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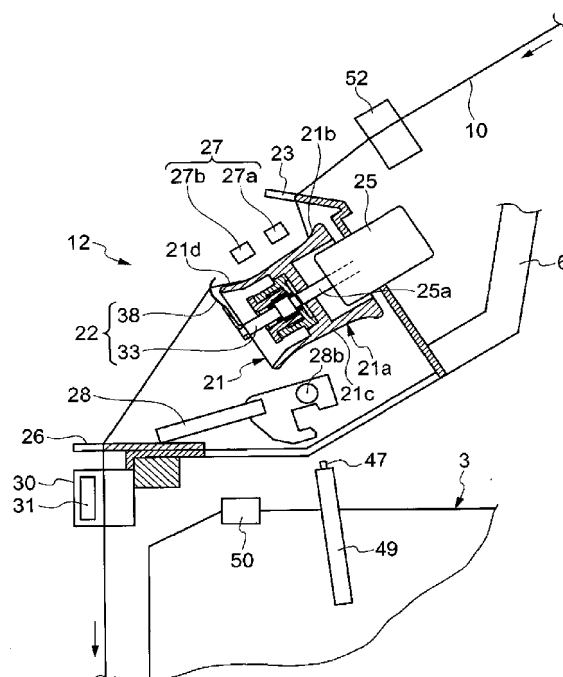
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(54) **Spinning unit, spinning machine and yarn processing method**

(57) A spinning machine includes an air-jet spinning device (9) adapted to produce a spun yarn (10) by twisting a fiber bundle (8), a yarn accumulating roller (21) provided downstream of the air-jet spinning device (9) and adapted to temporarily accumulate the spun yarn (10) by rotating and winding the spun yarn (10) around an outer peripheral surface (21a) thereof, a yarn hooking member (22) provided downstream of the yarn accumulating roller (21) and adapted to wind the spun yarn (10) around the outer peripheral surface (21a) of the yarn accumulating roller (21) by integrally rotating with the yarn accumulating roller (21) while being in contact with the spun yarn (10), a yarn removing lever (28) that can remove the spun yarn (10) from the yarn hooking member (22), and a yarn removal detecting section that detects a removal of the spun yarn (10) from the yarn hooking member (22) by the yarn removing lever (28).

FIG. 4



Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a spinning unit, a spinning machine, and a yarn processing method.

2. Description of the Related Art

[0002] A spinning unit described in Japanese Unexamined Patent Application Publication No. 2011-38225 is conventionally known. In such a spinning unit, a yarn accumulating roller for temporarily accumulating a spun yarn is provided downstream of a spinning device. In order to wind the spun yarn on an outer peripheral surface of the yarn accumulating roller, the spinning unit is provided with a yarn hooking member which is integrally rotated with the yarn accumulating roller. Since the yarn hooking member is integrally rotated with the yarn accumulation roller while being engaged with the spun yarn, the spun yarn is wound around the outer peripheral surface of the yarn accumulating roller. The spinning unit includes a yarn removing member. While the spun yarn is engaged with the yarn hooking member, the yarn removing member moves a yarn path of the spun yarn to remove the spun yarn from the yarn hooking member.

SUMMARY OF THE INVENTION

[0003] When the yarn removing member removes a spun yarn from the yarn hooking member, the yarn removing member may fail to remove the spun yarn from the yarn hooking member. Conventionally, detection is not carried out to confirm whether the spun yarn has been removed from the yarn hooking member when the yarn removing member is operated.

[0004] An object of the present invention is to provide a spinning unit and a spinning machine capable of detecting whether or not a spun yarn is removed from a yarn hooking member, and a corresponding yarn processing method.

[0005] A spinning unit includes a spinning device, a yarn accumulating roller, a yarn hooking member, a yarn removing member and a yarn removal detecting section. The spinning device produces a spun yarn by applying twists to a fiber bundle. The yarn accumulating roller is arranged downstream of the spinning device in a yarn travelling direction, and temporarily accumulates the spun yarn while rotating and winding the spun yarn around an outer peripheral surface thereof. The yarn hooking member is arranged downstream of the yarn accumulating roller, and adapted to wind the spun yarn around the outer peripheral surface of the yarn accumulating roller by integrally rotating with the yarn accumulating roller while being in contact with the spun yarn. The yarn removing member is capable of removing the spun

yarn from the yarn hooking member. The yarn removal detecting section detects that the spun yarn has been removed from the yarn hooking member with the yarn removing member.

[0006] In the spinning unit, the yarn removal detecting section can detect whether or not a spun yarn has been removed from the yarn hooking member. Accordingly, a failure which occurs when a yarn removal is not detected can be prevented.

[0007] The spinning unit includes a wax applying device which is arranged downstream of the yarn accumulating roller, and adapted to apply wax to a travelling spun yarn. The yarn removal detecting section provided in the wax applying device detects a travelling state of the spun yarn, and detects removal of the spun yarn from the yarn hooking member in accordance with the travelling state of the spun yarn. With the detecting section provided in the wax applying device, removal of the spun yarn from the yarn hooking member can be detected.

[0008] The yarn removal detecting section detects the spun yarn moved in a peripheral direction of the yarn accumulating roller and on the outer peripheral surface thereof by the yarn hooking member rotating while making contact with the spun yarn, and detects removal of the spun yarn from the yarn hooking member in accordance with a detection of the spun yarn moving in the peripheral direction. With the detecting section that detects a spun yarn moving in the peripheral direction of the yarn accumulating roller and on the outer peripheral surface thereof, removal of the spun yarn from the yarn hooking member can be detected.

[0009] A spinning device is preferably an air-jet spinning device that produces a spun yarn by twisting a fiber bundle with whirling airflow. Also in the spinning unit including the air-jet spinning device, removal of the spun yarn from the yarn hooking member can be detected.

[0010] A spinning machine includes a plurality of the above-described spinning units and a service cart arranged to be capable of moving among the plurality of spinning units. The yarn removal detecting section is provided on the service cart, and detects the spun yarn moved in the peripheral direction of the yarn accumulating roller by the yarn hooking member rotating while making contact with the spun yarn. In accordance with a detection result of the spun yarn moving in the peripheral direction of the yarn accumulating roller, the yarn removal detecting section detects that the spun yarn has been removed from the yarn hooking member. By detecting the spun yarn moving in the peripheral direction of the yarn accumulating roller using the detecting section provided on the service cart, removal of the spun yarn from the yarn hooking member can be detected.

[0011] The service cart is preferably at least one of a yarn joining cart for joining spun yarns and a yarn doffing cart for moving a package which is formed by winding the spun yarn produced by the spinning device. By arranging the yarn removal detecting section on the yarn joining cart or the yarn doffing cart, removal of the spun

yarn from the yarn hooking member can be detected.

[0012] A detection can be carried out as to whether or not the spun yarn has been removed from the yarn hooking member. Further, the present invention provides a yarn processing method according to claim 8 to 11.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013]

Fig. 1 is a front view illustrating a spinning machine according to one embodiment of the present invention.

Fig. 2 is a longitudinal sectional view of the spinning machine illustrated in Fig. 1.

Fig. 3 is a block diagram of a main structure of the spinning machine illustrated in Fig. 1.

Fig. 4 is a longitudinal sectional view of a yarn accumulating device illustrated in Fig. 1.

Fig. 5 is an external perspective view of the yarn accumulating device illustrated in Fig. 1.

Fig. 6 is a front view schematically illustrating a structure of a yarn accumulating roller and its periphery illustrated in Fig. 1.

Fig. 7 is a side view schematically illustrating a structure of the yarn accumulating roller and its periphery illustrated in Fig. 1.

Fig. 8 is a flowchart describing a first half of control of unwinding a portion with unstable yarn quality from the yarn accumulating roller.

Fig. 9 is a flowchart describing a last half of the control of unwinding a portion with unstable yarn quality from the yarn accumulating roller.

Fig. 10 is a timing chart of unwinding a portion with unstable yarn quality from the yarn accumulating roller.

Fig. 11 is a longitudinal sectional view illustrating how a suction pipe and a suction mouth (illustrated in Fig. 1) catch an upper yarn and a lower yarn.

Fig. 12 is a longitudinal sectional view illustrating how a portion with unstable yarn quality is unwound from the yarn accumulating roller.

Fig. 13 is a side view schematically illustrating the yarn accumulating roller and its periphery when a yarn removing lever (illustrated in Fig. 7) is located at a lifted position.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0014] Next, a spinning unit and a spinning machine according to an embodiment of the present invention will be described with reference to the drawings. Herein, "upstream" and "downstream" respectively refer to upstream and downstream in a traveling direction of a spun yarn during a spinning operation.

[0015] The spinning machine 1 includes a plurality of spinning units 2 arranged in line. The spinning machine

1 includes a yarn joining cart 3, a blower box 80, and a motor box 5. In a plant provided with the spinning machine 1, an operator passage extending in a direction in which the spinning units 2 are arranged is provided at a side of a yarn path with respect to the yarn joining cart (service cart) 3. An operator can operate each spinning unit 2 or monitor its operational status at the operator passage.

[0016] Each spinning unit 2 includes a draft device 7, an air-jet spinning device 9, a yarn accumulating device 12, a waxing device (wax applying device) 30, and a winding device 13 in this order from upstream to downstream. The draft device 7 is provided in the vicinity of an upper end portion of a frame 6 of the spinning machine 1. A fiber bundle 8 fed from the draft device 7 is spun with the air-jet spinning device 9. After the spun yarn 10 spun with the air-jet spinning device 9 passes through a yarn clearer 52, the spun yarn 10 is conveyed further downstream with the yarn accumulating device 12, and waxed with the waxing device 30. Then, the spun yarn 10 is wound with the winding device 13, and a package 45 is formed.

[0017] The draft device 7 drafts a sliver 15 into the fiber bundle 8. As illustrated in Fig. 2, the draft device 7 includes the following four pairs of rollers: a pair of back rollers 16, a pair of third rollers 17, a pair of middle rollers 19 provided with an apron belt 18, and a pair of front rollers 20. A bottom roller of each of the pairs of rollers 16, 17, 19 and 20 is driven to rotate by power from the motor box 5 or an individually provided driving source (not illustrated). Each pair of rollers 16, 17, 19 and 20 is driven to rotate at a different rotation speed, and as a result, the sliver 15 fed from the upstream is drafted into the fiber bundle 8 and conveyed to the air-jet spinning device 9 located downstream. As illustrated in Fig. 3, among the pairs of rollers 16, 17, 19 and 20 provided in the draft device 7, a pair of rollers that is driven to rotate by the power from an individually provided driving source (not illustrated) (in the embodiment of the present invention, the pairs of rollers 16 and 17) is controlled by a unit controller 60. However, if a driving source (not illustrated) provided in the motor box 5 drives all of the pairs of rollers 16, 17, 19 and 20 to rotate, a control unit for controlling driving of the driving source provided in the motor box 5 may control the rotation of the pairs of rollers 16, 17, 19 and 20.

[0018] The air-jet spinning device 9 twists the fiber bundle 8 using whirling airflow to produce the spun yarn 10. Although a detailed description or an illustration will be omitted, the air-jet spinning device 9 includes a fiber guiding section, a whirling airflow generating nozzle, and a hollow guide shaft body. The fiber guiding section guides the fiber bundle 8 fed from the draft device 7 to a spinning chamber formed in the air-jet spinning device 9. The whirling airflow generating nozzle is provided around a path of the fiber bundle 8 and generates whirling airflow in the spinning chamber. Fiber ends of the fiber bundle 8 in the spinning chamber are reversed and whirled with the whirling airflow. The hollow guide shaft guides the

spun yarn 10 from the spinning chamber to outside of the air-jet spinning device 9. As illustrated in Fig. 3, the whirling airflow is generated or stopped by the control of the unit controller 60.

[0019] The yarn accumulating device 12 is provided downstream of the air-jet spinning device 9. The yarn accumulating device 12 includes the following functions: drawing the spun yarn 10 from the air-jet spinning device 9 by applying a predetermined tension thereto, preventing slackening of the spun yarn 10 by accumulating the spun yarn 10 fed from the air-jet spinning device 9 during a yarn joining operation performed by the yarn joining cart 3, and adjusting a tension such that tension change at the winding device 13 is prevented from propagating to the air-jet spinning device 9. As illustrated in Fig. 2, the yarn accumulating device 12 includes a yarn accumulating roller 21, a yarn hooking member 22, an upstream guide 23, an electric motor 25, a downstream guide 26, an accumulated amount detecting sensor 27, and a yarn removing lever (yarn removing member) 28.

[0020] The yarn hooking member 22 is capable of engaging with (hooking) the spun yarn 10. By being integrally rotated with the yarn accumulating roller 21 while being engaged with the spun yarn 10, the yarn hooking member 22 can guide the spun yarn 10 to an outer peripheral surface 21a of the yarn accumulating roller 21.

[0021] The yarn accumulating roller 21 can wind and accumulate the spun yarn 10 on the outer peripheral surface 21a thereof. The yarn accumulating roller 21 is driven to rotate at a constant rotation speed by the electric motor 25 controlled by the unit controller 60. When the yarn accumulating roller 21 is rotated, the spun yarn 10 guided to the outer peripheral surface 21a of the yarn accumulating roller 21 by the yarn hooking member 22 is wound as if to tighten the yarn accumulating roller 21, and hence the spun yarn 10 located upstream of the yarn accumulating device 12 is drawn. Accordingly, the spun yarn 10 can be continuously drawn from the air-jet spinning device 9.

[0022] When the spun yarn 10 accumulated on the yarn accumulating roller 21 reaches or exceeds a certain amount, a contact area between the yarn accumulating roller 21 and the spun yarn 10 becomes large, and hence a slip or the like will hardly occur. Therefore, when the yarn accumulating roller 21 is rotationally driven under a state in which the spun yarn 10 of the certain amount or more is wound on the yarn accumulating roller 21, the yarn accumulating device 12 can draw the spun yarn 10 from the air-jet spinning device 9 at a stable speed without causing a slip or the like. In the following description, the certain amount (that is, a yarn accumulated amount in which no slip occurs and the force to draw the spun yarn 10 is stabilized) may be referred to as a minimal accumulation amount.

[0023] The accumulated amount detecting sensor 27 detects in a non-contact manner, the amount of the spun yarn 10 accumulated on the yarn accumulating roller 21, and transmits a detected amount to the unit controller 60.

[0024] The upstream guide 23 is arranged slightly upstream of the yarn accumulating roller 21. The upstream guide 23 functions as a guiding member to properly guide the spun yarn 10 to the outer peripheral surface 21a of the yarn accumulating roller 21. The upstream guide 23 also functions as a twist stopper for preventing propagation of twists of the spun yarn 10 from the air-jet spinning device 9 to the downstream of the upstream guide 23.

[0025] The downstream guide 26 is arranged slightly downstream of the yarn accumulating roller 21. The downstream guide 26 regulates a path of the spun yarn 10 swung by the rotating yarn hooking member 22 in a peripheral direction of the yarn accumulating roller 21. The downstream guide 26 stabilizes a travelling path of the spun yarn 10 located downstream of the downstream guide 26, and guides the spun yarn 10.

[0026] The yarn removing lever 28 is arranged upstream of the downstream guide 26 in the vicinity of a downstream end portion of the yarn accumulating roller 21. The yarn removing lever 28 can swing around a swing shaft 28b.

[0027] The yarn clearer 52 is arranged between the air-jet spinning device 9 and the yarn accumulating device 12. The yarn clearer 52 monitors a thickness of a travelling spun yarn 10. When detecting a yarn defect in the spun yarn 10, the yarn clearer 52 transmits a yarn defect detection signal to the unit controller 60. The unit controller 60 that has received the yarn defect detection signal stops the air-jet spinning device 9 from twisting the fiber bundle 8 using the whirling airflow to cut the spun yarn 10.

[0028] As illustrated in Figs. 1 and 2, the yarn joining cart 3 includes a splicer (yarn joining device) 43, a suction pipe 44, a suction mouth 46, a pushing arm 47, a pneumatic cylinder (moving section) 49, and a yarn movement detecting sensor (yarn removal detecting section) 50. When a yarn breakage or a yarn cut occurs in a spinning unit 2, the yarn joining cart 3 runs on a rail 41 fixed to the frame 6 and stops at the relevant spinning unit 2 to perform a joining operation (splicing operation). The yarn joining operation refers to a series of operations in which yarn ends formed due to a yarn breakage or a yarn cut are caught and joined. The series of these operations may be referred to as a yarn joining cycle.

[0029] The suction pipe 44 can vertically swing around an axis. The suction pipe 44 can suck and catch a yarn end (upper yarn) of the spun yarn 10 fed from the air-jet spinning device 9, and guide the yarn end to the splicer 43. The suction mouth 46 can vertically swing around an axis. The suction mouth 46 can suck and catch a yarn end (lower end) of the package 45 supported by the winding device 13, and guide the yarn end to the splicer 43. The operation of sucking the yarn ends by the suction pipe 44 and the suction mouth 46 is controlled by the unit controller 60. Although a detailed description will be omitted, the splicer 43 untwists both yarn ends and then twists the yarn ends together using the whirling airflow to join the upper yarn and the lower yarn.

[0030] The pushing arm 47 is arranged at a tip end portion of the pneumatic cylinder 49 as an actuator. By driving the pneumatic cylinder 49, the pushing arm 47 is moved to an upper advanced position to lift the yarn removing lever 28, and thus the yarn removing lever 28 can be moved to the lifted position. The driving of the pneumatic cylinder 49 is controlled by the unit controller 60.

[0031] The yarn movement detecting sensor 50 detects the spun yarn 10 moved in the peripheral direction of the yarn accumulating roller 21 by the yarn hooking member 22 being rotated while being engaged with the spun yarn 10 (the spun yarn 10 moved as if to travel around the vicinity of the downstream end portion of the yarn accumulating roller 21 by the yarn hooking member 22 being rotated). The detection result by the yarn movement detecting sensor 50 is transmitted to the unit controller 60.

[0032] The waxing device 30 is provided between the yarn accumulating device 12 and the winding device 13. A travelling detecting sensor (yarn removal detecting sensor) 31 is provided in the waxing device 30. The travelling detecting sensor 31 detects at least one of travelling of the spun yarn 10 to be waxed with the waxing device 30 along a yarn path and stop of travelling. The detection result by the travelling detecting sensor 31 is transmitted to the unit controller 60.

[0033] The winding device 13 includes a cradle arm 71 that is supported to be capable of swinging around a supporting shaft 70. The cradle arm 71 can rotatably support the bobbin 48 used to wind the spun yarn 10.

[0034] The winding device 13 includes a winding drum 72 and a traverse device 75. The winding drum 72 can be driven while making contact with an outer peripheral surface of the bobbin 48 or an outer peripheral surface of the package 45. The traverse device 75 includes a traverse guide 76 that can be engaged with the spun yarn 10. By driving the winding drum 72 by an electric motor (not illustrated) while reciprocating the traverse guide 76 by a driving means (not illustrated), the package 45 making contact with the winding drum 72 is rotated and the spun yarn 10 is wound while being traversed.

[0035] The blower box 80 is provided with an air supplying source (negative pressure source) (not illustrated) that generates air to be supplied to each section of the spinning unit 2, the yarn joining cart 3 and the like.

[0036] Next, a specific structure of the yarn accumulating device 12 will be described with reference to Figs. 4 and 5.

[0037] The yarn accumulating roller 21 is a roller member made from an abrasion-resistant material, and is fixed to a motor shaft 25a of the electric motor 25. On the outer peripheral surface 21a of the yarn accumulating roller 21, provided that a side on which the yarn hooking member 22 is provided is a tip end, and a side on which the electric motor 25 is provided is a base end, a base end side tapered portion 21b, a cylindrical portion 21c and a tip end side tapered portion 21d are provided in

this order from the base end to the tip end.

[0038] The cylindrical portion 21c is formed to slightly taper toward the tip end side and also to be smoothly connected with the tapered portions 21b and 21d at both sides without difference in level. The size of the cylindrical portion 21c is appropriately determined so that at least a minimal amount or more of the spun yarn 10 can be accumulated. The accumulated amount detecting sensor 27 includes a minimum accumulated amount detecting sensor 27a and an excessive accumulation detecting sensor (yarn removal detecting sensor) 27b. The minimum accumulated amount detecting sensor 27a and the excessive accumulation detecting sensor 27b are arranged to face the cylindrical portion 21c.

[0039] Each of the base end side tapered portion 21b and the tip end side tapered portion 21d is formed in a gradual tapered shape with a larger diameter at a corresponding end side. On the outer peripheral surface 21a of the yarn accumulating roller 21, the base end side tapered portion 21b functions to smoothly move the supplied spun yarn 10 to a small diameter portion from the large diameter portion until the spun yarn 10 reaches the cylindrical portion 21c located at the middle to orderly wind the spun yarn 10 around the surface of the cylindrical portion 21c. The tip end side tapered portion 21d functions to prevent a sloughing phenomenon in which the wound spun yarn 10 sloughs all at once while the spun yarn 10 is being unwound from the yarn accumulating roller 21. The tip end side tapered portion 21d also functions to sequentially rewind the spun yarn 10 from the small diameter portion to the large diameter portion at the end side so as to maintain smooth drawing of the spun yarn 10.

[0040] As illustrated in Figs. 4 and 5, the yarn hooking member 22 arranged at the tip end side of the yarn accumulating roller 21 is arranged coaxially with the yarn accumulating roller 21. The yarn hooking member 22 includes a flyer axis 33 and a flyer 38 fixed to the tip end of the flyer axis 33.

[0041] The flyer axis 33 is rotatably supported relative to the yarn accumulating roller 21. A permanent magnet (not illustrated) is attached to either one of the flyer axis 33 or the yarn accumulating roller 21, and a magnetic hysteresis material (not illustrated) is attached to another one of the flyer 33 or the yarn accumulating roller 21. These magnetic mechanisms generate resistance torque against the rotation of the yarn hooking member 22 relative to the yarn accumulating roller 21. With such resistance torque, the yarn hooking member 22 is rotated in response to the rotation of the yarn accumulating roller 21, and accordingly, the yarn hooking member 22 is integrally rotated with the yarn accumulating roller 21. When a force surpassing the resistance torque is applied to the yarn hooking member 22, the yarn hooking member 22 is relatively rotated with respect to the yarn accumulating roller 21.

[0042] The flyer 38 is properly curved toward the outer peripheral surface 21a of the yarn accumulating roller

21, and is configured to be engaged with the spun yarn 10 (to hook the spun yarn 10). When the flyer 38 is integrally rotated together with the yarn accumulating roller 21 under a state in which the spun yarn 10 has not been wound around the yarn accumulating roller 21, the flyer 38 is engaged with the spun yarn 10. The spun yarn 10 engaged with the rotating flyer 38 is swung around by the flyer 38, and guided to and wound around the outer peripheral surface 21a of the rotating yarn accumulating roller 21.

[0043] Next, the spun yarn 10 wound around the yarn accumulating roller 21 will be described. After passing through the upstream guide 23, the spun yarn 10 is guided from the base end side of the yarn accumulating roller 21 to the outer peripheral surface 21a thereof, and then wound around the cylindrical portion 21c several times. Then, after passing through the flyer 38, the spun yarn 10 drawn from the tip end side of the outer peripheral surface 21a is conveyed downstream through the downstream guide 26.

[0044] Under a state in which the spun yarn 10 has been wound around the yarn accumulating roller 21 as illustrated in Fig. 5, when a force is applied on the spun yarn 10 to draw the spun yarn 10 engaged with the flyer 38 towards the downstream side, a force to rotate the yarn hooking member 22 is applied to the flyer 38 so as to unwind the spun yarn 10 from the tip end side of the yarn accumulating roller 21. Therefore, if a yarn tension at downstream of the yarn accumulating device 12 (a yarn tension between the yarn accumulating device 12 and the winding device 13) is great enough to surpass the resistance torque (that is, if a yarn tension of a predetermined value or more is applied to the spun yarn 10 engaged with the flyer 38), the yarn hooking member 22 is independently rotated from the yarn accumulating roller 21, and the spun yarn 10 is gradually unwound from the tip end side of the yarn accumulating roller 21 through the flyer 38.

[0045] When the yarn tension at the downstream of the yarn accumulating device 12 is not strong enough to surpass the resistance torque, the yarn hooking member 22 is integrally rotated with the yarn accumulating roller 21. The yarn hooking member 22 functions to prevent the spun yarn 10 from being unwound from the tip end side of the rotating yarn accumulating roller 21.

[0046] When the tension of the spun yarn 10 at the downstream increases, the yarn accumulating device 12 unwinds the spun yarn 10. When the tension of the spun yarn 10 lowers (that is, the spun yarn 10 is about to slacken), the yarn accumulating device 12 stops the unwinding of the spun yarn 10. Thus, the yarn accumulating device 12 can eliminate the slackening of the spun yarn 10 and apply an appropriate tension to the spun yarn 10. The yarn hooking member 22 operates to absorb changes in tension applied to the spun yarn 10 located between the yarn accumulating device 12 and the winding device 13. Accordingly, such tension changes can be prevented from influencing the spun yarn 10 located between the

air-jet spinning device 9 and the yarn accumulating device 12. Thus, the yarn accumulating device 12 can draw the spun yarn 10 at a more stable speed from the air-jet spinning device 9.

[0047] Since the yarn accumulating roller 21 is driven to rotate at a predetermined speed, the spun yarn 10 is wound around the base end side of the yarn accumulating roller 21 at the predetermined speed. When the speed at which the spun yarn 10 is unwound from the tip end side of the yarn accumulating roller 21 is faster than the speed at which the spun yarn 10 is wound around the base end side, the yarn accumulated amount decreases. When the spun yarn 10 is not unwound from the tip end side of the yarn accumulating roller 21, the yarn accumulated amount gradually increases.

[0048] The yarn accumulating device 12 includes the yarn removing lever 28. As illustrated in Fig. 5, the yarn removing lever 28 is formed as a substantially L-letter shaped member with a horizontally arranged elongate portion (an operating section 28a). A base portion of the yarn removing lever 28 is supported by the swinging shaft 28b. The yarn removing lever 28 is capable of swinging vertically around the swinging shaft 28b between a lifted position and a lowered position. When the yarn removing lever 28 is located at the lowered position, the yarn removing lever 28 is not in contact with a yarn path of the spun yarn 10. When the yarn removing lever 28 is located at the lifted position, the operating section 28a pushes a yarn path of the spun yarn 10 so that the spun yarn 10 can be removed from the flyer 38. By being urged by a spring member (not illustrated), the yarn removing lever 28 is normally held at the lowered position. When the pneumatic cylinder 49 provided in the yarn joining cart 3 is driven, the yarn removing lever 28 is lifted by the pushing arm 47 to be moved to the lifted position.

[0049] By moving the yarn removing lever 28 to the lifted position, the spun yarn 10 can be removed from the yarn hooking member 22. Thus, the resistance developed when the spun yarn 10 is unwound from the tip end side of the yarn accumulating roller 21 (i.e. resistance torque applied to the yarn hooking member 22) will no longer influence the spun yarn 10. As a result, even if the yarn tension at the downstream of the yarn accumulating roller 21 is weak, the spun yarn 10 can be unwound from the yarn accumulating roller 21. By maintaining the yarn removing lever 28 lifted under the state in which the spun yarn 10 is not wound around the yarn accumulating roller 21, the flyer 38 can be prevented from being engaged with the spun yarn 10. As a result, the spun yarn 10 can be controlled to be not wound around the yarn accumulating roller 21.

[0050] Next, the yarn movement detecting sensor 50 provided in the yarn joining cart 3 will be specifically described with reference to Figs. 6 and 7. The yarn movement detecting sensor 50 is arranged at an upper portion of the yarn joining cart 3. The yarn movement detecting sensor 50 detects in a non-contact manner the spun yarn 10 moved around the tip end portion of the yarn accu-

mulating roller 21 in response to the rotation of the yarn hooking member 22 engaged with the spun yarn 10. The yarn movement detecting sensor 50 emits a laser beam L50 from a position located below the yarn accumulating roller 21 towards a cover 12a covering a side of the yarn accumulating roller 21. The yarn movement detecting sensor 50 emits the laser beam L50 such that the spun yarn 10 moving around the tip end portion of the yarn accumulating roller 21 intersects an optical path of the laser beam L50. Accordingly, the spun yarn 10 moving in the peripheral direction of the yarn accumulating roller 21 at the tip end portion of the yarn accumulating roller 21 intermittently interrupts the laser beam L50 emitted by the yarn movement detecting sensor 50. The yarn movement detecting sensor 50 detects the spun yarn 10 which intermittently interrupts the laser beam L50. The detection result by the yarn movement detecting sensor 50 is transmitted to the unit controller 60.

[0051] Next, the accumulated amount detecting sensor 27 will be specifically described with reference to Figs. 6 and 7. The excessive accumulation detecting sensor 27b is arranged in the vicinity of the tip end portion of the yarn accumulating roller 21. The excessive accumulation detecting sensor 27b emits a laser beam L27b towards the outer peripheral surface 21a of the yarn accumulating roller 21. An emitting position of the laser beam L27b is a position where the tip end of the spun yarn 10 is located when a predetermined length of the spun yarn 10 has been wound around the outer peripheral surface 21a of the yarn accumulating roller 21 from the base end side to the tip end side. The predetermined length of the spun yarn 10 is a minimum length to satisfy a minimal accumulation amount or more and also is a maximum length permitted to be wound around the yarn accumulating roller 21. The excessive accumulation detecting sensor 27b detects whether or not the spun yarn 10 is located at the emitting position of the laser beam L27b on the outer peripheral surface 21a of the yarn accumulating roller 21. When the spun yarn 10 is located at the emitting position of the laser beam L27b, an excessive amount of spun yarn 10 is wound around the yarn accumulating roller 21. That is, a determination can be made that the spun yarn 10 is excessively accumulated.

[0052] When the yarn hooking member 22 is rotated while being engaged with the spun yarn 10, the spun yarn 10 moves in a space between the outer peripheral surface 21a of the yarn accumulating roller 21 and the excessive accumulation detecting sensor 27b. That is, in response to the rotation of the yarn hooking member 22, the spun yarn 10 moves in the peripheral direction of the yarn accumulating roller 21 on the outer peripheral surface 21a thereof. The spun yarn 10 moving in the peripheral direction of the yarn accumulating roller 21 intermittently interrupts the laser beam L27b emitted from the excessive accumulation detecting sensor 27b. The excessive accumulation detecting sensor 27b also detects the spun yarn 10 that intermittently interrupts the laser beam L27b. The detection result by the excessive accu-

mulation detecting sensor 27b is transmitted to the unit controller 60.

[0053] The minimum accumulated amount detecting sensor 27a is provided at a position closer to the base end side of the yarn accumulating roller 21 than the excessive accumulation detecting sensor 27b. Like the excessive accumulation detecting sensor 27b, the minimum accumulated amount detecting sensor 27a emits a laser beam L27a towards the outer peripheral surface 21a of the yarn accumulating roller 21. An emitting position of the laser beam L27a is a position where a tip end of the spun yarn 10 is located when the spun yarn 10 of a minimal accumulation amount is wound around the outer peripheral surface 21a of the yarn accumulating roller 21 from the base end side to the tip end side. The minimum accumulated amount detecting sensor 27a detects whether or not the spun yarn 10 is located at the emitting position of the laser beam L27a on the outer peripheral surface 21a of the yarn accumulating roller 21. When the spun yarn 10 is located at the emitting position of the laser beam L27a, a determination can be made that the minimal amount or more of the spun yarn 10 has been wound around the yarn accumulating roller 21. The detection result by the minimum accumulated amount detecting sensor 27a is transmitted to the unit controller 60.

[0054] Next, with reference to Figs. 8 to 12, a description will be made on a yarn processing method during a yarn joining operation in the spinning machine 1 according to an embodiment of the present invention.

[0055] In Fig. 10, a state in which the suction pipe 44 is sucking is indicated with "ON", and a state in which sucking of the suction pipe 44 is stopped is indicated with "OFF". A state in which the yarn removing lever 28 is lifted is indicated with "ON", and a state in which the yarn removing lever 28 is lowered is indicated with "OFF".

[0056] When the yarn clearer 52 detects a yarn defect while the spun yarn 10 is being wound, the yarn clearer 52 transmits a yarn defect detection signal to the unit controller 60. Upon receipt of such a yarn defect detection signal ("YES" in Step S101), the unit controller 60 stops the draft device 7 and the air-jet spinning device or the like from spinning the fiber-bundle 8 to cut the spun yarn 10 (Step S102). At this time, the winding device 13 continues winding of the package 45, and the spun yarn 10 located downstream of the cut position is once wound into the package 45. Accordingly, the spun yarn 10 wound around the yarn accumulating roller 21 is also wound into the package 45, and no spun yarn 10 exists on the yarn accumulating roller 21. A portion including the yarn defect of the spun yarn 10 is also once wound into the package 45.

[0057] Then, the unit controller 60 transmits a control signal to the yarn joining cart 3, and the yarn joining cart 3 travels to the relevant spinning unit 2 in which the yarn defect has been detected (Step S103).

[0058] Then, the yarn joining operation cycle is started. Specifically, the unit controller 60 operates to rotationally move the suction mouth 46 to the vicinity of a surface of

the package 45 (refer to Fig. 11), and commands the winding device 13 to reversely rotate the package 45. Accordingly, the yarn end of the lower yarn is drawn from an outer peripheral surface of the package 45, and the yarn end is caught by the suction mouth 46 (Step S104). Since the defective portion of the spun yarn 10 drawn from the package 45 is sucked with suction airflow by the suction mouth 46, a portion of the spun yarn 10 including the yarn defect can be eliminated from the package 45.

[0059] Then, while reversely rotating the package 45, the unit controller 60 operates to swing the suction mouth 46, which is sucking the lower yarn, to guide the lower yarn to the splicer 43. The lower yarn is guided to the splicer 43, and also the rotation of the package 45 is stopped (Step S105).

[0060] At approximately the same time as the swinging movement of the suction mouth 46, the unit controller 60 swings the suction pipe 44 to the vicinity of the downstream side of the air-jet spinning device 9 (refer to Fig. 11). The unit controller 60 reactivates the air-jet spinning device 9 and the like to produce the spun yarn 10 (Step S107). At approximately the same time as the start of the production of the spun yarn 10, the unit controller 60 commands the suction pipe 44 to generate suction airflow so that the suction pipe 44 can catch a yarn end of the spun yarn 10 (upper yarn) produced by the air-jet spinning device 9 (Step S108).

[0061] After the suction pipe 44 catches the upper yarn, the unit controller 60 swings the suction pipe 44 downward while continuing the suction, and the spun yarn 10 is drawn from the air-jet spinning device 9 and guided to the splicer 43 (Step S109). In the flowchart of Fig. 8, after the lower yarn is caught (Steps S104 and S105), the upper yarn is caught (Steps S106 and S109). However, this flowchart indicates just one example of the operation. The lower yarn may be caught after the upper yarn, or the upper and lower yarns may be caught simultaneously.

[0062] After the spun yarn 10 is guided to the splicer 43, the spun yarn 10 located between the air-jet spinning device 9 and the suction pipe 44 is engaged with the flyer 38 and the winding of the spun yarn 10 on the yarn accumulating roller 21 is started. Although the winding of the package 45 by the winding device 13 is stopped during the yarn joining operation, the spun yarn 10 is continuously fed from the air-jet spinning device 9. Therefore, if the spun yarn 10 is left as is, the spun yarn 10 slackens. By winding the spun yarn 10 around the yarn accumulating roller 21, the spun yarn 10 can be prevented from slackening. After that, the amount of the spun yarn 10 accumulated on the yarn accumulating roller 21 increases, and the force to draw the spun yarn 10 from the air-jet spinning device 9 increases.

[0063] Until the minimal accumulation amount or more of the spun yarn 10 is wound around the yarn accumulating roller 21, slip is likely to occur between the spun yarn 10 and the yarn accumulating roller 21, and the force to draw the spun yarn 10 is unstable. The spun yarn 10

drawn from the air-jet spinning device 9 until the sufficient amount of the spun yarn 10 (minimal accumulation amount) is accumulated on the yarn accumulating roller 21 includes many portions having a weak yarn strength and an unstable yarn quality.

[0064] In a conventional spinning machine, when a yarn end is guided to the splicer 43 by the suction pipe 44, the splicer 43 immediately starts a yarn joining operation. The yarn joining operation refers to cutting, untwisting and twisting of an upper yarn and a lower yarn located at a predetermined position of the splicer 43, that is, a splicing operation of the spun yarn 10. If the yarn joining operation is carried out at the above-described timing, since a yarn with an unstable portion is wound around the yarn accumulating roller 21, the unstable yarn portion is also wound into the package 45.

[0065] In order to prevent the unstable yarn portion from being mixed into the package 45, the spinning machine 1 according to an embodiment of the present invention is configured with the following structure.

[0066] Even when the upper yarn is guided to the splicer 43 by the suction pipe 44, the yarn splicing operation is not started immediately, and the unit controller 60 determines whether or not the yarn accumulated amount has reached the minimal accumulation amount by monitoring the yarn accumulated amount on the yarn accumulating roller 21 by the minimum accumulated amount detecting sensor 27a (Step S110). When the yarn accumulated amount is less than the minimal accumulation amount ("NO" in Step S110), by maintaining the yarn removing lever 28 at the lowered position, the spun yarn 10 is wound around the yarn accumulating roller 21 and the accumulated yarn amount increases. When the minimum accumulated amount detecting sensor 27a detects that the accumulated amount has reached or exceeded the minimal accumulation amount ("YES" in Step S110), the unit controller 60 elevates the pneumatic cylinder 49 to move the yarn removing lever 28 to the lifted position (Step S111) to remove the spun yarn 10 from the flyer 38.

[0067] When the spun yarn 10 is removed from the flyer 38 while the yarn accumulating roller 21 is rotating, the resistance that prevents the spun yarn 10 from being unwound from the tip end portion of the yarn accumulating roller 21 is eliminated. The spun yarn 10 thus can be unwound from the yarn accumulating roller 21 even with a weak suctioning power of the suction pipe 44 or the like. Therefore, under a state illustrated in Fig. 12, the spun yarn 10 wound around the yarn accumulating roller 21 is unwound and sucked by the suction pipe 44. Accordingly, an unstable spun yarn 10 on the yarn accumulating roller 21 can be removed with the suction pipe 44.

[0068] On the base end side of the yarn accumulating roller 21, the spun yarn 10 is newly wound by the rotation of the yarn accumulating roller 21. Since the spun yarn 10 is newly wound by the amount that has been sucked by the suction pipe 44, the amount of the spun yarn 10 accumulated on the yarn accumulating roller 21 can be

maintained substantially constant.

[0069] Therefore, the spun yarn 10 is drawn from the air-jet spinning device 9 while the minimal accumulation amount or more of the spun yarn 10 is maintained. Consequently, the quality of the spun yarn 10 newly wound around the base end side of the yarn accumulating roller 21 is stabilized. While the spun yarn 10 with the stable quality is wound from the base end side of the yarn accumulating roller 21, the spun yarn 10 with unstable quality is unwound from the tip end side of the yarn accumulating roller 21. As a result, the spun yarn 10 on the yarn accumulating roller 21 is sequentially replaced with the spun yarn 10 with the stable quality.

[0070] A predetermined period of time required to replace all of the spun yarn 10 accumulated on the yarn accumulating roller 21 with the spun yarn 10 with stable quality from the start of unwinding of the unstable spun yarn 10 by lifting the yarn removing lever 28 (that is, a period of time necessary for disposing all the spun yarn 10 with the unstable quality from the yarn accumulating roller 21) is previously input to the unit controller 60. The unit controller 60 determines whether or not the predetermined period of time has elapsed (Step S112). After the predetermined period of time has elapsed ("YES" in Step S112), the unit controller 60 lowers the pneumatic cylinder 49 to lower the yarn removing lever 28 (Step S113). Then, the unit controller 60 starts the yarn joining operation by the splicer 43 (Step S114).

[0071] By lowering the yarn removing lever 28, the flyer 38 is engaged with the spun yarn 10. Accordingly, the spun yarn 10 is not unwound from the tip end of the yarn accumulating roller 21, and slackening of the spun yarn 10 is prevented.

[0072] During the yarn joining operation by the splicer 43, the suction airflow continues to be generated from the suction mouth 46 and the suction pipe 44, and the spun yarn 10 is sucked. During the yarn joining operation, the unnecessary spun yarn 10 is cut by the splicer 43, and the unnecessary spun yarn 10 is sucked and removed.

[0073] When the yarn joining operation is finished, the unit controller 60 commands the winding device 13 to resume winding.

[0074] By removing the spun yarn 10 from the yarn hooking member 22 by lifting the yarn removing lever 28, the spun yarn 10 with unstable quality accumulated on the yarn accumulating roller 21 can be removed with the suction pipe 44 and replaced with the spun yarn 10 with stable quality. However, even if the yarn removing lever 28 is lifted, the spun yarn 10 may not be removed from the yarn hooking member 22. Hereinafter, Fig. 13 will be referred to describe a structure for detecting a failure of the yarn removing lever 28 to remove the spun yarn 10 from the yarn hooking member 28.

[0075] In accordance with the detection result of the above-described excessive accumulation detecting sensor 27b, the travelling detecting sensor 31 and/or the yarn movement detecting sensor 50, the unit controller

60 can detect a failure of the yarn removing lever 28 to remove the spun yarn 10.

[0076] First, a description will be made on a detection of a yarn removal failure in accordance with the detection result of the excessive accumulation detecting sensor 27b. The excessive accumulation detecting sensor 27b can detect the spun yarn 10 moving in the peripheral direction of the yarn accumulating roller 21 on the outer peripheral surface 21a thereof. As illustrated in Fig. 13, when the yarn removing lever 28 is moved to the lifted position and the spun yarn 10 is removed from the yarn hooking member 22, the spun yarn 10 wound around the yarn accumulating roller 21 travels towards the downstream via the yarn removing lever 28 and the downstream guide 26. Consequently, the spun yarn 10 does not move in the peripheral direction of the yarn accumulating roller 21 on the outer peripheral surface 21a thereof. After the yarn removing lever 28 is moved to the lifted position, when the spun yarn 10 intermittently interrupting the laser beam L27b is no longer detected by the excessive accumulation detecting sensor 27b, a determination can be made that the spun yarn 10 has been removed from the yarn hooking member 22. Meanwhile, even after the yarn removing lever 28 is moved to the lifted position, when the spun yarn 10 intermittently interrupting the laser beam L27b is detected by the excessive accumulation detecting sensor 27b, a determination can be made that the spun yarn 10 has not been removed from the yarn hooking member 22.

[0077] A description will be made on the detection of a yarn removal failure in accordance with the detection result of the travelling detecting sensor 31. The traveling detecting sensor 31 detects whether or not the spun yarn 10 is traveling on a yarn path in the waxing device 30. After the spun yarn 10 is cut, while the spun yarn 10 engaged with the yarn hooking member 22 is being wound around the yarn accumulating roller 21 in order to accumulate the minimal amount of spun yarn 10 (a state before the yarn removing lever 28 is moved to the lifted position), the downstream end portion of the spun yarn 10 wound around the yarn accumulating roller 21 is sucked by the suction pipe 44. However, since the suctioning power of the suction pipe 44 is weak, the spun yarn 10 is not unwound from the tip end portion of the yarn accumulating roller 21. Thus, the spun yarn 10 is not travelling at the downstream of the yarn accumulating device 12, and the travelling detecting sensor 31 detects that the travelling of the spun yarn 10 is stopped. When the yarn removing lever 28 is moved to the lifted position and the spun yarn 10 is removed from the yarn hooking member 28, the resistance that prevents the spun yarn 10 from being unwound from the tip end portion of the yarn accumulating roller 21 is eliminated. Therefore, the spun yarn 10 can be unwound even with the weak suctioning power of the suction pipe 44 or the like. Accordingly, the spun yarn 10 starts travelling on a yarn path at the downstream of the yarn accumulating device 12, and the travelling detecting sensor 31 detects the spun yarn

10 travelling on a yarn path in the waxing device 30. When the yarn removing lever 28 is moved to the lifted position, if a travelling of the spun yarn 10 is detected by the travelling detecting sensor 31, a determination can be made that the spun yarn 10 has been removed from the yarn hooking member 22. Even if the yarn removing lever 28 is moved to the lifted position, when a travelling of the spun yarn 10 is not detected by the travelling detecting sensor 31, a determination can be made that the removal of the spun yarn 10 from the yarn hooking member 22 has failed.

[0078] A description will be made on the detection of a yarn removal failure in accordance with the detection result of the yarn movement detecting sensor 50. The yarn movement detecting sensor 50 detects the spun yarn 10 moving in the peripheral direction of the yarn accumulating roller 21 at the tip end portion thereof. As illustrated in Fig. 13, when the yarn removing lever 28 is moved to the lifted position and the spun yarn 10 is removed from the yarn hooking member 22, the spun yarn 10 wound around the yarn accumulating roller 21 travels towards the downstream through the yarn removing lever 28 and the downstream guide 26. Consequently, the spun yarn 10 does not move in the peripheral direction of the yarn accumulating roller 21 on the tip end portion thereof. Thus, when the yarn removing lever 28 is moved to the lifted position, if the yarn movement detecting sensor 50 does not detect the spun yarn 10 intermittently interrupting the laser beam L50, a determination can be made that the spun yarn 10 has been removed from the yarn hooking member 22. Even if the yarn removing lever 28 is moved to the lifted position, when the yarn movement detecting sensor 50 detects the spun yarn 10 intermittently interrupting the laser beam L50, a determination can be made that the spun yarn 10 has not been removed from the yarn hooking member 22.

[0079] The unit controller 60 can detect a yarn removal failure of the yarn removing lever 28 in accordance with the detection result of any one of the excessive accumulation detecting sensor 27b, the travelling detecting sensor 31 and the yarn movement detecting sensor 50. When a yarn removal failure of the yarn removing lever 28 is detected, for example, the unit controller 60 carries out control to return the yarn removing lever 28 to the lowered position and then to move the yarn removing lever 28 to the lifted position again to remove the spun yarn 10 from the yarn hooking member 22.

[0080] In the spinning machine 1 and the spinning unit 2 according to an embodiment of the present invention, since a sensor for detecting the yarn removal from the yarn hooking member 22 (the excessive accumulation detecting sensor 27b, the travelling detecting sensor 31 and/or the yarn movement detecting sensor 50) is provided, a detection can be carried out as to whether or not the spun yarn 10 has been removed from the yarn hooking member 22 by the sensor for detecting the yarn removal. Accordingly, a failure which may occur when a yarn removal from the yarn hooking member 22 is not

detected can be prevented.

[0081] The travelling detecting sensor 31 provided in the waxing device 30 and/or the excessive accumulation detecting sensor 27b for detecting an excessive accumulated amount of the spun yarn 10 can detect whether or not the spun yarn 10 has been removed from the yarn hooking member 22. Accordingly, an additional sensor for detecting a yarn removal from the yarn hooking member 22 is not necessary to be provided.

[0082] In the spinning unit 2 including an air-jet spinning device 9, a detection can be carried out as to whether or not the spun yarn 10 has been removed from the yarn hooking member 22.

[0083] The movement detecting sensor 50 provided in the yarn joining cart 3 detects the spun yarn 10 moving in the peripheral direction of the yarn accumulating roller 21 at the tip end portion thereof, to detect whether or not the spun yarn 10 has been removed from the yarn hooking member 22.

[0084] An embodiment of the present invention has been described. However, the present invention is not limited to the above described embodiment, and various changes and modifications may be made without departing from the scope of the claims

[0085] In the spinning machine 1 and the spinning unit 2 according to an embodiment of the present invention, when a yarn defect is detected, the air-jet spinning device 9 is stopped from generating whirling airflow to cut the spun yarn 10. The present invention may be applied to a spinning machine or a spinning unit that cuts a spun yarn 10 with a cutter.

[0086] In the spinning machine 1 and the spinning unit 2 according to an embodiment of the present invention, a yarn path is arranged such that the spun yarn 10 travels downward in the height direction of a machine frame from the draft device 7 arranged at the upper portion to the winding device 13 arranged at the lower portion. The present invention may be applied to a spinning machine or a spinning unit in which a yarn path is provided such that a spun yarn travels from a lower portion to an upper portion in the height direction of the machine frame.

[0087] In the spinning machine 1 and the spinning unit 2 according to an embodiment of the present invention, a yarn removal from the yarn hooking member 22 is detected by the following three sensors, that is, the excessive accumulation detecting sensor 27b, the travelling detecting sensor 31 and the yarn movement detecting sensor 50. However, a yarn removal may be detected using only one of the above three sensors, or prescribed two sensors may be used to detect a yarn removal.

[0088] In the spinning machine 1 and the spinning unit 2 according to an embodiment of the present invention, the pushing arm 47 and the pneumatic cylinder 49 are provided in the yarn joining cart 3 as a means for driving the yarn removing lever 28. However, for example, each spinning unit 2 may include a structure for driving the yarn removing lever 28. Instead of the pneumatic cylinder 49, the yarn removing lever 28 may be moved by an

appropriate structure such as a rack and pinion mechanism or a cam mechanism.

[0089] In the spinning machine 1 and the spinning unit 2 according to an embodiment of the present invention, at least a portion of the plurality of the bottom rollers of the draft device 7, and a traverse mechanism of the traverse device 75 are driven together among the spinning units 2. The present invention may be applied to a spinning machine or a spinning unit in which each portion of a spinning unit (e.g. the draft device, the air-jet spinning device and the yarn winding device or the like) is individually driven in each spinning unit 2.

[0090] In the spinning machine 1 and the spinning unit 2 according to the embodiment of the present invention, the air-jet spinning device 9 may include a needle held by a fiber guiding section and arranged to be projected into a spinning chamber. The needle prevents twists of the fiber bundle 8 from propagating to the upstream of the air-jet spinning device 9. In the air-jet spinning device 9, propagation of twists of the fiber bundle 8 may be prevented by the downstream end portion of the fiber guiding section instead of using the needle. The air-jet spinning device 9 may include a pair of air-jet nozzles that applies twists in opposite directions to one another. In the spinning machine 1 and the spinning unit 2 according to an embodiment of the present invention, the air-jet spinning device 9 that carries out a spinning operation with whirling airflow is provided. However, a spinning device that carries out the spinning operation with another method may be provided.

[0091] In the spinning machine 1 and the spinning unit 2 according to an embodiment of the present invention, a yarn movement detecting sensor 50 is arranged in the yarn joining cart 3 that carries out a yarn joining operation. Alternatively, the yarn movement detecting sensor 50 may be arranged in a doffing cart that removes a fully wound package 45 from the winding device 13 and moves the package 45 to a predetermined position. The yarn movement detecting sensor 50 may be arranged in a service cart other than the yarn joining cart or the doffing cart. The yarn joining cart 3 with the yarn movement detecting sensor 50 and the doffing cart with the yarn movement detecting sensor 50 may be provided as one cart in one spinning machine 1.

[0092] The yarn clearer 52 according to an embodiment of the present invention detects a yarn defect in the spun yarn 10 by monitoring a thickness of the spun yarn 10. The yarn clearer 52 may monitor a presence or an absence of a foreign object in a spun yarn 10, and may detect the presence of the yarn defect when a foreign object is contained.

[0093] In Fig. 1, the spinning machine 1 includes one yarn joining cart 3. However, the spinning machine 1 may include a plurality of yarn joining carts 3 according to the number of spinning units 2 provided therein. Likewise, a plurality of doffing carts may be provided.

Claims

1. A spinning unit comprising:

a spinning device (9) adapted to produce a spun yarn (10) by twisting a fiber bundle (8),
a yarn accumulating roller (21) provided downstream of the spinning device (9) in a yarn travelling direction and adapted to accumulate the spun yarn (10) by rotating and winding the spun yarn (10) around an outer peripheral surface (21a) thereof,
a yarn hooking member (22) arranged downstream of the yarn accumulating roller (21) and adapted to wind the spun yarn (10) around the outer peripheral surface (21a) of the yarn accumulating roller (21) by rotating with the yarn accumulating roller (21) while being in contact with the spun yarn (10), **characterized by**
a yarn removing member (28) adapted to remove the spun yarn (10) from the yarn hooking member (22), and
a yarn removal detecting section (27b, 31, 50) adapted to detect a removal of the spun yarn (10) from the yarn hooking member (22).

2. The spinning unit according to Claim 1, further comprising a wax applying device (30) arranged downstream of the yarn accumulating roller (21) and adapted to apply wax to the spun yarn (10), **characterized in that**

the wax applying device (30) is provided with the yarn removal detecting section (31), and
the yarn removal detecting section (31) is adapted to detect a travelling state of the spun yarn (10) and to detect a removal of the spun yarn (10) from the yarn hooking member (22) in accordance with the detected travelling state of the spun yarn (10).

3. The spinning unit according to Claim 1 or Claim 2, **characterized in that** wherein the yarn removal detecting section (27b) is adapted to detect the spun yarn (10) moved in a peripheral direction of the yarn accumulating roller (21) on the outer peripheral surface (21a) of the yarn accumulating roller (21) by the yarn hooking member (22) rotating while making contact with the spun yarn (10), and to detect the removal of the spun yarn (10) from the yarn hooking member (22) in accordance with a detection result of the spun yarn (10) moving in the peripheral direction of the yarn accumulating roller (21).

4. The spinning unit according to any one of Claim 1 through Claim 3, **characterized in that** the spinning device (9) is an air-jet spinning device adapted to produce the spun yarn (10) by twisting the fiber bundle (8) with a whirling airflow.

5. The spinning unit according to any one of Claim 1 through Claim 4, further comprising a moving section (49) adapted to move the yarn removing member (28) to a standby position where the yarn removing member (28) is retracted from a yarn path of the spun yarn (10) and to a yarn removal position where the yarn removing member (28) removes the spun yarn (10) from the yarn hooking member (22), **characterized in that**

when the yarn removal detecting section (27b, 31, 50) detects failure of the removal of the spun yarn (10) from the yarn hooking member (22), the moving section (49) moves the yarn removing member (28) to the standby position and then to the yarn removal position.

6. A spinning machine comprising:

a plurality of spinning units (2) according to any one of Claim 1 through Claim 5, and a service cart (3) arranged capable of moving among the plurality of the spinning units (2) and provided with the yarn removal detecting section (50), **characterized in that**

the yarn removal detecting section (50) detects the spun yarn (10) moved in the peripheral direction of the yarn accumulating roller (21) by the yarn hooking member (22) rotating while making contact with the spun yarn (10), and to detect the removal of the spun yarn (10) from the yarn hooking member (22) in accordance with a detection result of the spun yarn (10) moving in the peripheral direction of the yarn accumulating roller (21).

7. The spinning machine according to Claim 6, **characterized in that** the service cart (3) is at least one of a yarn joining cart (3) adapted to join the spun yarn (10) and a doffing cart adapted to move a package (45) formed by winding the spun yarn (10) produced by the spinning device (9).

8. A yarn processing method during a yarn joining operation in a spinning machine (1) with a spinning device (9), a yarn joining device (43) and a yarn accumulating device (12), wherein directly after a yarn cut or breakage, a yarn of unstable quality is produced due to slip of the yarn in the yarn accumulating device (12), **characterized in that** the yarn joining operation is not started immediately after an upper yarn from the spinning device (9) has been guided to the yarn joining device (43), but it is waited until a sufficient amount of yarn is again collected in the yarn accumulating device (12) to avoid slip therein, then the first yarn of unstable quality is removed from the yarn accumulating device (12) and replaced by normal yarn produced after a sufficient amount of yarn had again been collected in the yarn accumu-

lating device (12), and only then the yarn joining operation is started in the yarn joining device (43), thus avoiding to include yarn of unstable quality in the produced yarn.

9. The yarn processing method according to claim 8 in the spinning machine (1) with the yarn accumulating device (12) with a yarn accumulating roller (21) and a yarn hooking member (22), which winds the spun yarn into a package (45), **characterized in that** the yarn of unstable quality is removed from the yarn accumulating device (12) by actuating a yarn removing member (28) which removes the yarn from the yarn hooking member (22) and thus allows the yarn of unstable quality to be sucked by a suction pipe (44) which is normally used to catch the yarn from the package (45).

10. The yarn processing method according to claim 8 or 9, **characterized in that** the amount of yarn of unstable quality is measured by an optical sensor (27a) at the yarn accumulating device (12).

11. The yarn processing method according to claims 9 and 10, **characterized in that** a further sensor (27b; 31; 50) is used to check whether the yarn is indeed removed from the yarn hooking member (22).

FIG. 1

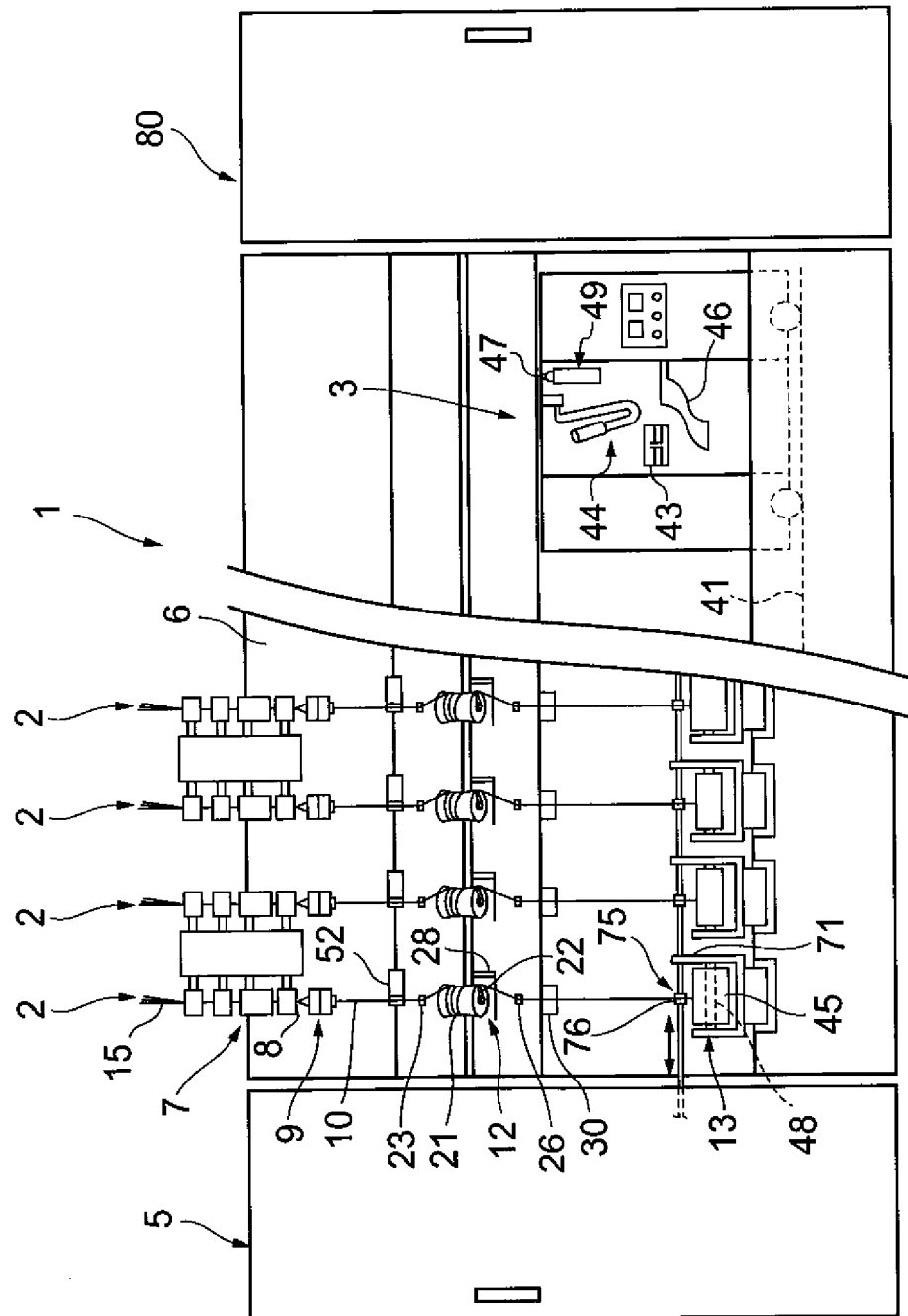


FIG. 2

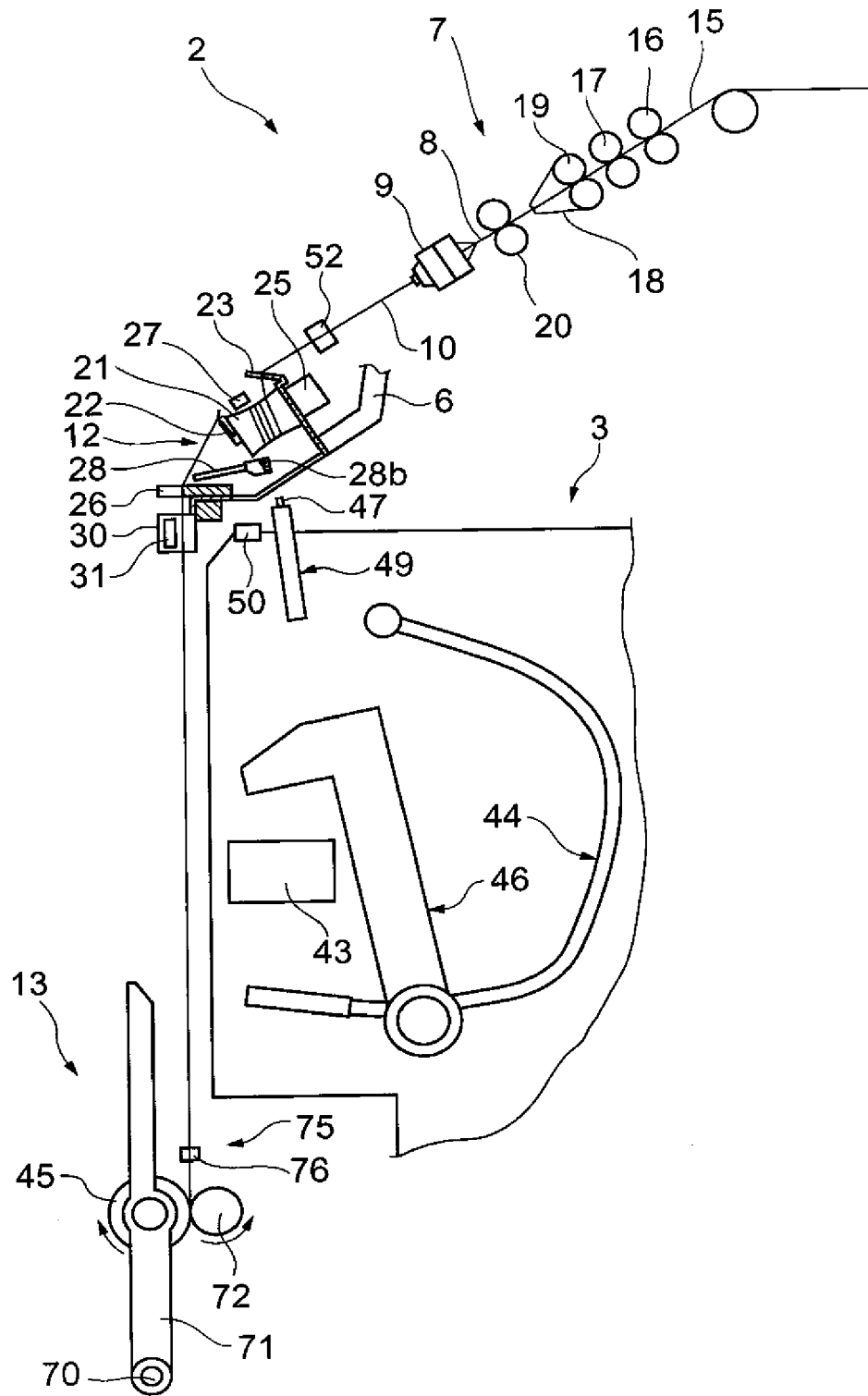


FIG. 3

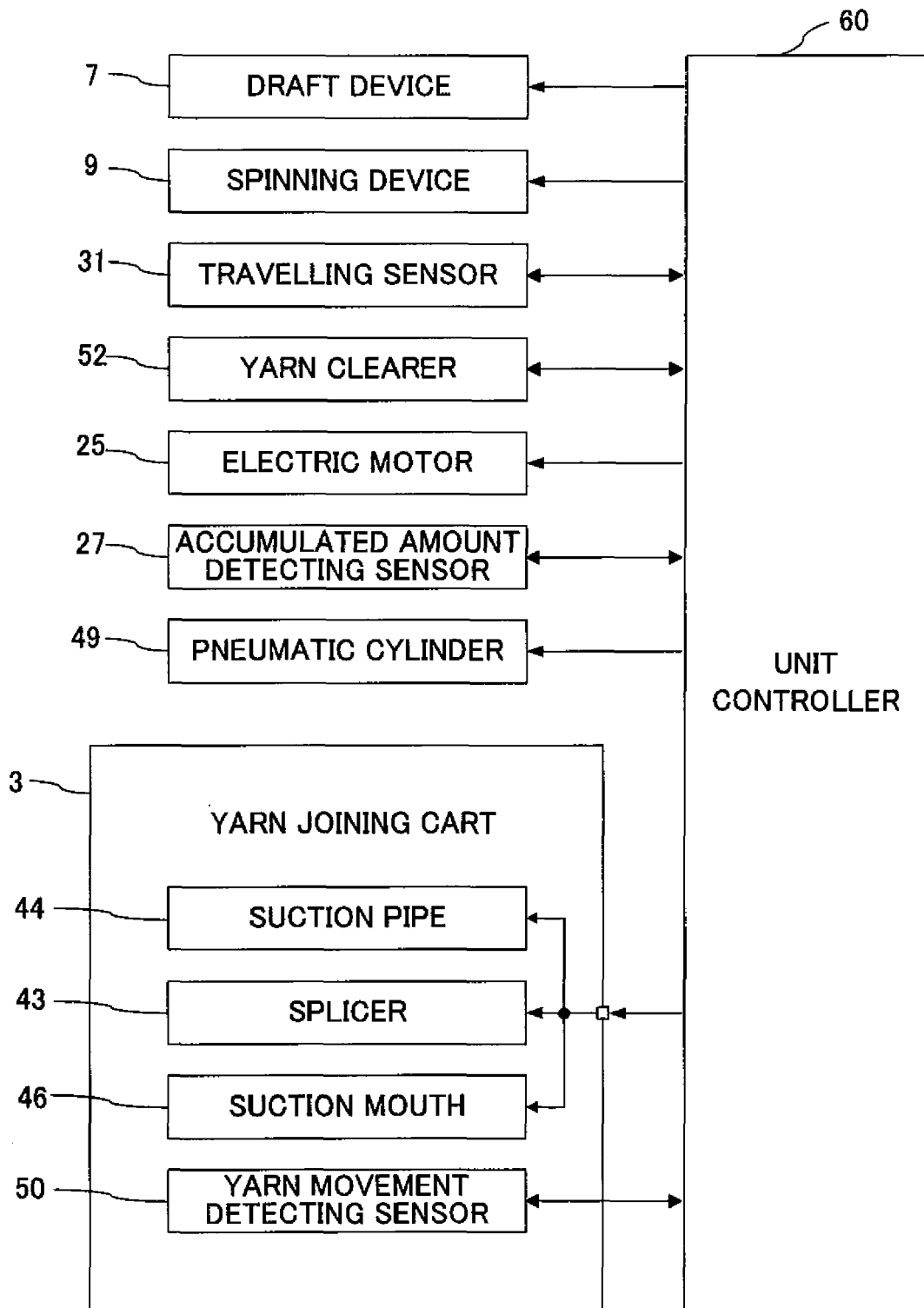


FIG. 4

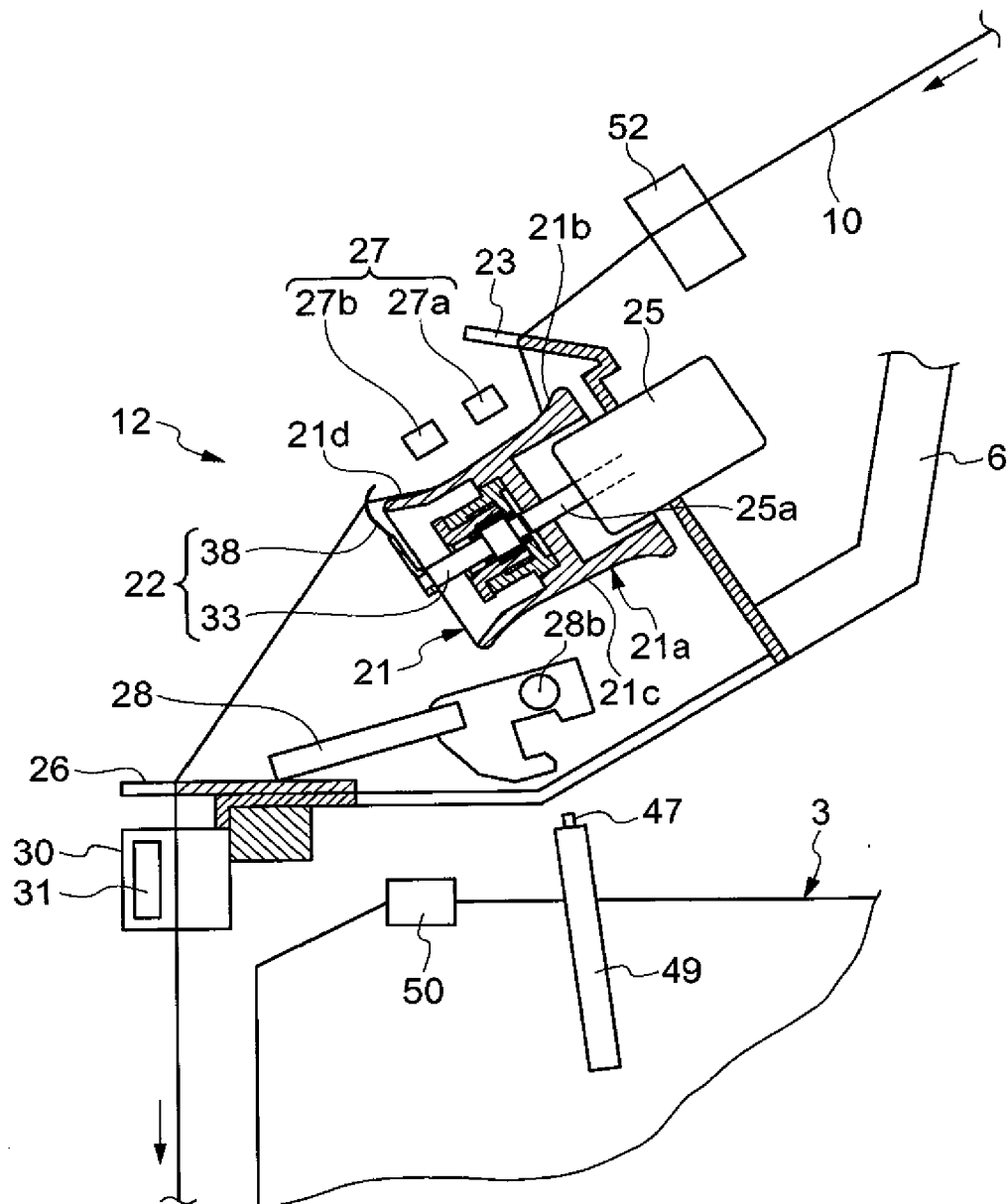


FIG. 5

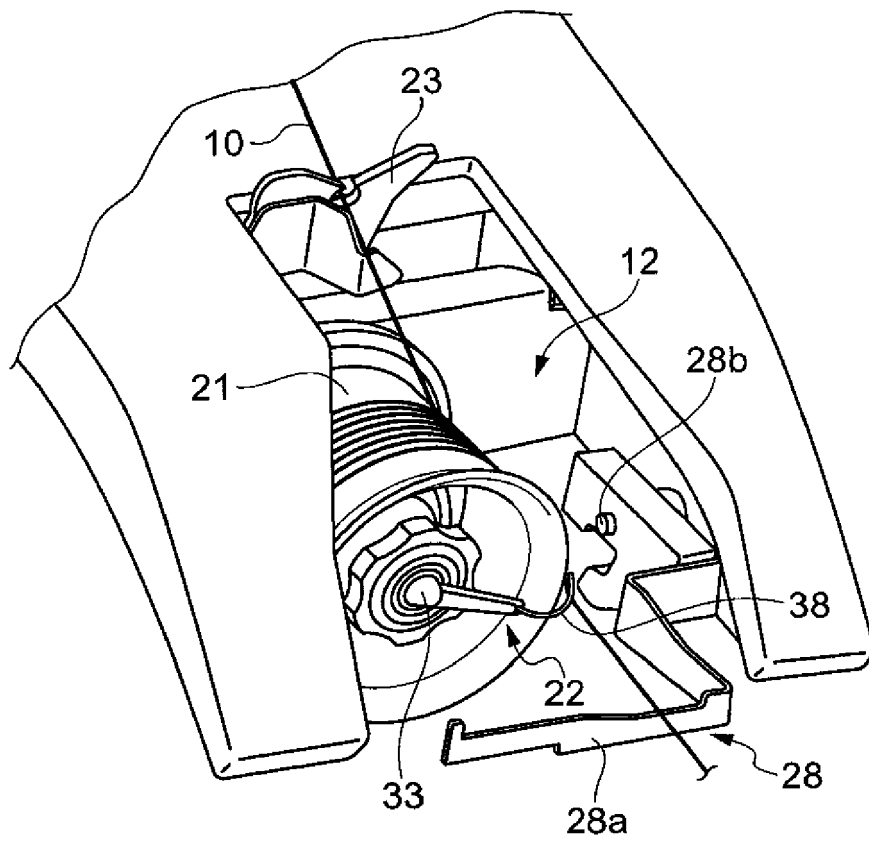


FIG. 6

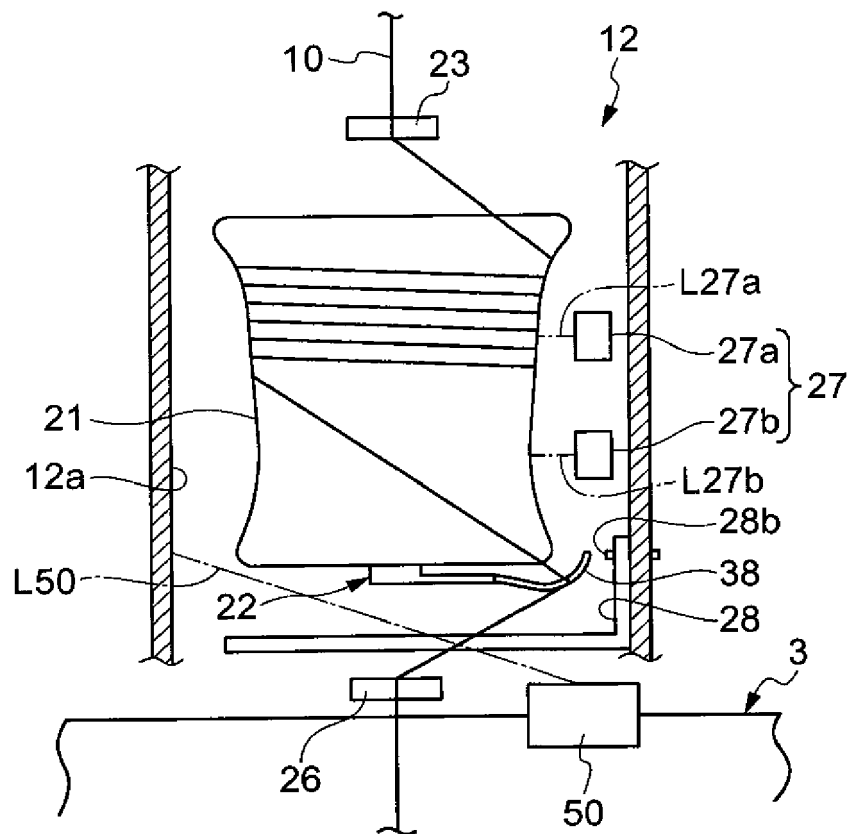


FIG. 7

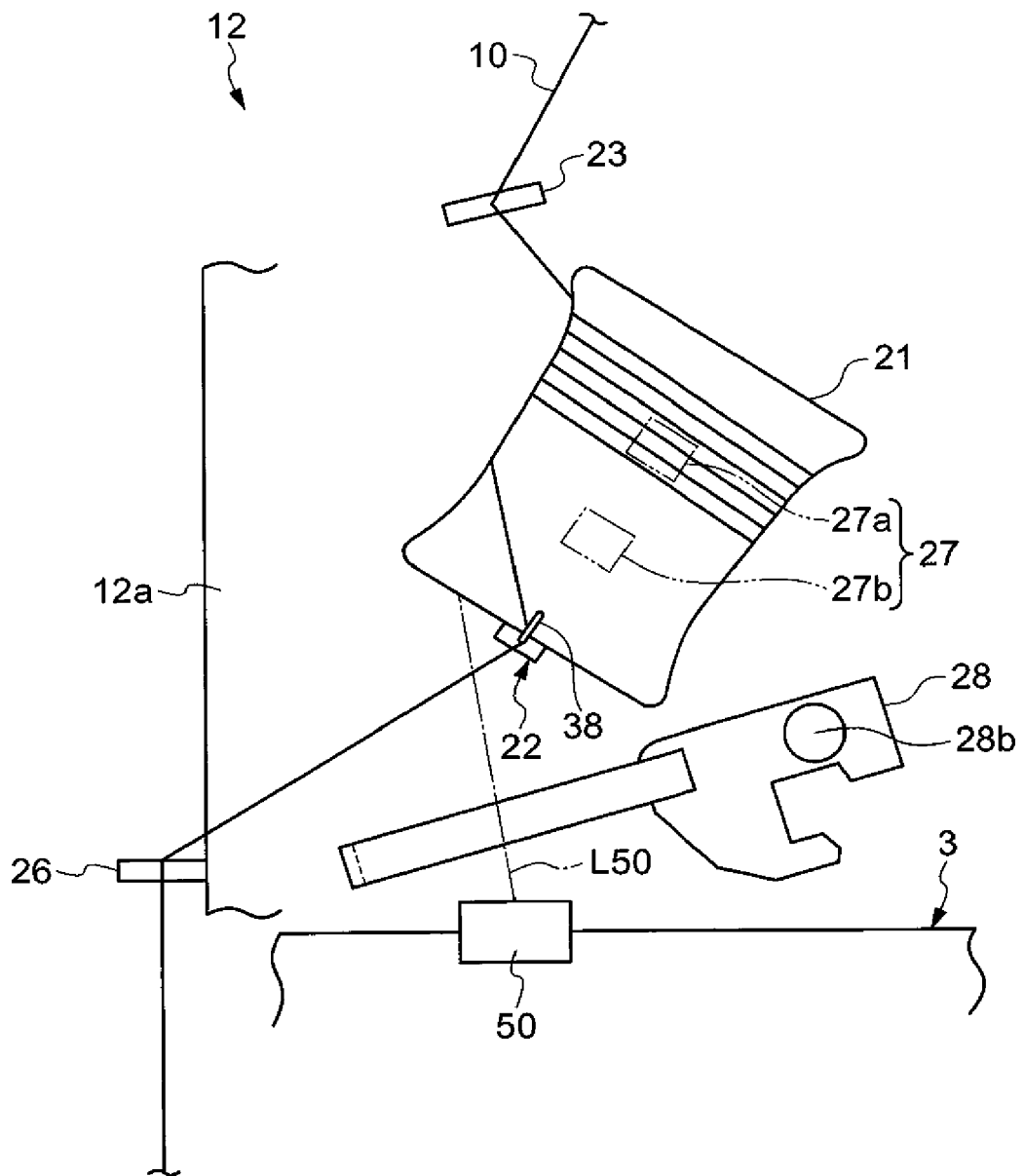


FIG. 8

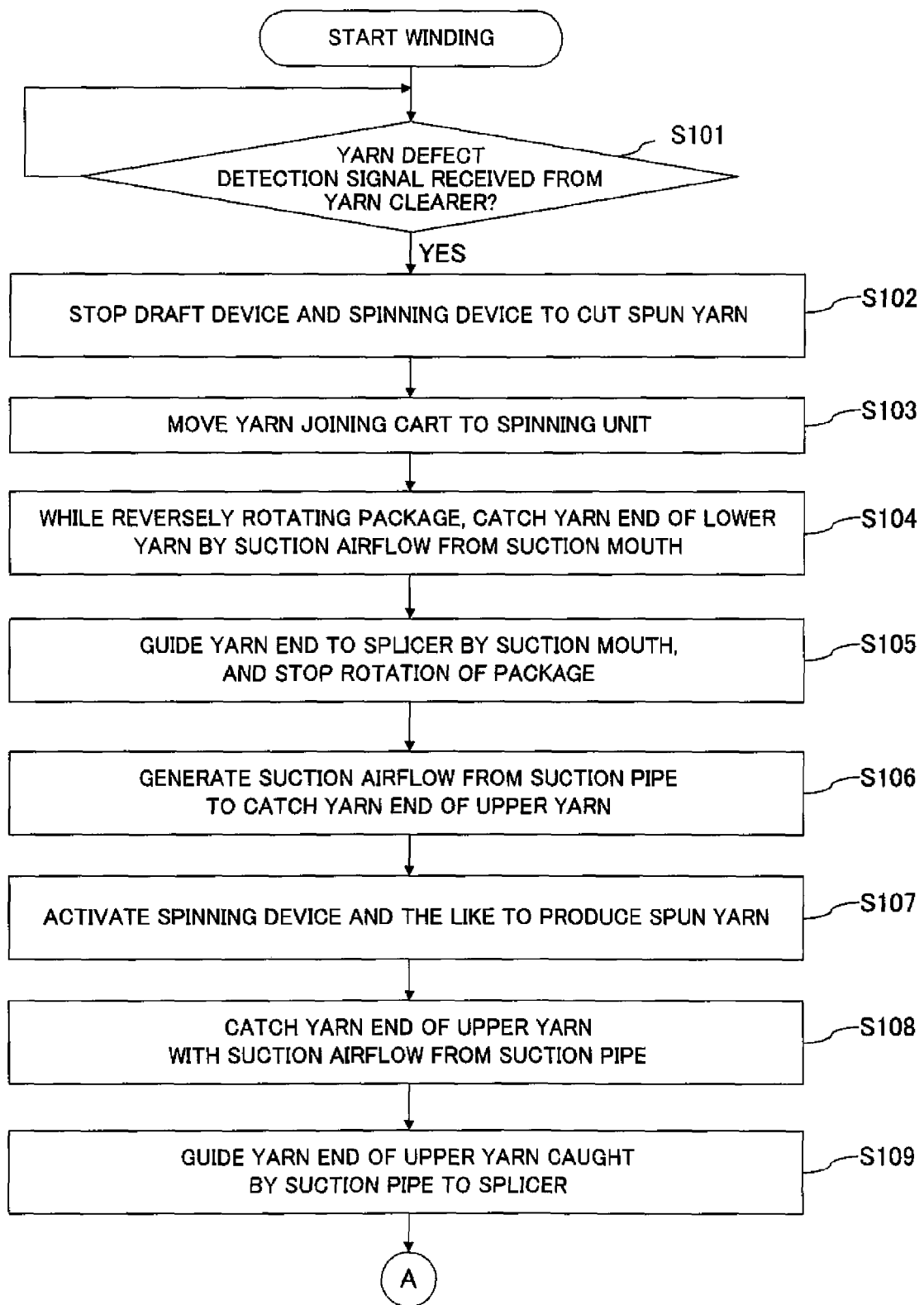


FIG. 9

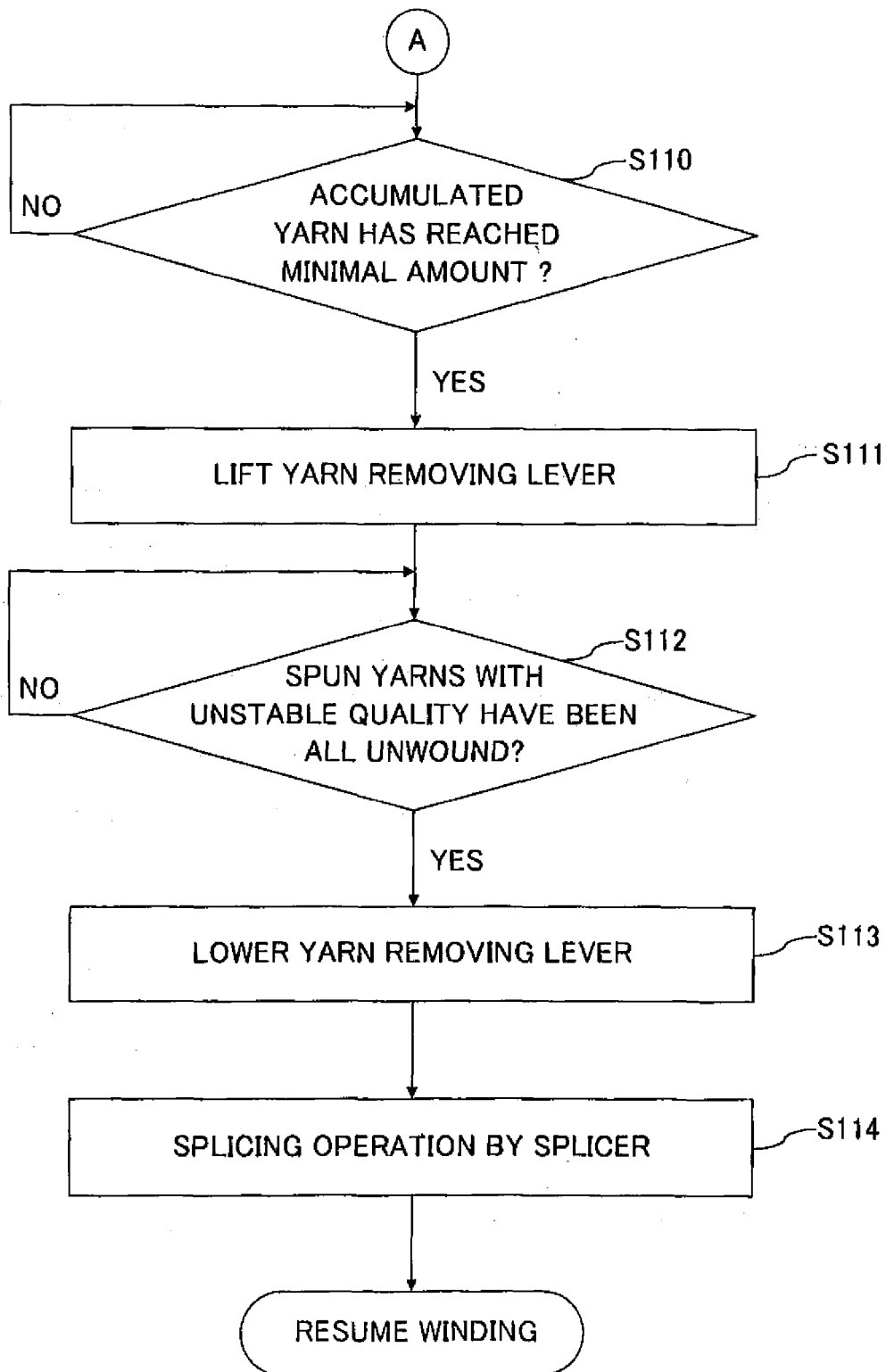


FIG. 10

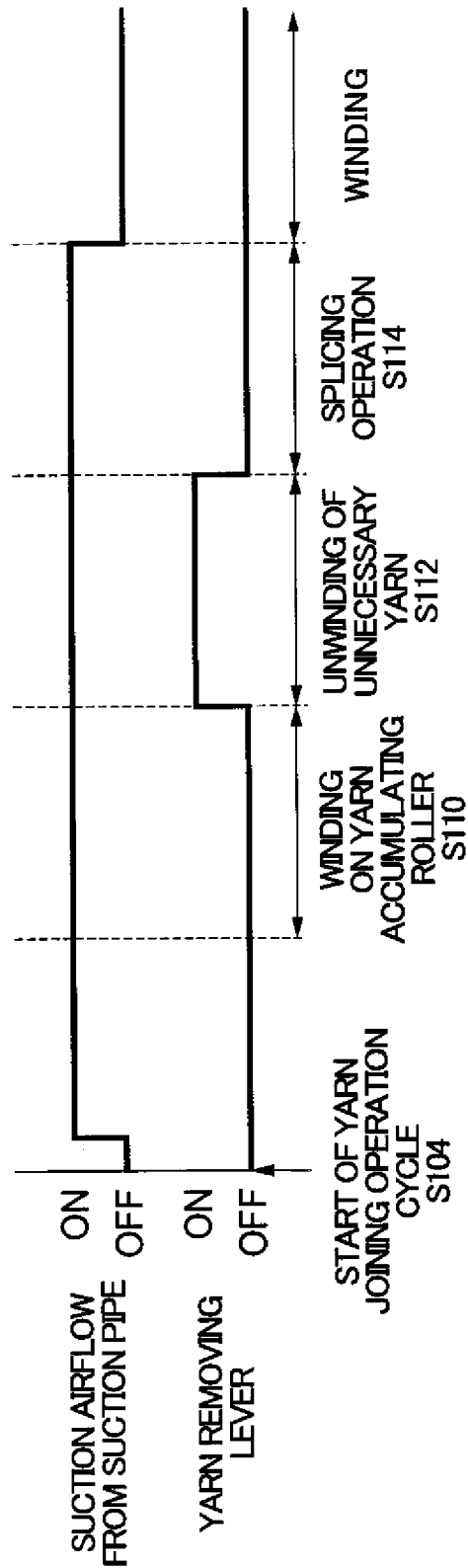


FIG. 11

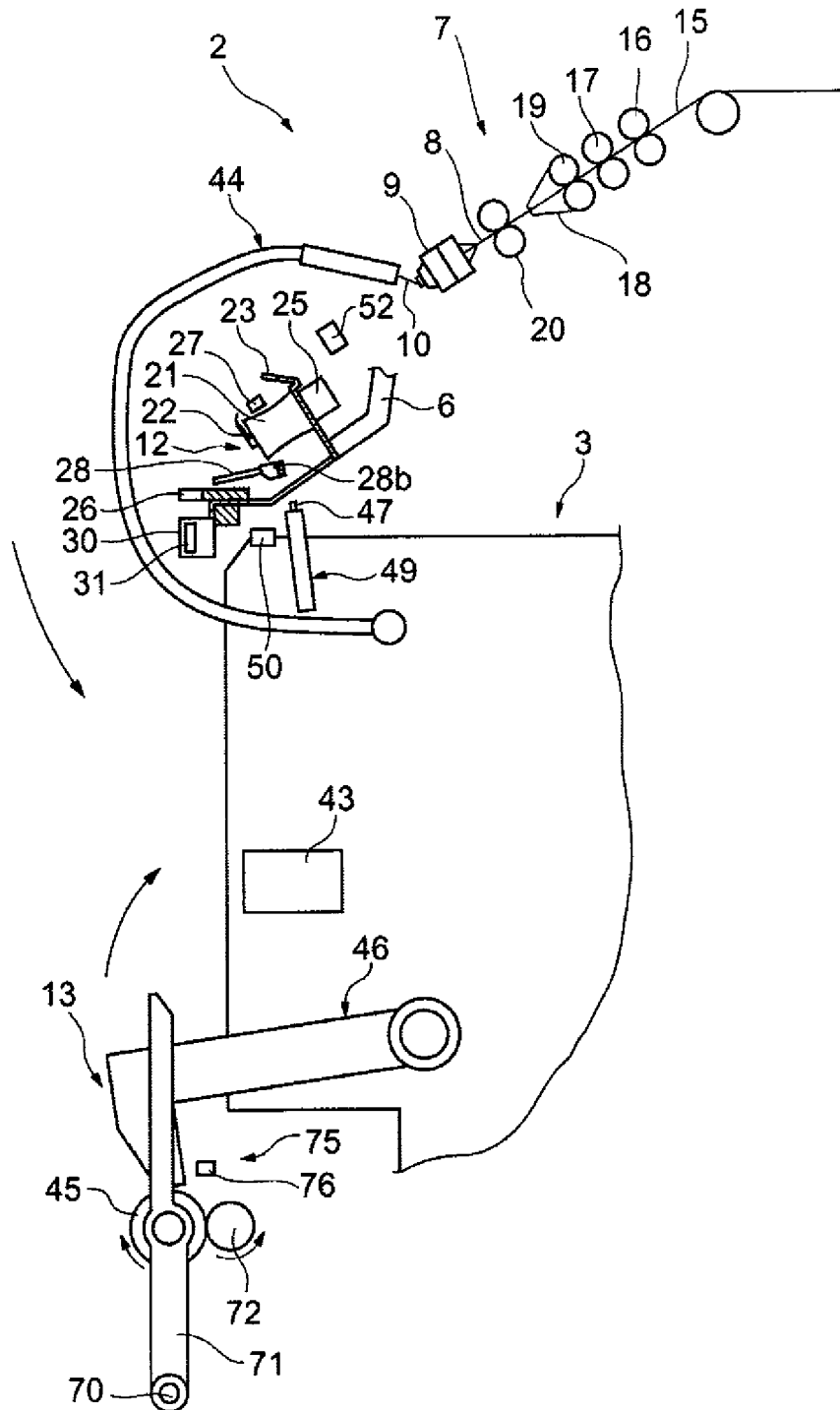


FIG. 12

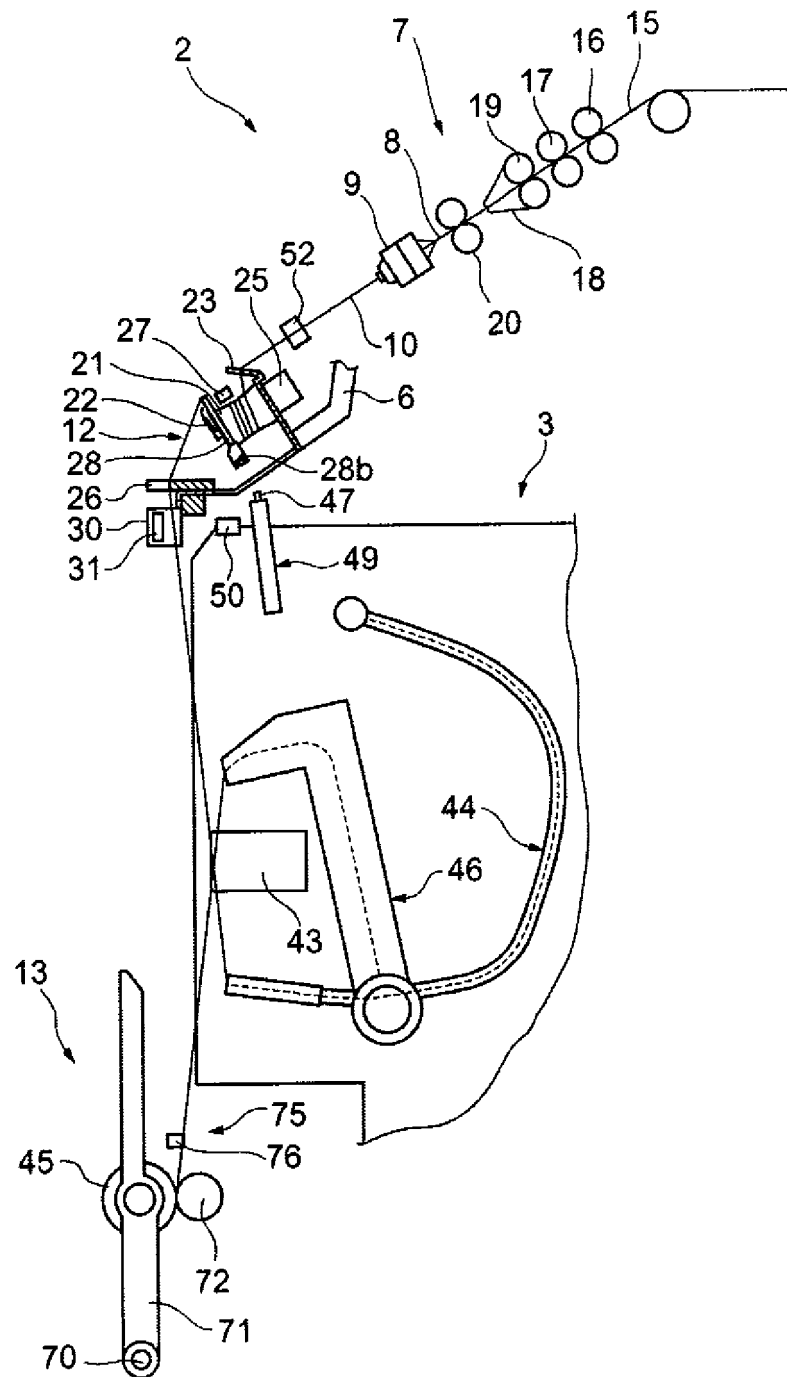
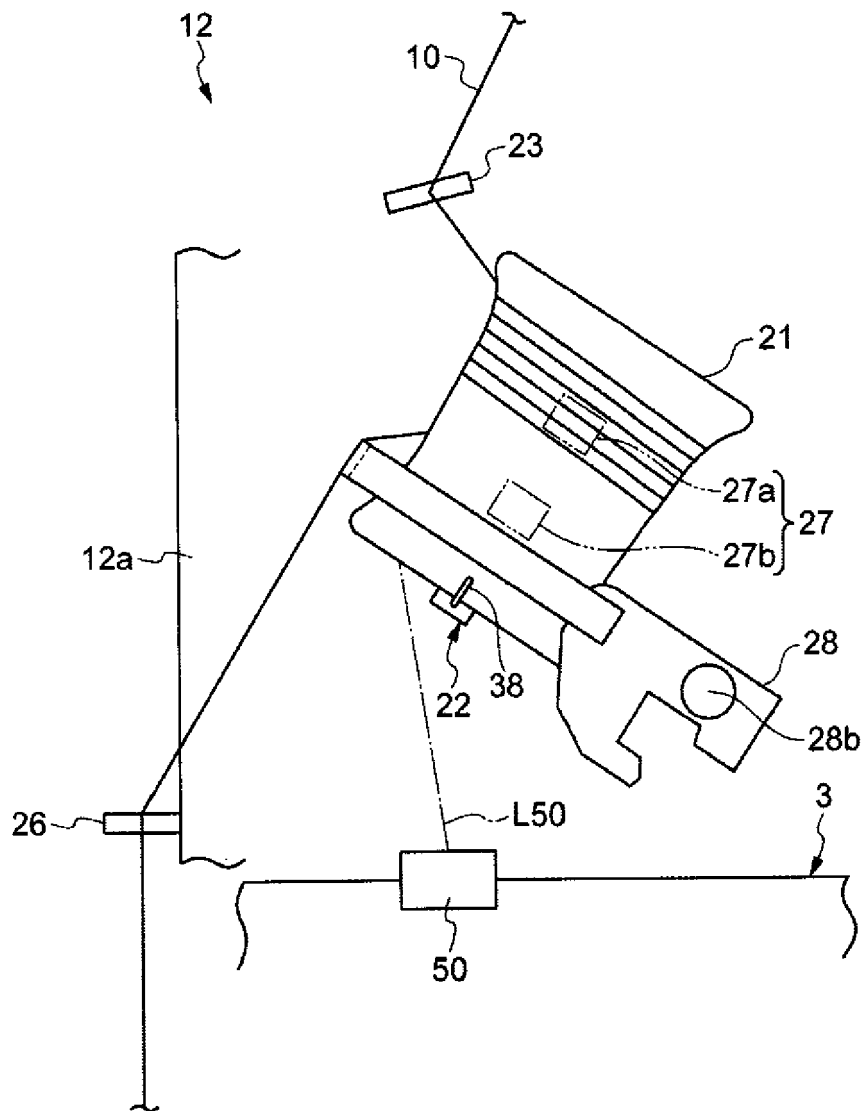


FIG. 13



REFERENCES CITED IN THE DESCRIPTION

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