



(11) **EP 2 573 030 A2**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:  
**27.03.2013 Bulletin 2013/13**

(51) Int Cl.:  
**B65H 69/04 (2006.01) B65H 69/06 (2006.01)**

(21) Application number: **12175315.6**

(22) Date of filing: **06.07.2012**

(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**

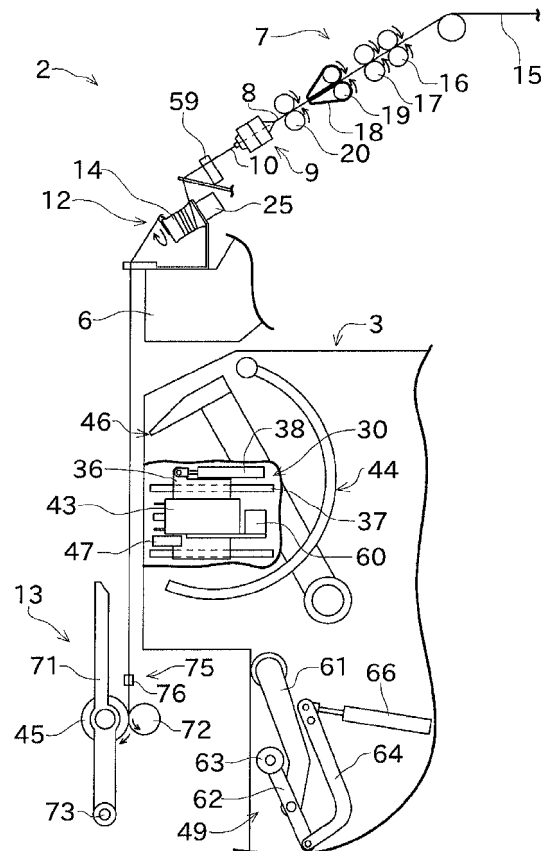
(72) Inventors:  
• **Ueda, Kenichi**  
**Kyoto-shi, Kyoto 612-8686 (JP)**  
• **Toyoda, Tkahiro**  
**Kyoto-shi, Kyoto 612-8686 (JP)**

(30) Priority: **21.09.2011 JP 2011206506**

(74) Representative: **Stöckeler, Ferdinand et al**  
**Patentanwälte Schoppe, Zimmermann, Stöckeler, Zinkler & Partner**  
**Postfach 246**  
**82043 Pullach (DE)**

(54) **Yarn winding machine**

(57) A fine spinning machine includes a winding device (13) adapted to wind a yarn into a package (45); a spinning device (9) adapted to supply a spun yarn (10) to the winding device (13); a yarn joining device (43) adapted to perform a yarn joining operation to join the spun yarn (10) between the package (45) and the spinning device (9); and a moving means (30). The moving means (30) can move the yarn joining device (43) between a yarn joining position and a retreated position, the yarn joining position being a position located close to a yarn path between the package (45) and the spinning device (9) during a normal winding, and the retreated position being a position located away from the yarn path.



**FIGURE 2**

**EP 2 573 030 A2**

## 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.

#### 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 (Patent Document 1). As described in Patent Document 1, the spinning machine includes a spinning device adapted to produce a spun yarn by applying a twist to 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 of Patent Document 1 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]** The above yarn joining device is arranged at a position deviated from a yarn path (travelling path of the yarn) during a normal winding so as not to interfere with the yarn being wound into the package. For example, in Patent Document 1, as illustrated in FIG. 2, the yarn joining device is arranged at a receded position on a rear side of the spinning machine (right side of FIG. 2) than the yarn path during the normal winding.

### BRIEF SUMMARY OF THE INVENTION

**[0005]** Since the yarn is guided to the yarn joining device at the receded position and then a yarn joining operation is carried out, the yarn path during the yarn joining operation is bent more than the yarn path during the normal winding. Since the yarn path is bent, the spun yarn between the spinning device and the package becomes longer during the yarn joining operation than during the normal winding. When the winding by the winding device is resumed after the yarn joining operation is finished, the lengthened spun yarn slackens. As a result, the yarn may be wound into a package in a slackened state or in a kinked state.

**[0006]** If the yarn is slackened as described above, the

slackened yarn may get caught at a surrounding member. For example, the spinning machine described in Patent Document 1 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 Patent Document 1 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.

**[0007]** An object of the present invention is to provide a yarn winding machine which eliminates slackening of a yarn generated when a winding is resumed after a yarn joining operation is finished.

**[0008]** According to one aspect of the present invention, a yarn winding machine includes a winding section adapted to wind a yarn into a package; a yarn supplying section adapted to supply the yarn to the winding section; a yarn joining device adapted to perform a yarn joining operation to join the yarn between the package and the yarn supplying section at an operating position; and a moving means. The moving means can move the yarn joining device at the operating position between an advanced position and a receded position, the advanced position being a position located close to a yarn path between the package and the yarn supplying section during a normal winding, and the receded position being a position located away from the yarn path.

**[0009]** Accordingly, the yarn joining device can be advanced towards the yarn path only when necessary. In other words, the yarn joining device can be retreated so that the yarn joining device does not interfere with the yarn path during the normal winding. When the yarn joining operation is required, the yarn joining device is advanced towards the yarn path so that the yarn can be guided to the yarn joining device. In this manner, the yarn joining device itself can be brought close to the yarn path, and hence the yarn path is not required to be greatly bent to guide the yarn to the yarn joining device. Since the bending of the yarn becomes small, the slackening of the yarn can be prevented. Therefore, the yarn can be prevented from being wound into a package in a slackened state, and a quality of the package produced by the yarn winding machine can be improved. The slackened yarn can also be prevented from getting caught at the surrounding members.

**[0010]** In the above yarn winding machine, the yarn joining device includes at least an untwisting section adapted to untwist a yarn end from the package and a yarn end from the yarn supplying section, and a twisting section adapted to twist the untwisted yarn ends. The moving means is adapted to move at least the untwisting section and the twisting section to the advanced position located close to the yarn path and the receded position located away from the yarn path.

**[0011]** Accordingly, the untwisting and the twisting can be performed in proximity to the yarn path. As a result,

the yarn joining operation can be performed without greatly bending the yarn from the yarn path during the normal winding.

**[0012]** The above yarn winding machine further includes a yarn catching section adapted to catch a yarn from the package and a yarn from the yarn supplying section when the yarn between the package and the yarn supplying section is disconnected. The moving means is adapted to maintain the yarn joining device at the receded position during the normal winding and to advance the yarn joining device to the advanced position during the yarn joining operation. The yarn catching section guides the caught yarn to a position where the yarn can be guided into the yarn joining device located at the advanced position.

**[0013]** Accordingly, the yarn can be guided to the yarn joining device located at the advanced position, and the yarn joining operation by the yarn joining device can be performed.

**[0014]** In the above yarn winding machine, the yarn catching section is adapted to guide the yarn by swinging while keeping the caught yarn. After the yarn catching section completes guiding the yarn, the moving means starts to advance the yarn joining device from the receded position to the advanced position.

**[0015]** In other words, when swinging the yarn catching section, the yarn joining device is retreated to a position located away from the yarn path to prevent the swinging yarn catching section from interfering with the yarn joining device. As a result, a degree of freedom in layout of the yarn catching section is improved.

**[0016]** The above yarn winding machine further includes a plurality of yarn 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 is provided capable of travelling to at least some of the plurality of the yarn winding units. The yarn joining cart is adapted to stop in proximity of a yarn winding unit in which the yarn is disconnected and to perform the yarn joining operation to the target yarn winding unit by the yarn joining device. The moving means maintains the yarn joining device at the receded position at least when the yarn joining cart travels.

**[0017]** Accordingly, since the yarn joining cart travels with the yarn joining device retreated to the position located away from the yarn path, the yarn joining device can be prevented from making contact with the yarn being wound by each yarn winding unit.

**[0018]** In the above yarn winding machine, the moving means is preferably adapted to linearly move the yarn joining device in a direction substantially orthogonal to the yarn path between the package and the yarn supplying section during the normal winding. Accordingly, the distance of moving the yarn joining device with respect to the yarn path can be reduced.

**[0019]** In the above yarn winding machine, the yarn joining device further includes a clamp section adapted

to clamp the yarn during the yarn joining operation, and a drive source for the clamp section. The moving means is adapted to move the clamp section and the drive source to an activating position located close to the yarn path and a non-activating position located away from the yarn path. Accordingly, the yarn joining device can be moved with respect to the yarn path to perform the yarn joining operation.

**[0020]** The above yarn winding machine further includes a yarn-joint monitoring device adapted to monitor a quality of a yarn joint formed by the yarn joining operation of the yarn joining device. The moving means simultaneously moves the yarn-joint monitoring device and the yarn joining device.

**[0021]** Accordingly, the yarn-joint monitoring device can be moved in a direction of advancing towards the yarn path, and the yarn joint of the yarn can be monitored by the yarn-joint monitoring device. If the yarn joint is not required to be monitored by the yarn-joint monitoring device, the yarn-joint monitoring device may be retreated to a position located away from the yarn path so that the yarn-joint monitoring device can be prevented from interfering with the yarn path. Furthermore, in the above yarn winding machine, the slackening of the yarn during the yarn joining operation can be prevented, and monitoring accuracy of the yarn joint by the yarn-joint monitoring device can be improved.

**[0022]** In the above yarn winding machine, the moving means includes a rail and a movement driving source. The rail is adapted to guide the yarn joining device between the advanced position and the receded position. The movement driving source is adapted to drive the yarn joining device along the rail. By guiding the yarn joining device along the rail, the yarn joining device can be moved on an accurate path along the direction in which the yarn joining device advances or recedes from the yarn path.

**[0023]** The above yarn winding machine further preferably includes a stopper mechanism adapted to define an end of a movable range in which the yarn joining device can be moved in a direction to approach the yarn path. Accordingly, the yarn joining device can be prevented from excessively approaching the yarn path during the yarn joining operation, and the yarn joining operation can be performed while appropriately maintaining a positional relationship between the yarn joining device and the yarn path.

**[0024]** The above yarn winding machine further includes a yarn accumulating device arranged between the yarn supplying section and the winding section and adapted to temporarily accumulate the yarn around an outer peripheral surface 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 a travelling direction of the yarn.

**[0025]** In other words, the slackening of the yarn during the yarn joining operation can be prevented in the above yarn winding machine, and the yarn can be prevented

from getting entangled around the rotating yarn accumulating roller. Therefore, the yarn can be appropriately accumulated by the yarn accumulating device.

**[0026]** The above yarn winding machine further preferably includes a traverse device adapted to traverse the yarn by a reciprocating traverse guide before the yarn is wound into the package.

**[0027]** In other words, since the slackening of the yarn during the yarn joining operation can be prevented in the above yarn winding machine, the slackened yarn can be prevented from getting caught at the reciprocating traverse guide and causing the yarn breakage. Therefore, the yarn can be appropriately traversed by the traverse device.

**[0028]** According to another aspect of the present invention, a yarn winding unit includes one winding section adapted to wind a yarn into a package; one yarn supplying section adapted to supply the yarn to the winding section; a yarn joining device adapted to perform a yarn joining operation to join the yarn between the package and the yarn supplying section; and a moving means. The moving means moves the yarn joining device between an advanced position and a receded position, the advanced position being a position located close to a yarn path between the package and the yarn supplying section during a normal winding, and the receded position being a position located away from the yarn path.

**[0029]** As described above, by arranging the yarn joining device movable with respect to the yarn path, the yarn joining device can be advanced towards the yarn path only when necessary. Accordingly, the yarn joining device can be retreated so that the yarn joining device does not interfere with the yarn path during the normal winding. When the yarn joining operation is required, the yarn joining device is advanced towards the yarn path so that the yarn can be guided to the yarn joining device. Therefore, the yarn joining device itself can be brought close to the yarn path, and hence the yarn path is not required to be greatly bent to guide the yarn to the yarn joining device. As a result, the slackening of the yarn can be prevented. Therefore, the slackened portion or the kinked portion of the yarn can be prevented from mixing into the package, and the quality of the package produced by the yarn winding unit can be improved. The slackened yarn can also be prevented from getting caught at the surrounding members.

#### BRIEF DESCRIPTION OF THE DRAWINGS

**[0030]** FIG. 1 is a front view illustrating an overall configuration 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 clamp section;

FIG. 9 is a cross-sectional side view of the yarn joining device illustrating a state in which 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 a winding of the spun yarn is resumed after a yarn joining operation is finished; and

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 yarn joint monitor.

#### 25 DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

**[0031]** A fine spinning machine serving 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.

**[0032]** 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 for the spinning units 2 is arranged in the motor box 5.

**[0033]** 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 prescribed peripheral speed so that the spun yarn 10 is wound at a substantially prescribed speed.

**[0034]** 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 thereto, and the sliver 15 is drafted to a predetermined width to obtain the fiber bundle 8.

**[0035]** 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. Therefore, the spinning device 9 is the yarn supplying section adapted to supply the spun yarn 10 to the winding device 13.

**[0036]** In the fine spinning machine 1 of the present embodiment, an air-jet spinning device which uses whirling 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.

**[0037]** A spinning chamber 26 is formed between the nozzle block 35 and the hollow guide shaft body 23. An air injecting nozzle 27 is formed in the nozzle block 35. The air is injected from the air injecting nozzle 27 into the spinning chamber 26, and the whirling airflow is generated in the spinning chamber 26. An introducing port 21 for introducing the fiber bundle 8 into the spinning chamber 26 is formed in the fiber guiding section 22.

**[0038]** 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 introducing port 21. In the spinning chamber 26, the fiber bundle 8 is swung around a periphery of the hollow guide shaft body 23 by the whirling airflow, and the twist is applied to produce the spun yarn 10. 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.

**[0039]** A needle-like guide needle 22a is arranged in the introducing port 21, and a tip 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 fiber 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.

**[0040]** 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.

**[0041]** 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. The drive source is provided in the motor box 5. 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.

**[0042]** The traverse device 75 includes the 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.

**[0043]** 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.

**[0044]** The yarn accumulating roller 14 can have a prescribed amount of the spun yarn 10 wound around the 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 by the yarn accumulating device 12.

**[0045]** 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 (optical sensor). The yarn quality measuring equipment 59 may detect a foreign substance contained in the spun yarn 10 as a yarn defect.

**[0046]** A cutter (not illustrated) arranged in proximity to the yarn quality measuring equipment 59 immediately cuts the spun yarn 10 when the yarn defect of the spun yarn 10 is detected by the yarn quality measuring equipment 59. 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.

**[0047]** 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.

**[0048]** 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 yarn joint monitor (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.

**[0049]** The suction pipe 44 and the suction mouth 46 can respectively swing vertically with an axis as the 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.

**[0050]** The yarn joining device 43 can perform the yarn joining operation (join) 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 99 by applying a twist to the yarn ends with the whirling airflow. The configuration of the yarn joining device 43 is not limited thereto, and may be a mechanical knotter, for example. Formation of the yarn joint 99 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.

**[0051]** 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" (or an advanced 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" (or a receded position).

**[0052]** The moving means 30 includes a rail 37, and an air cylinder (movement driving source) 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, and 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.

**[0053]** 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.

**[0054]** Next, a structure of the yarn joining device 43 will be described with reference to FIG. 10. The yarn joining device 43 includes a yarn joining nozzle 94, a clamp section 97, a yarn path regulating member (yarn guiding levers 96 and yarn controlling levers 98), cutters 92, and untwisting pipes 82.

**[0055]** The yarn joining nozzle (twisting section) 94 is arranged on the front side of the 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.

**[0056]** The yarn joining device 43 includes two untwisting pipes (untwisting section) 82. The two untwisting pipes 82 are formed in an elongate cylindrical shape, and longitudinal directions thereof are 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 a 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.

**[0057]** The yarn joining nozzle 94 and the untwisting pipes 82 are both fixedly arranged to the main body of the yarn joining device 43. 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.

**[0058]** The yarn path regulating member (the yarn guiding levers 96 and the yarn controlling levers 98) are lever-like members swingably arranged in the main body of the yarn joining device 43. 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.

**[0059]** One clamp section 97 is arranged above and below the yarn joining nozzle 94, respectively, in the yarn travelling direction. The clamp sections 97 are configured

to be openable/closable, and can clamp the spun yarn 10 in a closed state. One cutter 92 is arranged above and below the yarn nozzle 94, respectively, in the yarn travelling direction. The cutters 92 can cut the spun yarn 10.

**[0060]** The yarn joining device 43 includes a cam mechanism (not illustrated) for causing the swinging operation of the yarn guiding levers 96 and the yarn controlling levers 98, the open/close operation of the clamp sections 97, and the cutting operation by the cutters 92 to be performed. 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, as well as, the regulation of the yarn path 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 clamp sections 97, and the cutters 92) are integrally moved. Accordingly, the electric motor 60, the clamp sections 97, and the like can be moved between an activating position and a non-activating position, the activating position being a position located close to the yarn path of the spun yarn 10 to be activated, and the non-activating position being a position located away from the yarn path.

**[0061]** Assume that the electric motor 60, which is the drive source of the cam mechanism, is arranged on the cart main body of the yarn joining cart 3 apart from the yarn joining device 43. In this case, if the yarn joining device 43 is moved, the positional relationship between the electric motor 60 and the cam mechanism changes. An assumption can be made that it is difficult to configure a drive transmission path from the electric motor 60 to the cam mechanism. In the present embodiment, the yarn joining device 43 itself includes the electric motor 60, and the electric motor 60, the cam mechanism, and the members driven by the cam mechanism move integrally. Thus, a configuration of moving the yarn joining device 43 can be easily realized.

**[0062]** The yarn joint monitor 47 is arranged immediately downstream of the yarn joining device 43 to measure the quality of the spun yarn 10 that has been joined by the yarn joining device 43. In the present embodiment, the yarn joint monitor 47 monitors a thickness of the yarn joint 99 formed by the yarn joining device 43 with a capacitance sensor. The yarn joint monitor 47 may be, for example, a light transmissive sensor (optical sensor). Information detected by the yarn joint monitor 47 is transmitted to the cart control section. The yarn joint monitor 47 is fixed to the supporting bracket 36. When the moving means 30 moves the yarn joining device 43, the yarn

joint monitor 47 moves simultaneously with the yarn joining device 43.

**[0063]** 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.

**[0064]** 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.

**[0065]** One end side 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 side 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-receding air cylinder 66 is attached to the link rod 64. The link rod 64 can be swung by advancement and the recession of the reversely-rotating roller advancing-and-receding air cylinder 66.

**[0066]** 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-receding 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 made to advance and recede. The reversely-rotating roller 63 thus can be moved between a "retreated position" of not making contact with the package 45 (e.g., the position illustrated in FIG. 2) and a "contacting position" of making contact with the package 45 (e.g., a position illustrated in FIG. 5). An operation of the reversely-rotating roller advancing-and-receding air cylinder 66 is controlled by the cart control section.

**[0067]** Next, the yarn joining operation by the yarn joining cart 3 will be described. The yarn joining operation is carried out 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.

**[0068]** 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.

**[0069]** 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. The yarn joining device 43 is thus located at the operating position. When the yarn joining cart 3 travels along the spinning units 2, the moving means 30 retreats the yarn joining device 43 to the retreated position. If the yarn joining device 43 is advanced to a position close to the yarn path when the yarn joining cart 3 travels, the yarn joining device 43 makes contact with the spun yarn 10 wound by each spinning unit 2, and a yarn breakage may occur. When the yarn joining cart 3 travels, since the yarn joining device 43 is retreated to a position located away from the yarn path (retreated position), the yarn joining device 43 is prevented from making contact with the spun yarn 10.

**[0070]** As illustrated in FIG. 5, when the yarn joining cart 3 stops at the target spinning unit 2, the cart control section rotates 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.

**[0071]** In this case, the cart control section advances the reversely-rotating roller 63 to the contacting position and rotatably drives the reversely-rotating roller 63 in a direction opposite to the winding drum 72. Accordingly, the package 45 is rotatably driven in a direction opposite to the winding direction (hereinafter referred to as an unwinding direction). Under this state, when the spun yarn 10 at the surface of the package 45 is sucked by the suction mouth 46, the spun yarn 10 is pulled out from the package 45 and caught by the suction mouth 46.

**[0072]** 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). Until the guiding of the spun yarn 10 by the suction pipe 44 and the suction mouth 46 is completed, the moving means 30 maintains the yarn joining device 43 at the retreated position. By retreating the yarn joining device 43 to a position located away from the yarn path, the suction pipe 44 and the suction mouth 46 to be swung are prevented from making contact with the yarn joining device 43.

**[0073]** 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. Then, the moving means 30 extends the air cylinder 38 to a limit of a stroke length, 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). Thus, according to the present embodiment, since the yarn joining device 43 itself can advance towards the yarn path, the yarn path is not required to be greatly bent to introduce the spun yarn 10 into the yarn joining device 43. The spun yarn 10 can be introduced into the yarn

joining device 43 in a state close to the yarn path during the normal winding (a state in which yarn path is not greatly bent).

**[0074]** Since there is a limit to the stroke length of the air cylinder 38, the yarn joining device 43 does not move beyond the stroke length. That is, the air cylinder 38 itself has a function as a stopper mechanism for determining a moving end position (a yarn joining position) of the yarn joining device 43. A stopper member for determining the position of the yarn joining position of the yarn joining device 43 may be arranged separately from the air cylinder 38.

**[0075]** As illustrated in FIG. 7 and the like, the yarn joint monitor 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 yarn joint monitor 47. The spun yarn 10 thus can be monitored by the yarn joint monitor 47. Since the yarn joint monitor 47 itself can be advanced towards the yarn path, and a member for introducing the spun yarn 10 into the yarn joint monitor 47 is unnecessary. As illustrated in FIG. 2 and the like, when the moving means 30 retreats the yarn joining device 43 to the retreated position, the spun yarn 10 is not introduced into the yarn joint monitor 47. Thus, when the yarn joining cart 3 travels, the yarn joint monitor 47 is prevented from interfering with the yarn path of the spun yarn 10.

**[0076]** When the yarn joining device 43 is advanced to the yarn joining position, the cart control section swings the yarn guiding levers 96 to cause 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 guide the spun yarn 10 to a position where the spun yarn 10 can be clamped by the clamp sections 97 (a state of FIG. 8). The cart control section closes the clamp sections 97 under this state, and the spun yarn 10 is clamped by the clamp sections 97. In the present embodiment, since the members (the yarn guiding levers 96) for guiding the spun yarn 10 are arranged in the yarn joining device 43, when the moving means 30 advances the yarn joining device 43 to the yarn joining position, the yarn guiding levers 96 can also be advanced to a position in proximity to the yarn path. Therefore, the spun yarn 10 can be reliably guided to the yarn joining hole 90 of the yarn joining nozzle 94 by the yarn guiding levers 96. Since the yarn joining nozzle 94 is also advanced to a position close to the yarn path, the distance in which the spun yarn 10 is to be guided by the yarn guiding levers 96 is reduced and the bending of the yarn path when the spun yarn 10 is guided to the yarn joining hole 90 can be reduced.

**[0077]** 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, and suction airflow is generated at an 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 operates 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. The yarn ends formed by the cutting are sucked by the untwisting pipes 82, and pulled into the untwisting pipes 82. The pulled-in yarn ends are subjected to the action of the airflow in the untwisting pipes 82 so that the twisting of the fiber is resolved and untwisted (FIG. 9).

**[0078]** 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 further bends 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 under this state, the whirling flow is generated in the yarn joining hole 90 to twist the fiber. 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 99.

**[0079]** After the yarn joint 99 is formed, the cart control section stops the injection of air into the yarn joining hole 90. Further, the cart control section opens the clamp sections 97 to release the clamped spun yarn 10, and releases the regulation of the yarn path by the yarn guiding levers 96 and the yarn controlling levers 98. Before or after this operation, 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 stopped package 45 thus resumes the rotation in the winding direction, and the winding of the spun yarn 10 is resumed.

**[0080]** In the fine spinning machine 1 of the present embodiment, the yarn joining device 43 itself advances to the yarn path to perform the yarn joining operation. As illustrated in FIG. 11, the yarn path when resuming the winding of the spun yarn 10 may be located close to the yarn path during the normal winding (a state of not being bent greatly). Therefore, after the yarn joining operation is finished, the slackening of the spun yarn 10 when the winding of the spun yarn 10 is resumed can be suppressed to a minimum.

**[0081]** As illustrated in FIG. 12, when the winding of the spun yarn 10 is resumed, a yarn joint 99 formed in the yarn joining device 43 is passed through the yarn joint monitor 47. The yarn joint 99 is monitored by the yarn joint monitor 47. The cart control section determines the quality of the yarn joint 99 based on a monitoring

result by the yarn joint monitor 47. 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.

**[0082]** After the monitoring of the yarn joint 99 by the yarn joint monitor 47 is finished, the moving means 30 moves the yarn joining device 43 to the retreated position. Accordingly, the yarn joining cart 3 is able to travel, and can travel to another spinning unit 2. When the moving means 30 causes the yarn joining device 43 to retreat to the retreated position, the yarn guiding levers 96 and the like arranged in the yarn joining device 43 are also caused to retreat to the position located away from the yarn path. Since the yarn guiding levers 96 can be retreated when the yarn guiding levers 96 are not operated, a structure of the yarn joining cart 3 can be made small.

**[0083]** As described above, the fine spinning machine 1 of the present embodiment includes the winding device 13 adapted to wind the spun yarn 10 into the package 45, the spinning device 9 adapted to supply the spun yarn 10 to the winding device 13, the yarn joining device 43 adapted to perform a yarn joining operation to join the spun yarn 10 between the package 45 and the spinning device 9 at the operating position, and the moving means 30. The moving means 30 can move the yarn joining device 43 at the operating position to the yarn joining position and the retreated position, the yarn joining position being a position located close to the yarn path between the package 45 and the spinning device 9 during the normal winding, and the retreated position being a position located away from the yarn path.

**[0084]** Thus, the yarn joining device 43 can be advanced towards the yarn path only when necessary. In other words, the yarn joining device 43 can be retreated so that the yarn joining device 43 does not interfere with the yarn path during the normal winding. When the yarn joining operation is required, the yarn joining device 43 is advanced to the yarn path and the spun yarn 10 can be introduced into the yarn joining device 43. Therefore, the yarn joining device 43 itself can be brought close to the yarn path, and hence the yarn path is not required to be greatly bent to introduce the spun yarn 10 to the yarn joining device 43. As a result of reduction in the bending of the spun yarn 10, the slackening of the spun yarn 10 can be prevented. Therefore, the spun yarn 10 can be prevented from being wound into the package 45 in a slackened state, and the quality of the package 45 produced by the fine spinning machine 1 can be improved. The slackened spun yarn 10 can be prevented from getting caught at the surrounding members.

**[0085]** In the fine spinning machine 1 of the present embodiment, the yarn joining device 43 includes the untwisting pipes 82 adapted to untwist the yarn end from the package 45 and the yarn end from the spinning device 9, and the yarn joining nozzle 94 adapted to twist the

untwisted yarn ends. The moving means 30 moves the untwisting pipes 82 and the yarn joining nozzle 94 to the yarn joining position located close to the yarn path and the retreated position located away from the yarn path.

5 **[0086]** Accordingly, the untwisting and twisting can be carried out in proximity to the yarn path. As a result, the yarn joining operation can be carried out without greatly bending the spun yarn 10 from the yarn path during the normal winding.

10 **[0087]** The fine spinning machine 1 of the present embodiment includes a yarn catching section (the suction pipe 44 and the suction mouth 46) adapted to catch the spun yarn 10 from the package 45 and the spun yarn 10 from the spinning device 9 when the spun yarn 10 between the package 45 and the spinning device 9 is disconnected. The moving means 30 maintains the yarn joining device 43 at the retreated position during the normal winding, and advances the yarn joining device 43 to the yarn joining position during the yarn joining operation.

15 The yarn catching section guides the caught spun yarn 10 to a position where the spun yarn 10 can be introduced into the yarn joining device 43 located at the yarn joining position.

20 **[0088]** Accordingly, the spun yarn 10 can be guided to the yarn joining device 43 located at the yarn joining position, and the yarn joining operation by the yarn joining device 43 can be performed.

25 **[0089]** In the fine spinning machine 1 of the present embodiment, the yarn catching section guides the spun yarn 10 by swinging while keeping the caught spun yarn 10. After the yarn catching section completes the guiding of the spun yarn 10, the moving means 30 starts to advance the yarn joining device 43 from the retreated position to the yarn joining position.

30 **[0090]** In other words, when swinging the yarn catching section, the yarn joining device 43 is retreated to the position located away from the yarn path to prevent the swinging yarn catching section from interfering with the yarn joining device 43. As a result, the degree of freedom in the layout of the yarn catching section is improved.

35 **[0091]** The fine spinning machine 1 of the present embodiment includes a plurality of spinning units 2 and the yarn joining cart 3. The spinning unit 2 includes the spinning device 9 and the winding device 13. The yarn joining cart 3 includes a 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. When the yarn joining cart 3 travels, the moving means 30 maintains the yarn joining device 43 at the retreated position.

40 **[0092]** Accordingly, since the yarn joining cart 3 travels with the yarn joining device 43 retreated to the position located away from the yarn path, the yarn joining device 43 is prevented from making contact with the spun yarn 10 being wound by each spinning unit 2.

45 **[0093]** In the fine spinning machine 1 of the present embodiment, the moving means 30 is adapted to linearly

move the yarn joining device 43 in a direction substantially orthogonal to the yarn path between the package 45 and the spinning device 9 during the normal winding. The distance of moving the yarn joining device 43 with respect to the yarn path thus can be reduced.

**[0094]** In the fine spinning machine 1 of the present embodiment, the yarn joining device 43 further includes the clamp sections 97 adapted to clamp the spun yarn 10 during the yarn joining operation, and the electric motor 60 which is a drive source for the clamp sections 97. The moving means 30 moves the clamp sections 97 and the electric motor 60 to the activating position located close to the yarn path and the non-activating position located away from the yarn path. Accordingly, the yarn joining device 43 can be moved with respect to the yarn path to perform the yarn joining operation.

**[0095]** The fine spinning machine 1 of the present embodiment includes the yarn joint monitor 47 adapted to monitor a quality of the yarn joint formed by the yarn joining operation of the yarn joining device 43. The moving means 30 simultaneously moves the yarn joint monitor 47 and the yarn joining device 43.

**[0096]** Accordingly, the yarn joint monitor 47 can be moved in a direction of advancing towards the yarn path, and the yarn joint of the spun yarn 10 can be monitored by the yarn joint monitor 47. If the yarn joint is not required to be monitored by the yarn joint monitor 47, the yarn joint monitor 47 can be retreated to the position located away from the yarn path so that the yarn joint monitor 47 can be prevented from interfering with the yarn path. According to the present embodiment, the slackening of the spun yarn 10 during the yarn joining operation can be prevented, and the monitoring accuracy of the yarn joint 99 by the yarn joint monitor 47 can be improved.

**[0097]** In the fine spinning machine 1 of the present embodiment, the moving means 30 includes the rail 37 and the air cylinder 38. The rail 37 guides the yarn joining device 43 between the yarn joining position and the retreated position. The air cylinder 38 moves the yarn joining device 43 along the rail 37. By guiding the yarn joining device 43 with the rail 37, the yarn joining device 43 can be moved on an accurate path along the direction of advancing towards or receding from the yarn path.

**[0098]** In the fine spinning machine 1 of the present embodiment, the air cylinder 38 also functions as a stopper mechanism for defining an end of a movable range in which the yarn joining device 43 can be moved in a direction to approach the yarn path. Thus, the yarn joining device 43 can be prevented from excessively approaching the yarn path during the yarn joining operation, and the yarn joining operation can be performed while appropriately maintaining the positional relationship of the yarn joining device 43 and the yarn path.

**[0099]** The fine spinning machine 1 of the present embodiment includes the yarn accumulating device 12 arranged between the spinning device 9 and the winding device 13, and adapted to temporarily accumulate the spun yarn 10 around the outer peripheral surface 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. In other words, according to the present embodiment, since the slackening of the spun yarn 10 during the yarn joining operation can be prevented, the spun yarn 10 can be prevented from getting entangled around the rotating yarn accumulating roller 14. Therefore, the spun yarn 10 can be appropriately accumulated by the yarn accumulating device 12.

**[0100]** The fine spinning machine 1 of the present embodiment includes the traverse device 75 adapted to traverse the spun yarn 10 by the reciprocating traverse guide 76 before the spun yarn 10 is wound into the package 45.

**[0101]** In other words, according to the present embodiment, 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 getting 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.

**[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 embodiment described above, a structure in which the yarn joining cart 3 includes the yarn joining device 43 is adopted, but instead, the following structure may be adopted. In other words, the spinning unit 2 includes the winding device 13 adapted to wind the spun yarn 10 into the package 45, the spinning device 9 adapted to supply the spun yarn 10 to the winding device 13, the yarn joining device 43 adapted to perform a yarn joining operation to join the spun yarn 10 between the package 45 and the spinning device 9, and the moving means 30. The moving means 30 can move the yarn joining device 43 between the yarn joining position and the retreated position, the yarn joining position being a position located close to the yarn path between the package 45 and the spinning device 9 during the normal winding, and the retreated position being a position located away from the yarn path.

**[0104]** A structure in which each spinning unit 2 includes the yarn joining device 43 may also be adopted.

**[0105]** The structure of the moving means 30 adapted to move the yarn joining device 43 with respect to the yarn path is not limited to the above, and may be appropriately changed. For example, the drive source for moving the yarn joining device 43 with respect to the yarn path is not limited to the air cylinder 38, and may be a motor or the like. The yarn joining device 43 is not necessarily moved so as to be orthogonal to the yarn path, and may be moved diagonally with respect to the yarn path. Instead of linearly moving on the rail 37, the yarn joining device 43 may advance or recede from the yarn path by swinging with a supporting point as a center, for example.

**[0106]** 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.

**[0107]** The yarn joint monitor 47 may move independently from the yarn joining device 43. However, in order to simplify the structure of the fine spinning machine 1, the movement of the yarn joint monitor 47 and the yarn joining device 43 is desirably carried out simultaneously.

**[0108]** The structure for monitoring the yarn joint 99 formed by the yarn joining device 43 may be omitted. In this case, the yarn joint monitor 47 may be omitted.

**[0109]** In the embodiments described above, the travelling direction of the spun yarn 10 is from top to bottom in a height direction. However, the travelling direction of the spun yarn 10 is not particularly limited thereto, and the spinning unit 2 may be structured such that the spun yarn 10 travels from the bottom to the top.

**[0110]** In FIG. 2 and the like, the yarn path of the spun yarn 10 is in a substantially vertical direction. However, for example, the winding device 13 may be located more closer to the rear side of the spinning unit 2 than the position illustrated in FIG. 2, and the yarn path may be formed inclining from the front side to the rear side.

**[0111]** 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 in accordance with the number of spinning units 2.

**[0112]** In the embodiments described above, the winding drum 72 is commonly driven for the plurality of spinning units 2. However, the winding drum 72 may be individually driven in the respective spinning unit 2. In this case, the rotation speed and the rotating direction of the winding drum 72 may be changed in each spinning unit 2. Therefore, the package 45 can be reversely rotated by rotating the winding drum 72 in the opposite direction, and the reversely-rotating roller 63 may be omitted.

**[0113]** The structure of the yarn joining device 43 is not limited to the above, and the present invention can be applied to the yarn joining device 43 of other structures.

**[0114]** The spinning device is not limited to an 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. 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);

a yarn joining device (43) adapted to perform a yarn joining operation to join the yarn (10) between the package (45) and the yarn supplying section (9) at an operating position; and

a moving means (30) for moving the yarn joining device (43) at the operating position between an advanced position and a receded position, the advanced position being a position located close to a yarn path between the package (45) and the yarn supplying section (9) during a normal winding, and the receded position being a position located away from the yarn path.

2. The yarn winding machine according to claim 1, wherein the yarn joining device (43) includes at least an untwisting section (82) adapted to untwist a yarn end from the package (45) and a yarn end from the yarn supplying section (9), and a twisting section (94) adapted to twist the untwisted yarn ends, and the moving means (30) is adapted to move at least the untwisting section (82) and the twisting section (94) to the advanced position located close to the yarn path and the receded position located away from the yarn path.

3. The yarn winding machine according to claim 1 or claim 2, further comprising a yarn catching section (44, 46) adapted to catch a yarn (10) from the package (45) and a yarn (10) from the yarn supplying section (9) when the yarn (10) between the package (45) and the yarn supplying section (9) is disconnected, wherein the moving means (30) is adapted to maintain the yarn joining device (43) at the receded position during the normal winding and to advance the yarn joining device (43) to the advanced position during the yarn joining operation, and the yarn catching section (44, 46) guides the caught yarn (10) to a position where the yarn (10) can be guided into the yarn joining device (43) located at the advanced position.

4. The yarn winding machine according to claim 3, wherein the yarn catching section (44, 46) is adapted to guide the yarn (10) by swinging while keeping the caught yarn (10), and after the yarn catching section (44, 46) completes guiding the yarn (10), the moving means (30) starts to advance the yarn joining device (43) from the receded position to the advanced position.

5. The yarn winding machine according to claim 3 or claim 4, 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) and being provided capable of travelling to at least some of the plurality of the yarn winding units (2), the yarn joining cart (3) is adapted to stop in proximity of a target yarn winding unit (2) in which the yarn (10) is disconnected and to perform the yarn joining operation to the target yarn winding unit (2) by the yarn joining device (43), wherein at least when the yarn joining cart (3) travels, the moving means (30) is adapted to maintain the yarn joining device (43) at the receded position.
6. The yarn winding machine according to any one of claim 1 through claim 5, wherein the moving means (30) is adapted to linearly move the yarn joining device (43) in a direction substantially orthogonal to the yarn path between the package (45) and the yarn supplying section (9) during the normal winding.
7. The yarn winding machine according to any one of claim 1 through claim 6, wherein the yarn joining device (43) further includes a clamp section (97) adapted to clamp the yarn (10) during the yarn joining operation, and a drive source (60) for the clamp section (97), and the moving means (30) is adapted to move the clamp section (97) and the drive source (60) to an activating position located close to the yarn path and a non-activating position located away from the yarn path.
8. The yarn winding machine according to any one of claim 1 through claim 7, further comprising a yarn-joint monitoring device (47) adapted to monitor a quality of a yarn joint (99) formed by the yarn joining operation of the yarn joining device (43), wherein the moving means (30) is adapted to simultaneously move the yarn-joint monitoring device (47) and the yarn joining device (43).
9. The yarn winding machine according to any one of claim 1 through claim 8, wherein the moving means (30) includes a rail (37) adapted to guide the yarn joining device (43) between the advanced position and the receded position, and a movement driving source (38) adapted to drive the yarn joining device (43) along the rail (37).
10. The yarn winding machine according to any one of claim 1 through claim 9, further comprising a stopper mechanism (38) adapted to define an end of a movable range in which the yarn joining device (43) can be moved in a direction to approach the yarn path.
11. The yarn winding machine according to any one of claim 1 through claim 10, further comprising a yarn accumulating device (12) arranged between the yarn supplying section (9) and the winding section (13) and adapted to accumulate the yarn (10) around an outer peripheral surface 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 a travelling direction of the yarn (10).
12. The yarn winding machine according to any one of claim 1 through claim 11, 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).

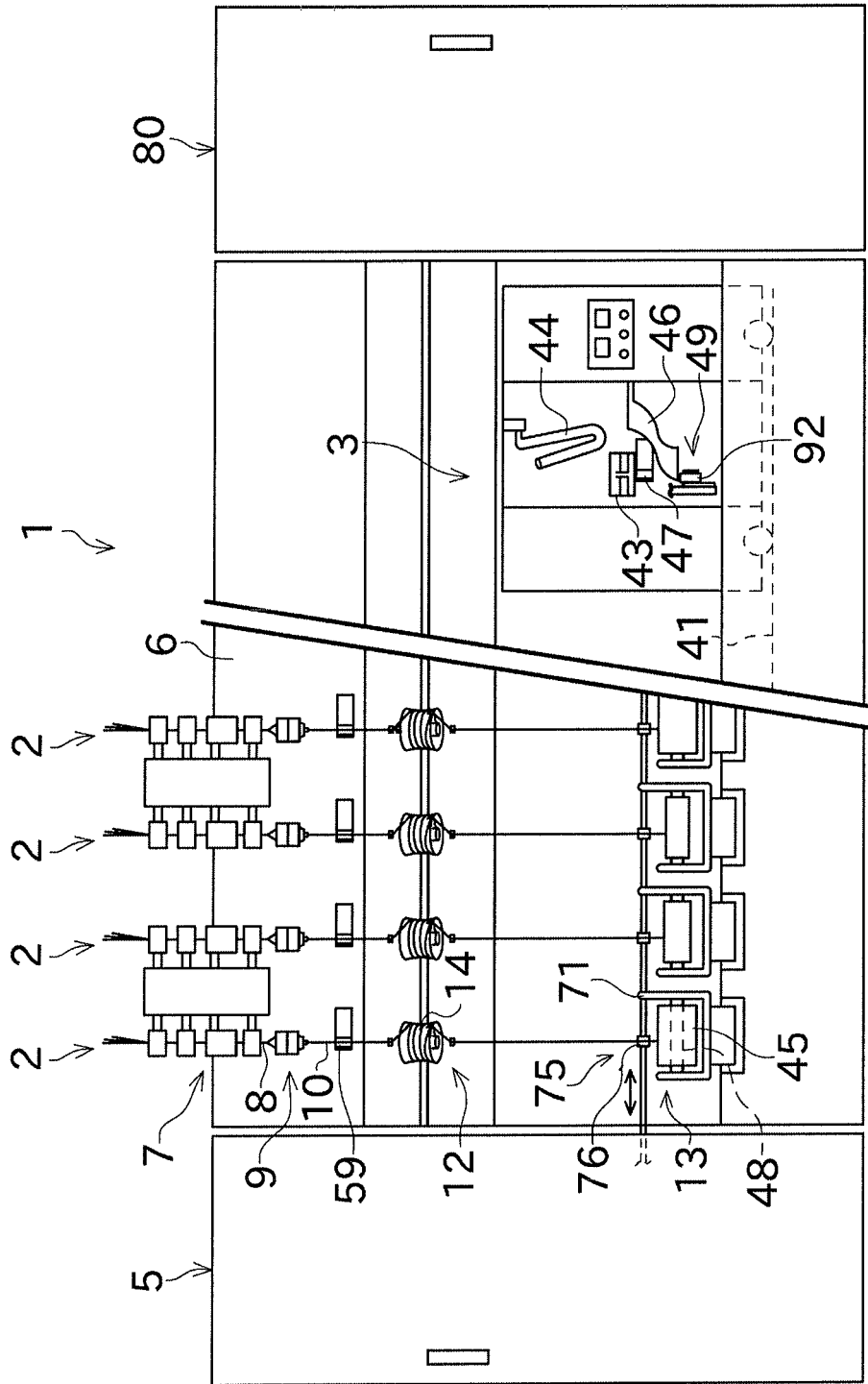


FIGURE 1

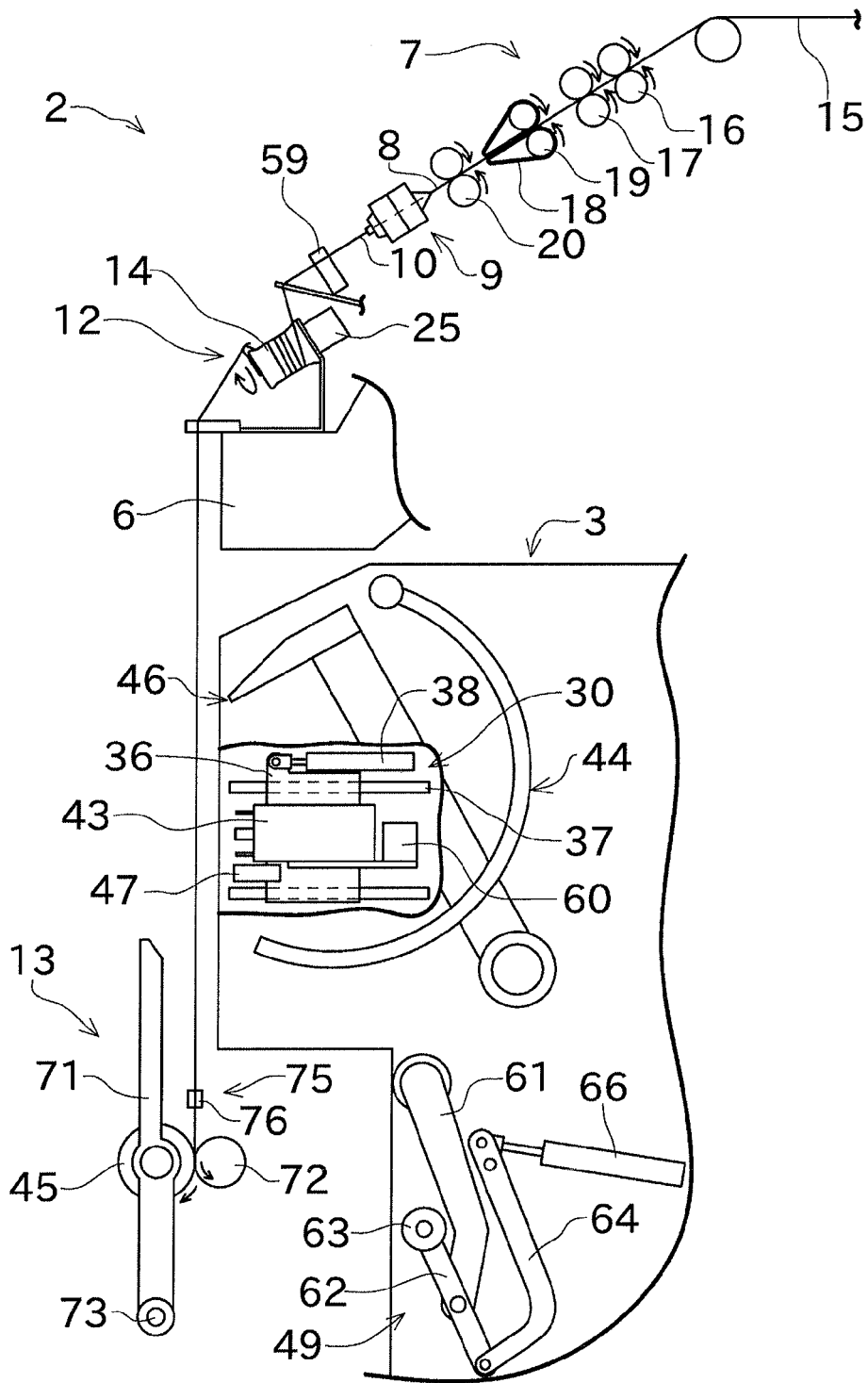


FIGURE 2



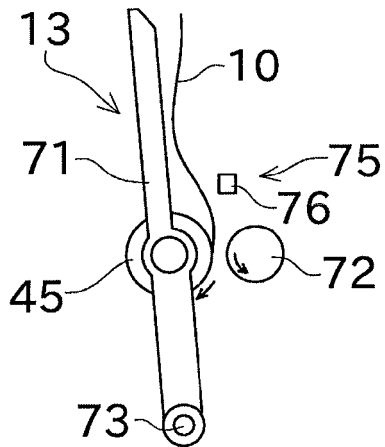
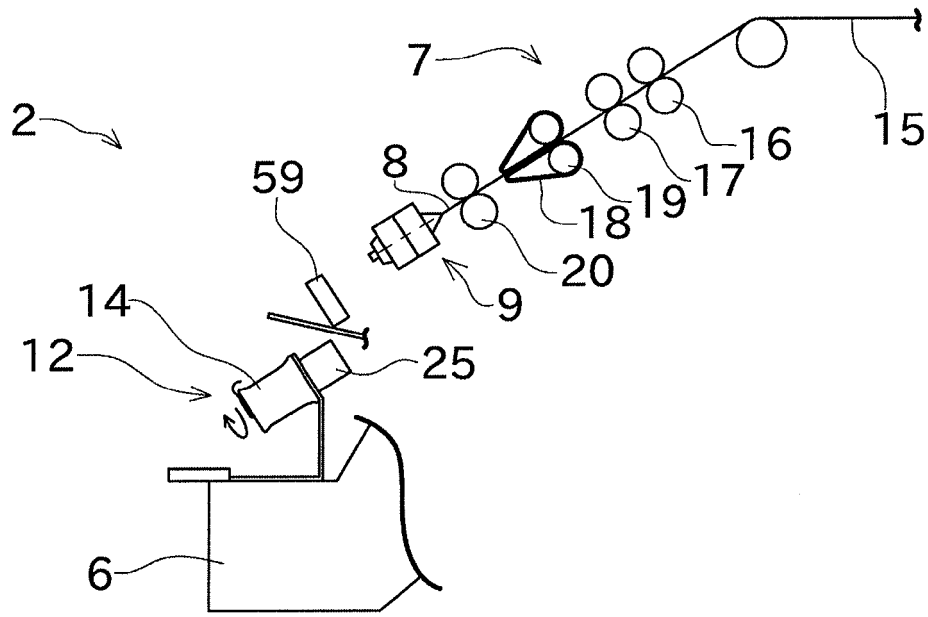


FIGURE 4

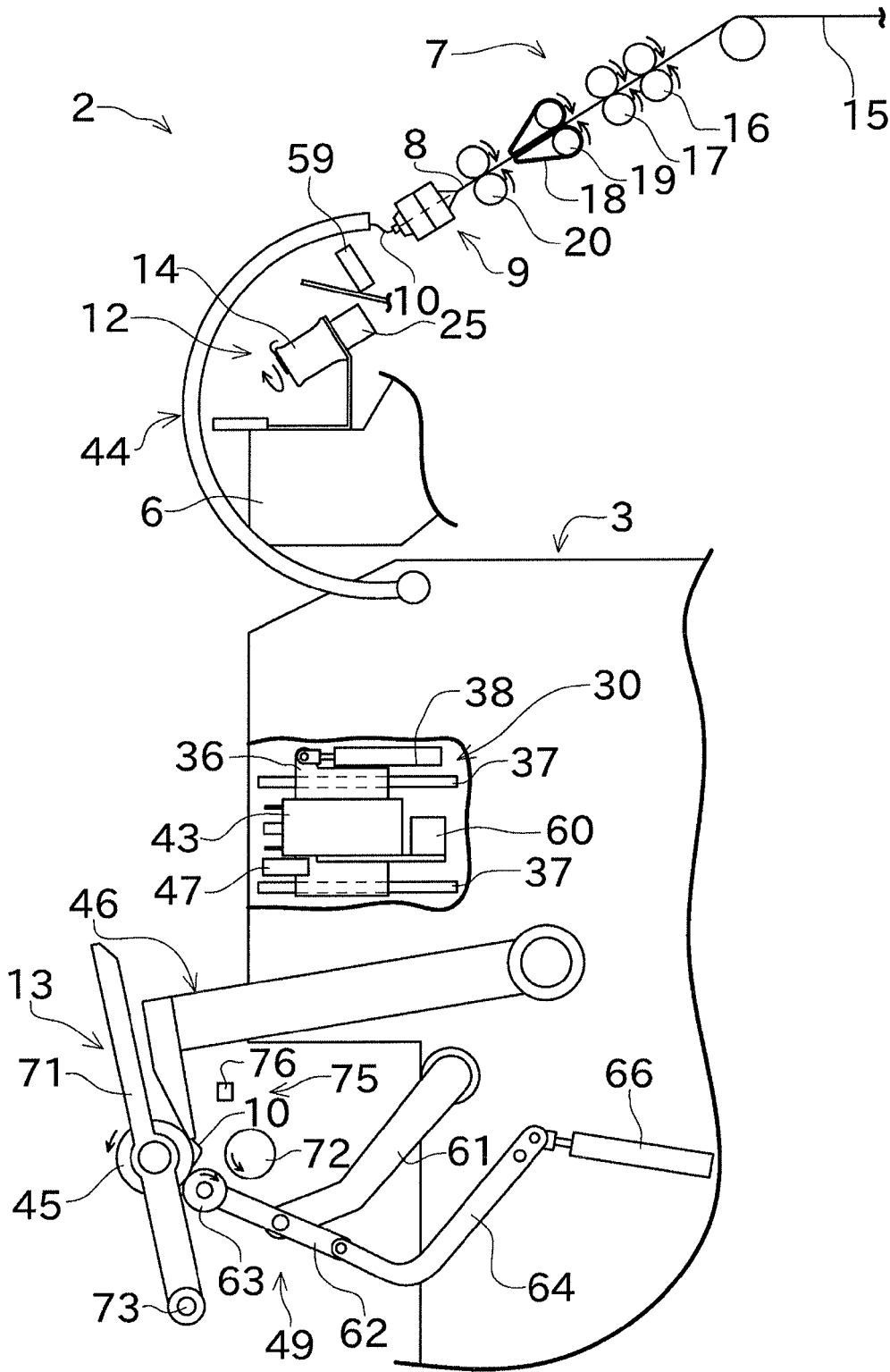


FIGURE 5

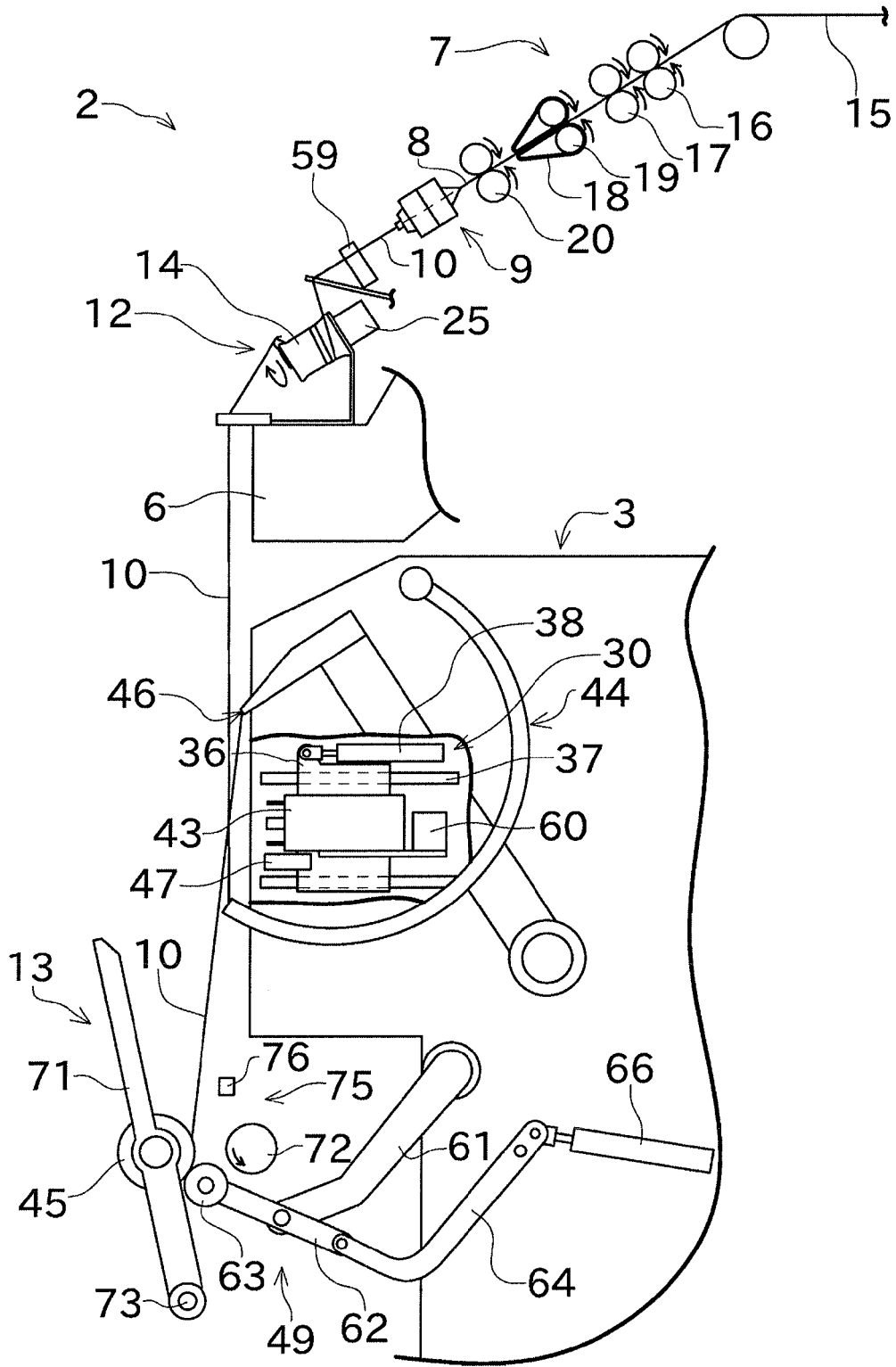


FIGURE 6

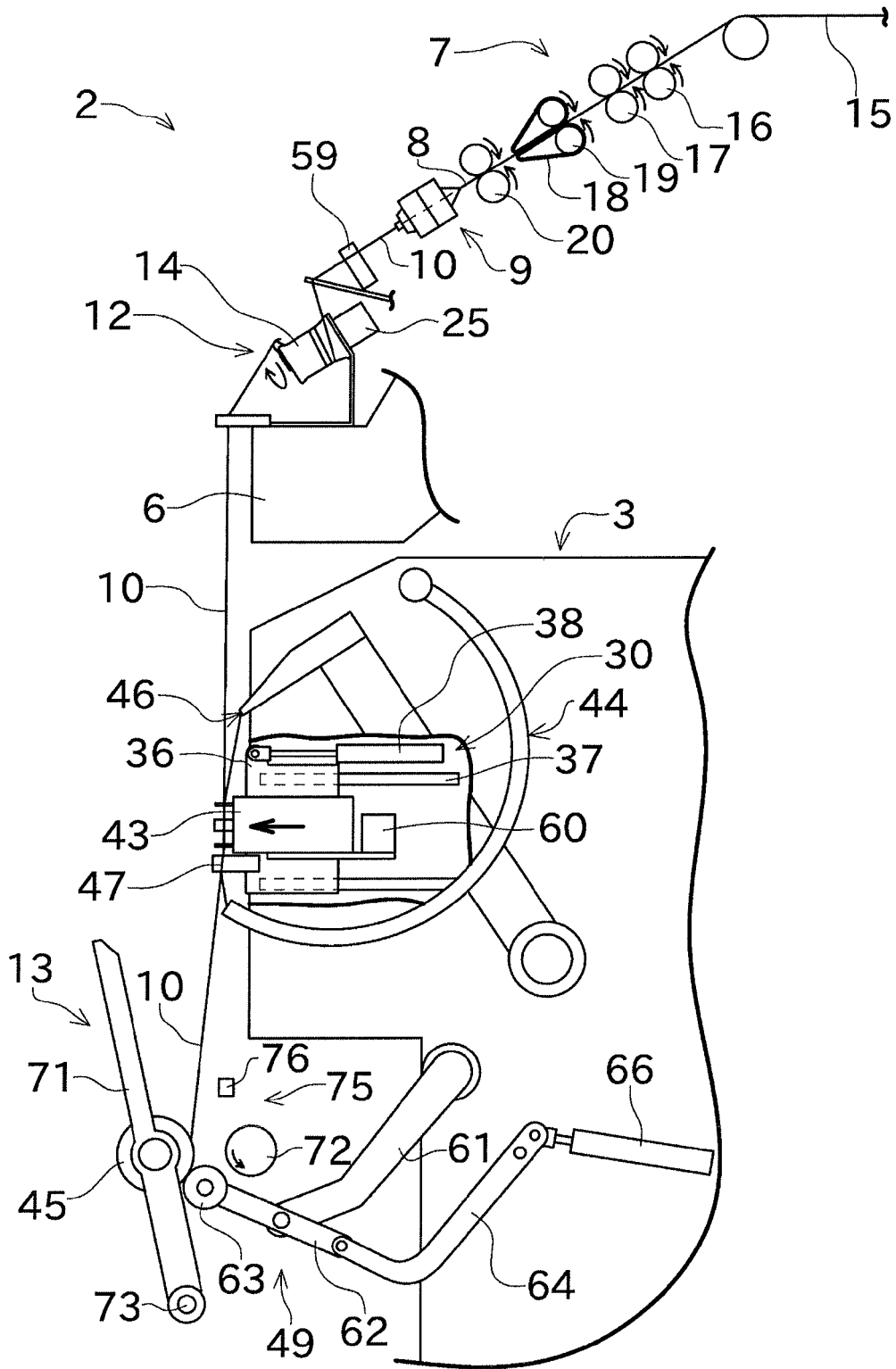


FIGURE 7

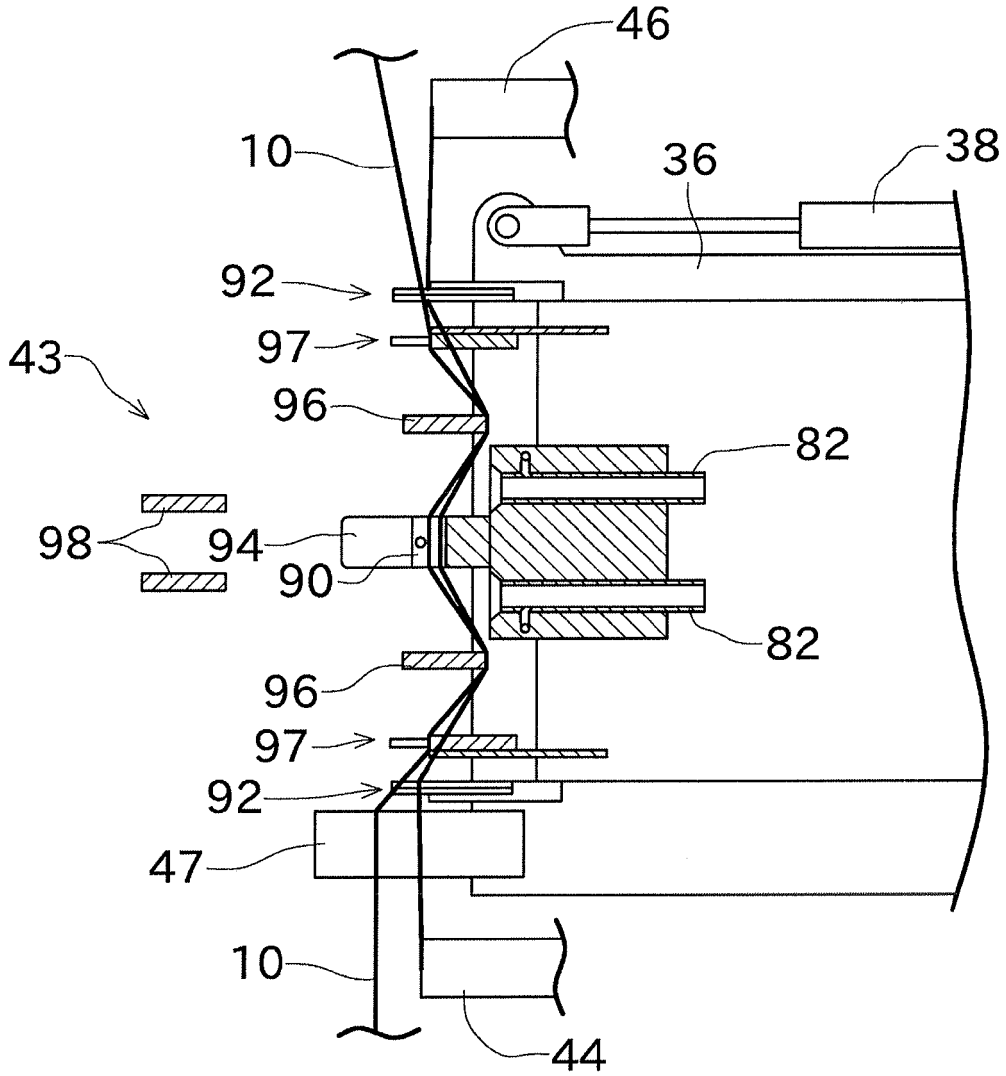


FIGURE 8

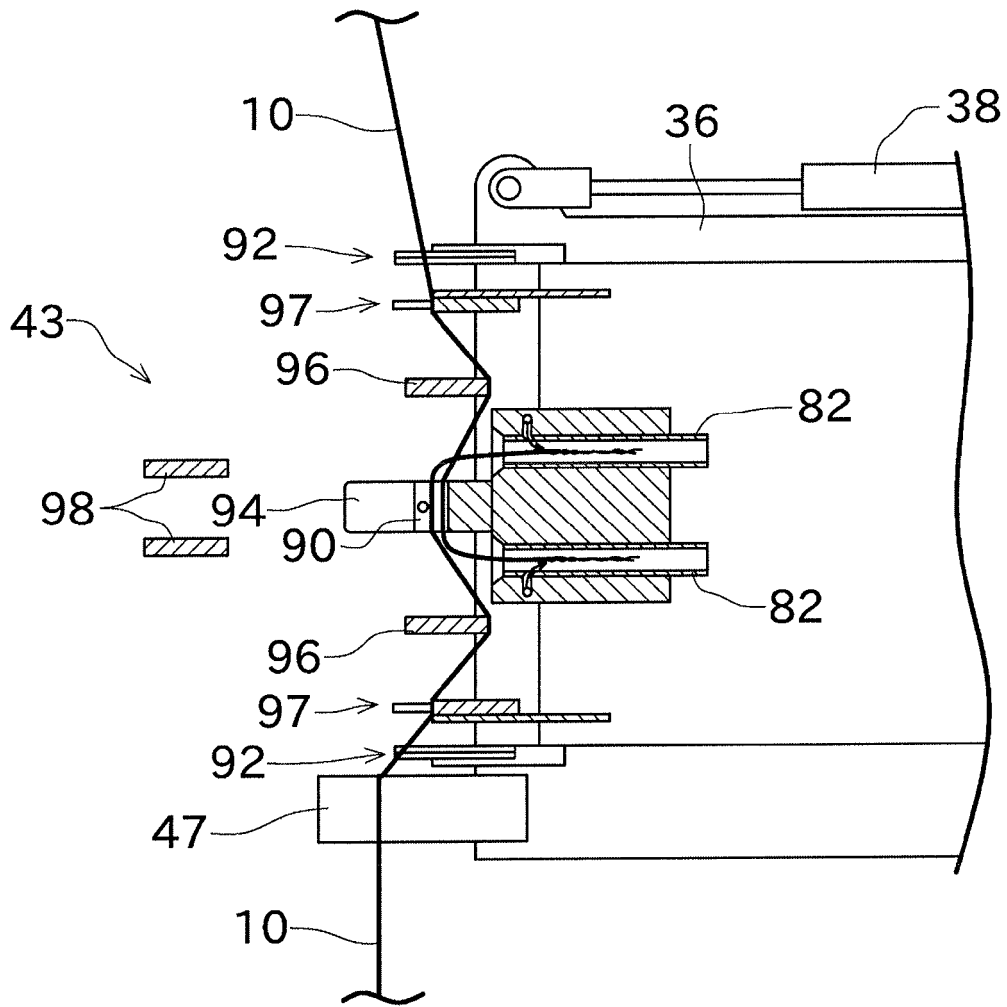


FIGURE 9

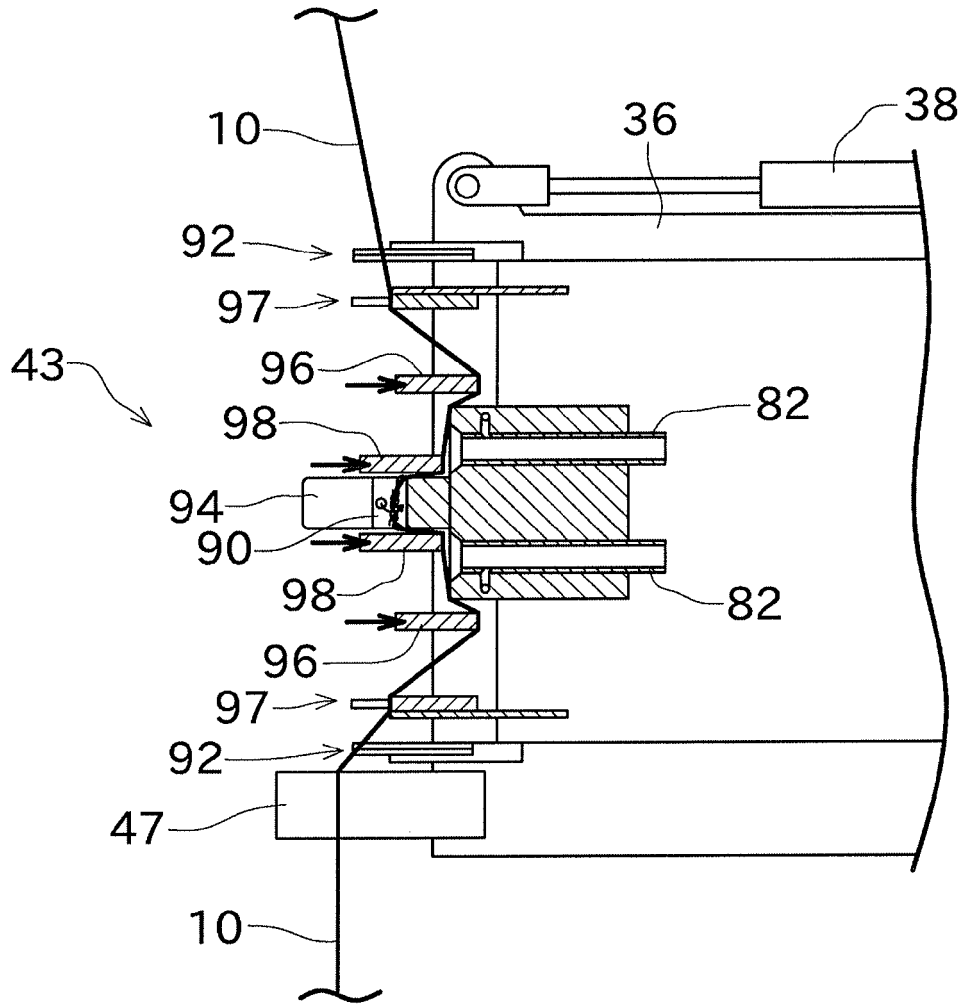


FIGURE 10

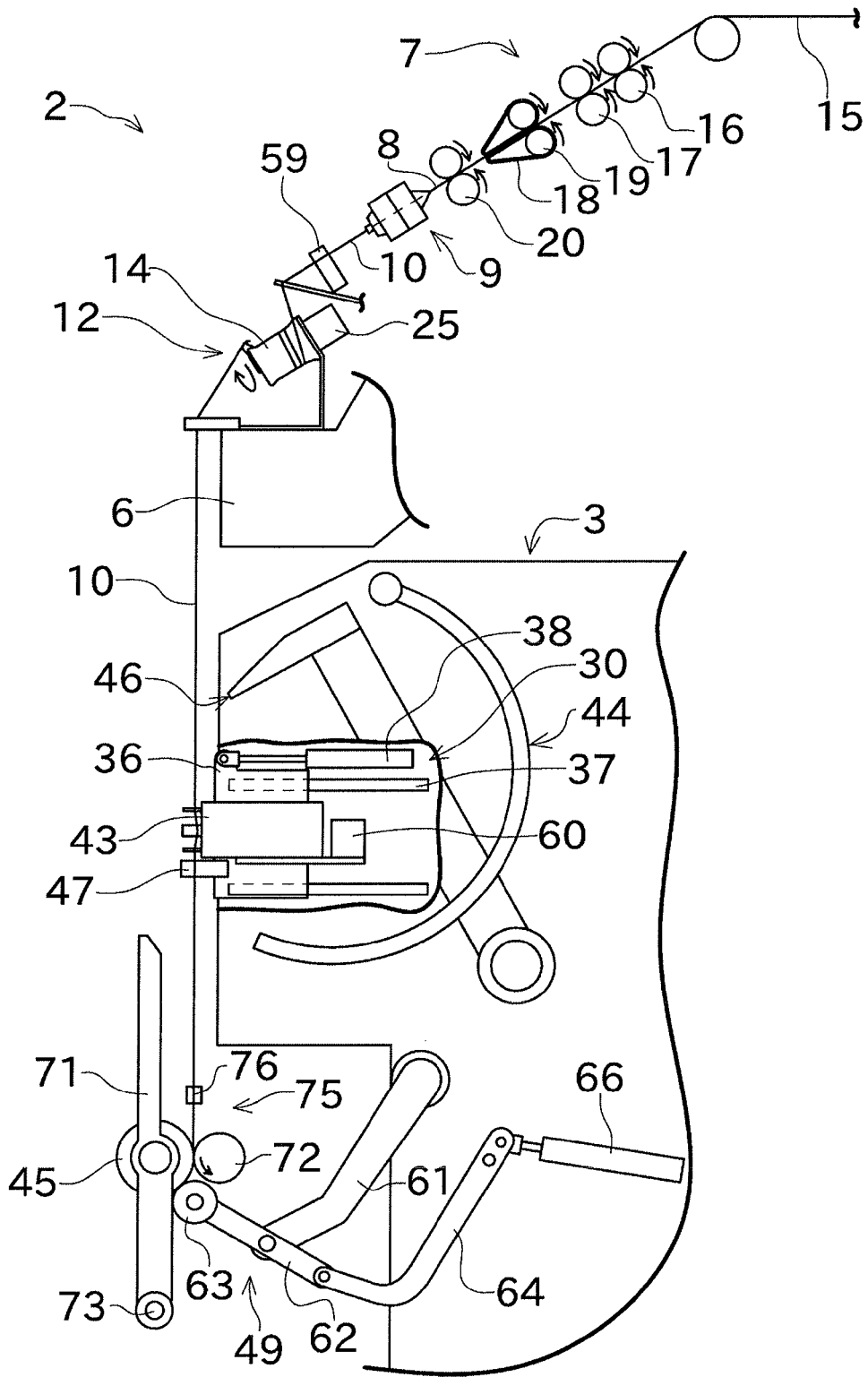


FIGURE 11

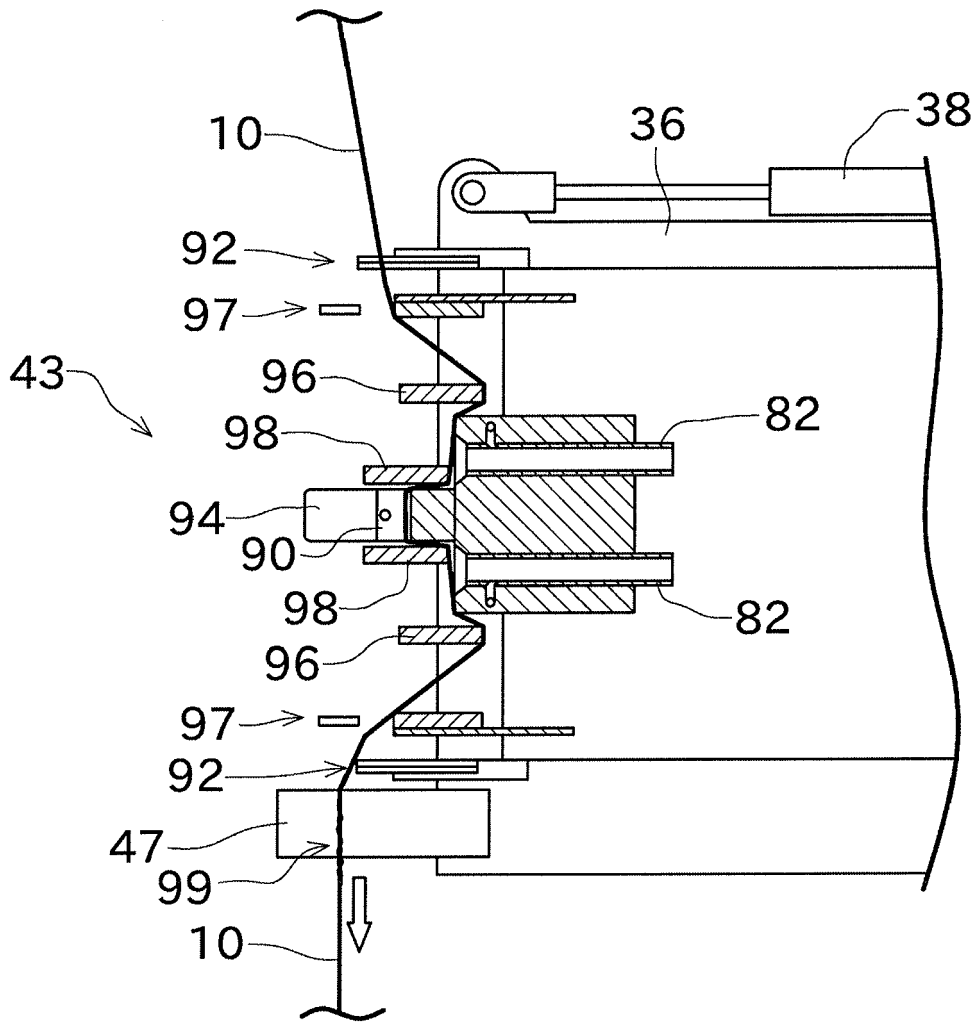


FIGURE 12

**REFERENCES CITED IN THE DESCRIPTION**

*This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.*

**Patent documents cited in the description**

- JP 2010077576 A [0002]
- JP 2005220484 A [0106]