in the yarn travelling direction. The clamping sections 97 are configured to be openable and closable. The clamping sections 97 can clamp the spun yarn 10 in a closed state. One cutter 92 is arranged above and below the yarn joining nozzle 94, respectively, in the yarn travelling direction. The cutters 92 can cut the spun yarn 10.

[0058] The yarn joining device 43 includes a cam mechanism (not illustrated) for executing a swinging movement of the yarn guiding levers 96 and the yarn controlling levers 98, the open and close operation of the clamping sections 97, and the cutting operation by the cutters 92. The yarn joining device 43 includes an electric motor 60, which is a drive source of the cam mechanism. By appropriately controlling the operation of the electric motor 60, the clamping and cutting of the spun yarn 10, and/or the regulation of the yarn path or the like can be carried out at an appropriate timing. An operation of the electric motor 60 is controlled by the cart control section. As illustrated in FIG. 2 and the like, the electric motor 60 is arranged in proximity to the main body of the yarn joining device 43, and is fixed with respect to the main body of the yarn joining device 43. When the moving means 30 moves the yarn joining device 43, the electric motor 60, the cam mechanism, and the members driven by the cam mechanism (the yarn guiding levers 96, the yarn controlling levers 98, the clamping sections 97, and the cutters 92) are integrally moved.

[0059] The joint monitoring device 47 adapted to measure the quality of the spun yarn 10 that has been joined by the yarn joining device 43 is arranged immediately downstream of the yarn joining device 43. In the present embodiment, the joint monitoring device 47 monitors a thickness of the yarn-joint formed by the yarn joining device 43 with a capacitance sensor. A structure of the joint monitoring device 47 is not limited thereto, and the thickness of the yarn-joint may be monitored with a light transmissive sensor, for example. Information detected by the joint monitoring device 47 is transmitted to the cart control section. The joint monitoring device 47 is fixed to the supporting bracket 36. Therefore, when the moving means 30 moves the yarn joining device 43, the joint monitoring device 47 moves simultaneously with the yarn joining device 43.

[0060] Next, the reverse-rotation driving mechanism 49 will be described. As illustrated in FIG. 2 and the like, the reverse-rotation driving mechanism 49 includes a first supporting arm 61 and a second supporting arm 62, a reversely-rotating roller 63, and a reversely-rotating roller driving motor (not illustrated), which is a drive source of the reversely-rotating roller 63.

[0061] The reversely-rotating roller 63 is rotatably driven by a driving force from the reversely-rotating roller driving motor (not illustrated). An operation of the reversely-rotating roller driving motor is controlled by the cart control section.

[0062] One end of the first supporting arm 61 is rotatably attached to a housing main body of the yarn joining cart 3. The second supporting arm 62 is swingably provided on the other end of the first supporting arm 61. The reversely-rotating roller 63 is rotatably arranged at a tip-end of the second supporting arm 62. The yarn joining cart 3 includes a link rod 64 swingably arranged with respect to the housing of the yarn joining cart 3. A tip-end of the link rod 64 is coupled to the second supporting arm 62. A reversely-rotating roller advancing-and-retrieving air cylinder 66 is attached to the link rod 64. The link rod 64 can be swung by advancement and retrieval of the reversely-rotating roller advancing-and-retrieving air cylinder 66.

[0063] The first supporting arm 61, the second supporting arm 62, and the link rod 64 configure a link mechanism. By extending and contracting the reversely-rotating roller advancing-and-retrieving air cylinder 66 connected to the link mechanism, the reversely-rotating roller 63 at the tip-end of the second supporting arm 62 can be advanced and retrieved. The reversely-rotating roller 63 thus can be moved between a "retreated position" where the reversely-rotating roller 63 does not make contact with the package 45 (e, g. , the position illustrated in FIG. 2) and a "contacting position" where the reversely-rotating roller 63 makes contact with the package 45 (e. g. , a position illustrated in FIG. 5). An operation of the reversely-rotating roller advancing-and-retrieving air cylinder 66 is controlled by the cart control section.

[0064] Next, the yarn joining operation by the yarn join-

ing cart 3 will be described. The yarn joining operation is performed when the spun yarn 10 between the spinning device 9 and the package 45 is disconnected due to some reason in a certain spinning unit 2.

[0065] In a certain spinning unit 2, for example, when the spun yarn 10 between the spinning device 9 and the package 45 is disconnected as in FIG. 4, the unit controller of the spinning unit 2 carries out a control to swing and drive the cradle arm 71 to move the package 45 away from the winding drum 72, and activates a brake mechanism (not illustrated) arranged in the winding device 13. As a result, the package 45 stops the rotation.

[0066] The unit controller then transmits a control signal to the yarn joining cart 3. The yarn joining cart 3 that received the control signal travels to the target spinning unit 2 on the yarn joining cart travelling rail 41 and stops thereat. When the yarn joining cart 3 travels along the spinning units 2, the yarn joining device 43 is retreated to the retreated position by the moving means 30.

[0067] As illustrated in FIG. 5, when the yarn joining cart 3 stops at the target spinning unit 2, the cart control section swings the suction pipe 44 and the suction mouth 46 to respectively suck and catch the yarn end from the spinning device 9 and the yarn end from the package 45.

[0068] In this case, the cart control section controls the reversely-rotating roller advancing-and-retrieving air cylinder 66 to advance the reversely-rotating roller 63 to the contacting position and cause the reversely-rotating roller 63 to make contact with the package 45. The cart control section rotatably drives the reversely-rotating roller 63 in a direction opposite to the winding drum 72 with the reversely-rotating driving motor. Accordingly, the package 45 is rotatably driven in a direction opposite to the winding direction (hereinafter referred to as an unwinding direction). By sucking the spun yarn 10 at a surface of the package 45 by the suction mouth 46, the spun yarn 10 is pulled out from the package 45 and caught by the suction mouth 46.

[0069] Then, by swinging the suction pipe 44 and the suction mouth 46 in the opposite direction while keeping the caught spun yarn 10, the cart control section guides the caught spun yarn 10 to a position facing the front side of the yarn joining device 43 (a state of FIG. 6). When the guiding of the spun yarn 10 by the suction pipe 44 and the suction mouth 46 is finished, the cart control section stops the rotation of the reversely-rotating roller 63. Accordingly, the package 45 becomes stationary.

[0070] Then, the moving means 30 extends the air cylinder 38, and moves the yarn joining device 43 in a direction of approaching the yarn path to advance to the yarn joining position. When the yarn joining device 43 is advanced to the yarn joining position, the spun yarn 10 from the spinning device 9 caught by the suction pipe 44 and the spun yarn 10 from the package 45 caught by the suction mouth 46 are guided to the yarn joining device 43 (a state of FIG. 7). As illustrated in FIG. 7 and the like, the joint monitoring device 47 is arranged such that when the moving means 30 advances the yarn joining device 43 to the yarn joining position, the spun yarn 10 is introduced into the joint monitoring device 47. Therefore, by advancing the yarn joining device 43 to the yarn joining position, the spun yarn 10 can be inspected by the joint monitoring device 47.

[0071] When the yarn joining device 43 is advanced to the yarn joining position, the cart control section appropriately controls the electric motor 60 to swing the yarn guiding levers 96 to make contact with the spun yarn 10. Accordingly, the spun yarn 10 between the package 45 and the suction mouth 46 and the spun yarn 10 between the spinning device 9 and the suction pipe 44 are respectively bent by the yarn guiding levers 96, and the yarn path of the spun yarn 10 is regulated. The yarn guiding levers 96 bend the spun yarn 10 to a position where the spun yarn 10 can be clamped by the clamping sections 97 (a state of FIG. 8). The cart control section appropriately controls the electric motor 60 to close the clamping sections 97, and the spun yarn 10 is clamped by the clamping sections 97.

[0072] Then, the cart control section starts the injection of the compressed air into the untwisting pipes 82. The airflow directed towards the rear side of the yarn joining device 43 (right side in the drawing of FIG. 8) is thus generated in the untwisting pipes 82. Suction airflow is generated at the opening on the front side of the untwisting pipes 82 (left side in the drawing of FIG. 8). Before or after this operation, the cart control section appropriately controls the electric motor 60 to operate the cutters 92 to cut the spun yarn 10 between the suction pipe 44 and the yarn joining device 43 and the spun yarn 10 between the suction mouth 46 and the yarn joining device 43, respectively. The yarn ends formed by the cutting are respectively sucked by the untwisting pipes 82, and pulled into the untwisting pipes 82. The pulled-in yarn ends are subjected to action of the airflow in the untwisting pipes 82, and the twisting of the fibers is resolved and untwisted (FIG. 9).

[0073] When the untwisting of the yarn ends is finished, the cart control section terminates the injection of the compressed air into the untwisting pipes 82. Furthermore, the cart control section appropriately controls the electric motor 60 to further bend the yarn path of the spun yarn 10 by the yarn guiding levers 96 and the yarn controlling levers 98, and pulls out the untwisted yarn ends from the untwisting pipes 82. The yarn ends pulled out from the untwisting pipes 82 are set to overlap each other in the yarn joining hole 90 of the yarn joining nozzle 94 (FIG. 10) . When the compressed air is injected into the yarn joining hole 90, the whirling airflow is generated in the yarn joining hole 90 to twist the fibers. Accordingly, the yarn end of the spun yarn 10 from the spinning device 9 and the yarn end of the spun yarn 10 from the package 45 are twisted together and connected to form a yarn-joint.

[0074] After the yarn-joint is formed, the cart control section stops the injection of air into the yarn joining hole 90. The cart control section appropriately controls the

electric motor 60 to open the clamping sections 97 to release the clamped spun yarn 10. Next, the unit controller of the spinning unit 2 swings the cradle arm 71 to cause the outer peripheral surface of the package 45 to make contact with the rotating winding drum 72 (a state of FIG. 11). The package 45 in contact with the winding drum 72 thus resumes the rotation in the winding direction, and the winding of the spun yarn 10 is started.

[0075] In the present embodiment, when opening the clamping sections 97 to release the spun yarn 10, the cart control section controls the electric motor 60 such that the yarn-path regulating member (the yarn guiding levers 96 and the yarn controlling levers 98) remains still without swinging, and the bending of the spun yarn 10 by the yarn-path regulating member is maintained. Therefore, in the present embodiment, the winding of the spun yarn 10 is resumed while the yarn path is regulated. At the start of the winding of the spun yarn 10, if the yarn-path regulating member (the yarn guiding levers 96 and the yarn controlling levers 98) is swung so that the yarn-path regulating member does not make contact with the spun yarn 10 and then the winding is resumed, the spun yarn 10 bent by the yarn-path regulating member becomes free and the spun yarn 10 slackens, as illustrated in FIG. 13.

[0076] In the present embodiment, since the state in which the spun yarn 10 is bent by the yarn-path regulating member is maintained when the winding is resumed, the winding of the spun yarn 10 can be resumed while the yarn path is regulated. Accordingly, the spun yarn 10 can be prevented from slackening when resuming the winding of the spun yarn 10.

[0077] In the present embodiment, the yarn accumulating device 12 is arranged between the spinning device 9 and the yarn joining device 43. The winding of the spun yarn 10 by the winding device 13 is interrupted during the yarn joining operation, but the spinning of the spun yarn 10 by the spinning device 9 is continued. The yarn accumulating device 12 winds the spun yarn 10 spun from the spinning device 9 around the yarn accumulating roller 14 and temporarily accumulates the spun yarn 10. In the present embodiment, the spinning device 9 is an air-jet spinning device. The air-jet spinning device can perform high speed spinning, and the spun yarn 10 is spun at high speed. Thus, since the spun yarn 10 spun at high speed from the spinning device 9 is sequentially accumulated in the yarn accumulating device 12 during the yarn joining operation, there is only a short period of time until an accumulation limit of the yarn accumulating device 12 is exceeded. In the fine spinning machine 1 of the present embodiment provided with the air-jet spinning device 9, the winding of the spun yarn 10 cannot be interrupted for a long period of time during the yarn joining operation.

[0078] In the conventional fine spinning machine provided with the air-jet spinning device, in order to resume the winding of the spun yarn 10 as early as possible, the regulation of the yarn path by the yarn-path regulating member is released immediately after the yarn joining operation is completed. At a point of time when the regulation of the yarn path is released, the winding of the spun yarn 10 is resumed. In the conventional fine spinning machine, since the winding is started after the regulation of the yarn path is released, the slackening of the spun yarn 10 has occurred.

[0079] Although the yarn-path regulating member (the yarn guiding levers 96 and the yarn controlling levers 98) makes contact with the spun yarn 10, the yarn-path regulating member does not clamp the spun yarn 10. Thus, even if the yarn path of the spun yarn 10 is regulated by the yarn-path regulating member (the spun yarn 10 is bent), the spun yarn 10 can travel. After the yarn joining operation performed by the yarn joining device 43 is completed, and at the stage the clamping of the spun yarn 10 by the clamping sections 97 is released, the fine spinning machine 1 of the present embodiment resumes the winding of the spun yarn 10 while continuing the regulation of the yarn path (while maintaining the bending of the spun yarn 10) by the yarn-path regulating member. The winding of the spun yarn 10 can be resumed at a point of time when the clamping of the spun yarn 10 by the clamping sections 97 is released. Accordingly, the winding can be resumed at an early stage after the completion of the yarn joining operation while regulating the yarn path of the spun yarn 10. Therefore, the spun yarn 10 in the yarn accumulating device 12 can be prevented from exceeding the accumulation limit of the yarn accumulating device 12.

[0080] When the winding of the spun yarn 10 is resumed as described above, a yarn-joint 99 formed by the yarn joining device 43 is passed through the joint monitoring device 47, as illustrated in FIG. 12. The yarn-joint 99 is inspected by the joint monitoring device 47. Based on an inspection result by the joint monitoring device 47, the cart control section determines the quality of the yarn-joint 99. Therefore, the cart control section is a determination section. For example, if the yarn-joint 99 is a defective yarn-joint that does not satisfy a dimensional condition of predetermined thickness, length, or the like, the yarn joining cart 3 cuts and removes the defective yarn-joint with the cutter (not illustrated) and performs the yarn joining operation again by the yarn joining device 43. According to the structure of the present embodiment, the slackening of the spun yarn 10 immediately after the winding is resumed can be prevented, and the spun yarn 10 can be prevented from passing the joint monitoring device 47 in a slackened state. Therefore, in the joint monitoring device 47, the quality of the yarn-joint 99 can be accurately inspected.

[0081] After the inspection of the yarn-joint 99 by the joint monitoring device 47 is completed, the cart control section appropriately controls the electric motor 60 to release the regulation of the yarn path by the yarn-path regulating member (the yarn guiding levers 96 and the yarn controlling levers 98) . In this case, the cart control section appropriately controls the electric motor 60 to

swing the yarn-path regulating member at a speed the yarn-path regulating member (the yarn guiding levers 96 and the yarn controlling levers 98) can maintain the bending of the spun yarn 10. The cart control section slowly moves the yarn-path regulating member. If the yarn-path regulating member is promptly moved, the yarn-path regulating member moves away from the spun yarn 10. As a result, the spun yarn 10 cannot be bent by the yarn-path regulating member (the spun yarn 10 becomes free), and the spun yarn 10 slackens. By slowly moving the yarn-path regulating member, the spun yarn 10 can be released while regulating the yarn path of the spun yarn 10 (while maintaining the bending of the spun yarn 10) by the yarn-path regulating member. As a result, the slackening of the spun yarn 10 can be prevented.

[0082] In the conventional spinning machine, in order to resume the winding of the spun yarn 10 as quickly as possible, it is considered that the regulation of the yarn path by the yarn-path regulating member should be released as quickly as possible. However, on the contrary, in the present embodiment, the winding of the spun yarn 10 is resumed while the yarn path is regulated by the yarn-path regulating member. Therefore, the release of the yarn path by the yarn-path regulating member is not required to be carried out promptly. The yarn-path regulating member can be moved slowly for a certain period of time. Accordingly, the state in which the yarn path is regulated by the yarn-path regulating member (the state in which the spun yarn 10 is bent) is thus reliably maintained, and the spun yarn 10 can be reliably prevented from slackening.

[0083] When the yarn-path regulating member (the yarn guiding levers 96 and the yarn controlling levers 98) is swung and the yarn path of the spun yarn 10 is returned to the yarn path during the normal winding (i. e. , when the yarn path of the spun yarn 10 bent by the yarn-path regulating member is returned to a linear state), the yarn-path regulating member moves away from the spun yarn 10. Accordingly, the spun yarn 10 can be released from the yarn-path regulating member. After the spun yarn 10 is released from the yarn-path regulating member, the moving means 30 moves the yarn joining device 43 to the retreated position. Accordingly, the yarn joining cart 3 becomes capable of travelling, and can travel to another spinning unit 2.

[0084] As described above, the fine spinning machine 1 of the present embodiment includes the winding device 13, the spinning device 9, the yarn joining device 43, the yarn-path regulating member (the yarn guiding levers 96 and the yarn controlling levers 98), and the cart control section. The winding device 13 is adapted to wind the spun yarn 10 into the package 45. The spinning device 9 is adapted to supply the spun yarn 10 to the winding device 13. The yarn joining device 43 is adapted to perform the yarn joining operation to join the spun yarn 10 between the spinning device 9 and the package 45. The yarn-path regulating member can move between the position of bending the spun yarn 10 by making contact with the spun yarn 10, and the position of releasing the spun yarn 10. The cart control section is adapted to control the yarn-path regulating member to make contact with the spun yarn 10 to bend the spun yarn 10 during the yarn joining operation, and to control the yarn-path regulating member to maintain the bending of the spun yarn 10 after the completion of the yarn joining operation and until at least the winding of the spun yarn 10 by the winding device 13 is started.

[0085] By starting the winding of the spun yarn 10 while the yarn path is regulated by the yarn-path regulating member, the spun yarn 10 can be prevented from slackening immediately after the completion of the yarn joining operation.

[0086] The fine spinning machine 1 of the present embodiment includes the joint monitoring device 47 adapted to inspect the quality of the yarn-joint 99 formed by the yarn joining operation performed by the yarn joining device 43. After the completion of the yarn joining operation performed by the yarn joining device 43, and until the yarn-joint 99 passes at least the joint monitoring device 47, the cart control section controls the yarn-path regulating member to maintain the bending of the spun yarn 10.

[0087] Accordingly, the joint monitoring device 47 can inspect the yarn-joint 99 while the yarn path is regulated by the yarn-path regulating member. Since the spun yarn 10 does not slacken when the joint monitoring device 47 inspects the yarn-joint 99, the inspection accuracy of the yarn-joint 99 can be improved.

[0088] The fine spinning machine 1 of the present embodiment further includes the clamping sections 97 adapted to clamp the spun yarn 10 during the yarn joining operation performed by the yarn joining device 43. After the completion of the yarn joining operation performed by the yarn joining device 43, the cart control section performs the control to release the spun yarn 10 clamped by the clamping sections 97, and start the winding of the spun yarn 10 by the winding device 13 with the spun yarn 10 bent by the yarn-path regulating member.

[0089] By releasing the spun yarn 10 clamped by the clamping sections 97, the spun yarn 10 becomes capable of travelling, and the winding of the spun yarn 10 can be started. By continuing the regulation of the yarn path by the yarn-path regulating member at the start of the winding, the spun yarn 10 can be prevented from slackening.

[0090] In the fine spinning machine 1 of the present embodiment, the spinning device 9 is an air-jet spinning device adapted to twist the fiber bundle 8 by whirling airflow to produce the spun yarn 10.

[0091] In the air-jet spinning device 9, since the speed of producing the spun yarn 10 is high, the fluctuation of the yarn path easily influences the spinning of the spinning device 9. Thus, by preventing the slackening of the spun yarn 10 immediately after the completion of the yarn joining operation, the quality of the produced spun yarn 10 can be improved.

[0092] In the fine spinning machine 1 of the present

embodiment, after the completion of the yarn joining operation performed by the yarn joining device 43, and until at least the winding of the spun yarn 10 by the winding device 13 is started, the cart control section controls the yarn-path regulating member to stop while bending the spun yarn 10, and thereafter to move to a position to release the spun yarn 10.

[0093] By once stopping the yarn-path regulating member, the state in which the spun yarn 10 is bent by the yarn-path regulating member can be reliably maintained. As a result, the spun yarn 10 can be reliably prevented from slackening.

[0094] In the fine spinning machine 1 of the present embodiment, when the yarn-path regulating member is moved from the position where the yarn-path regulating member bends the spun yarn 10 to the position where the yarn-path regulating member releases the spun yarn 10, the cart control section controls the yarn-path regulating member to move under a speed in which the bending of the spun yarn 10 can be maintained.

[0095] When releasing the spun yarn 10, the yarn-path regulating member is slowly moved. Accordingly, the yarn-path regulating member can be moved while the yarn path is regulated by the yarn-path regulating member. As a result, the spun yarn 10 can be prevented from slackening when the yarn-path regulating member releases the spun yarn 10.

[0096] The fine spinning machine 1 of the present embodiment further includes a yarn accumulating device 12 arranged between the spinning device 9 and the winding device 13 in the travelling direction of the spun yarn 10 and adapted to temporarily accumulate the spun yarn 10 by winding the spun yarn 10 around the outer periphery of the rotating yarn accumulating roller 14. The yarn joining device 43 performs the yarn joining operation between the yarn accumulating device 12 and the winding device 13 in the travelling direction of the spun yarn 10.

[0097] Since the slackening of the spun yarn 10 during the yarn joining operation can be prevented in the fine spinning machine 1, the spun yarn 10 can be prevented from entangling around the rotating yarn accumulating roller 14. Therefore, the spun yarn 10 can be appropriately accumulated by the yarn accumulating device 12.

[0098] The fine spinning machine 1 of the present embodiment further includes a traverse device 75 adapted to traverse the spun yarn 10 by a reciprocating traverse guide 76 before the spun yarn 10 is wound into the package 45.

[0099] In the fine spinning machine 1, since the slackening of the spun yarn 10 during the yarn joining operation can be prevented, the slackened spun yarn 10 can be prevented from being caught at the reciprocating traverse guide 76 and causing a yarn breakage. Therefore, the spun yarn 10 can be appropriately traversed by the traverse device 75.

[0100] The fine spinning machine 1 of the present embodiment includes a plurality of spinning units 2 and a yarn joining cart 3. The spinning unit 2 includes the spinning device 9 and the winding device 13. The yarn joining cart 3 includes the yarn joining device 43, and can travel to the plurality of spinning units 2 and stop in proximity of the spinning unit 2 in which the spun yarn 10 is disconnected to perform the yarn joining operation to the target spinning unit 2 by the yarn joining device 43.

[0101] By providing the yarn joining cart 3 that travels with the yarn joining device 43 mounted thereto, the structure of the entire fine spinning machine 1 can be simplified and the cost can be reduced as compared to the structure in which the yarn joining device 43 is provided for each spinning unit 2.

[0102] The preferred embodiments of the present invention have been described above, but the structures described above may be modified as below.

[0103] In the embodiments described above, the yarn joining cart 3 includes the yarn joining device 43, but the present invention is not limited thereto. The spinning unit 2 includes the winding device 13, the spinning device 9, the yarn joining device 43, the yarn-path regulating member (the yarn guiding levers 96 and the yarn controlling levers 98), and the cart control section. The winding device 13 winds the spun yarn 10 into the package 45. The spinning device 9 supplies the spun yarn 10 to the winding device 13. The yarn joining device 43 performs the yarn joining operation to join the spun yarn 10 between the spinning device 9 and the package 45. The yarn-path regulating member is movable between the position of bending the spun yarn 10 by making contact with the spun yarn 10 and the position of releasing the spun yarn 10. The cart control section controls the yarn-path regulating member to make contact with the spun yarn 10 to bend the spun yarn 10 during the yarn joining operation, and to control the yarn-path regulating member to maintain the bending of the spun yarn 10 after the completion of the yarn joining operation and until at least the winding of the spun yarn 10 by the winding device 13 is started.

[0104] Each spinning unit 2 may include the yarn joining device 43.

[0105] In the embodiments described above, when the yarn-path regulating member (the yarn guiding levers 96 and the yarn controlling levers 98) releases the spun yarn 10, the cart control section appropriately controls the electric motor 60 to slowly move the yarn-path regulating member. When regulating the yarn path of the spun yarn 10 by the yarn-path regulating member (when moving the yarn-path regulating member in a direction of making contact with the spun yarn 10), necessity to slowly move the yarn-path regulating member is low. Thus, for example, when releasing the spun yarn 10 from the yarn-path regulating member, the control can be suitably performed to drive the electric motor 60 slower than in the case of starting to regulate the yarn path of the spun yarn 10.

[0106] In the embodiments described above, the cart control section appropriately controls the electric motor 60 to control the yarn-path regulating member (the yarn guiding levers 96 and the yarn controlling levers 98), the clamping sections 97, the cutters 92, and the like. A mov-

ing speed, a movement timing, and the like of the yarn-path regulating member (the yarn guiding levers 96 and the yarn controlling levers 98) and the like can be appropriately controlled by changing and controlling a driving speed and a driving direction of the electric motor 60. However, for example, the electric motor 60 may be controlled to be driven at a prescribed (constant) driving speed. In other words, if a shape of a cam of the cam mechanism is appropriately set, the yarn-path regulating member and the like can be controlled to move at an appropriate speed and timing by simply driving the electric motor 60 at a prescribed driving speed.

[0107] The mechanism for moving the yarn-path regulating member (the yarn guiding levers 96 and the yarn controlling levers 98) is not limited to the cam mechanism, and an appropriate structure may be adopted.

[0108] In the embodiments described above, the yarn-path regulating member (the yarn guiding levers 96 and the yarn controlling levers 98) is maintained still until the yarn-joint 99 passes the joint monitoring device 47, and thereafter, the yarn-path regulating member is slowly moved (while maintaining the regulation of the yarn path). However, the yarn-path regulating member may be controlled to slowly move (while maintaining the regulation of the yarn path) immediately after the clamping of the spun yarn 10 by the clamping sections 97 is released. Also in this case, the yarn path of the spun yarn 10 can be regulated to prevent the slackening of the spun yarn 10.

[0109] In the embodiments described above, the yarn-path regulating member releases the spun yarn 10 after the yarn-joint 99 passes the joint monitoring device 47. Whether or not the yarn-joint 99 passed the joint monitoring device 47 can be determined based on a detection result of the joint monitoring device 47. Therefore, based on the detection result of the joint monitoring device 47, the regulation of the yarn path of the spun yarn 10 by the yarn-path regulating member can be released. However, if a period of time sufficient for the yarn-joint 99 to pass the joint monitoring device 47 has elapsed after the winding of the spun yarn 10 by the winding device 13 is resumed, the regulation of the yarn path of the spun yarn 10 by the yarn-path regulating member may be released.

[0110] In the embodiments described above, by rotating the yarn accumulating roller 14 of the yarn accumulating device 12, the spun yarn 10 is pulled out from the spinning device 9. Alternatively, as described in Japanese Unexamined Patent Publication No. 2005-220484, for example, a yarn feeding device may be arranged in which the spun yarn is sandwiched with a delivery roller and a nip roller and the rollers are rotated to pull out the spun yarn from the spinning device.

[0111] The joint monitoring device 47 may move independently from the yarn joining device 43. However, in order to simplify the structure of the fine spinning machine 1, the joint monitoring device 47 and the yarn joining device 43 is desirably moved simultaneously.

[0112] The structure for inspecting the yarn joint 99 formed by the yarn joining device 43 may be omitted. In this case, the joint monitoring device 47 may be omitted.

[0113] In the embodiments described above, the travelling direction of the spun yarn 10 is from top to bottom in a height direction of the fine spinning machine 1, but the travelling direction of the spun yarn 10 is not particularly limited. For example, the travelling direction of the spun yarn 10 may be from the bottom to the top in the height direction of the fine spinning machine 1.

[0114] In FIG. 2 and the like, the yarn path of the spun yarn 10 is in a substantially vertical direction, but the present invention is not limited thereto. For example, when the winding device 13 is located more closer to a rear side of the spinning unit 2 than a position illustrated in FIG. 2, the yarn path may be formed inclining from the front side to the rear side.

[0115] In FIG. 1 and the like, the fine spinning machine 1 includes one yarn joining cart 3, but a plurality of yarn joining carts 3 may be arranged according to the number of spinning units 2.

[0116] In the embodiments described above, the winding drum 72 is commonly driven for the plurality of spinning units 2. The winding drum 72 may be individually driven in the respective spinning unit 2. In this case, since the rotation speed and the rotating direction of the winding drum 72 can be changed in each spinning unit 2, the package 45 may be reversely rotated by rotating the winding drum 72 in an opposite direction. In this case, the reversely-rotating roller 63 may be omitted.

[0117] The structure of arranging the yarn joining device 43 movable with respect to the yarn path may be omitted.

[0118] The spinning device is not limited to the air-jet spinning device, and may be other types of spinning devices. The structure of the present invention is not limited to the spinning machine, and may be widely applied to other types of yarn winding machines such as an automatic winder.

Claims

1. An apparatus for joining a yarn (10), the apparatus comprising:

   a yarn joining device (43) adapted to perform a yarn joining operation to join the yarn (10),
   a yarn-path regulating member (96, 98) adapted to move between a position where the yarn-path regulating member (96, 98) makes contact with the yarn (10) to bend the yarn (10) and a position where the yarn-path regulating member (96, 98) releases the yarn (10), and
   a control section adapted to control the yarn-path regulating member (96, 98) to make contact with the yarn (10) to bend the yarn (10) during the yarn joining operation, and to control the yarn-path regulating member (96, 98) to main-

tain bending of the yarn (10) after completion of the yarn joining operation and until at least winding of the yarn (10) is started.

2. A yarn winding machine comprising:

a winding section (13) adapted to wind a yarn (10) into a package (45),
a yarn supplying section (9) adapted to supply the yarn (10) to the winding section (13), and
an apparatus for joining the yarn (10) according to claim 1,
wherein the yarn joining device (43) is adapted to perform the yarn joining operation to join the yarn (10) between the package (45) and the yarn supplying section (9), and
wherein the control section is adapted to control the yarn-path regulating member (96, 98) to maintain bending of the yarn (10) after completion of the yarn joining operation and until at least winding of the yarn (10) by the winding section (13) is started.

3. The yarn winding machine according to claim 2, further comprising a joint monitoring device (47) adapted to inspect a quality of a yarn-joint (99) formed by the yarn joining operation performed by the yarn joining device (43),
wherein after completion of the yarn joining operation performed by the yarn joining device (43), and until the yarn-joint (99) passes at least the joint monitoring device (47), the control section is adapted to control the yarn-path regulating member (96, 98) to maintain the bending of the yarn (10).

4. The yarn winding machine according to any one of claim 1 through claim 3, further comprising a clamping section (97) adapted to clamp the yarn (10) during the yarn joining operation performed by the yarn joining device (43),
wherein the control section is adapted to control the clamping section (97) to release the clamped yarn (10) after the completion of the yarn joining operation performed by the yarn joining device (43), and to control the winding section (13) to start winding of the yarn (10) while controlling the yarn-path regulating member (96, 98) to maintain the bending of the yarn (10).

5. The yarn winding machine according to any one of claim 1 through claim 4, wherein the yarn supplying section (9) is an air-jet spinning device adapted to twist a fiber bundle (8) by whirling airflow to produce a spun yarn (10).

6. The yarn winding machine according to any one of claim 1 through claim 5, wherein after completion of the yarn joining operation performed by the yarn joining device (43), and until at least the winding of the yarn (10) by the winding section (13) is started, the control section is adapted to control the yarn-path regulating member (96, 98) to stop while bending the yarn (10), and after the winding of the yarn (10) by the winding section (13) is started, the control section is adapted to control the yarn-path regulating member (96, 98) to move a position to release the yarn (10).

7. The yarn winding machine according to any one of claim 1 through claim 6, wherein when moving the yarn-path regulating member (96, 98) from the position where the yarn-path regulating member (96, 98) bends the yarn (10) to the position where the yarn-path regulating member (96, 98) releases the yarn (10), the control section is adapted to control the yarn-path regulating member (96, 98) to move with a speed such that the yarn-path regulating member (96, 98) can maintain the bending of the yarn (10).

8. The yarn winding machine according to any one of claim 1 through claim 7, further comprising a yarn accumulating device (12) arranged between the yarn supplying section (9) and the winding section (13) in a travelling direction of the yarn (10) and adapted to accumulate the yarn (10) by winding the yarn (10) around an outer periphery of a rotating yarn accumulating roller (14),
wherein the yarn joining device (43) is adapted to perform the yarn joining operation between the yarn accumulating device (12) and the winding section (13) in the travelling direction of the yarn (10).

9. The yarn winding machine according to any one of claim 1 through claim 8, further comprising a traverse device (75) adapted to traverse the yarn (10) by a reciprocating traverse guide (76) before the yarn (10) is wound into the package (45).

10. The yarn winding machine according to any one of claim 1 through claim 9, further comprising:

a plurality of yarn winding units (2), each yarn winding unit (2) including the yarn supplying section (9) and the winding section (13), and
a yarn joining cart (3) including the yarn joining device (43), the yarn joining cart (3) being provided capable of travelling along the plurality of the yarn winding units (2), to stop near a yarn winding unit (2) in which the yarn (10) is disconnected, and to perform the yarn joining operation by the yarn joining device (43) to the yarn winding unit (2).

11. A yarn winding unit comprising:

a winding section (13) adapted to wind a yarn (10) into a package (45),
a yarn supplying section (9) adapted to supply the yarn (10) to the winding section (13), and
an apparatus for joining the yarn (10) according to claim 1,
wherein the yarn joining device (43) is adapted to perform a yarn joining operation to join the yarn (10) between the package (45) and the yarn supplying section (9), and
wherein the control section is adapted to control the yarn-path regulating member (96, 98) to maintain bending of the yarn (10) after completion of the yarn joining operation and until at least winding of the yarn (10) by the winding section (13) is started.

FIG. 1

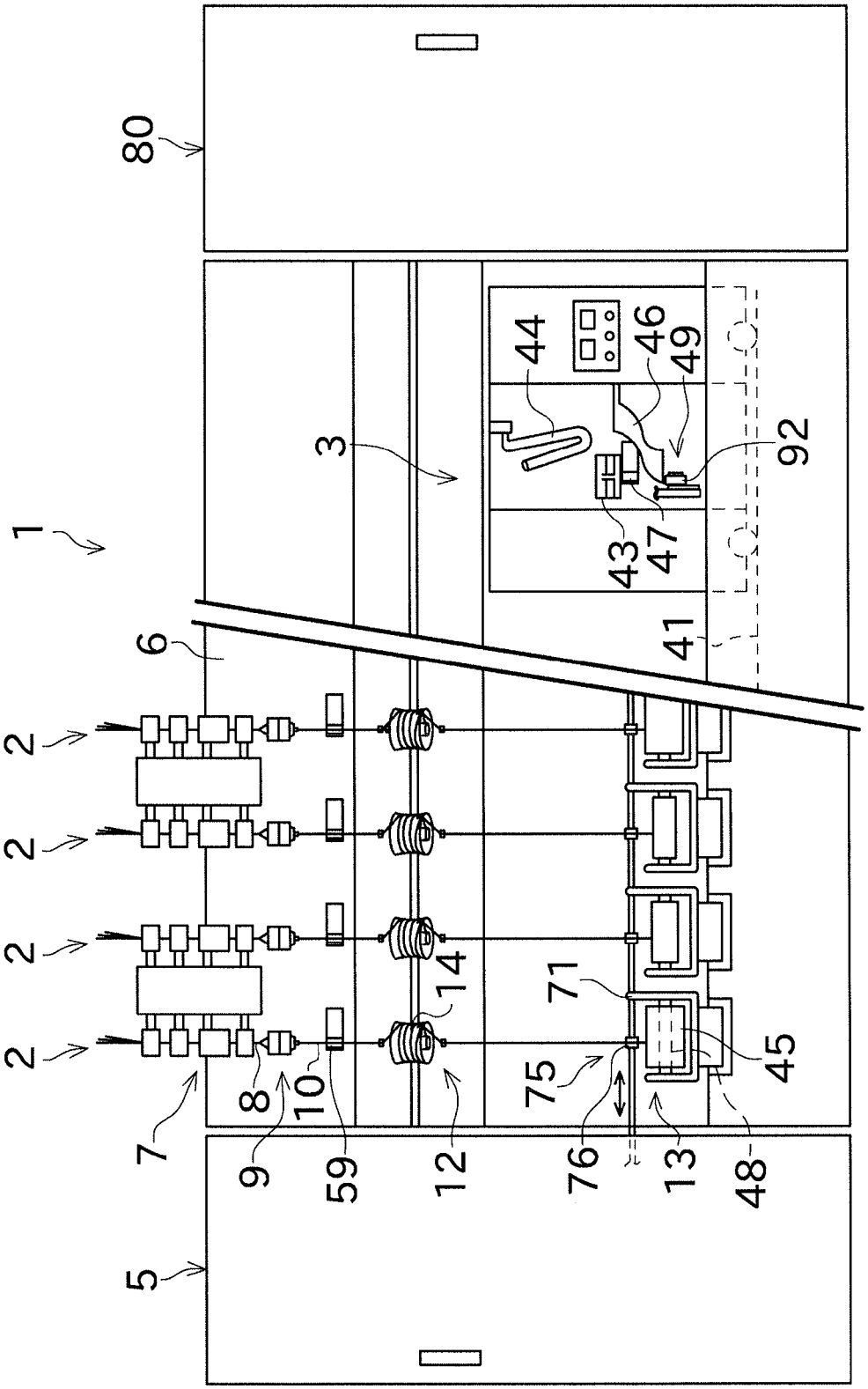

FIG. 2

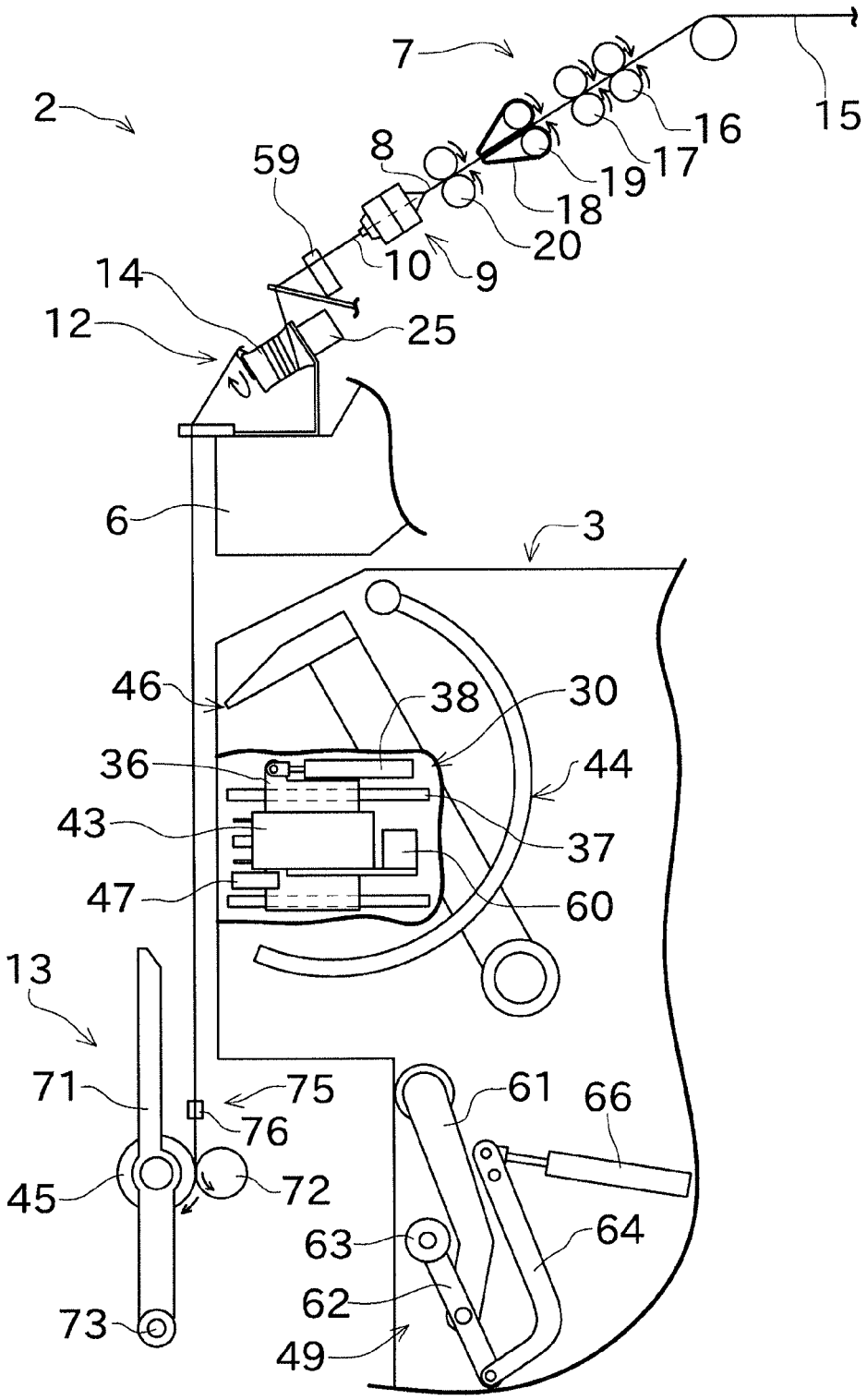
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FIG. 3

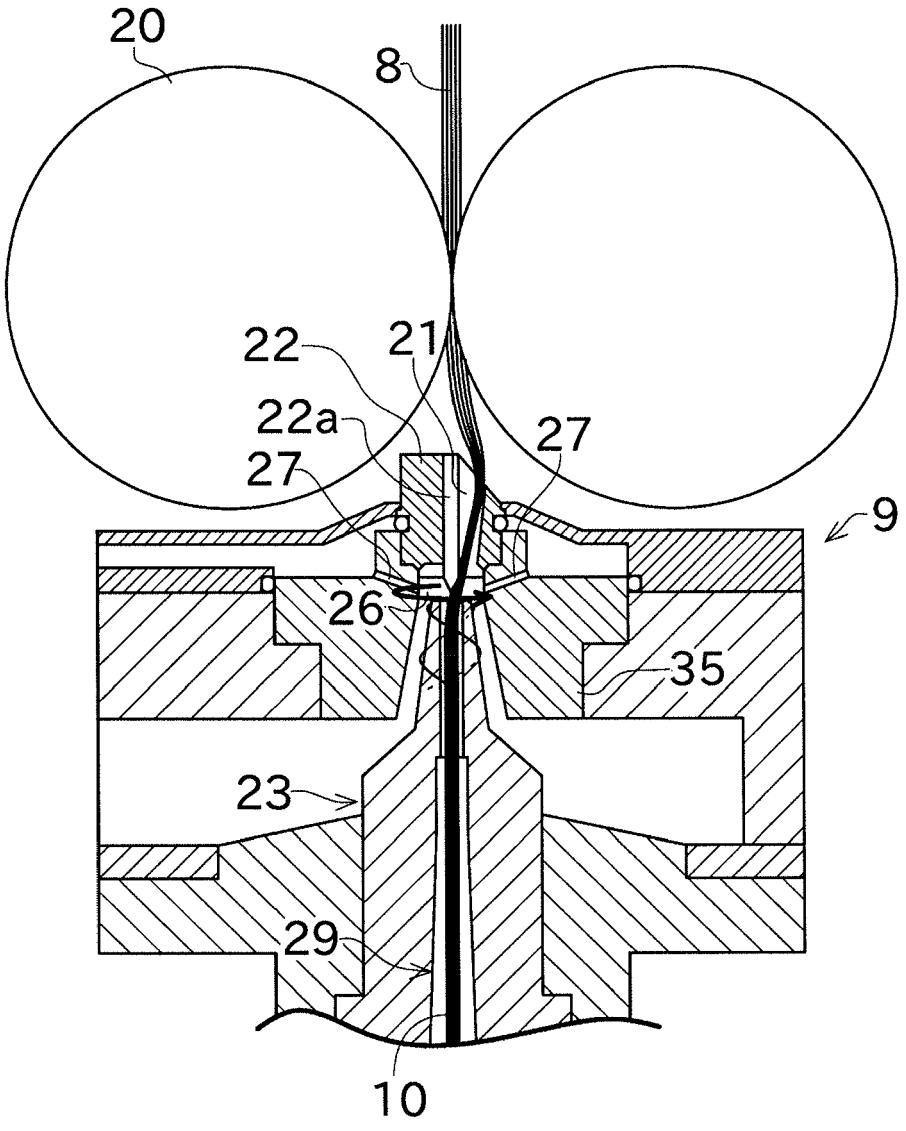
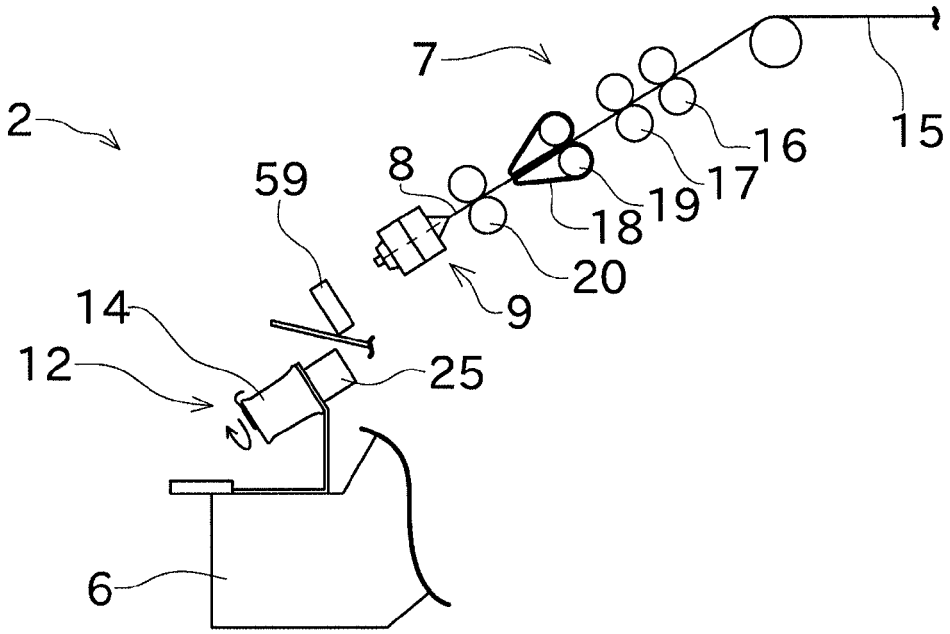


FIG. 4



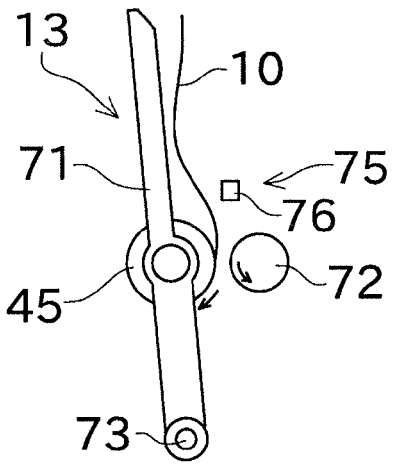


FIG. 5

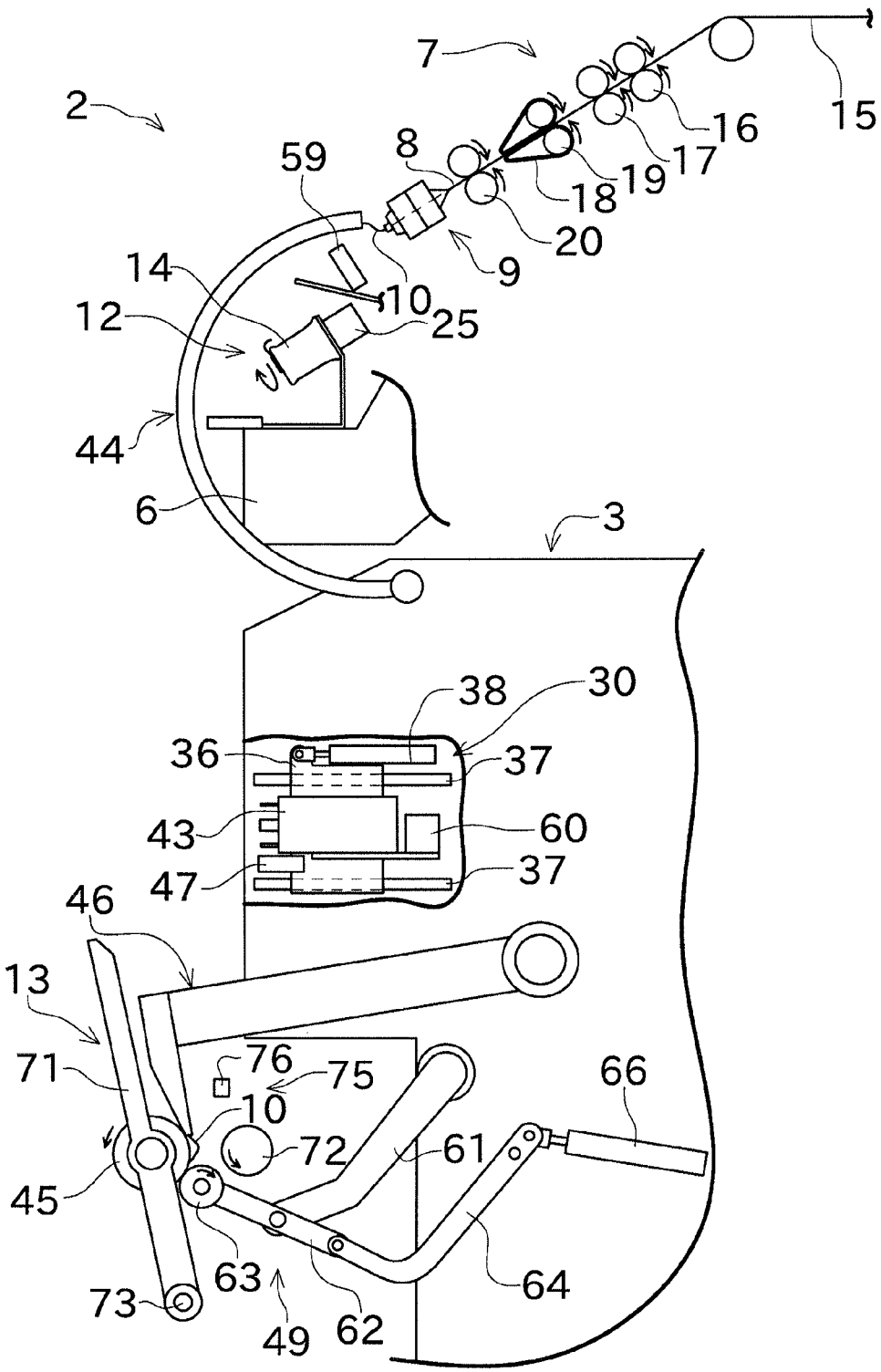

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FIG. 6

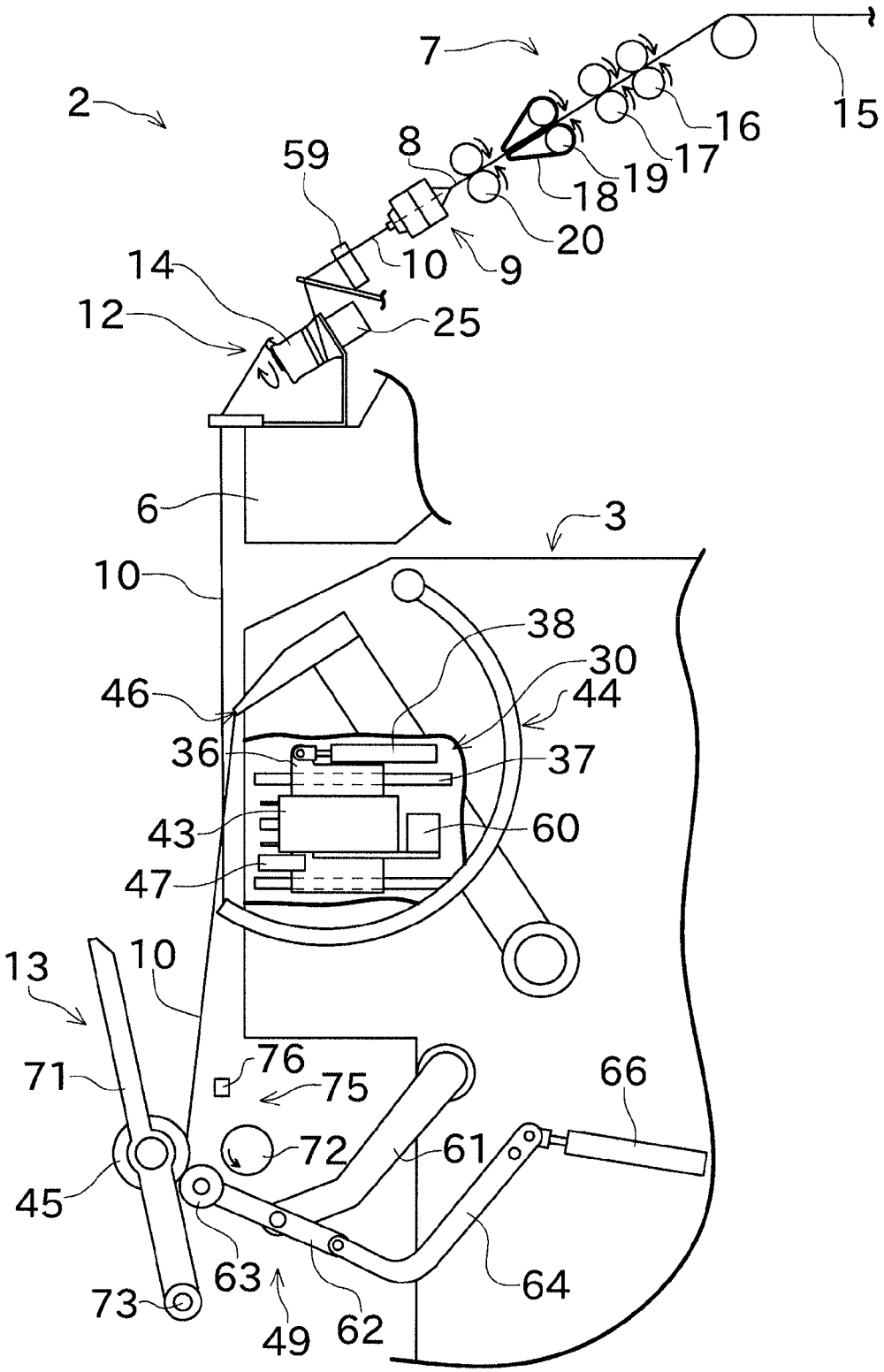
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FIG. 7

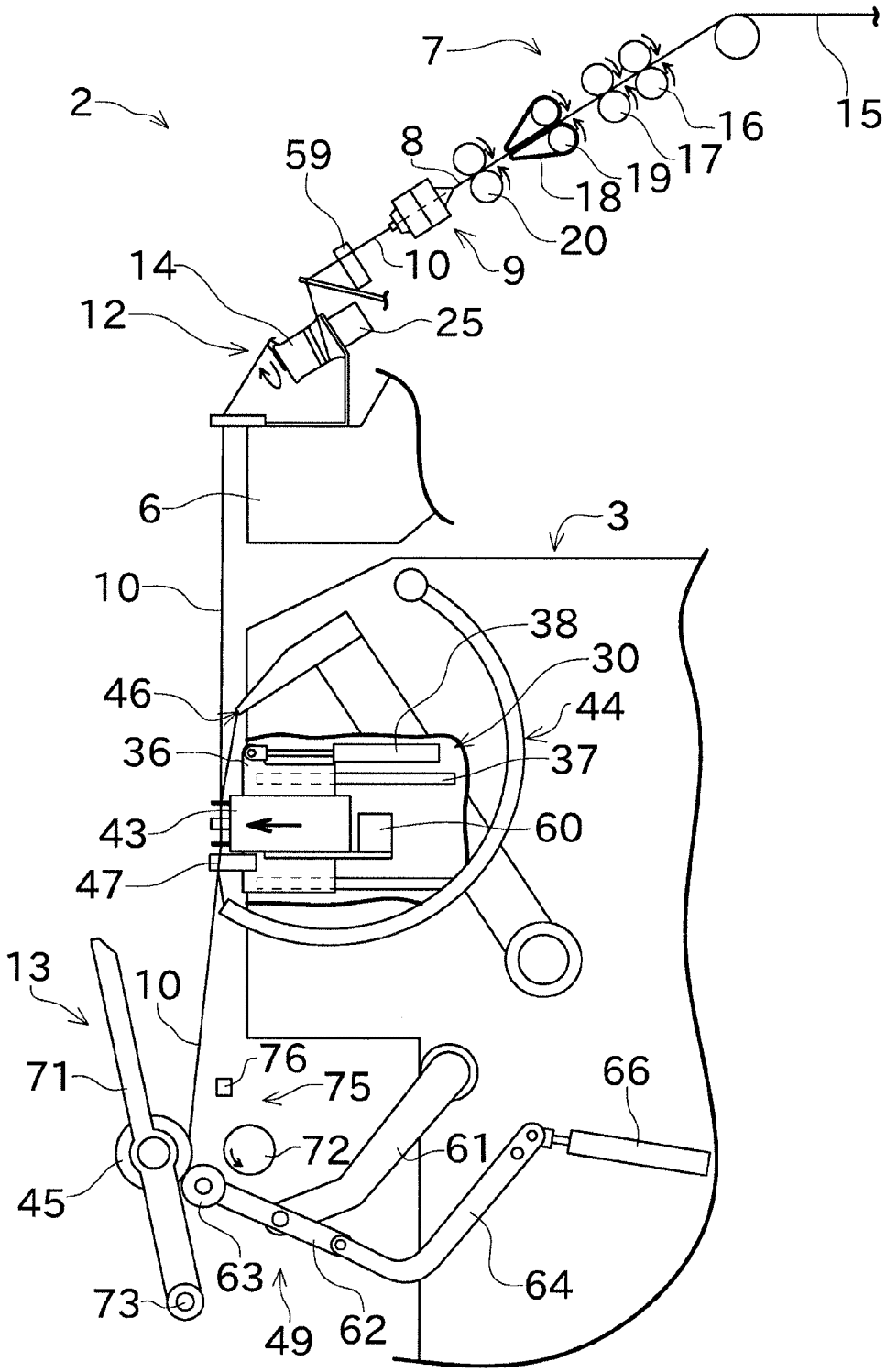
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FIG. 8

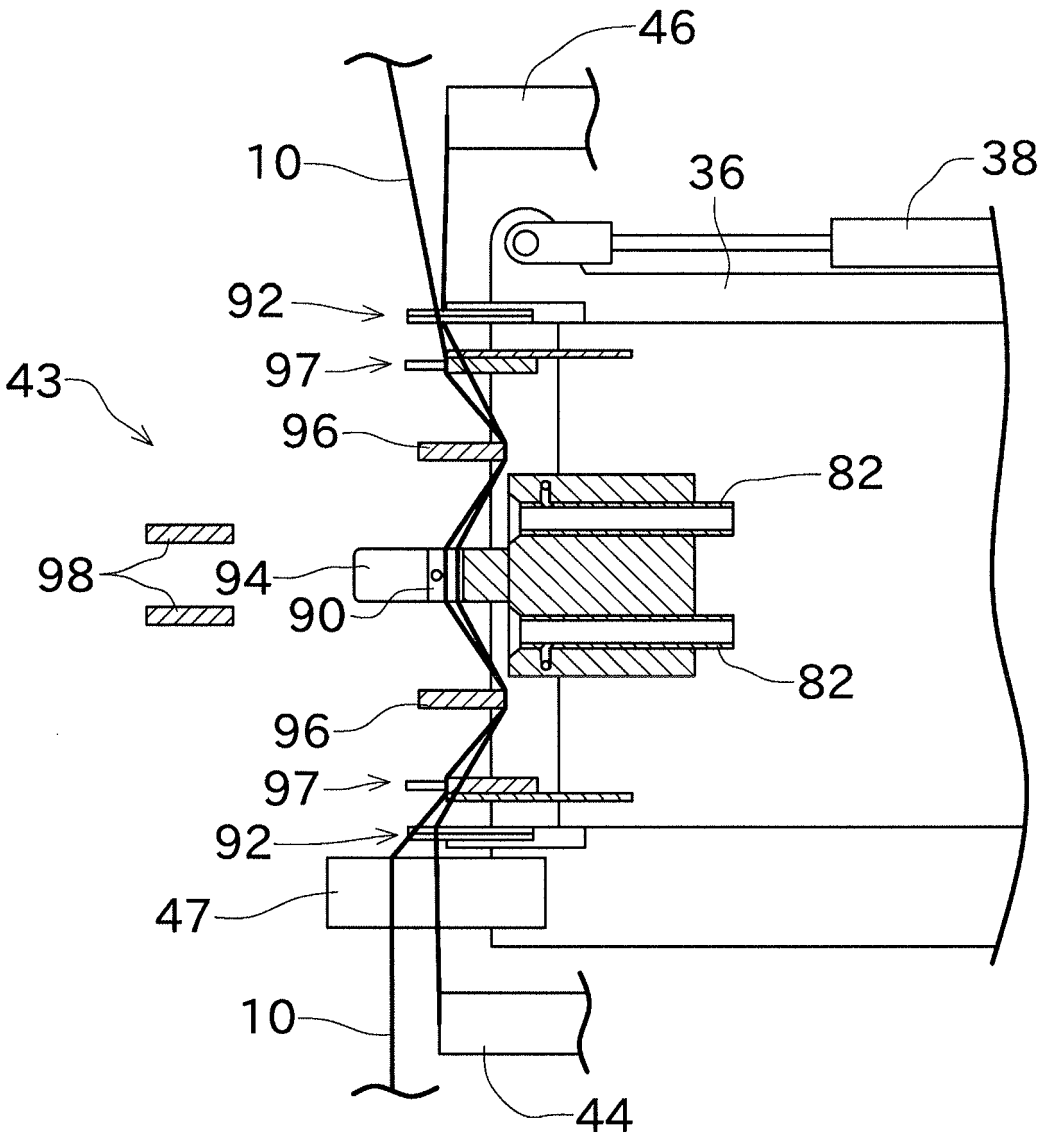

FIG. 9

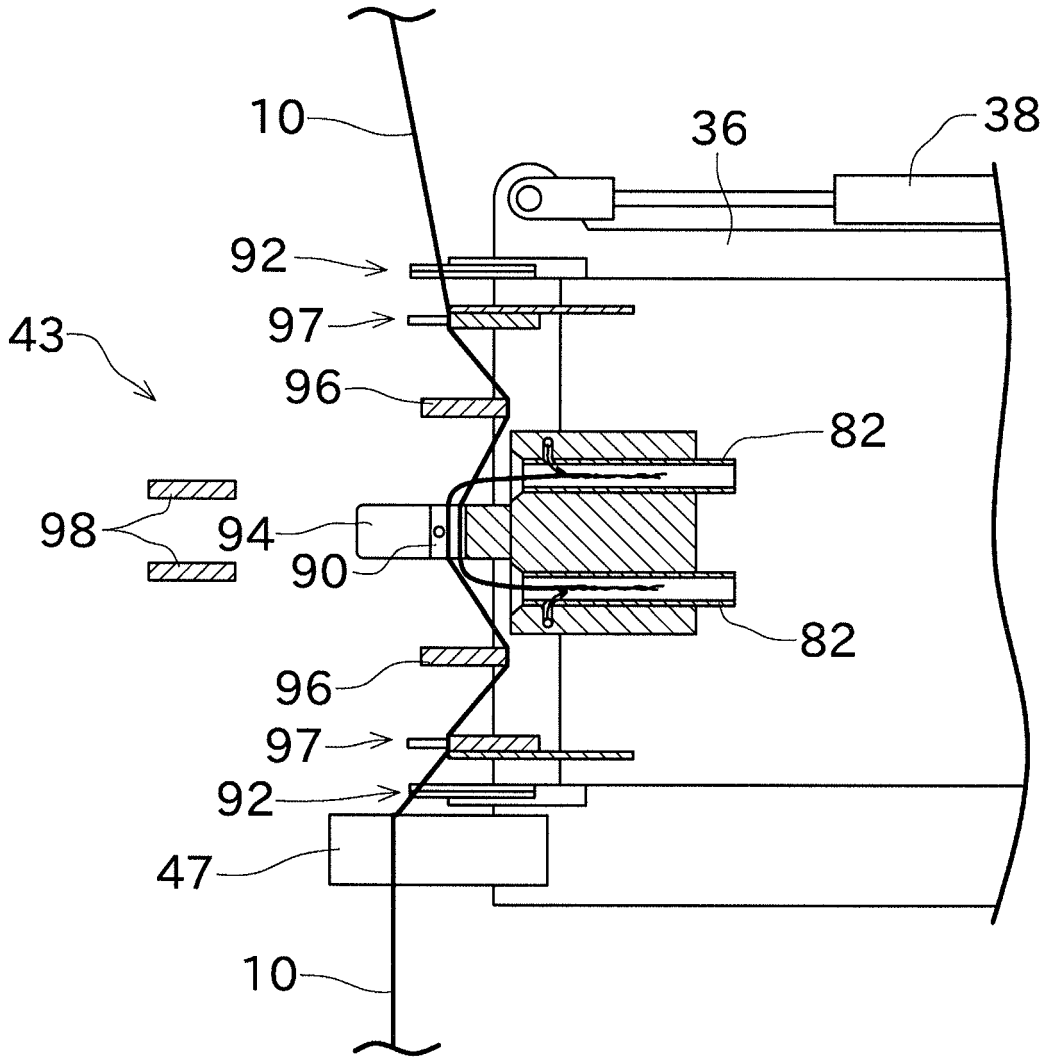

FIG. 10

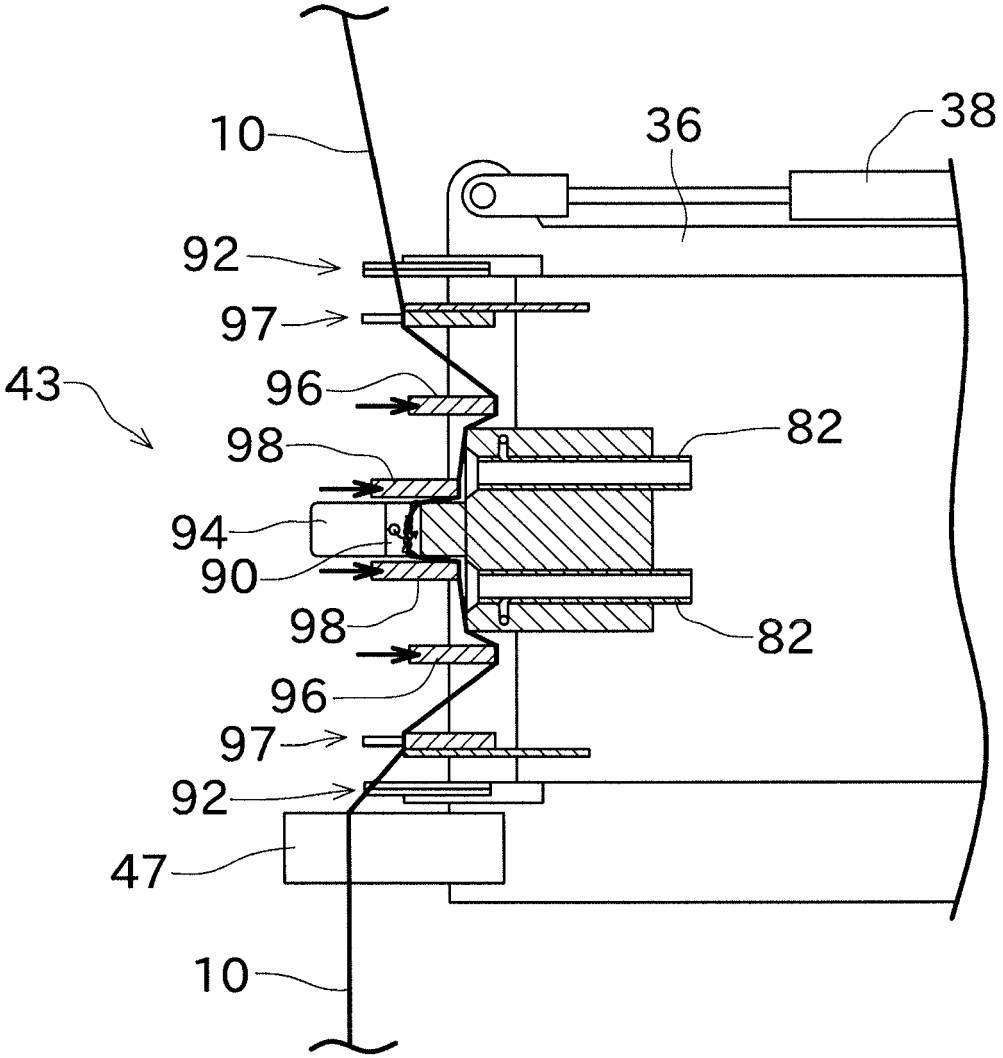

FIG. 11

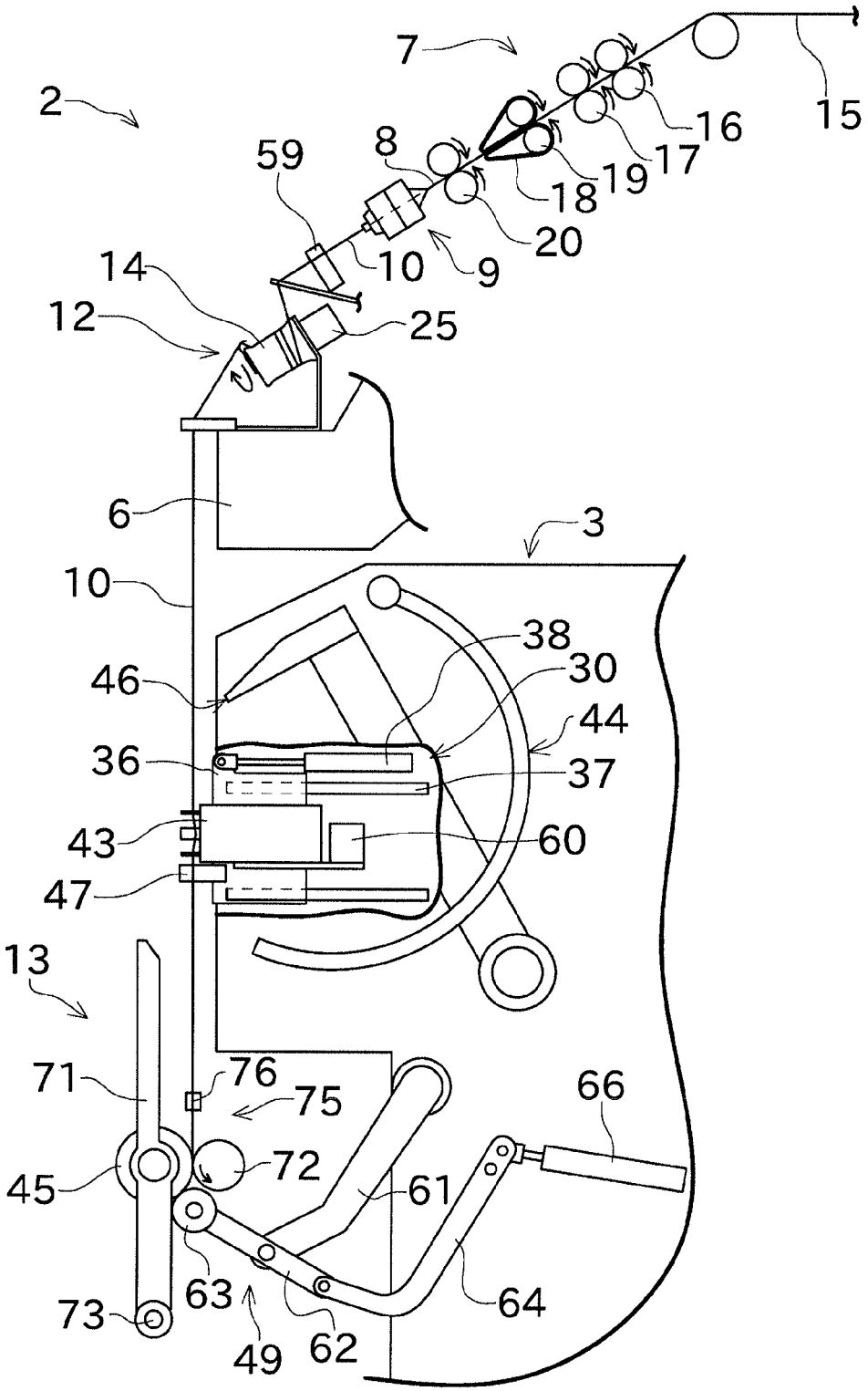
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FIG. 12

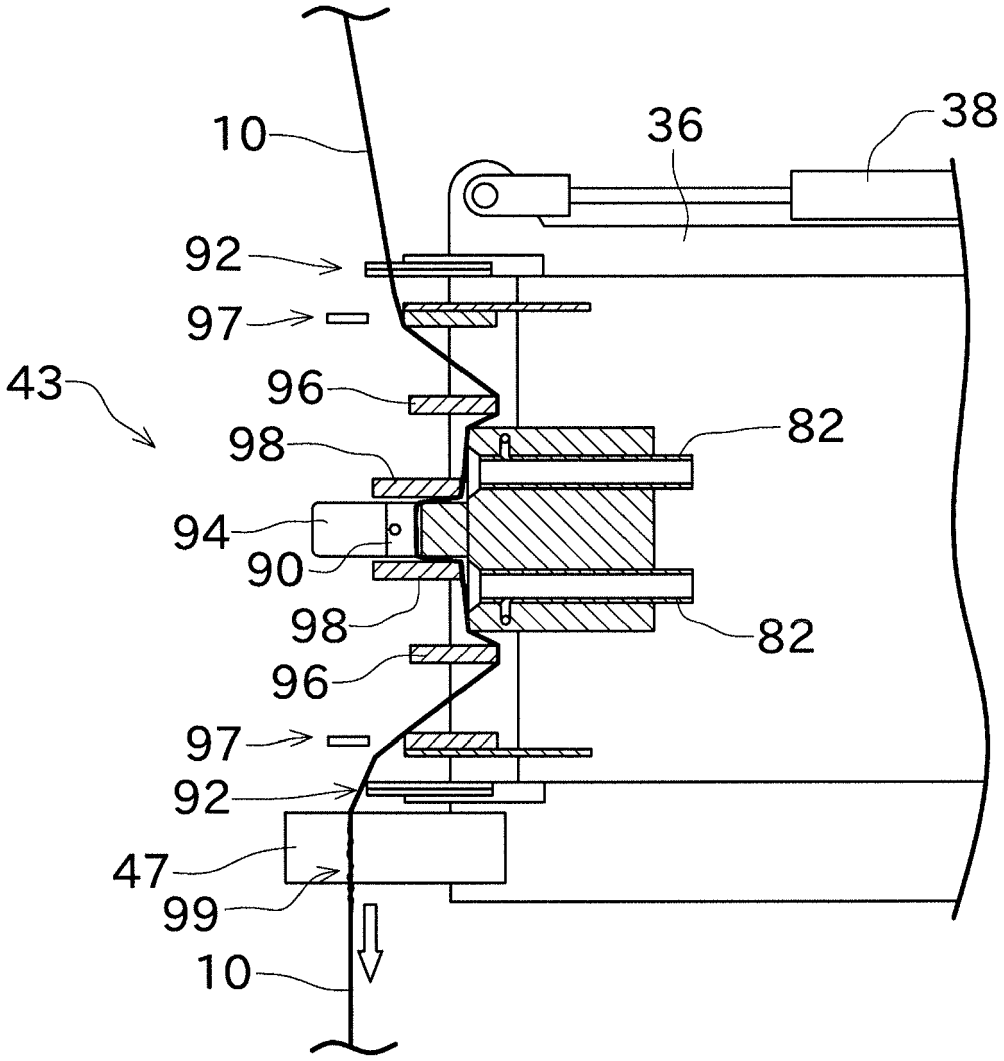
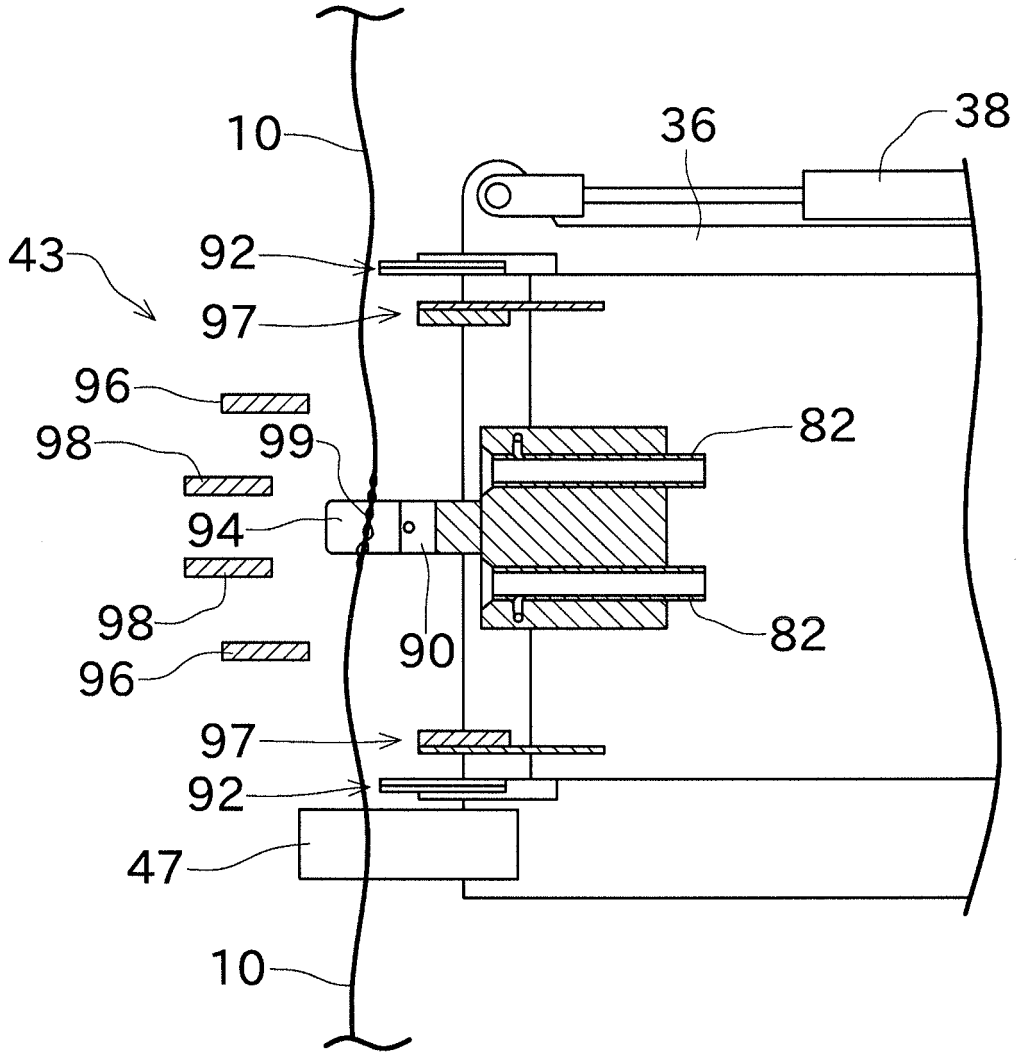


FIG. 13

COMPARATIVE EXAMPLE



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2010077576 A **[0002] [0003] [0006]**
- JP 2001199637 A **[0004]**
- JP 2005220484 A **[0110]**