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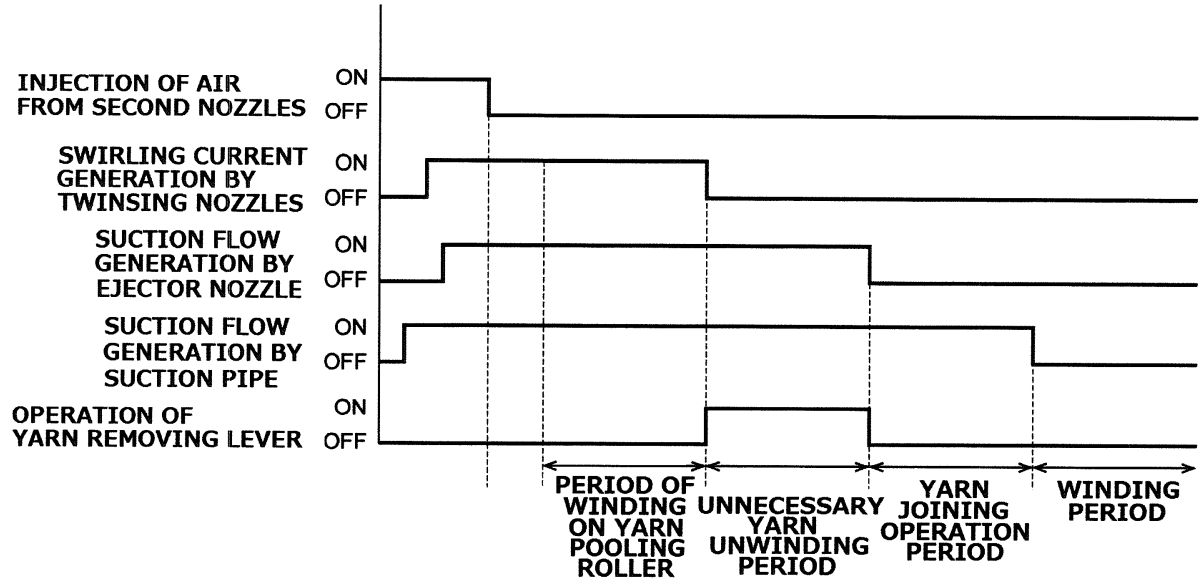
(54) SPINNING MACHINE

(57) In a spinning machine (1), at least one operation out of a first operation performed by an air-jet spinning device (7) and a second operation performed by a yarn catching device (27) is executed during a period when the yarn catching device (27) catches a yarn end. The first operation is an operation of changing an air pressure in the air-jet spinning device (7) from a first air pressure to a different second air pressure at a time when the yarn is guided to outside, and the second operation is an operation of sucking, by the yarn catching device (27), the end of the yarn with a first suction pressure and thereafter continuing a sucked state of the yarn end with a different second suction pressure.

FIG.8



EP 2 985 371 A2

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a spinning machine.

2. Description of the Related Art

[0002] A spinning machine disclosed in Japanese Patent Application Laid-open No. 2011-38225 includes an air-jet spinning device that forms a yarn by the action of a swirling air current, a winding device that winds the yarn formed by the air-jet spinning device, and a yarn joining device that joins the yarn from the air-jet spinning device and the yarn from the winding device when the yarn is cut. Yarn ends of the cut yarn are sucked and caught by yarn catching devices and guided to the yarn joining device.

SUMMARY OF THE INVENTION

[0003] Air-jet spinning devices that include a nozzle block and a hollow guide shaft are known in the art. The nozzle block includes a spinning chamber in which fibers are swirled around by a swirling current and first nozzles that inject air into the spinning chamber. The hollow guide shaft includes a passageway through which the fibers swirled in the spinning chamber are guided to the outside, and second nozzles that inject air into the passageway. The yarn end is guided to the outside by the air injected from the second nozzles, and this yarn end is sucked and caught by the yarn catching device. However, if the guiding of the yarn end to the outside by the air injected from the second nozzles and the sucking of the yarn end by the yarn catching device are performed at the same time, excessive force acts on the yarn and the yarn may break. To take care of this, the injection of the air from the second nozzles is stopped and then the yarn end from the air-jet spinning device is caught by the yarn catching device. However, if a time period from a time point when the injection of the air from the second nozzles is stopped to a time point when the yarn catching device starts to suck the yarn end is long, the possibility of failed yarn catching increases.

[0004] It is an object of the present invention to provide a spinning machine in which the occurrence of failed yarn catching and yarn breakage during yarn catching can be suppressed.

[0005] According to one aspect of the present invention, a spinning machine includes an air-jet spinning device that forms a yarn by an action of a swirling air current; a yarn catching device that catches an end of the yarn from the air-jet spinning device by suction; and a controller that controls at least one of the air-jet spinning device and the yarn catching device so as to execute at least one operation out of a first operation performed by the air-jet spinning device and a second operation performed by the yarn catching device during a period when the yarn catching device catches the end of the yarn. The first operation is an operation of changing an air pressure in the air-jet spinning device from a first air pressure to a second air pressure that is different from the first air pressure at a time when the yarn is guided to the outside, and the second operation is an operation of sucking, by the yarn catching device, the end of the yarn with a first suction pressure and thereafter continuing a sucked state of the end of the yarn with a second suction pressure that is different from the first suction pressure.

[0006] According to another aspect of the present invention, a spinning machine includes an air-jet spinning device that forms a yarn by an action of a swirling air current; and a yarn catching device that catches an end of the yarn by suction. The yarn catching device includes a first pressure regulating section that generates a first suction pressure, a second pressure regulating section that generates a second suction pressure that is different from the first suction pressure, and a switching section that switches between the first suction pressure and the second suction pressure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007]

FIG. 1 is a front view of a spinning machine according to an embodiment of the present invention.
FIG. 2 is a side view of a spinning unit of the spinning machine shown in FIG. 1.
FIG. 3 is a block diagram showing principal structural components of the spinning machine.
FIG. 4 is a cross-sectional view of an air-jet spinning device.
FIG. 5 is a cross-sectional view of a yarn pooling device.
FIG. 6 is a cross-sectional view of a leading end of a suction pipe.
FIG. 7 is a drawing of a structure for supplying air from an air supply source to an ejector nozzle.
FIG. 8 is a timing chart of operations performed by the suction pipe and the air-jet spinning device during a yarn joining operation.
FIG. 9 is a drawing for explaining a first suction pressure and a second suction pressure.

DETAILED DESCRIPTION

[0008] Exemplary embodiments of the present invention are explained in detail below with reference to the accompanying drawings. Identical or equivalent parts in the drawings are denoted by the same reference symbol and repeated explanation thereof is omitted.

[0009] As shown in FIG. 1, a spinning machine 1 includes plural spinning units 2, a yarn joining carrier 3, a

first end frame 4, and a second end frame 5. The spinning units 2 are arranged side by side in a line. Each spinning unit 2 forms a yarn Y and winds the yarn Y into a package P. When the yarn Y is cut or yarn breakage occurs due to any reason in any spinning unit 2, the yarn joining carrier 3 performs a yarn joining operation at that particular spinning unit 2. The first end frame 4 houses an air supply source that generates a swirling current or the like and/or a suction source that generates a suction flow, and the like, in each structural component of the spinning unit 2.

[0010] The second end frame 5 houses a driving motor or the like that supplies power to each structural component of the spinning unit 2. The second end frame 5 is provided with a main control device C (controller), a display screen D, and input keys K. The main control device C centrally manages and controls all the structural components of the spinning machine 1. The display screen D displays information and the like pertaining to settings and/or status of the spinning units 2. An operator can appropriately operate the input keys K to perform setting operations of the spinning units 2.

[0011] As shown in FIGS. 1 and 2, each of the spinning units 2 includes, sequentially from upstream in a running direction of the yarn Y, a drafting device 6, an air-jet spinning device 7, a yarn monitoring device 8, a tension sensor 9, a yarn pooling device 11, a waxing device 12, and a winding device 13. As shown in FIG. 1, a unit controller (controller) 10 is arranged for a predetermined number of spinning units 2 and controls the operations of those spinning units 2.

[0012] The drafting device 6 drafts a fiber bundle S. The drafting device 6 includes, sequentially from upstream in a running direction of the fiber bundle S, a back roller pair 14, a third roller pair 15, a middle roller pair 16, and a front roller pair 17. Each of the roller pairs 14 to 17 includes a bottom roller and a top roller. The bottom rollers are driven to rotate by the driving motor housed in the second end frame 5 or a driving motor arranged in each spinning unit 2. An apron belt 16a is stretched over the top roller of the middle roller pair 16. An apron belt 16b is stretched over the bottom roller of the middle roller pair 16.

[0013] The air-jet spinning device 7 forms the yarn Y by applying twists to the fiber bundle S drafted by the drafting device 6 by the action of the swirling air current. The yarn monitoring device 8 monitors information pertaining to the running yarn Y at a position between the air-jet spinning device 7 and the yarn pooling device 11, and detects presence of a yarn defect based on the monitored information. Upon detecting a yarn defect, the yarn monitoring device 8 transmits a yarn defect detection signal to the unit controller 10. The yarn monitoring device 8 detects, for example, a thickness abnormality of the yarn Y and/or presence of a foreign matter in the yarn Y as yarn defects. The yarn monitoring device 8 also detects yarn breakage or the like.

[0014] The tension sensor 9 measures a tension on the running yarn Y at a position between the air-jet spinning device 7 and the yarn pooling device 11, and transmits a tension measurement signal to the unit controller 10. The yarn Y is cut in the spinning unit 2 when the unit controller 10 determines presence of abnormality based on the detection results of the yarn monitoring device 8 and/or the tension sensor 9. Specifically, the yarn Y is cut by suspending the formation of the yarn Y by stopping the supply of the air to the air-jet spinning device 7. Alternatively, the yarn Y can be cut by a dedicated cutter.

[0015] The waxing device 12 applies wax on the yarn Y at a position between the yarn pooling device 11 and the winding device 13.

[0016] The yarn pooling device 11 eliminates the slack of the yarn Y between the air-jet spinning device 7 and the winding device 13. The yarn pooling device 11 performs the functions of stably pulling the yarn Y from the air-jet spinning device 7, preventing the slackening of the yarn Y by accumulating the yarn Y from the air-jet spinning device 7 during yarn joining or the like by the yarn joining carrier 3, and preventing a change in the tension on the yarn Y that is further downstream than the yarn pooling device 11 from being conveyed to the air-jet spinning device 7.

[0017] The winding device 13 winds the yarn Y on a bobbin B and forms the package P. The winding device 13 includes a cradle arm 21, a winding drum 22, and a traverse guide 23. The cradle arm 21 rotatably supports the bobbin B. The cradle arm 21 is pivotably supported by a shaft 24. By appropriately pivoting around the shaft 24, the cradle arm 21 brings a surface of the bobbin B or of the package P into contact with a surface of the winding drum 22 with an appropriate pressure. The not shown driving motor housed in the second end frame 5 drives the winding drums 22 of plural spinning units 2 together. By this action, in each of the spinning units 2, the bobbin B or the package P is rotated in a winding direction. The traverse guide 23 of each spinning unit 2 is arranged on a shaft 25 that is common to plural spinning units 2. The driving motor housed in the second end frame 5 drives the shaft 25 to reciprocate in a rotation axis direction of the winding drum 22. By this action, the traverse guide 23 traverses the yarn Y by a predetermined width on the rotating bobbin B or the package P.

[0018] The yarn joining carrier 3 moves to the spinning unit 2 in which the yarn Y is cut or yarn breakage has occurred due to some reason, and performs the yarn joining operation at that particular spinning unit 2. The yarn joining carrier 3 includes a yarn joining device 26, a suction pipe (yarn catching device) 27, a suction mouth 28, a push-up arm 29, and a pneumatic cylinder 30. The suction pipe 27 is pivotably supported by a shaft 31. The suction pipe 27 catches the yarn Y (yarn end) from the air-jet spinning device 7 and guides it to the yarn joining device 26. The suction mouth 28 is pivotably supported by a shaft 32. The suction mouth 28 catches the yarn Y from the winding device 13 and guides it to the yarn joining device 26. The yarn joining device 26 joins the two

yarns Y that are guided thereto. The yarn joining device 26 is a device that performs yarn joining by the action of air, or a piecer that performs yarn joining by using a seeding yarn, or a knotter that mechanically joins the yarns Y, or the like.

[0019] When the yarn joining carrier 3 performs the yarn joining operation, the package P is rotated in the direction opposite to the winding direction (reverse-rotated). To accomplish the reverse rotation of the package P, the cradle arm 21 is moved by a not shown air cylinder such that the package P is separated from the winding drum 22 and the package P is reverse-rotated by a not shown reverse rotation roller arranged in the yarn joining carrier 3.

[0020] The push-up arm 29 is arranged on a leading end portion of the pneumatic cylinder 30 that functions as an actuator. Driving of the pneumatic cylinder 30 leads to movement of the push-up arm 29 to an upper advancement position, whereupon a later-explained yarn removing lever 65 is pushed and driven to a yarn removal position. The driving of the pneumatic cylinder 30 is controlled by the unit controller 10.

[0021] The air-jet spinning device 7 is explained below in greater detail. As shown in FIG. 4, the air-jet spinning device 7 includes a nozzle block 40 and a hollow guide shaft 50. The nozzle block 40 guides the fiber bundle S supplied from the drafting device 6 to its inside and blows the swirling current on the fiber bundle S. The hollow guide shaft 50 guides the twisted fiber bundle S to the outside. The generation and stopping of the swirling current are controlled by the unit controller 10.

[0022] The nozzle block 40 includes a fiber guide 41 and a swirling current generating section 42. The fiber guide 41 has a guide hole 41a through which the fiber bundle S supplied from the drafting device 6 is guided. The swirling current generating section 42 includes a spinning chamber 43 and plural first nozzles 44. A tip portion 45a of a needle 45 held by the fiber guide 41 is positioned inside the spinning chamber 43.

[0023] Trailing ends of the fibers of the fiber bundle S guided into the spinning chamber 43 through the guide hole 41a are swirled around by the swirling air current. Air is injected from plural first nozzles 44 into the spinning chamber 43 for generating the swirling current in the spinning chamber 43. The swirling current generating section 42 has an opening 42a that is continuous with the spinning chamber 43. The opening 42a is truncated cone-shaped and tapers in the upstream direction.

[0024] An upstream end 50a of the hollow guide shaft 50 is truncated cone-shaped and tapers in the upstream direction, and arranged inside the opening 42a of the swirling current generating section 42 with a gap therebetween. The hollow guide shaft 50 is positioned relative to the spinning chamber 43 by a flange-shaped cap 57 mounted on the hollow guide shaft 50 abutting against a frame-like holder 46 that supports the nozzle block 40. The air injected into the spinning chamber 43 from plural first nozzles 44 flows into a compression chamber 47 arranged in the holder 46 via the gap formed between the upstream end 50a of the hollow guide shaft 50 and the opening 42a of the swirling current generating section 42, and is discharged along with the fibers that could not be converted into the yarn Y.

[0025] A passageway 51 and plural second nozzles 54 are arranged in the hollow guide shaft 50. The passageway 51 guides the yarn Y (the fibers swirled around in the spinning chamber 43) to the outside. Air is injected into the passageway 51 from plural second nozzles 54.

[0026] The passageway 51 extends along the central line of the hollow guide shaft 50 and widens toward an outlet 53. The passageway 51 includes, sequentially from upstream, a first portion 51a, a second portion 51b, a third portion 51c, and a fourth portion 51d. The first portion 51a extends in the downstream direction from an inlet 52 formed in the upstream end 50a of the hollow guide shaft 50 that opens into the spinning chamber 43. The second portion 51b is connected to the first portion 51a. The third portion 51c is connected to the second portion 51b. The fourth portion 51d is connected to the third portion 51c and ends at the outlet 53 formed in a downstream end 50b of the hollow guide shaft 50 that opens to the outside.

[0027] Air is supplied to each of the second nozzles 54 via an air supply passage 56 and an airflow passage 55. The air supply passage 56 is connected to the downstream end 50b of the hollow guide shaft 50. The airflow passage 55 is arranged in the hollow guide shaft 50 so as to encompass the passageway 51 when viewed along the central line of the hollow guide shaft 50.

[0028] In the air-jet spinning device 7, during yarn discharge spinning, air is injected into the spinning chamber 43 from plural first nozzles 44, and air is also injected into the passageway 51 from plural second nozzles 54. With these actions, the air in the spinning chamber 43 flows in the downstream direction (that is, toward the gap formed between the upstream end 50a of the hollow guide shaft 50 and the opening 42a of the swirling current generating section 42) while being swirled in one direction, and the fiber bundle S guided from the drafting device 6 to the spinning chamber 43 via the guide hole 41a is conveyed to a position near the inlet 52 of the passageway 51 while being loosely false-twisted. The air in the passageway 51 flows in the downstream direction (that is, toward the outlet 53 of the passageway 51 that widens toward the outlet 53) while being swirled in the opposite direction to the flow of the air in the spinning chamber 43, and the fiber bundle S conveyed to the position near the inlet 52 of the passageway 51 is guided through the passageway 51 while being spun into a bundled fiber form and is guided out from the outlet 53. The yarn discharge spinning refers to spinning performed when spinning is commenced or resumed. During regular spinning in which the yarn Y guided from the air-jet spinning device 7 is wound into the package P, air is injected only from the first nozzles 44 and not from the second nozzles 54.

[0029] A detailed structure of the yarn pooling device 11 is explained below. As shown in FIG. 5, the yarn pooling device 11 includes a yarn pooling roller 60, a yarn hooking member 61, a pooled amount sensor 62, an upstream guide 63, a downstream guide 64, and the yarn removing lever 65.

[0030] The yarn pooling roller 60 temporarily pools the yarn Y by winding the yarn Y on an outer circumferential surface thereof. The yarn pooling roller 60 is fixed to a drive shaft 66a of an electric motor 66 and is driven to rotate by the electric motor 66.

[0031] The yarn hooking member 61 is configured so as to be able to guide (engage with) the yarn Y, and wind the yarn Y on the outer circumferential surface of the yarn pooling roller 60 by integrally rotating with the yarn pooling roller 60 while guiding the yarn Y. The yarn hooking member 61 includes a flier shaft 61a and a flier 61b.

[0032] The flier shaft 61a is supported so as to be rotatable relative to the yarn pooling roller 60. A permanent magnet is mounted on either one of the flier shaft 61a and the yarn pooling roller 60, and a magnetic hysteresis material is mounted on the other one of the flier shaft 61a and the yarn pooling roller 60. A torque resisting the relative rotation of the yarn hooking member 61 with respect to the yarn pooling roller 60 is generated by the magnetic means. The yarn hooking member 61 rotates following the rotation of the yarn pooling roller 60 because of the resistance torque with the result that the yarn hooking member 61 and the yarn pooling roller 60 rotate integrally. If the yarn hooking member 61 is subjected to a force that can overcome the resistance torque, the yarn hooking member 61 will rotate relative to the yarn pooling roller 60.

[0033] The flier 61b is bent toward the outer circumferential surface of the yarn pooling roller 60 and is shaped so as to be able to guide the yarn Y (to be able to engage with the yarn Y). The flier 61b starts to guide the yarn Y by rotating integrally with the yarn pooling roller 60 when the yarn Y is not wound on the yarn pooling roller 60. As a result, the yarn Y is wound on the outer circumferential surface of the rotating yarn pooling roller 60.

[0034] The pooled amount sensor 62 detects, in a contactless manner, a pooled amount of the yarn Y on the yarn pooling roller 60 and transmits a detection result to the unit controller 10.

[0035] The upstream guide 63 is arranged upstream of the yarn pooling roller 60, and properly guides the yarn Y to the outer circumferential surface of the yarn pooling roller 60. The upstream guide 63 prevents the twists of the yarn Y propagating from the air-jet spinning device 7 being conveyed further downstream than the upstream guide 63.

[0036] The downstream guide 64 is arranged downstream of the yarn pooling roller 60. The downstream guide 64 regulates a track of the yarn Y, and guides the yarn Y while stabilizing a running path of the yarn Y further downstream of the downstream guide 64.

[0037] As shown in FIG. 5, a base portion of the yarn removing lever 65 is supported by a pivot shaft 65a. The yarn removing lever 65 is pivotable around the pivot shaft 65a between a yarn removal position and a standby position. At the standby position, the yarn removing lever 65 does not come into contact with the yarn Y or a yarn path. At the yarn removal position, the yarn removing lever 65 pushes up the yarn Y and removes the yarn Y from the flier 61b. The yarn removing lever 65 is normally held at the standby position by the urging action of a not shown spring member. When the pneumatic cylinder 30 of the yarn joining carrier 3 is driven, the push-up arm 29 pushes and moves the yarn removing lever 65 to the yarn removal position.

[0038] A detailed structure of a leading end of the suction pipe 27 of the yarn joining carrier 3 is explained below. As shown in FIG. 6, a nozzle member 70 is fixed to the leading end of the suction pipe 27. The nozzle member 70 is cylindrical. A suction passageway 71 having a circular cross-section is formed inside the nozzle member 70. One end of the suction passageway 71 is connected to a suction port 72 formed in a leading end surface of the nozzle member 70.

[0039] The suction passageway 71 is a stepped passageway that includes a small-diameter portion 73 formed in the portion near the suction port 72 and a large-diameter portion 74 connected to the small-diameter portion 73. A flow passage cross-sectional area of the large-diameter portion 74 is larger than a flow passage cross-sectional area of the small-diameter portion 73. An annular first air chamber 75 and an annular second air chamber 76 are formed inside the nozzle member 70 so as to encompass the suction passageway 71. An air pipe 77 is connected to the first air chamber 75. An air pipe 78 is connected to the second air chamber 76. The air pipes 77 and 78 are connected to an air supply source 79 (see FIG. 7).

[0040] An ejector nozzle (suction member) 80 that injects air into the suction passageway 71 is connected to the first air chamber 75. The ejector nozzle 80 is a ring-shaped nozzle having a triangular cross-section. The cross-sectional outline of the ejector nozzle 80 gradually narrows as it approaches the suction passageway 71 that is present on the inside. A blowout hole is formed at the tip end of the ejector nozzle 80 in an inner wall of the suction passageway 71. Air is injected into the suction passageway 71 from the blowout hole.

[0041] The ejector nozzle 80 is arranged at an appropriate inclination so as to form an airflow that is slanting toward a base end of the suction pipe 27. The injection of the air at high speed from the first air chamber 75 into the suction passageway 71 via the ejector nozzle 80 leads to a drop in the pressure resulting from the known Venturi effect (ejector effect). The suction flow generated toward the base end of the suction pipe 27 acts on the suction port 72. The generation and stopping of the suction flow are controlled by the unit controller 10.

[0042] As shown in FIG. 7, a first pressure regulator (first pressure regulating section) 81, a second pressure

regulator (second pressure regulating section) 82, and a shuttle valve (switching section) 83 are arranged between the air pipe 77 and the air supply source 79. The first pressure regulator 81 regulates air pressure such that air having a first pressure is supplied to the ejector nozzle 80. The second pressure regulator 82 regulates air pressure such that air having a second pressure is supplied to the ejector nozzle 80. The first pressure is set lower than, for example, one-fourth of, the second pressure. The shuttle valve 83 includes two inlets and one common outlet. When the air is introduced from the two inlets, the shuttle valve 83 connects the inlet through which the air having the higher pressure is fed and the outlet. That is, when the air having the first pressure is fed through one inlet and the air having the second pressure is fed through the other inlet, the shuttle valve 83 connects the inlet through which the air having the higher second pressure is fed and the outlet.

[0043] The suction pipe 27 is connected to the suction source via a not shown blower duct. A suction flow is generated in the suction pipe 27 and this suction flow is different from the suction flow that is generated by the ejector nozzle 80.

[0044] Plural twisting nozzles (twisting members) 84 that inject air into the suction passageway 71 are connected to the second air chamber 76. The twisting nozzles 84 are arranged at equal intervals around the suction passageway 71 with each twisting nozzle 84 having a blowout hole in the inner wall of the suction passageway 71. The twisting nozzles 84 are shown extending radially in FIG. 6; however, the twisting nozzles 84 are actually oriented tangentially to the circular suction passageway 71.

[0045] Airflow is generated in the suction passageway 71 by the injection of the air from the second air chamber 76 into the suction passageway 71 via the twisting nozzles 84. The yarn Y guided into the suction passageway 71 is pulled to the base end of the suction pipe 27 while being twisted by the action of the swirling current generated by the twisting nozzles 84. The generation and stopping of the swirling current are controlled by the unit controller 10.

[0046] The yarn joining operation performed in the spinning machine 1 is explained below. A case where the yarn joining operation is performed when the yarn Y is cut after a yarn defect is detected is explained below.

[0047] Upon detecting a yarn defect during winding of the yarn Y, the yarn monitoring device 8 transmits the yarn defect detection signal to the unit controller 10. Upon receiving the yarn defect detection signal, the unit controller 10 exerts control to suspend the formation of the yarn Y by stopping the supply of air to the air-jet spinning device 7, and thereby cut the yarn Y.

[0048] The unit controller 10 then transmits a control signal to the yarn joining carrier 3, and thereby exerts control to move the yarn joining carrier 3 to the spinning unit 2 in which the yarn Y is cut. The unit controller 10 controls the suction mouth 28 to pivot to a position near the surface of the package P and controls the reverse rotation roller of the yarn joining carrier 3 to reverse-rotate the package P. With this control, the end of the yarn Y from the package P is caught by the suction mouth 28. The unit controller 10 then exerts control to reverse-rotate the package P, pivot the suction mouth 28 upward with the yarn Y sucked in, guide the yarn Y to the yarn joining device 26, and thereafter stop the rotation of the package P.

[0049] The unit controller 10 then exerts control to pivot the suction pipe 27 and position the nozzle member 70 at a position between the air-jet spinning device 7 and the yarn pooling device 11. Substantially simultaneously with the pivoting action of the suction pipe 27, as shown in FIG. 8, the unit controller 10 exerts control to generate the suction flow in the suction pipe 27 and inject the air from the second nozzles 54 of the air-jet spinning device 7. When the air is injected from the second nozzles 54 of the air-jet spinning device 7, the end of the yarn Y is guided to the outside of the air-jet spinning device 7 by the air pressure. Thereafter, the unit controller 10 controls the twisting nozzles 84 to inject the air and generate the swirling current, and the ejector nozzle 80 to inject the air and generate the suction flow. Upon elapse of a predetermined time period after the generation of the suction flow by the injection of the air from the ejector nozzle 80, the unit controller 10 exerts control to stop the injection of the air from the second nozzles 54 of the air-jet spinning device 7.

[0050] When the air is being injected from the second nozzles 54 of the air-jet spinning device 7, the unit controller 10 exerts control such that the yarn end is caught in the suction pipe 27 by the action of the suction flow generated by the injection of the air from the ejector nozzle 80. As shown in FIG. 9, when the air is being injected from the second nozzles 54, the unit controller 10 exerts control to inject the air having the first pressure from the ejector nozzle 80 into the suction passageway 71 so as to generate the suction flow having a first suction pressure (second operation). During this control, the shuttle valve 83 shown in FIG. 7 connects the inlet connected to the first pressure regulator 81 and the outlet, and thereby the air having the first pressure is guided to the air pipe 77. With this action, the suction pipe 27 sucks the end of the yarn Y, that is being guided to the outside of the air-jet spinning device 7 by the injection of the air from the second nozzles 54, by the action of the first suction pressure that is lower than nearly one-fourth of a second suction pressure explained later.

[0051] When the injection of the air from the second nozzles 54 is stopped, the unit controller 10 controls the ejector nozzle 80 to inject air having the second pressure into the suction passageway 71 such that the suction flow having the second suction pressure that is higher than the first suction pressure is generated (second operation). During this control, the shuttle valve 83 shown in FIG. 7 connects the inlet connected to the second pressure regulator 82 and the outlet, and thereby the air hav-

ing the second suction pressure is guided to the air pipe 77. The second suction pressure is nearly four times the first suction pressure. The suction force generated by the second suction pressure enables the suction pipe 27 to successfully suck and catch the yarn end.

[0052] Once the suction pipe 27 catches the yarn Y (yarn end), the unit controller 10 exerts control to pivot the suction pipe 27 downward while continuing the suction, thereby enabling the yarn Y to be pulled from the air-jet spinning device 7 and guided to the yarn joining device 26.

[0053] Once the yarn Y is guided to the yarn joining device 26, the yarn Y between the air-jet spinning device 7 and the suction pipe 27 engages with the flier 61b, thereby the winding of the yarn Y on the yarn pooling roller 60 is started (start of a period of winding on the yarn pooling roller shown in FIG. 8). The unit controller 10 controls the pooled amount sensor 62 to monitor the pooled amount of the yarn Y on the yarn pooling roller 60 and determines whether the minimum required pooled amount has been reached. When it is determined that the pooled amount has reached the minimum required pooled amount or greater, the unit controller 10 exerts control to stop the injection of the air from the twisting nozzles 84.

[0054] Thereafter, the unit controller 10 controls the pneumatic cylinder 30 to rise and move the yarn removing lever 65 to the yarn removal position, and thereby remove the yarn Y from the flier 61b. When the yarn Y is removed from the flier 61b while the yarn pooling roller 60 is being rotated, the yarn Y present on the yarn pooling roller 60 is unwound and sucked by the suction pipe 27. With this action, the unstable yarn Y present on the yarn pooling roller 60 is removed by the suction pipe 27.

[0055] After letting the unstable yarn Y to be sucked by the suction pipe 27 for a predetermined time period (unnecessary yarn unwinding period shown in FIG. 8), the unit controller 10 controls the ejector nozzle 80 to stop injection of the air. The unit controller 10 then controls the pneumatic cylinder 30 to be lowered and return the yarn removing lever 65 to the standby position. The unit controller 10 thereafter controls the yarn joining device 26 to start the yarn joining operation (start of a yarn joining operation period shown in FIG. 8). After the yarn joining operation ends, the unit controller 10 controls resumption of winding of the yarn Y in the winding device 13 (start of a winding period shown in FIG. 8).

[0056] As explained above, in the spinning machine 1 according to the present embodiment, the suction pipe 27 first sucks the yarn end with the first suction pressure generated by the air injected from the ejector nozzle 80 and thereafter continues the sucked state of the yarn Y with the second suction pressure. The first suction pressure is lower than the second suction pressure. In this manner, because a suction force generated by the suction pipe 27 and that acts on the yarn Y when the yarn end is first caught is low, the yarn Y is not subjected to excessive force even when the suction pipe 27 sucks the yarn end while the yarn Y is being guided to the outside by the air injected from the second nozzles 54 in the air-jet spinning device 7. Hence, yarn breakage can be suppressed. Because the suction pipe 27 continues the sucked state of the yarn Y with the second suction pressure after the end of the yarn Y has been caught, the yarn Y can be guided to the yarn joining device 26 with the yarn end reliably caught. Furthermore, because the yarn end can be caught by the suction pipe 27 without having to stop the yarn Y from being guided out of the air-jet spinning device 7, the occurrence of failed yarn catching can be suppressed.

[0057] In the present embodiment, the air-jet spinning device 7 stops the injection of the air from the second nozzles 54 when the yarn end is being sucked with the first suction pressure by the suction pipe 27. Hence, unnecessary load on the yarn Y can be avoided, and thereby yarn breakage can be suppressed.

[0058] In the present embodiment, the suction pipe 27 twists the end of the caught yarn Y by the air injected from the twisting nozzles 84 into the suction passageway 71. Hence, the yarn Y can be guided to the yarn joining device 26 while twists are being applied to the end of the caught yarn Y. Consequently, even when catching a yarn end that is weak in yarn strength, yarn breakage can be effectively avoided and thereby the occurrence of failed yarn catching can be suppressed.

[0059] The present invention is not limited to the above embodiment. In the present embodiment, for example, a case in which the suction pipe 27 sucks the yarn end with the first suction pressure generated by the air injected from the ejector nozzle 80 and thereafter continues the sucked state of the yarn Y with the second suction pressure that is higher than the first suction pressure is cited as an example. The first suction pressure only needs to be different from the second suction pressure and can also be higher than the second suction pressure. A level relation can be set between the first suction pressure and the second suction pressure in accordance with the type of the yarn Y formed by the spinning unit 2.

[0060] In the present embodiment, when catching the yarn end, the suction pipe 27 starts to suck the yarn end with the first suction pressure and thereafter continues the sucked state of the yarn Y with the second suction pressure. However, when the suction pipe 27 starts to catch the yarn end, the air pressure in the air-jet spinning device 7 that guides the yarn Y to the outside, that is, the pressure of the air that is injected from the second nozzles 54, can be changed from the first air pressure to the second pressure that is lower than the first air pressure (first operation). That is, in the air-jet spinning device 7, the yarn Y is guided to the passageway 51 by the action of the first air pressure; and, when the suction pipe 27 starts to suck the yarn end, the air pressure is switched to the second air pressure. With this control, the force applied on the yarn Y can be reduced. Consequently, the yarn Y is not subjected to excessive force even when the suction pipe 27 sucks the yarn end while the yarn Y is

guided to the outside of the air-jet spinning device 7 by the air pressure. Hence, yarn breakage can be suppressed. Furthermore, because the yarn end can be caught by the suction pipe 27 without having to stop the yarn Y from being guided out by the air-jet spinning device 7, the occurrence of failed yarn catching can be suppressed. The first air pressure only needs to be different from the second air pressure and can also be lower than the second air pressure. A level relation can be set between the first air pressure and the second air pressure in accordance with the type of the yarn Y formed by the spinning unit 2.

[0061] In the present embodiment, a case in which the suction pipe 27 executes the first operation or the air-jet spinning device 7 executes the second operation during the period when the suction pipe 27 performs the operation of catching the yarn end is cited as an example. As an alternative method, both the first operation by the suction pipe 27 and the second operation by the air-jet spinning device 7 can be executed during the period when the suction pipe 27 performs the operation of catching the yarn end.

[0062] In the present embodiment, a case in which the suction pipe 27 sucks the yarn end with the first suction pressure and thereafter continues the sucked state of the yarn Y with the second suction pressure is cited as an example. The process by which the suction pipe 27 sucks the yarn end is not limited to a two-step process. For example, following the second suction pressure, the suction pipe 27 can further continue the sucked state of the yarn end with a third suction pressure. The suction pressure can be increased continuously or intermittently.

[0063] In the spinning unit 2, the yarn pooling device 11 performs the function of pulling the yarn Y from the air-jet spinning device 7. As an alternative configuration, the yarn Y can be pulled from the air-jet spinning device 7 by a delivery roller and a nip roller. When the delivery roller and the nip roller are used for pulling the yarn Y from the air-jet spinning device 7, instead of the yarn pooling device 11, a slack tube or a mechanical compensator or the like can be arranged that can absorb the slack of the yarn Y by a suction flow.

[0064] In the spinning machine 1, the structural components are arranged in a machine height direction such that the yarn Y is supplied at the top end and wound at the bottom end. As an alternative configuration, the structural components can be arranged such that the yarn is supplied at the bottom end and wound at the top end.

[0065] In the spinning machine 1, the traverse guide 23 and at least one of the bottom rollers of the drafting device 6 are driven by power from the second end frame 5 (that is, common to plural spinning units 2). As an alternative configuration, the structural components (for example, the drafting device, the spinning device, the winding device, and the like) of the spinning unit 2 can be driven independently for each spinning unit 2.

[0066] The tension sensor 9 can be arranged upstream of the yarn monitoring device 8 in the running direction of the yarn Y. A separate unit controller 10 can be arranged for each spinning unit 2. The waxing device 12, the tension sensor 9, and the yarn monitoring device 8 of the spinning unit 2 can be omitted. The winding device 13 can be driven by a driving motor arranged separately for each spinning unit 2.

[0067] In FIG. 1, the spinning machine 1 is shown to wind the package P in cheese form; alternatively, the package can be wound in cone form. When forming the package in cone form, slackening of the yarn Y occurs due to traversing of the yarn Y. The slack, however, can be absorbed by the yarn pooling device 11.

[0068] In the air-jet spinning device 7, the opening 42a of the swirling current generating section 42 is truncated cone-shaped and tapers in the upstream direction, and the upstream end 50a of the hollow guide shaft 50 is truncated cone-shaped and tapers in the upstream direction. However, the shapes of the above structural components of the air-jet spinning device 7 can be suitably altered.

[0069] In the present embodiment, a case in which the unit controller 10 controls the operation of the air-jet spinning device 7 and the suction pipe 27 has been explained as an example. However, it is possible to configure such that the main control device C controls the operation of at least one of the air-jet spinning device 7 and the suction pipe 27. In an alternative configuration, a carrier controller can be provided in the yarn joining carrier 3 and the operation of the suction pipe 27 can be controlled by using this carrier controller.

[0070] Moreover, in the present embodiment, the yarn joining carrier 3 includes the yarn joining device 26, the suction pipe 27, the suction mouth 28, the push-up arm 29, and the pneumatic cylinder 30. However, in the spinning machine 1, one or more among the yarn joining device 26, the suction pipe 27, the suction mouth 28, the push-up arm 29, and the pneumatic cylinder 30 can be arranged in each spinning unit 2. When all of the yarn joining device 26, the suction pipe 27, the suction mouth 28, the push-up arm 29, and the pneumatic cylinder 30 are arranged in each spinning unit 2, the yarn joining carrier 3 can be omitted.

[0071] According to one aspect of the present invention, a spinning machine includes an air-jet spinning device that forms a yarn by an action of a swirling air current; a yarn catching device that catches an end of the yarn from the air-jet spinning device by suction; and a controller that controls at least one of the air-jet spinning device and the yarn catching device so as to execute at least one operation out of a first operation performed by the air-jet spinning device and a second operation performed by the yarn catching device during a period when the yarn catching device catches the end of the yarn. The first operation is an operation of changing an air pressure in the air-jet spinning device from a first air pressure to a second air pressure that is different from the first air pressure at a time when the yarn is guided to the outside, and the second operation is an operation of sucking, by

the yarn catching device, the end of the yarn with a first suction pressure and thereafter continuing a sucked state of the end of the yarn with a second suction pressure that is different from the first suction pressure.

[0072] In the spinning machine, the air-jet spinning device performs the first operation of changing the air pressure, at the time when the yarn is guided to the outside, from the first air pressure to the second air pressure. With this configuration, the air-jet spinning device reduces the second air pressure such that, for example, the second air pressure is lower than the first air pressure and guides the yarn with the second air pressure at the time when the yarn catching device starts to suck the yarn end, and thereby reduces the force applied on the yarn. Consequently, the yarn is not subjected to excessive force even when the yarn catching device sucks the yarn end while the yarn is being guided to the outside. Hence, yarn breakage can be suppressed. Furthermore, the yarn end can be caught by the yarn catching device without having to stop the yarn from being guided out of the air-jet spinning device. Consequently, occurrence of failed yarn catching can be suppressed.

[0073] In the spinning machine, the yarn catching device performs the second operation of sucking the yarn end with the first suction pressure and continuing the sucked state of the yarn end with the second suction pressure. With this configuration, by reducing the first suction pressure such that, for example, the first suction pressure is lower than the second suction pressure in the yarn catching device, a suction force acting on the yarn end when the yarn catching device starts to suck the yarn end can be reduced. Consequently, the yarn is not subjected to excessive force even when the yarn catching device sucks the yarn end while the yarn is being guided to the outside from the air-jet spinning device. Hence, yarn breakage can be suppressed. Furthermore, the yarn end can be caught by the yarn catching device without having to stop the yarn from being guided out of the air-jet spinning device. Consequently, the occurrence of failed yarn catching can be suppressed.

[0074] According to another aspect of the present invention, a spinning machine includes an air-jet spinning device that forms a yarn by an action of a swirling air current; and a yarn catching device that catches an end of the yarn by suction. The yarn catching device includes a first pressure regulating section that generates a first suction pressure, a second pressure regulating section that generates a second suction pressure that is different from the first suction pressure, and a switching section that switches between the first suction pressure and the second suction pressure.

[0075] In the spinning machine, the first pressure regulating section generates the first suction pressure, the second pressure regulating section generates the second suction pressure, and the switching section switches between the first suction pressure and the second suction pressure. With this configuration, by setting the suction pressure such that, for example, the first suction pressure is lower than the second suction pressure, and catching the yarn end with the first suction pressure, the suction force acting on the yarn end when the yarn catching device starts to suck the yarn end can be reduced. Consequently, the yarn is not subjected to excessive force even when the yarn catching device sucks the yarn end while the yarn is being guided to the outside from the air-jet spinning device. Hence, yarn breakage can be suppressed. Furthermore, the yarn end can be caught by the yarn catching device without having to stop the yarn from being guided out of the air-jet spinning device. Consequently, the occurrence of failed yarn catching can be suppressed.

[0076] According to still another aspect of the present invention, in the above spinning machine, the air-jet spinning device includes a nozzle block that includes a spinning chamber in which fibers are swirled by the action of the swirling air current and a first nozzle that allows passage of air that is injected into the spinning chamber to generate the swirling air current, and a hollow guide shaft that includes a passageway that guides the fibers swirled in the spinning chamber to outside and a second nozzle that allows passage of air that is injected into the passageway, and the yarn catching device is controlled to generate suction pressures when the air is being injected from the second nozzle. With this configuration, the yarn end can be caught by the yarn catching device while the yarn is being guided to the outside by the air injected from the second nozzle. Hence, the occurrence of failed yarn catching can be more reliably suppressed.

[0077] According to still another aspect of the present invention, in the above spinning machine, the yarn catching device is controlled to generate the first suction pressure that is lower than the second suction pressure when the air is being injected from the second nozzle in the air-jet spinning device. With this configuration, the yarn catching device can catch the yarn end while the yarn is guided to the outside of the air-jet spinning device without subjecting the yarn to excessive force.

[0078] According to still another aspect of the present invention, in the above spinning machine, the air-jet spinning device is controlled to stop the injection of the air from the second nozzle when the yarn catching device is controlled to generate the first suction pressure. With this configuration, unnecessary load on the yarn can be avoided, and thereby yarn breakage can be suppressed.

[0079] According to still another aspect of the present invention, in the above spinning machine, the yarn catching device includes a suction member that generates the first suction pressure and the second suction pressure. With this configuration, the first suction pressure and the second suction pressure can be reliably generated in the yarn catching device.

[0080] According to still another aspect of the present invention, the above spinning machine further includes a yarn pooling device that pools the yarn formed by the air-jet spinning device, and the yarn catching device catches the end of the yarn from the air-jet spinning de-

vice at a position between the air-jet spinning device and the yarn pooling device. With this configuration, the end of the yarn from the air-jet spinning device can be more reliably caught.

[0081] The yarn catching device according to still another aspect of the present invention can include a twisting member that twists the yarn end caught by the yarn catching device. With this configuration, the yarn can be guided to a target position (for example, the yarn joining device) while twists are being applied to the caught yarn end. Consequently, even when catching a yarn end that is weak in yarn strength, yarn breakage can be effectively avoided and thereby the occurrence of failed yarn catching can be suppressed.

[0082] According to still another aspect of the present invention, the above spinning machine further includes a controller that controls at least one of the air-jet spinning device and the yarn catching device so as to execute at least one operation out of the first operation and the second operation. With this configuration, the air-jet spinning device is controlled to execute the first operation and the yarn catching device is controlled to execute the second operation.

Claims

1. A spinning machine (1) comprising:

an air-jet spinning device (7) adapted to form a yarn (Y) by an action of a swirling air current;
a yarn catching device (27) adapted to catch an end of the yarn (Y) from the air-jet spinning device (7) by suction; and
a controller (10; C) adapted to control at least one of the air-jet spinning device (7) and the yarn catching device (27) so as to execute at least one operation out of a first operation performed by the air-jet spinning device (7) and a second operation performed by the yarn catching device (27) during a period when the yarn catching device (27) catches the end of the yarn (Y),
wherein the first operation is an operation of changing an air pressure in the air-jet spinning device (7) from a first air pressure to a second air pressure that is different from the first air pressure at a time when the yarn (Y) is guided to the outside, and
the second operation is an operation of sucking, by the yarn catching device (27), the end of the yarn (Y) with a first suction pressure and thereafter continuing a sucked state of the end of the yarn (Y) with a second suction pressure that is different from the first suction pressure.

2. A spinning machine (1) comprising:

an air-jet spinning device (7) adapted to form a yarn (Y) by an action of a swirling air current; and
a yarn catching device (27) adapted to catch an end of the yarn (Y) by suction,
wherein the yarn catching device (27) includes
a first pressure regulating section (81) adapted to generate a first suction pressure,
a second pressure regulating section (82) adapted to generate a second suction pressure that is different from the first suction pressure, and
a switching section (83) adapted to switch between the first suction pressure and the second suction pressure.

3. The spinning machine (1) as claimed in Claim 1 or Claim 2, wherein the air-jet spinning device (7) includes
a nozzle block (40) that includes a spinning chamber (42) in which fibers are swirled by the action of the swirling air current and a first nozzle (44) adapted to allow passage of air that is injected into the spinning chamber (42) to generate the swirling air current, and a hollow guide shaft (50) that includes a passageway (51) adapted to guide the fibers swirled in the spinning chamber (42) to outside and a second nozzle (54) adapted to allow passage of air that is injected into the passageway (51), and
the yarn catching device (27) is controlled to generate suction pressures when the air is being injected from the second nozzle (54).

4. The spinning machine (1) as claimed in Claim 3, wherein the yarn catching device (27) is controlled to generate the first suction pressure that is lower than the second suction pressure when the air is being injected from the second nozzle (54) in the air-jet spinning device (7).

5. The spinning machine (1) as claimed in Claim 4, wherein the air-jet spinning device (7) is controlled to stop the injection of the air from the second nozzle (54) when the yarn catching device (27) is controlled to generate the first suction pressure.

6. The spinning machine (1) as claimed in any one of Claims 1 to 5, wherein the yarn catching device (27) includes a suction member (80) adapted to generate the first suction pressure and the second suction pressure.

7. The spinning machine (1) as claimed in any one of Claims 1 to 6, further comprising a yarn pooling device (11) adapted to pool the yarn (Y) formed by the air-jet spinning device (7),
wherein the yarn catching device (27) is adapted to catch the end of the yarn (Y) from the air-jet spinning device (7) at a position between the air-jet spinning device (7) and the yarn pooling device (11).

8. The spinning machine (1) as claimed in any one of Claims 1 to 7, wherein the yarn catching device (27) includes a twisting member (84) adapted to twist the end of the yarn (Y) caught by the yarn catching device (27).

FIG.1

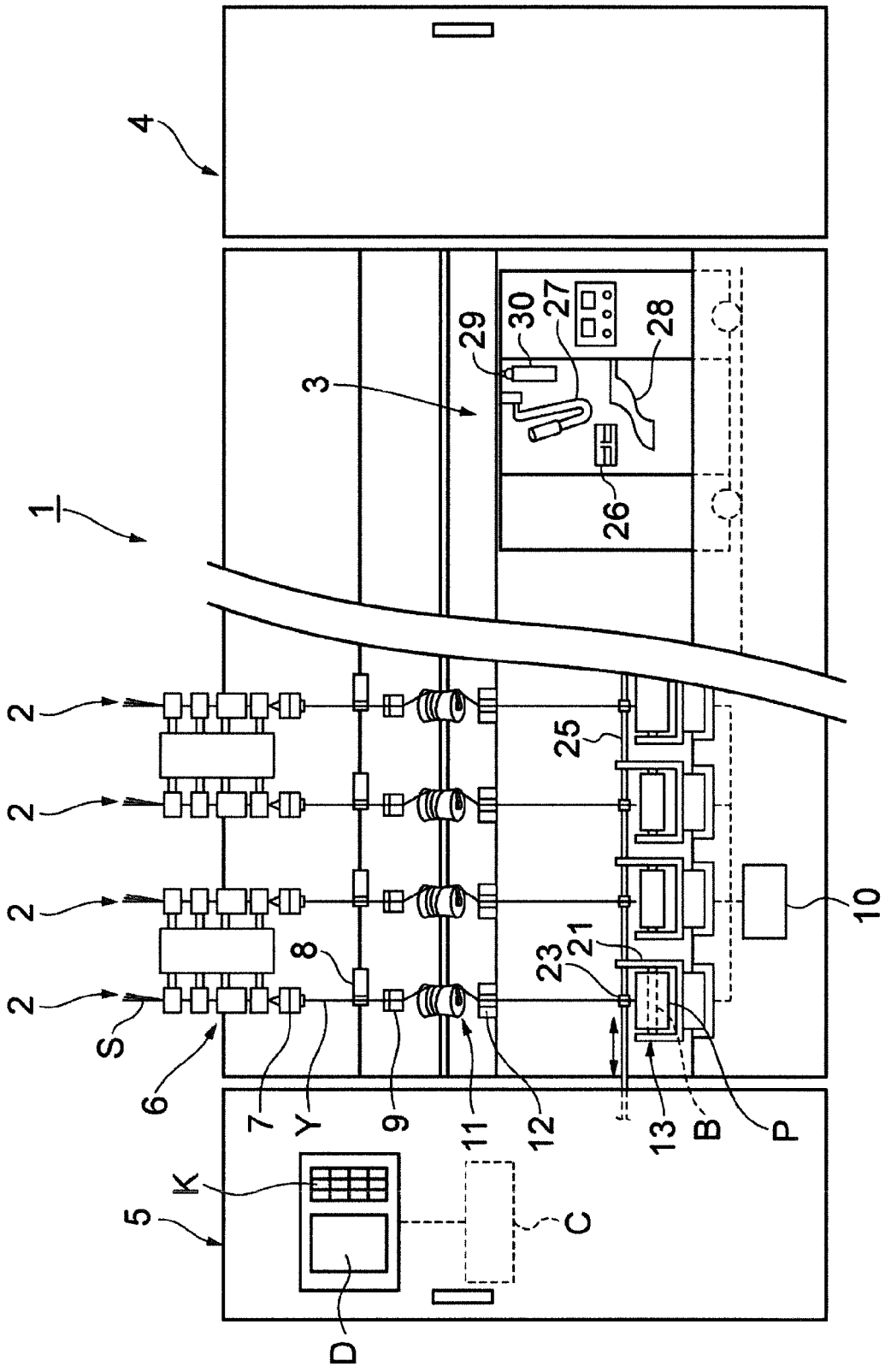
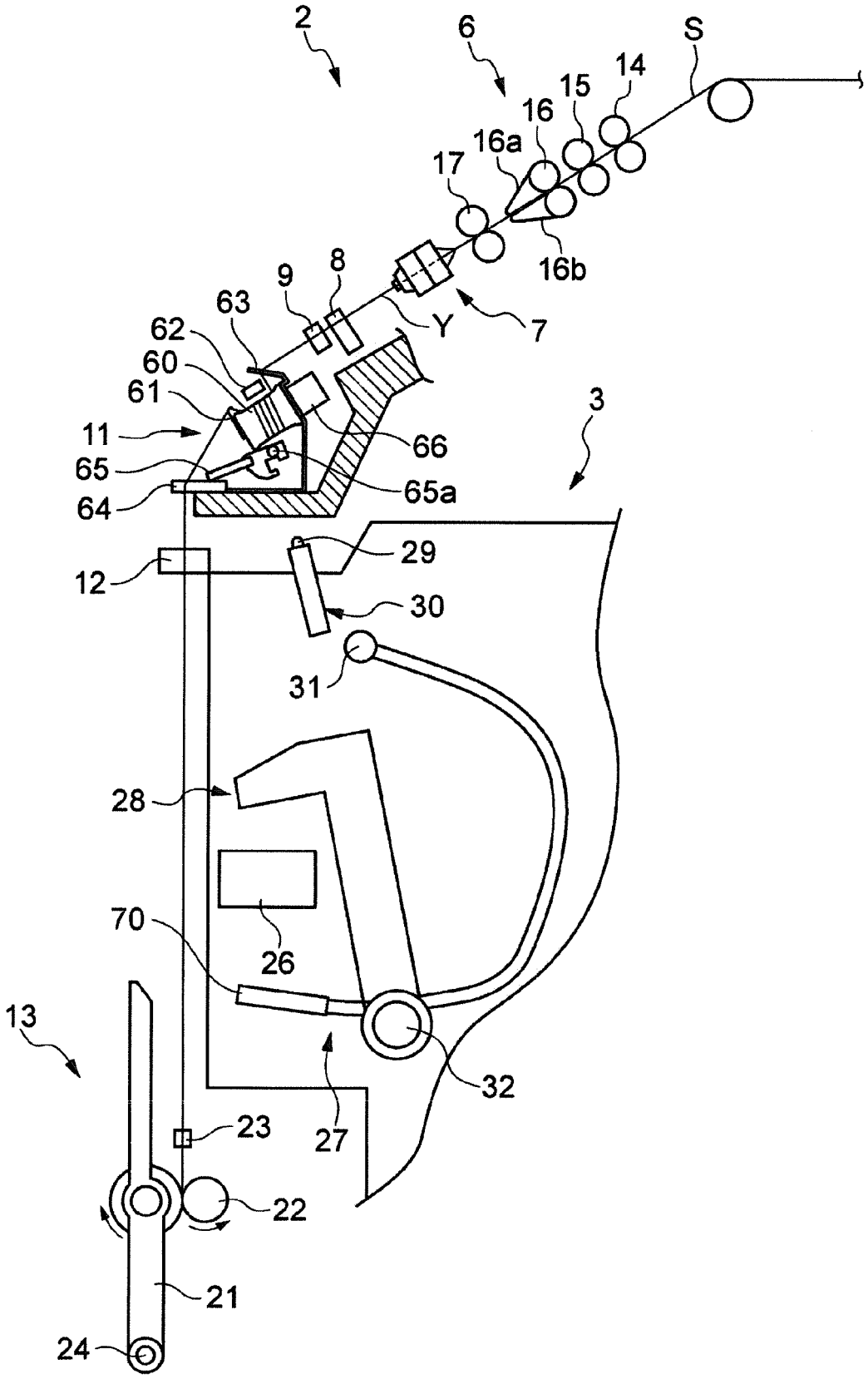


FIG.2


2
6
S
14
15
16
16a
17
16b
9
8
63
62
60
61
11
65
64
Y
7
66
65a
3
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12
30
31
28
70
26
13
32
27
23
22
21
24

FIG.3

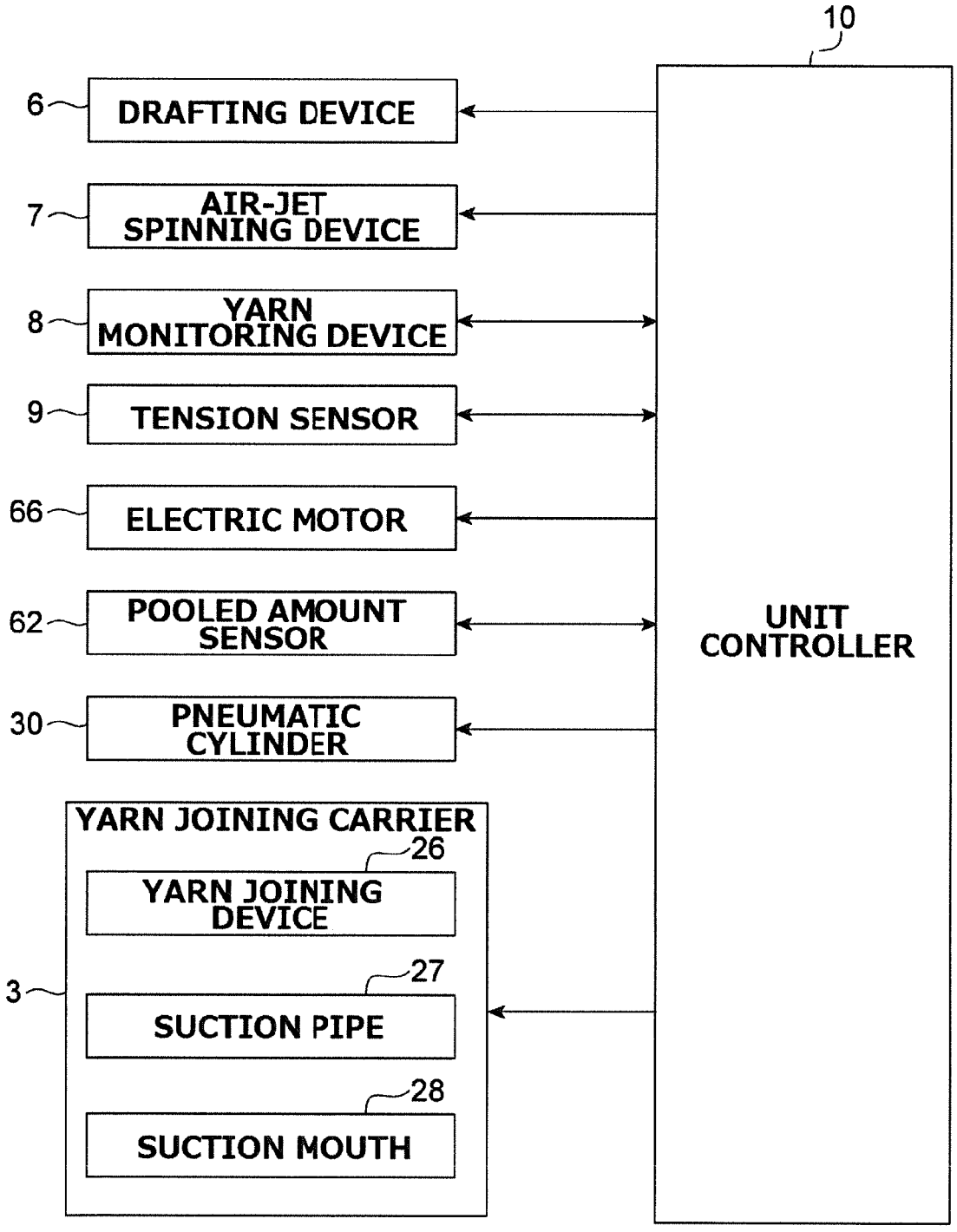
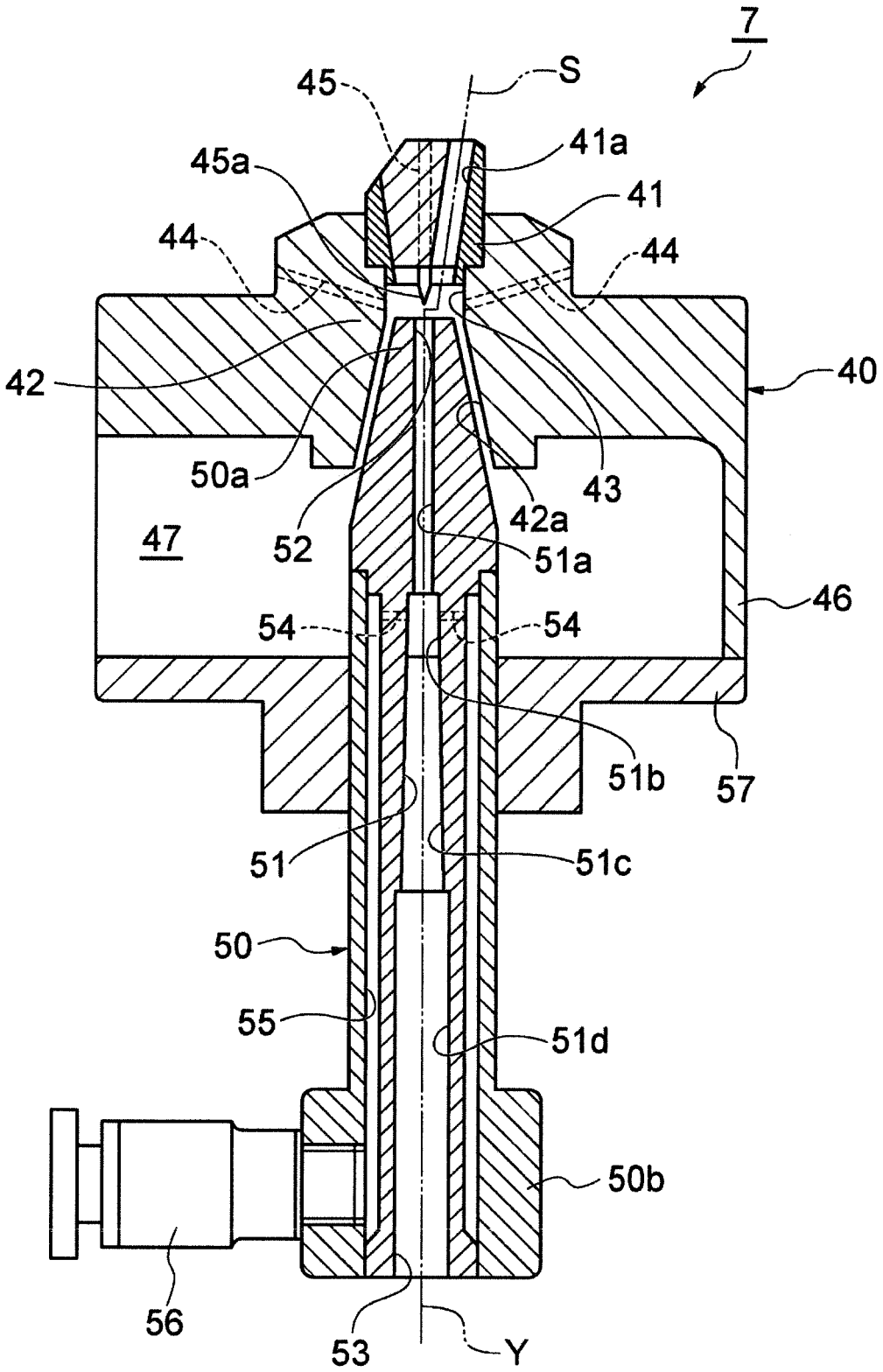

10
6
DRAFTING DEVICE
7
AIR-JET SPINNING DEVICE
8
YARN MONITORING DEVICE
9
TENSION SENSOR
66
ELECTRIC MOTOR
62
POOLED AMOUNT SENSOR
30
PNEUMATIC CYLINDER
UNIT CONTROLLER
YARN JOINING CARRIER
26
YARN JOINING DEVICE
27
3
SUCTION PIPE
28
SUCTION MOUTH

FIG.4


7
S
45
41a
45a
41
44
44
42
40
50a
43
42a
47
52
51a
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51b
57
51
51c
50
55
51d
50b
56
53
Y

FIG.5

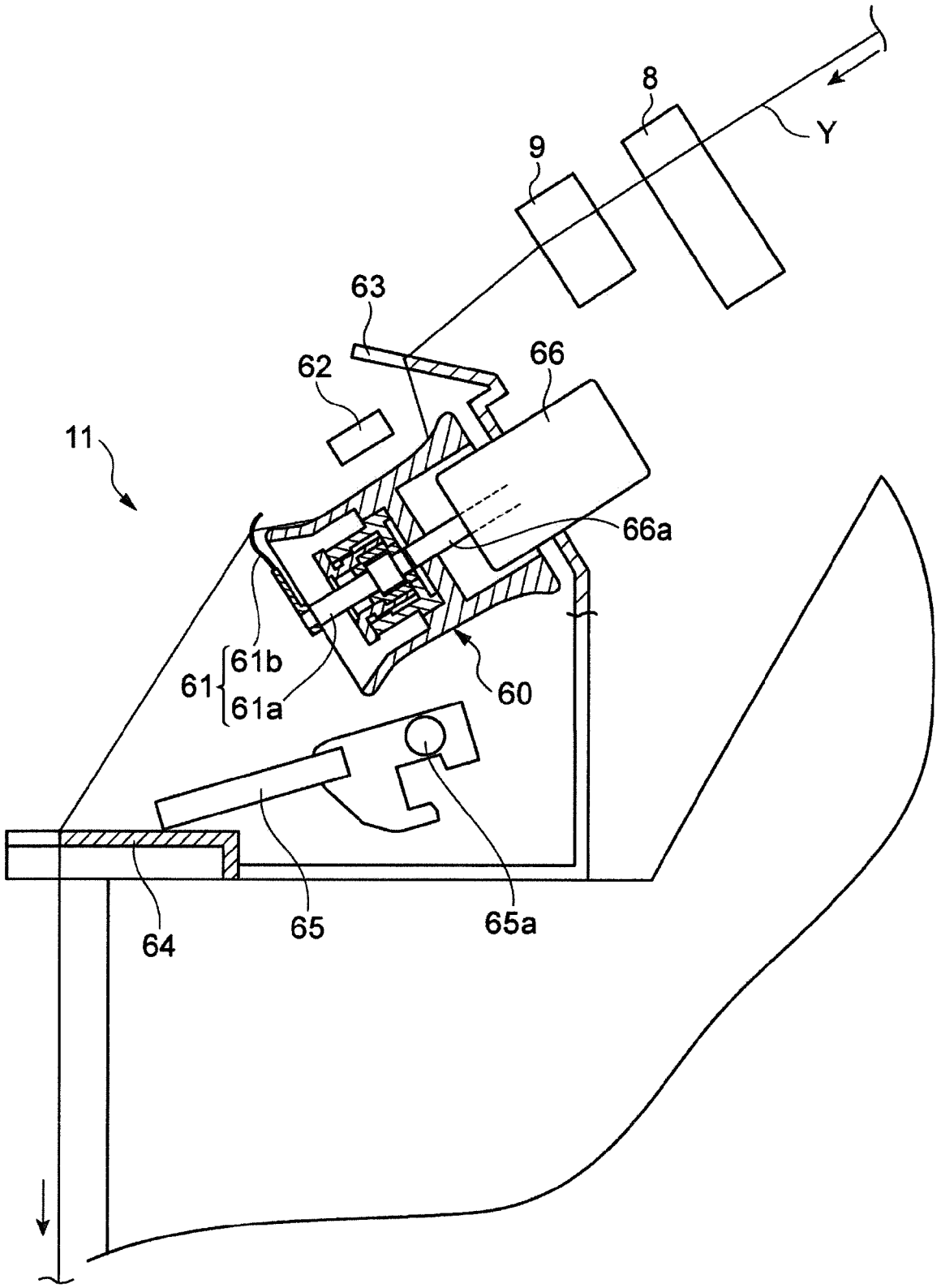


FIG.6

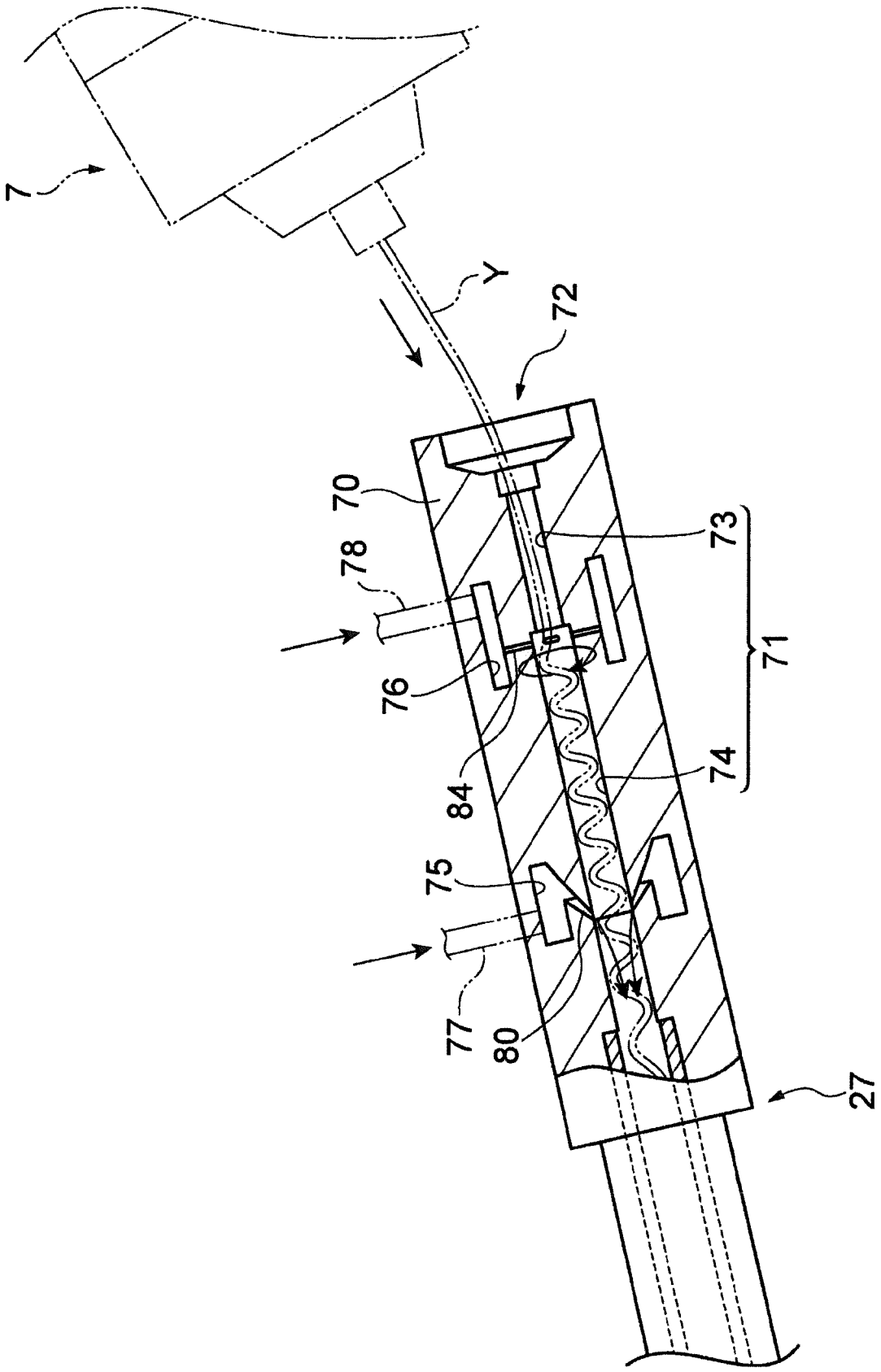


FIG.7

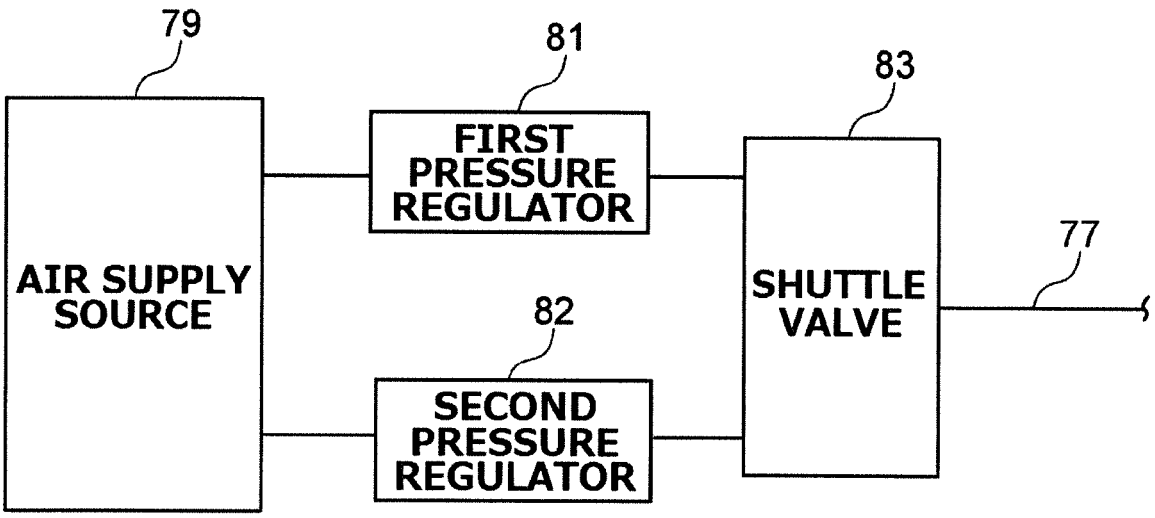

79
81
83
FIRST PRESSURE REGULATOR
AIR SUPPLY SOURCE
SHUTTLE VALVE
77
82
SECOND PRESSURE REGULATOR

FIG.8

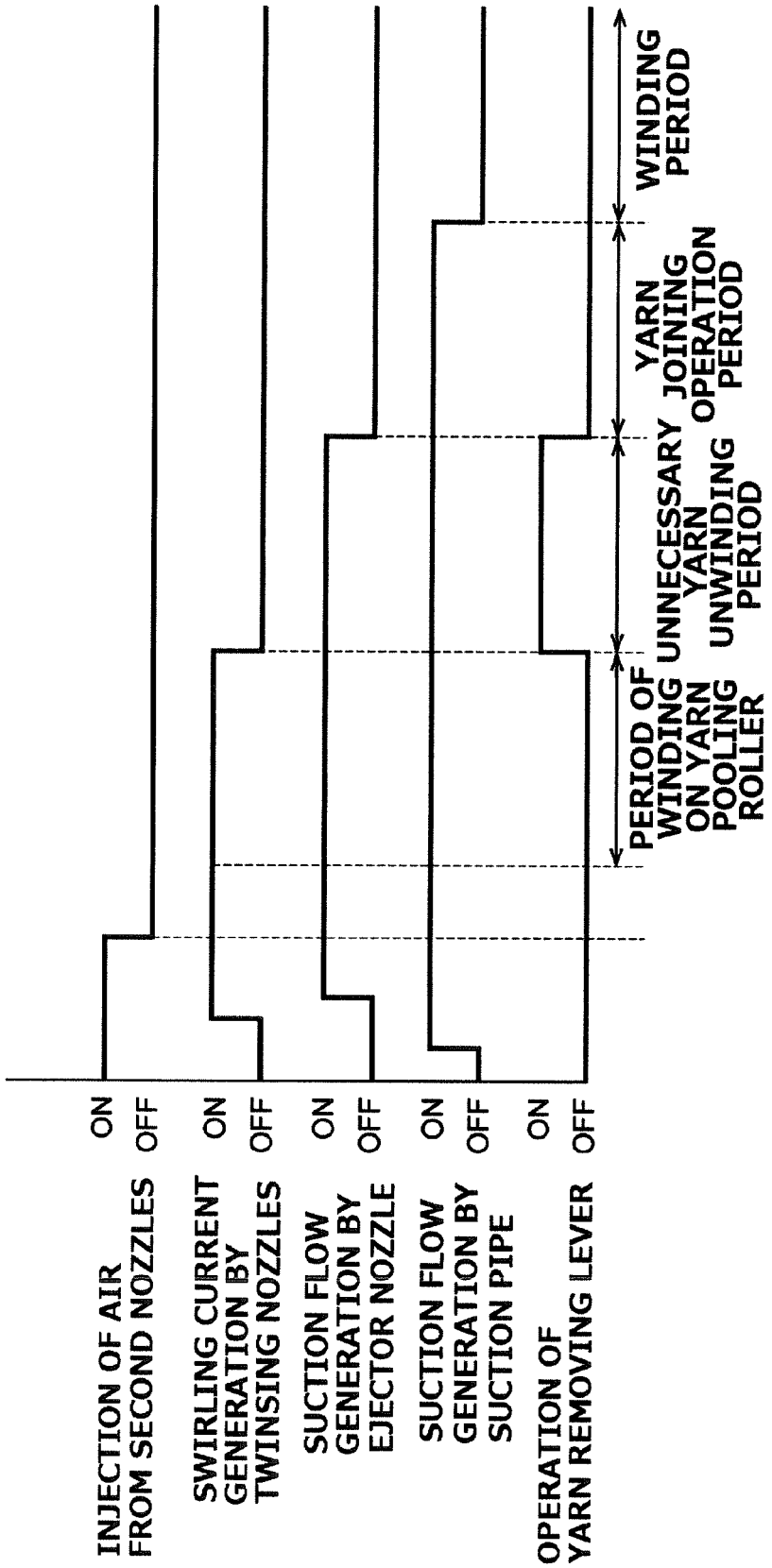
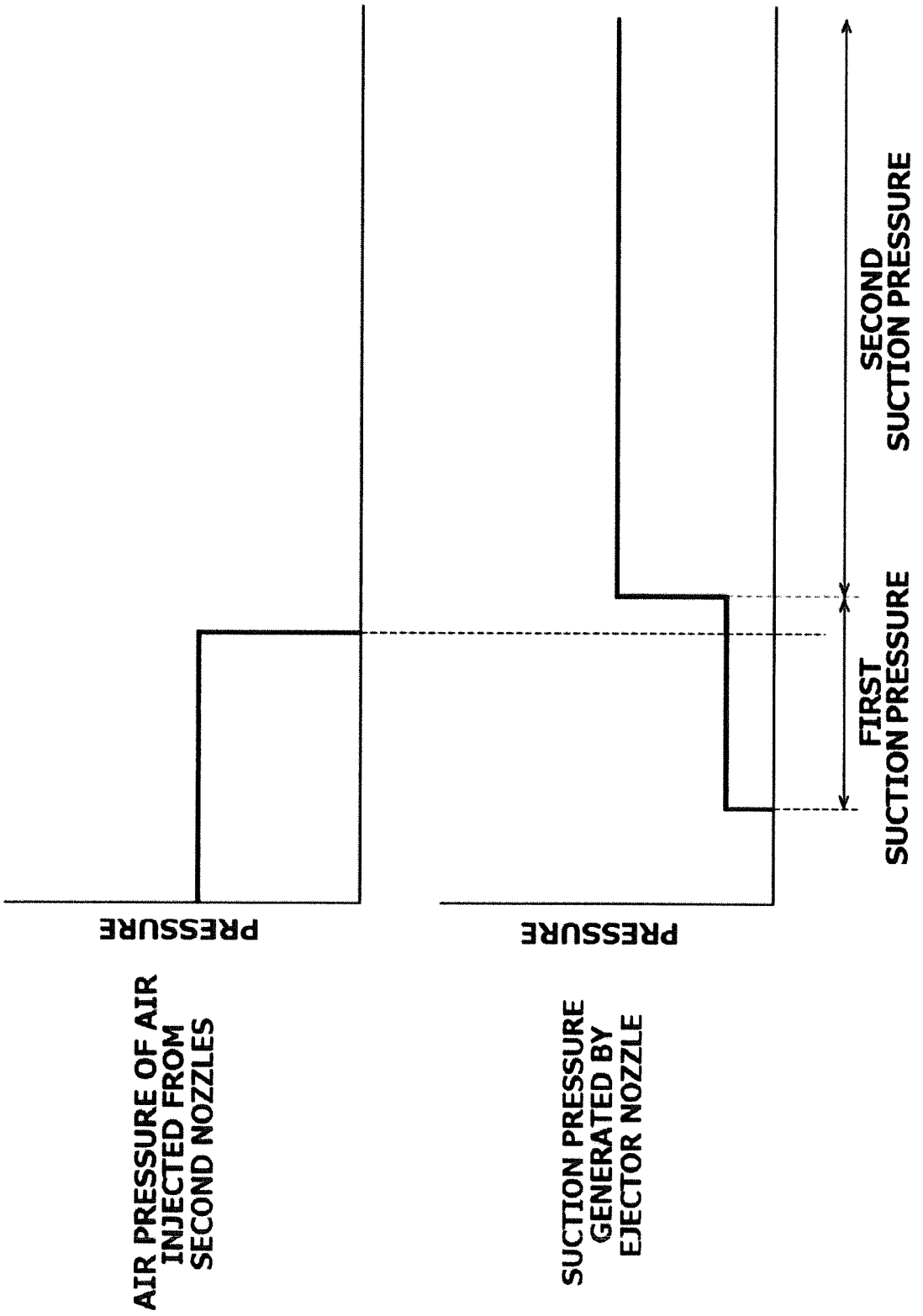

INJECTION OF AIR FROM SECOND NOZZLES
SWIRLING CURRENT GENERATION BY TWINSING NOZZLES
SUCTION FLOW GENERATION BY EJECTOR NOZZLE
SUCTION FLOW GENERATION BY SUCTION PIPE
OPERATION OF YARN REMOVING LEVER
ON
OFF
PERIOD OF WINDING ON YARN POOLING ROLLER
UNNECESSARY YARN UNWINDING PERIOD
YARN JOINING OPERATION PERIOD
WINDING PERIOD

FIG.9


AIR PRESSURE OF AIR INJECTED FROM SECOND NOZZLES
PRESSURE
SUCTION PRESSURE GENERATED BY EJECTOR NOZZLE
PRESSURE
FIRST SUCTION PRESSURE
SECOND SUCTION PRESSURE

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2011038225 A **[0002]**