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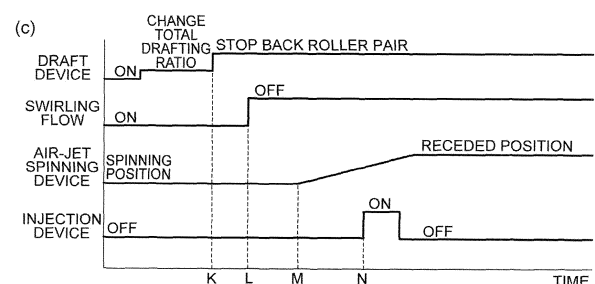
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(54) **SPINNING MACHINE AND SPINNING METHOD**

(57) A spinning machine (1) includes a draft device (6), an air-jet spinning device (7), and a control unit (10) configured to control operations of the draft device (6) and the air-jet spinning device (7). When a fiber bundle (F) is split, the control unit (10) changes a drafting ratio to a ratio different from a drafting ratio for a first drafting operation of drafting the fiber bundle (F) in the draft device (6) to cause the draft device (6) to perform a second drafting operation of drafting the fiber bundle (F), and then causes at least one splitting operation to be performed among splitting operations of stopping rotation of at least one of the roller pairs (14, 15, 16, 17), stopping injection of the air in the air-jet spinning device (7), and starting the movement of the air-jet spinning device (7) from the spinning position to the receded position.

Fig.6



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Description

TECHNICAL FIELD

[0001] The present disclosure relates to a spinning machine and a spinning method.

BACKGROUND

[0002] As a conventional spinning machine, a spinning machine including a draft device configured to draft a fiber bundle and an air-jet spinning device configured to twist the fiber bundle drafted by the draft device to generate yarn by injecting air into a spinning chamber at a spinning position is known (see Japanese Unexamined Patent Publication No. 2006-144136, for example). In this spinning machine, for example, when a yarn defect has been detected and drafting operation performed by the draft device is accordingly stopped, a fiber bundle portion (ear tip) that is not twisted is formed in a yarn end of yarn.

SUMMARY

[0003] In the spinning machine described above, for example, when yarn is stored in a yarn storage device using a yarn storage roller, an excessively long length of the fiber bundle portion may cause the fiber bundle portion to remain on the yarn storage roller. A too short length of the fiber bundle portion may cause yarn joining operation to fail to reliably catch the yarn end of yarn from a winding device.

[0004] It is an object of one aspect of the present disclosure to provide a spinning machine and a spinning method that enable dimensions of a fiber bundle portion formed in a yarn end of yarn to be adjusted.

[0005] A spinning machine according to one aspect of the present disclosure includes : a draft device including a plurality of rotatable roller pairs and configured to draft a fiber bundle with the roller pairs; an air-jet spinning device being movable to a spinning position and to a retracted position that is more distant from the draft device than the spinning position and configured to twist the fiber bundle drafted by the draft device to generate yarn by injecting air into a spinning chamber at the spinning position; and a control unit configured to control operations of the draft device and the air-jet spinning device. When the fiber bundle is split, the control unit changes a drafting ratio to a ratio different from a drafting ratio for a first drafting operation of drafting the fiber bundle in the draft device to cause the draft device to perform a second drafting operation of drafting the fiber bundle, and then causes at least one splitting operation to be performed among splitting operations of stopping rotation of at least one of the roller pairs, stopping injection of the air in the air-jet spinning device, and moving the air-jet spinning device from the spinning position to the retracted position.

[0006] In the spinning machine according to this aspect of the present disclosure, when the fiber bundle is split,

the draft device is caused to perform the second drafting operation and then the splitting operation is caused to be performed. The state of the fiber bundle drafted by the second drafting operation is different from that of the fiber bundle drafted by the first drafting operation. When the ratio is increased to become higher than the drafting ratio for the first drafting operation and then the second drafting operation is performed, the fiber bundle drafted by the second drafting operation is stretched more than the fiber bundle drafted by the first drafting operation. Consequently, the fiber volume (the volume of fibers in a cross-sectional area orthogonal to the drafting direction) of the fiber bundle after the second drafting operation becomes smaller than that of the fiber bundle after the first drafting operation. When the ratio is reduced to become lower than the drafting ratio for the first drafting operation and then the second drafting operation is performed, the fiber bundle drafted by the second drafting operation becomes shorter than the fiber bundle drafted by the first drafting operation. Consequently, the fiber volume of the fiber bundle after the second drafting operation becomes larger than that of the fiber bundle after the first drafting operation. In this manner, in the spinning machine, the fiber volume of the fiber bundle can be adjusted by changing the drafting ratio for the first drafting operation and the drafting ratio for the second drafting operation. Thus, in the spinning machine, dimensions (thickness and/or length) of a fiber bundle portion (portion that is not twisted appropriately) that is formed in a yarn end of yarn by the splitting operation can be adjusted appropriately. In the spinning machine, even when yarn is generated in a count that is not preferable for splitting of a fiber bundle, this adjustment enables the splitting in a suitable count in the splitting operation. Herein, the expression of splitting a fiber bundle includes a situation in which yarn formed by twisting the fiber bundle is split (cut).

[0007] In one embodiment, the control unit may increase the drafting ratio to a ratio higher than the drafting ratio for the first drafting operation to cause the draft device to perform the second drafting operation, and then may cause the splitting operation to be performed. In this configuration, the fiber bundle drafted by the second drafting operation is stretched more than the fiber bundle drafted by the first drafting operation is. Consequently, the fiber volume of the fiber bundle after the second drafting operation becomes smaller than the fiber bundle after the first drafting operation. For example, when yarn the count of which is low (thick yarn) is generated, the fiber volume of the fiber bundle supplied to the air-jet spinning device in a unit time is large. In this case, when the fiber bundle has been split in the splitting operation, a situation may occur in which the fiber bundle has not been split appropriately and a fiber bundle portion formed in a yarn end of yarn has become thicker and longer. In the spinning machine, when the fiber bundle is split, the fiber volume of the fiber bundle is reduced by the second drafting operation, which can prevent the fiber bundle portion

from becoming thicker and longer when the fiber bundle is split in the splitting operation. Thus, in the spinning machine, dimensions (thickness and/or length) of the fiber bundle portion formed in a yarn end of yarn can be adjusted appropriately.

[0008] In one embodiment, the control unit may reduce the drafting ratio to a ratio lower than the drafting ratio for the first drafting operation to cause the draft device to perform the second drafting operation, and then may cause the splitting operation to be performed. In this configuration, the fiber volume of the fiber bundle after the second drafting operation becomes larger than that of the fiber bundle after the first drafting operation. Thus, in the spinning machine, a situation in which the thickness of the fiber bundle portion has become too small when the fiber bundle has been split in the splitting operation, making it difficult for a yarn catching device to catch the corresponding yarn end in the following yarn joining operation can be avoided.

[0009] In one embodiment, the control unit may cause the fiber bundle to be drafted in the second drafting operation at a drafting ratio such that a count of the yarn generated by the air-jet spinning device falls within a range higher than Ne 15 and equal to or lower than Ne 45. In this manner, in the spinning machine, the fiber volume of the fiber bundle to be split can be adjusted to an appropriate volume by drafting the fiber bundle such that the yarn count falls within the range higher than Ne 15 and equal to or lower than Ne 45. Thus, in the spinning machine, the fiber bundle portion can be prevented from becoming too thick, too thin, too long, or too short. Furthermore, in the spinning machine, a situation in which fibers are more likely to fly in the surroundings because the fiber bundle portion is excessively thick and long can be avoided, and a situation in which it is difficult for the yarn catching device to catch the corresponding yarn end because the fiber bundle portion is too thin can be avoided.

[0010] In one embodiment, the control unit may cause the draft device to perform the second drafting operation when the count of the yarn generated by the air-jet spinning device is equal to or lower than Ne 15. When yarn with a count of Ne 15 or lower is generated, the fiber volume of the fiber bundle is relatively large. If the splitting operation is performed with such a large volume, the fiber bundle portion tends to become thicker and longer. Thus, in the spinning machine, when yarn with a count of Ne 15 or lower is generated, the second drafting operation is performed, whereby the fiber bundle portion can be prevented from becoming thicker and longer, and the thickness and/or length of the fiber bundle portion can be adjusted appropriately.

[0011] In one embodiment, the spinning machine may further include a yarn detecting device configured to detect a yarn defect of the yarn, and the control unit may cause the draft device to perform the second drafting operation when a yarn defect of the yarn has been detected by the yarn detecting device. By this configuration,

in the spinning machine, when a yarn defect has been detected and the yarn has been cut, the length of a fiber bundle portion formed in a yarn end of the yarn can be adjusted appropriately.

[0012] In one embodiment, the spinning machine may further include: a yarn catching device configured to catch yarn ends of the yarn split; and a yarn joining device configured to perform yarn joining operation of yarn joining the yarn ends caught by the yarn catching device. The yarn catching device may cut off at least a part of each of the yarn ends caught, and the yarn joining device may join the yarn ends at least a part of each of which has been cut off by the yarn catching device. Fiber bundle portions formed in the yarn ends have not been twisted appropriately, and thus yarn joining operation in which the fiber bundle portions are included in the yarn ends to be joined may cause a problem in a joined portion. In the spinning machine, the at least a part of each of the yarn ends in which the fiber bundle portions are formed is cut off, whereby the problem in a joined portion can be prevented. Thus, quality of yarn can be prevented from deteriorating.

[0013] In one embodiment, the roller pairs are a first roller pair, a second roller pair, a third roller pair, and a fourth roller pair that are disposed in this order from a downstream side toward an upstream side in a path through which the fiber bundle is drafted. The control unit may change, in the second drafting operation, a drafting ratio between the third roller pair and the fourth roller pair from the ratio for the first drafting operation. By this control, in the spinning machine, the drafting ratio in the second drafting operation can be changed to a ratio that is more suitable than the drafting ratio in the first drafting operation.

[0014] In one embodiment, the spinning machine may include a plurality of spinning units, and each spinning unit may include: the first roller pair; the second roller pair; the third roller pair; the fourth roller pair; and the air-jet spinning device. The third roller pair and the fourth roller pair may be capable of being driven and rotated independently in each spinning unit. With this configuration, in the spinning machine, by using the third roller pair and the fourth roller pair that are driven and rotated independently in each spinning unit, the drafting ratio can be changed in the second drafting operation. Thus, in the spinning machine, in each spinning unit, the second drafting operation can be performed to split yarn at a desired timing.

[0015] In one embodiment, the spinning machine may include a plurality of spinning units, each spinning unit including at least three roller pairs as the roller pairs and the air-jet spinning device. Each of the at least three roller pairs may be capable of being driven and rotated independently in each spinning unit, and the control unit may change any drafting ratio among the at least three roller pairs. With this configuration, in the spinning machine, by using the roller pairs that are driven and rotated independently in each spinning unit, the drafting ratio can be

changed in the second drafting operation. Thus, in the spinning machine, in each spinning unit, the second drafting operation can be performed at a desired timing to split yarn.

[0016] In one embodiment, the spinning machine may further include an injection device configured to inject air to an area between the draft device and the air-jet spinning device, and the injection device may inject air after the air-jet spinning device starts moving from the spinning position to the reeded position. With this configuration, air is injected by the injection device to the fiber bundle passing through the area between the draft device and the air-jet spinning device, and this air assists splitting of the fiber bundle. Thus, in the spinning machine, by adjusting the timing of injecting this air, the length of the fiber bundle portion can be adjusted appropriately.

[0017] In one embodiment, the control unit may, after causing the second drafting operation to be performed, cause the splitting operation to be performed after at least a part of the fiber bundle drafted by the second drafting operation flows into the air-jet spinning device. By this control, in the spinning machine, after the fiber bundle drafted by the second drafting operation is twisted by the air-jet spinning device even slightly, the fiber bundle at a portion on which the second drafting operation has been performed is reliably split. Thus, in the spinning machine, the fiber bundle portion can be prevented from becoming longer.

[0018] In one embodiment, the control unit may, after causing the second drafting operation to be performed, cause at least one of the roller pairs to stop rotating, and then may, after causing the air to stop being injected in the air-jet spinning device, cause the air-jet spinning device to start moving from the spinning position to the reeded position. The spinning machine causes the draft device and the air-jet spinning device to operate in this order, thereby being able to adjust the length of the fiber bundle portion more appropriately. Furthermore, the splitting operation of splitting the fiber bundle can be performed efficiently.

[0019] In one embodiment, the air-jet spinning device may include: a fiber guiding portion configured to guide the fiber bundle delivered from the draft device; the spinning chamber in which fibers of the fiber bundle guided by the fiber guiding portion are swirled by a swirling flow of the air; a nozzle through which the air injected into the spinning chamber passes; and a hollow guide shaft member having a path communicating with the spinning chamber and guiding the yarn generated to outside. With this configuration, by stopping injection of the air from the nozzle, the fiber bundle can be split.

[0020] A spinning method according to one aspect of the present disclosure is a spinning method performed in a spinning machine including: a draft device including a plurality of rotatable roller pairs and configured to draft a fiber bundle with the roller pairs; and an air-jet spinning device being movable to a spinning position and to a reeded position that is more distant from the draft device

than the spinning position and configured to twist the fiber bundle drafted by the draft device to generate yarn by injecting air into a spinning chamber at the spinning position. When the fiber bundle is split, a drafting ratio is changed to a ratio different from a drafting ratio for a first drafting operation of drafting the fiber bundle in the draft device, the draft device performs a second drafting operation of drafting the fiber bundle, and then at least one splitting operation is performed among splitting operations of stopping rotation of at least one of the roller pairs, stopping injection of the air in the air-jet spinning device, and moving the air-jet spinning device from the spinning position to the reeded position.

[0021] In the spinning method according to this aspect of the present disclosure, when the fiber bundle is split, the draft device is caused to perform the second drafting operation, and then the splitting operation is caused to be performed. The state of the fiber bundle drafted by the second drafting operation is different from that of the fiber bundle drafted by the first drafting operation. When the drafting ratio is increased to become higher than the drafting ratio for the first drafting operation and then the second drafting operation is performed, the fiber bundle drafted by the second drafting operation is stretched more than the fiber bundle drafted by the first drafting operation is. Consequently, the fiber volume of the fiber bundle after the second drafting operation becomes smaller than that of the fiber bundle after the first drafting operation. When the ratio is reduced to become lower than the drafting ratio for the first drafting operation and then the second drafting operation is performed, the fiber bundle drafted by the second drafting operation becomes shorter than the fiber bundle drafted by the first drafting operation. Consequently, the fiber volume of the fiber bundle after the second drafting operation becomes larger than that of the fiber bundle after the first drafting operation. In this manner, in the spinning method, the fiber volume of the fiber bundle can be adjusted by changing the drafting ratio for the first drafting operation and the drafting ratio for the second drafting operation. Thus, in the spinning method, dimensions (thickness and/or length) of a fiber bundle portion that is formed in a yarn end of yarn by the splitting operation can be adjusted appropriately. In the spinning method, even when yarn is generated in a count that is not preferable for splitting of a fiber bundle, this adjustment enables the splitting in a suitable count in the splitting operation.

[0022] In one embodiment, the drafting ratio may be increased to become higher than the drafting ratio for the first drafting operation, the draft device may be caused to perform the second drafting operation, and then the splitting operation may be caused to be performed. In this method, the fiber bundle drafted by the second drafting operation is stretched more than the fiber bundle drafted by the first drafting operation is. Consequently, the fiber volume of the fiber bundle after the second drafting operation becomes smaller than the fiber bundle after the first drafting operation. For example, when yarn the

count of which is low (thick yarn) is generated, the fiber volume of the fiber bundle supplied to the air-jet spinning device in a unit time is large. In this case, when the fiber bundle has been split in the splitting operation, a situation may occur in which the fiber bundle has not been split appropriately and a fiber bundle portion (portion that has not been twisted appropriately) formed in a yarn end of yarn has become thicker and longer. In the spinning method, when the fiber bundle is split, the fiber volume of the fiber bundle is reduced by the second drafting operation, which can prevent the fiber bundle portion from becoming thicker and longer when the fiber bundle is split in the splitting operation. Thus, in the spinning method, dimensions (thickness and/or length) of the fiber bundle portion formed in a yarn end of yarn can be adjusted appropriately.

[0023] In one embodiment, when a yarn defect of the yarn has been detected, when a count of the yarn generated by the air-jet spinning device falls within a predetermined first count range, the fiber bundle may be split by performing the at least one splitting operation among splitting operations of stopping rotation of at least one of the roller pairs, stopping injection of the air in the air-jet spinning device, and moving the air-jet spinning device from the spinning position to the receded position. When the count of the yarn generated by the air-jet spinning device falls within a predetermined second count range, the fiber bundle may be split by at least moving the air-jet spinning device from the spinning position to the receded position and injecting air to an area between the draft device and the air-jet spinning device after the air-jet spinning device starts moving toward the receded position. When the count of the yarn generated by the air-jet spinning device falls within a predetermined third count range, the fiber bundle may be split by, after the second drafting operation has been performed, at least moving the air-jet spinning device from the spinning position to the receded position and injecting air to an area between the draft device and the air-jet spinning device after the air-jet spinning device starts moving toward the receded position. The first count range may be a count range in which thickness of the yarn generated is smaller than a thickness in the second count range, and the second count range may be a count range in which the thickness of the yarn generated is smaller than a thickness in the third count range. By these processes and settings, in the spinning method, the fiber bundle and consequently the yarn can be split appropriately in the respective cases of falling within the first count range, the second count range, and the third count range.

[0024] In one embodiment, the first count range may be equal to or higher than Ne 30, the second count range may be higher than Ne 15 and lower than Ne 30, and the third count range may be equal to or lower than Ne 15.

[0025] According to one aspect of the present disclosure, dimensions of the fiber bundle portion formed in a yarn end of yarn can be adjusted.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026]

- 5 FIG. 1 is a front view of a spinning machine according to one embodiment:
 FIG. 2 is a side view of a spinning unit of the spinning machine in FIG. 1:
 FIG. 3 is a longitudinal sectional view of an air-jet spinning device of the spinning unit in FIG. 2:
 FIG. 4 is a longitudinal sectional view of the air-jet spinning device during movement from a spinning position to a receded position:
 FIG. 5 is a longitudinal sectional view of the air-jet spinning device at the receded position: and
 FIGs. 6 (a) to 6 (c) are timing charts of operations for adjusting the length of a fiber bundle portion.

DETAILED DESCRIPTION

[0027] A preferred embodiment of the present invention will now be described in detail with reference to the attached drawings. In the description of the drawings, like or equivalent elements are designated by like numerals, and duplicate description is omitted.

[0028] As depicted in FIG. 1, a spinning machine 1 includes a plurality of spinning units 2, a yarn joining carrier 3, a doffing carrier (not depicted), a first end frame 4, and a second end frame 5. The spinning units 2 are aligned in a row. Each spinning unit 2 generates yarn Y and winds the yarn into a package P. When the yarn Y has been cut or the yarn Y has broken for some reason in a certain spinning unit 2, the yarn joining carrier 3 performs a yarn joining operation in the spinning unit 2. When a package P has been fully wound in a certain spinning unit 2, the doffing carrier doffs the package P, and supplies a new bobbin B to the spinning unit 2.

[0029] The first end frame 4 accommodates, for example, a collection device configured to collect fiber waste, yarn waste, and the like generated in the spinning units 2. The second end frame 5 accommodates, for example, an air supply unit configured to adjust air pressure of compressed air (air) supplied to the respective units in the spinning machine 1 and supply the air to the respective units in the spinning machine 1 and a drive motor configured to supply power to the respective units in the spinning units 2. The second end frame 5 includes a machine control device 100, a display screen 102, and input keys 104. The machine control device 100 centrally manages and controls the respective units of the spinning machine 1. The display screen 102 can display, for example, information on settings and/or the states of the spinning units 2. An operator can make the settings of the spinning units 2 by performing appropriate operations with the input keys 104.

[0030] As depicted in FIG. 1 and FIG. 2, each spinning unit 2 includes, in the order from the upstream side in a direction in which the yarn Y travels, a draft device 6, an

injection device 40 and a suction device 42, an air-jet spinning device 7, a yarn monitoring device (yarn detecting device) 8, a tension sensor 9, a yarn storage device 11, a waxing device 12, and a winding device 13. The unit controller (control unit) 10 is provided for every predetermined number of spinning units 2, and controls operations of the spinning units 2. The unit controller 10 maybe provided individually to each spinning unit 2.

[0031] The draft device 6 drafts a sliver (fiber bundle) S. The draft device 6 includes, in the order from the upstream side in a direction in which a sliver S travels, a back roller pair (fourth roller pair) 14, a third roller pair (third roller pair) 15, a middle roller pair (second roller pair) 16, and a front roller pair (first roller pair) 17. In other words, in the draft device 6, from the downstream side toward the upstream side in a path through which the sliver S is drafted, the front roller pair 17, the middle roller pair 16, the third roller pair 15, and the back roller pair 14 are disposed in this order.

[0032] The back roller pair 14 has a top roller 14a and a bottom roller 14b. The third roller pair 15 has a top roller 15a and a bottom roller 15b. The middle roller pair 16 has a top roller 16a and a bottom roller 16b. The front roller pair 17 has a top roller 17a and a bottom roller 17b. The bottom rollers 14b, 15b, 16b, and 17b are driven and rotated by at least one drive motor provided to the second end frame 5 or at least one drive motor provided to each spinning unit 2. In the present embodiment, the bottom rollers 14b and 15b are driven and rotated by a drive motor provided to each spinning unit 2. The bottom rollers 16b and 17b are driven and rotated by a drive motor provided to the second end frame 5. Around the top roller 16a of the middle roller pair 16, an apron belt 18a is wound. Around the bottom roller 16b of the middle roller pair 16, an apron belt 18b is wound.

[0033] The air-jet spinning device 7 generates yarn Y by twisting a fiber bundle F drafted by the draft device 6 using swirling airflow. As depicted in FIG. 3, at a spinning position, the air-jet spinning device 7 injects air to a fiber bundle F drafted by the draft device 6, thereby twisting the fiber bundle to generate yarn Y. The spinning position is a position of the air-jet spinning device 7 where the air-jet spinning device 7 is disposed so as to be positioned close to the draft device 6 (specifically, the front roller pair 17) during spinning when the fiber bundle F is supplied from the draft device 6 to the air-jet spinning device 7. The air-jet spinning device 7 includes a nozzle block 70 and a hollow guide shaft member 80. The hollow guide shaft member 80 is inserted into the nozzle block 70 from the downstream side. An internal space formed by the nozzle block 70 and the hollow guide shaft member 80 thus inserted is a spinning chamber 73.

[0034] The nozzle block 70 includes a fiber guiding portion 71 and a swirling flow generating portion 72. In the fiber guiding portion 71, a guide hole 71a is provided for guiding the fiber bundle F supplied from the draft device 6 to the spinning chamber 73. The fiber guiding portion 71 is provided with a needle 75. The tip 75a of the needle

75 is positioned in the spinning chamber 73. The needle 75 has a function of preventing a twist from being transmitted upstream of the spinning chamber 73. In the swirling flow generating portion 72, a plurality of nozzles 74 communicating with the spinning chamber 73 are formed. The nozzles 74 are arranged such that a swirling flow is generated in the spinning chamber 73 when air is injected. In the swirling flow generating portion 72, a hole portion 72a into which the hollow guide shaft member 80 is to be inserted is formed. The hole portion 72a is formed in a shape of truncated cone that tapers off toward the upstream side, and communicates with the spinning chamber 73.

[0035] The hollow guide shaft member 80 can be inserted into the hole portion 72a of the swirling flow generating portion 72. An upper end portion 80a of the hollow guide shaft member 80 is formed in a shape of truncated cone that tapers off toward the upstream side. In the hollow guide shaft member 80, a channel 81 extending along the central axis of the hollow guide shaft member 80 is formed. The upstream side of the channel 81 communicates with the spinning chamber 73, and the channel 81 is formed so as to widen toward a downstream outlet 83 thereof. A collection portion 77 communicates with the spinning chamber 73 through a gap formed between the upper end portion 80a of the hollow guide shaft member 80 and the hole portion 72a of the swirling flow generating portion 72.

[0036] The air-jet spinning device 7 is movably (rotatably) supported by a support shaft (not depicted). As depicted in FIG. 4 and FIG. 5, the air-jet spinning device 7 is movable to a receded position that is more distant from the draft device 6 than the spinning position is. The hollow guide shaft member 80 is further movable from the nozzle block 70 at the receded position. When the air-jet spinning device 7 is moved from the spinning position to the receded position, as depicted in FIG. 4, the nozzle block 70 and the hollow guide shaft member 80 are integrally separated from the draft device 6. Subsequently, as depicted in FIG. 5, only the nozzle block 70 stops at a predetermined position. The hollow guide shaft member 80 continues to be moved, and is separated from the nozzle block 70. Subsequently, the hollow guide shaft member 80 separated from the nozzle block 70 stops at a predetermined position.

[0037] As depicted in FIG. 4, after the air-jet spinning device 7 starts moving from the spinning position to the receded position, the injection device 40 injects air to an area C between the draft device 6 and the air-jet spinning device 7. The injection device 40 is disposed to inject air such that the air blows across a fiber path (path through which the fiber bundle F travels) in the area C. The injection device 40 is preferably disposed so as to inject air along a direction orthogonal to the fiber path. The injection device 40 is controlled by the unit controller 10 so as to inject air at a desired timing.

[0038] The suction device 42 is disposed so as to be opposed to the injection device 40 with the area C there-

ebetween, and sucks fibers remaining in the area C and its vicinity. The injection device 40 is positioned on the top roller 17a side with respect to the area C, and the suction device 42 is positioned on the bottom roller 17b side with respect to the area C. The top roller 17a side denotes an area on the side on which the top roller 17a is disposed with respect to the fiber path when viewed from the axial direction (direction going into the plane of FIG. 3) of the front roller pair 17, and includes an area downstream of the top roller 17a. In the same manner, the bottom roller 17b side denotes an area on the side on which the bottom roller 17b is disposed with respect to the fiber path when viewed from the axial direction of the front roller pair 17, and includes an area downstream of the bottom roller 17b.

[0039] As depicted in FIG. 1 and FIG. 2, the yarn monitoring device 8 monitors information on travelling yarn Y between the air-jet spinning device 7 and the yarn storage device 11 to detect the presence or absence of a yarn defect on the basis of the monitored information. When having detected 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, as a yarn defect, thickness abnormality of yarn Y and/or foreign matter contained in the yarn Y, for example. The yarn monitoring device 8 also detects yarn breakage, for example. The tension sensor 9 measures the tension of travelling yarn Y between the air-jet spinning device 7 and the yarn storage device 11, and transmits a tension measurement signal to the unit controller 10. When the unit controller 10 determines that abnormality has occurred based on a result of detection by the yarn monitoring device 8 and/or the tension sensor 9, the yarn Y or the fiber bundle F is cut (split) in the spinning unit 2.

[0040] The waxing device 12 applies wax to yarn Y between the yarn storage device 11 and the winding device 13.

[0041] The yarn storage device 11 eliminates slack in yarn Y between the air-jet spinning device 7 and the winding device 13. The yarn storage device 11 has a function of stably pulling out yarn Y from the air-jet spinning device 7, a function of retaining yarn Y delivered from the air-jet spinning device 7 during, for example, yarn joining operation performed by the yarn joining carrier 3 to prevent the yarn Y from becoming slack, and a function of preventing variations of tension of yarn Y downstream of the yarn storage device 11 from being transmitted to the air-jet spinning device 7.

[0042] The winding device 13 winds yarn Y around a bobbin B to form a 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 swingably supported by a support shaft 24, and brings the surface of the bobbin B or the surface of the package P into contact with the surface of the winding drum 22 with an appropriate pressure. A drive motor (not depicted) provided to the second end frame 5 simultaneously drives the winding drums 22

of the spinning units 2. Accordingly, in each spinning unit 2, a bobbin B or a package P is rotated in the winding direction. The traverse guide 23 of each spinning unit 2 is provided on a shaft 25 that the spinning units 2 have in a shared manner. The drive motor of the second end frame 5 drives the shaft 25 so as to reciprocate in the rotation axis direction of the winding drum 22, and thus the traverse guide 23 traverses the yarn Y with respect to the rotating bobbin B or the package P at a predetermined width.

[0043] When yarn Y has been cut or the yarn Y has broken for some reason in a certain spinning unit 2, the yarn joining carrier 3 travels to the spinning unit 2 to perform yarn joining operation. The yarn joining carrier 3 includes a yarn joining device 26, a suction pipe (yarn catching device) 27, and a suction mouth (yarn catching device) 28. The suction pipe 27 is rotatably supported by a support shaft 31, and catches yarn Y from the air-jet spinning device 7 to guide the yarn to the yarn joining device 26. When having caught a yarn end of yarn Y, the suction pipe 27 cuts off a fiber bundle portion Y1 formed in the yarn end, and guides the yarn end of the yarn Y from which the fiber bundle portion Y1 has been cut off to the yarn joining device 26. The suction mouth 28 is rotatably supported by a support shaft 32, and catches yarn Y from the winding device 13 to guide the yarn to the yarn joining device 26. When having caught a yarn end of yarn Y, the suction mouth 28 cuts off a fiber bundle portion Y1 formed in the yarn end, and guides the yarn end of the yarn Y from which the fiber bundle portion Y1 has been cut off to the yarn joining device 26. The yarn joining device 26 joins the guided yarns Y to each other. The yarn joining device 26 is, for example, a splicer using compressed air or a knotter configured to mechanically join yarns Y.

[0044] When performing yarn joining operation, the yarn joining carrier 3 rotates a package P in the direction opposite to the winding direction (reversely rotates the package). At this time, the cradle arm 21 is moved by an air cylinder (not depicted) such that the package P separates from the winding drum 22, and the package P is reversely rotated by a reverse rotation roller (not depicted) provided to the yarn joining carrier 3.

[0045] The following describes operations (spinning method) for adjusting the length of a fiber bundle portion Y1 formed in a yarn end of yarn Y. The fiber bundle portion Y1 denotes an area that has not been twisted in a yarn end of yarn Y leading up to a package P as depicted in FIG. 5. Operation of forming a fiber bundle portion Y1 is performed, for example, when a yarn defect has been detected and accordingly spinning is stopped, or when a package P has been fully wound and accordingly spinning is completed.

[0046] Operation of adjusting the length of a fiber bundle portion Y1 differs depending on the count (thickness) of yarn Y to be spun. To begin with, a method of adjusting the length of a fiber bundle portion Y1 when yarn Y with a count of Ne 30 or higher (first count range) is spun will

be described with reference to FIG. 6(a). The count in the present embodiment is the English count.

[0047] During spinning, from the nozzles 74, air is injected into the spinning chamber 73, whereby a swirling flow is generated in the spinning chamber 73. This flow twists a fiber bundle F supplied to the spinning chamber 73, thereby generating yarn Y. The generated yarn Y passes through the channel 81, and is discharged from the outlet 83. Fibers that have not formed the yarn Y are collected in the collection portion 77. During spinning, the air-jet spinning device 7 is positioned at the spinning position.

[0048] When a yarn defect has been detected by the yarn monitoring device 8 during spinning, a yarn defect detection signal is transmitted to the unit controller 10. When having received the yarn defect detection signal, the unit controller 10 controls the draft device 6 such that rotation of the back roller pair 14 (drafting operation performed by the draft device 6) stops (splitting operation). Because the front roller pair 17 are connected to a drive source (drive source shared by the front roller pairs 17 of the other spinning units 2) different from that of the back roller pair 14, the front roller pair 17 continues to be driven. Consequently, the fiber bundle F is split between the back roller pair 14 and the front roller pair 17. The timing when the unit controller 10 controls the draft device 6 as described above is called "timing K of stopping drafting operation performed by the draft device 6".

[0049] Subsequently, the unit controller 10 controls the air-jet spinning device 7 such that injection of air from the nozzles 74 is stopped (splitting operation). When the injection of air from the nozzles 74 has been stopped, the swirling flow in the spinning chamber 73 disappears, and a yarn end of yarn Y is not twisted. Consequently, in the yarn end of the yarn Y, a fiber bundle portion Y1 that is not twisted is formed. The timing when the unit controller 10 controls the air-jet spinning device 7 as described above is called "first timing L of stopping injection of air". This first timing L is set by the unit controller 10 at a time when a predetermined period of time has lapsed after the timing K so as to be associated with the timing K of stopping drafting operation performed by the draft device 6. The unit controller 10 has a function as a unit of setting the first timing L.

[0050] Subsequently, the unit controller 10 controls the air-jet spinning device 7 so as to cause the air-jet spinning device 7 to start moving from the spinning position to the receded position (splitting operation). The timing when the unit controller 10 controls the air-jet spinning device 7 as described above is called "second timing M of causing the air-jet spinning device 7 to start moving from the spinning position to the receded position". This second timing M is set by the unit controller 10 at a time when a predetermined period of time has elapsed after the first timing L so as to be associated with the first timing L of stopping injection of air. By these operations, the yarn Y is split, and a fiber bundle portion Y1 is formed in a yarn end of the yarn Y.

[0051] The following describes a method of adjusting the length of a fiber bundle portion Y1 when yarn Y with a count higher than Ne 15 and lower than Ne 30 (second count range) is spun with reference to FIG. 6(b).

[0052] When the count of yarn Y is higher than Ne 15 and lower than Ne 30, until the second timing M of causing the air-jet spinning device 7 to start moving from the spinning position to the receded position, the same operation as that of adjusting the length of a fiber bundle portion Y1 when yarn Y with a count of Ne 30 or higher is spun is performed.

[0053] The unit controller 10 controls the injection device 40 such that air is injected after the air-jet spinning device 7 starts moving from the spinning position to the receded position (after the second timing M). The timing when the unit controller 10 controls the injection device 40 as described above is called "third timing N of injecting air". This third timing N is set by the unit controller 10 with respect to the second timing M of causing the air-jet spinning device 7 to start moving from the spinning position to the receded position. Air is injected to the fiber bundle F passing through the area C between the draft device 6 and the air-jet spinning device 7. The fiber bundle F is split by the injected air. As described above, the fiber bundle F is split between the back roller pair 14 and the front roller pair 17, and is further split by the injection device 40.

[0054] Fibers generated when the fiber bundle F is split are sucked by the suction device 42. Subsequently, the unit controller 10 controls the injection device 40 such that injection of air stops before the air-jet spinning device 7 reaches the receded position. By these operations, yarn Y is split, and a fiber bundle portion Y1 is formed in a yarn end of the yarn Y.

[0055] The unit controller 10 stores data selected with the input keys 104 by the operator in a storage unit, and executes a control program in accordance with the selected data, thereby being able to adjust the third timing N. If the length of the fiber bundle portion Y1 needs to be reduced, the third timing N is adjusted so as to be relatively early. This reduces the length of the fiber bundle portion Y1. If the length of the fiber bundle portion Y1 needs to be increased, the third timing N is adjusted so as to be relatively late (later than the timing in the case when the length of the fiber bundle portion Y1 needs to be reduced). This increases the length of the fiber bundle portion Y1. In this manner, the third timing N may be adjusted by the unit controller 10 so as to become earlier as the length of the fiber bundle portion Y1 is reduced.

[0056] The following describes a method of adjusting the length of a fiber bundle portion Y1 when yarn Y with a count of Ne 15 or lower (third count range) is spun with reference to FIG. 6(c).

[0057] When a yarn defect has been detected by the yarn monitoring device 8 during spinning, a yarn defect detection signal is transmitted to the unit controller 10. When having received the yarn defect detection signal, the unit controller 10 controls operation of the draft device

6. Specifically, when having received the yarn defect detection signal, the unit controller 10 increases a drafting ratio to a ratio higher than the drafting ratio for a first drafting operation of drafting a sliver S so as to achieve a count of yarn Y that needs to be generated by the air-jet spinning device 7, and causes a second drafting operation of drafting the sliver S to be performed. In other words, when having received the yarn defect detection signal, the unit controller 10 changes a total drafting ratio of the draft device 6.

[0058] Specifically, the unit controller 10 changes the total drafting ratio of the draft device 6 such that the count becomes finer than the count of yarn Y that is currently being spun. Specifically, the unit controller 10 changes the drafting ratio between the back roller pair 14 and the third roller pair 15. For example, when yarn Y with a count of Ne 10 is spun, the unit controller 10 changes the drafting ratio to a ratio that is a drafting ratio for yarn Y with a count of Ne 20 to be spun. Specifically, the unit controller 10 changes rotation speeds of the back roller pair 14 and the third roller pair 15 to change a back roller ratio (the drafting ratio between the back roller pair 14 and the third roller pair 15) and a third roller ratio (the drafting ratio between the third roller pair 15 and the middle roller pair 16), thereby setting the total drafting ratio to a ratio that is, for example, two times higher than the ratio in the case when the count is Ne 10. Thus, the total drafting ratio in the draft device 6 is changed, and the fiber bundle is drafted into a fiber bundle F for yarn Y with a count of Ne 20 to be spun.

[0059] Based on information that is set in advance in a storage unit (not depicted), the unit controller 10 sets a drafting ratio for performing the second drafting operation in the draft device 6. The storage unit stores therein yarn counts and drafting ratios corresponding to the respective counts for the second drafting operation. Each drafting ratio for the second drafting operation is set such that the corresponding count of yarn Y formed by the air-jet spinning device 7 falls within a range higher than Ne 15 and equal to or lower than Ne 45. In other words, in the second drafting operation, the unit controller 10 causes a sliver S to be drafted at a drafting ratio such that the count of yarn Y generated by the air-jet spinning device 7 falls within the range higher than Ne 15 and equal to or lower than Ne 45. For example, when a lot has been input with the input keys 104, the unit controller 10 acquires from the storage unit a drafting ratio for the second drafting operation corresponding to the count of yarn Y to be generated in the lot. The drafting ratio for the second drafting operation may be set by, for example, operator's input with the input keys 104.

[0060] Subsequently, after changing the total drafting ratio, the unit controller 10 causes the draft device 6 to draft the sliver S for a predetermined period of time (perform the second drafting operation), and then controls the draft device 6 such that rotation of the back roller pair 14 stops. The predetermined period of time is a period of time after the total drafting ratio has been changed and

until the fiber bundle F that has been drafted and the count of which has become finer flows into the air-jet spinning device 7. In other words, when the fiber bundle F the count of which has become finer flows into the air-jet spinning device 7, the unit controller 10 controls the draft device 6 such that rotation of the back roller pair 14 stops. Because the front roller pair 17 is connected to the drive source different from that of the back roller pair 14, the front roller pair 17 continues to be driven. Consequently, the fiber bundle F is split between the back roller pair 14 and the front roller pair 17.

[0061] Subsequently, the unit controller 10 controls the air-jet spinning device 7 such that injection of air from the nozzles 74 is stopped. The unit controller 10 then controls the air-jet spinning device 7 so as to cause the air-jet spinning device 7 to start moving from the spinning position to the retracted position. Subsequently, the unit controller 10 controls the injection device 40 such that air is injected after the air-jet spinning device 7 starts moving from the spinning position to the retracted position (after the second timing M). By these operations, yarn Y is split, and a fiber bundle portion Y1 is formed in a yarn end of the yarn Y.

[0062] Although a case has been described above in which a yarn defect has been detected by the yarn monitoring device 8 and spinning is accordingly interrupted, similar operation is performed in a case in which a package P is determined to have been fully wound and spinning is accordingly completed. In this case, in order to prevent a knot from breaking when the package P is hung on a warper in the next step, the length of the fiber bundle portion Y1 is preferably reduced. Thus, the third timing N is preferably adjusted at an earlier timing.

[0063] As described above, in the spinning machine 1 according to the present embodiment, the draft device 6 is caused to perform the second drafting operation, and then the splitting operations are caused to be performed. The sliver S drafted by the second drafting operation is stretched more than the sliver S drafted by the first drafting operation. Consequently, the fiber volume of the fiber bundle F after the second drafting operation becomes smaller than the fiber bundle F after the first drafting operation. For example, when yarn Y the count of which is low (coarse count yarn) is generated, the fiber volume of the fiber bundle F to be supplied to the air-jet spinning device 7 is large. In this case, when the fiber bundle F has been split in the splitting operations, a situation may occur in which the fiber bundle F has not been split appropriately and a fiber bundle portion (portion that has not been twisted appropriately) Y1 formed in a yarn end of yarn Y has become longer. In the spinning machine 1, when the fiber bundle F is split, the fiber volume of the fiber bundle F is reduced by the second drafting operation, which can prevent the fiber bundle portion Y1 from becoming longer when the fiber bundle F is split in the splitting operations. Thus, in the spinning machine 1, the length of the fiber bundle portion Y1 formed in a yarn end of yarn Y by the splitting operations can be adjusted ap-

appropriately.

[0064] Furthermore, the fiber bundle portion Y1 can be prevented from becoming longer, which can prevent fibers from flying in the surroundings of the front roller pair 17, for example, and adhering to the front roller pair 17, for example.

[0065] In the spinning machine 1 according to the present embodiment, the unit controller 10 causes the sliver S to be drafted in the second drafting operation at a drafting ratio such that the count of yarn Y generated by the air-jet spinning device 7 falls within a range higher than Ne 15 and equal to or lower than Ne 45. In this manner, in the spinning machine 1, the fiber volume of the fiber bundle F to be split can be adjusted to an appropriate volume by drafting the fiber bundle F into a fiber bundle the count of yarn Y of which falls within the range higher than Ne 15 and equal to or lower than Ne 45. Thus, in the spinning machine 1, the fiber bundle portion Y1 can be prevented from becoming too thick, too thin, too long, or too short. Furthermore, in the spinning machine 1, a situation in which fibers are more likely to fly in the surroundings because the fiber bundle portion Y1 is excessively thick and long can be avoided, and a situation in which it is difficult for the suction pipe 27 and the suction mouth 28 to catch the corresponding yarn end because the fiber bundle portion Y1 is too thin can be avoided.

[0066] In the spinning machine 1 according to the present embodiment, the unit controller 10 causes the draft device 6 to perform the second drafting operation when the count of yarn Y generated by the air-jet spinning device 7 is equal to or lower than Ne 15. When yarn Y with a count of Ne 15 or lower is generated, the fiber volume of the fiber bundle F is relatively large. Thus, in the spinning machine 1, when yarn Y with a count of Ne 15 or lower is generated, the second drafting operation is performed, whereby the fiber bundle portion Y1 can be prevented from becoming longer, and the length of the fiber bundle portion Y1 can be adjusted appropriately.

[0067] The spinning machine 1 according to the present embodiment includes the yarn monitoring device 8 configured to detect a yarn defect of yarn Y. The unit controller 10 causes the draft device 6 to perform the second drafting operation when a yarn defect has been detected by the yarn monitoring device 8. By this configuration, in the spinning machine 1, when a yarn defect has been detected and the yarn Y has been cut, the length of a fiber bundle portion Y1 formed in a yarn end of the yarn Y can be adjusted appropriately.

[0068] The spinning machine 1 according to the present embodiment includes the suction pipe 27 configured to catch yarn Y from the air-jet spinning device 7 and guide the yarn to the yarn joining device 26, the suction mouth 28 configured to catch yarn Y from the winding device 13 and guide the yarn to the yarn joining device 26, and the yarn joining device 26 configured to perform yarn joining operation of yarn joining the yarn ends caught by the suction pipe 27 and the suction mouth 28. The suction pipe 27 and the suction mouth 28 cut off fiber

bundle portions Y1 formed in the caught yarn ends. The yarn joining device 26 joins the yarn ends from which the fiber bundle portions Y1 have been cut off by the suction pipe 27 and the suction mouth 28. Fiber bundle portions Y1 formed in the yarn ends have not been twisted appropriately, and thus yarn joining operation in which the fiber bundle portions Y1 are included in the yarn ends to be joined may cause a problem in a joined portion. In the spinning machine 1, the fiber bundle portions Y1 are cut off by the suction pipe 27 and the suction mouth 28, whereby the problem in a joined portion can be prevented. Thus, in the spinning machine 1, quality of yarn Y can be prevented from deteriorating.

[0069] In the spinning machine 1 according to the present embodiment, the draft device 6 includes the front roller pair 17, the middle roller pair 16, the third roller pair 15, and the back roller pair 14 in this order from the downstream side toward the upstream side in a path through which the sliver S is drafted. The unit controller 10 increases the drafting ratio between the third roller pair 15 and the back roller pair 14 in the second drafting operation to a ratio higher than the drafting ratio in the first drafting operation. By this control, in the spinning machine 1, in each spinning unit 2, the drafting ratio in the second drafting operation can be appropriately increased to become higher than the drafting ratio in the first drafting operation. Thus, in the spinning machine 1, in each spinning unit 2, the second drafting operation can be performed at a desired timing to split yarn Y.

[0070] The spinning machine 1 according to the present embodiment includes the injection device 40 configured to inject air into the area C between the draft device 6 and the air-jet spinning device 7. The injection device 40 injects air after the air-jet spinning device 7 starts moving from the spinning position to the receded position. In the spinning machine 1, air is injected by the injection device 40 to a fiber bundle F passing through the area C between the draft device 6 and the air-jet spinning device 7, and this air assists splitting of the fiber bundle F. Thus, in the spinning machine 1, by adjusting the timing of injecting this air, the length of the fiber bundle portion Y1 can be adjusted more appropriately.

[0071] In the spinning machine 1 according to the present embodiment, after causing the second drafting operation to be performed, the unit controller 10 causes the splitting operations to be performed after at least a part of the fiber bundle F drafted by the second drafting operation flows into the air-jet spinning device 7. By this control, in the spinning machine 1, after the fiber bundle F drafted by the second drafting operation is twisted by the air-jet spinning device 7 even slightly, the fiber bundle F at a portion on which the second drafting operation has been performed is reliably split. Thus, in the spinning machine 1, the fiber bundle portion Y1 can be prevented from becoming longer.

[0072] In the spinning machine 1 according to the present embodiment, after causing the second drafting operation to be performed, the unit controller 10 causes

the back roller pair 14 to stop rotating. Subsequently, the unit controller 10 causes the air-jet spinning device 7 to stop injecting air, and then causes the air-jet spinning device 7 to start moving from the spinning position to the retracted position. The spinning machine 1 causes the draft device 6 and the air-jet spinning device 7 to operate in this order, thereby being able to adjust the length of the fiber bundle portion Y1 more appropriately. Furthermore, in the spinning machine 1, the splitting operations of splitting the fiber bundle F can be performed efficiently.

[0073] Although one embodiment of the present invention has been described above, the present invention is not limited to the embodiment.

[0074] In the embodiment, a mode has been described as one example in which, in the spinning machine 1, the total drafting ratio of the draft device 6 is changed such that the count becomes finer than the count of yarn Y that is currently being spun. However, in the spinning machine, the total drafting ratio of the draft device 6 may be changed such that the count becomes coarser than the count of yarn Y that is currently being spun. Specifically, the unit controller 10 reduces the drafting ratio to a ratio lower than the drafting ratio for the first drafting operation to cause the draft device 6 to perform the second drafting operation, and then causes the splitting operations to be performed.

[0075] As described above, the unit controller 10 has an ear-tip control mode of "changing the drafting ratio to a ratio different from the drafting ratio for the first drafting operation of drafting a sliver S so as to achieve a count of yarn Y that needs to be generated by the air-jet spinning device 7, causing the draft device 6 to perform the second drafting operation of drafting the sliver S, and then causing the splitting operations to be performed". The state of the fiber bundle F drafted by the second drafting operation is different from that of the fiber bundle F drafted by the first drafting operation. When the drafting ratio is increased to become higher than the drafting ratio for the first drafting operation and then the second drafting operation is performed, the fiber bundle F drafted by the second drafting operation is stretched more than the fiber bundle F drafted by the first drafting operation is. Consequently, the fiber volume of the fiber bundle F after the second drafting operation becomes smaller than that of the fiber bundle F after the first drafting operation. When the ratio is reduced to become lower than the drafting ratio for the first drafting operation and then the second drafting operation is performed, the fiber bundle F drafted by the second drafting operation becomes shorter than the fiber bundle F drafted by the first drafting operation. Consequently, the fiber volume of the fiber bundle F after the second drafting operation becomes larger than that of the fiber bundle F after the first drafting operation. In this manner, in the spinning machine, the fiber volume of the fiber bundle F can be adjusted by changing the drafting ratio for the first drafting operation and the drafting ratio for the second drafting operation. Thus, in the spinning machine, dimensions of a fiber bundle portion

Y1 that is generated in a yarn end of yarn Y can be adjusted appropriately. Thus, in the spinning machine, even when yarn Y is formed in a count that is not preferable for splitting of a fiber bundle F, this adjustment enables the splitting in a suitable count in the splitting operations.

[0076] The count of yarn Y that can be generated with the drafting ratio for the second drafting operation, that is, the count of yarn Y that is preferable for being split can be set based on quality and operating performance. The quality herein is the amount of fly waste in the fiber bundle portion Y1. The operating performance herein is the ratio of successful yarn end finding in the yarn joining carrier 3. The quality above tends to deteriorate as the count decreases (as yarn Y becomes thicker), and tends to improve as the count increases (yarn Y becomes thinner). In other words, the amount of fly waste increases as the count decreases, and decreases as the count increases. The operating performance above tends to become higher as the count decreases, and tends to become lower as the count increases. In other words, the ratio of successful yarn end finding becomes higher as the count decreases, and becomes lower as the count increases. From the viewpoint of balance between the quality and the operating performance, the count is preferably 15 to 45, for example. The count is more preferably 30 or higher and 40 or lower. However, the count is not limited to Ne 15 to Ne 45, or preferably to 30 or higher and 40 or lower.

[0077] The count above may be optionally set by a user, depending on which of the quality and the operating performance is emphasized. By operating an operation unit (e.g., the input keys 104 or a touch panel described later), the user may set in advance a predetermined count range (e.g., other than a range of "Ne $\bigcirc$ to Ne $\bigcirc$ ", more specifically, other than Ne 15 to Ne 45, for example) when the ear-tip control described above is performed and a target split count (e.g., Ne $\bigcirc$, more specifically, Ne 30, for example) to be achieved by the second drafting operation. In this case, the target split count is set so as to fall within preferably a target range higher than Ne 15 and equal to or lower than Ne 45, and more preferably a target range of Ne 30 or higher and Ne 40 or lower as described above. The predetermined count range is set outside the target range. During spinning in the predetermined count range, if a request to split yarn or a fiber bundle is received when a yarn defect has been detected or when a package is doffed, for example, the unit controller 10 may cause the second drafting operation to be performed at a drafting ratio corresponding to the target split count, and then may cause the splitting operations to be performed.

[0078] In the embodiment, an example has been described in which, in the second drafting operation, the rotation speeds of the back roller pair 14 and the third roller pair 15 are changed to change the back roller ratio and the third roller ratio, whereby the total drafting ratio is changed. However, in the second drafting operation, only the rotation speed of the back roller pair 14 may be

changed to change the total drafting ratio.

[0079] In the embodiment, a mode has been described as one example in which the bottom rollers 14b and 15b are driven and rotated by the drive motor provided to each spinning unit 2, and the bottom rollers 16b and 17b are driven and rotated by the drive motor provided to the second end frame 5. A mode has been described as one example in which, in this configuration, the drafting ratio between the back roller pair 14 and the third roller pair 15 of the draft device 6 is changed, and then the second drafting operation is performed. However, the bottom rollers 14b, 15b, 16b, and 17b may be configured to be driven and rotated by a drive motor provided to each spinning unit 2. In this configuration, the drafting ratio of any roller pair among the back roller pair 14, the third roller pair 15, the middle roller pair 16, and the front roller pair 17 may be changed, and then the second drafting operation may be performed.

[0080] In the embodiment, an example has been described in which the second drafting operation is performed and then rotation of the back roller pair 14 is stopped. However, rotations of both of the back roller pair 14 and the third roller pair 15 may be stopped. Note that the roller pair rotation of which is to be stopped as a splitting operation are preferably the uppermost-stream roller pair in the draft device 6, or are preferably a plurality of roller pairs including at least the uppermost-stream roller pair and excluding the lowermost-stream roller pair.

[0081] In the embodiment, a mode has been described as one example in which the draft device 6 includes four roller pairs of the back roller pair 14, the third roller pair 15, the middle roller pair 16, and the front roller pair 17. However, the draft device only needs to include at least three roller pairs. For example, the third roller pair 15 may be omitted, and the draft device may include three roller pairs as the back roller pair 14, the middle roller pair 16, and the front roller pair 17. Alternatively, the draft device may include, for example, five or more roller pairs.

[0082] In the embodiment, an example has been described in which the operator performs appropriate operations such as making settings with the input keys 104. However, the display screen 102 may be configured as a touch panel display that can be operated by the operator, instead of the input keys 104 or together with the input keys 104.

[0083] In the embodiment, the injection device 40 injects air thereby assisting splitting of a fiber bundle F, but the injection device 40 does not have to inject air.

[0084] In the embodiment, the count of yarn Y is expressed in Number English (Ne: English count), but the count of yarn Y may be expressed in other units.

[0085] In the embodiment, the injection device 40 is positioned on the top roller 17a side with respect to the area C, and the suction device 42 is positioned on the bottom roller 17b side with respect to the area C. However, the positions of the injection device 40 and the suction device 42 may be exchanged.

[0086] The yarn joining device 26 may be a piecer us-

ing a seed yarn.

[0087] In the air-jet spinning device 7, instead of the needle 75 described above, a downstream end portion of the fiber guiding portion may be configured to prevent a twist of a fiber bundle from being transmitted upstream of the air-jet spinning device. Instead of the configuration described above, the air-jet spinning device may include a pair of air-jet nozzles configured to twist a fiber bundle in directions opposite to each other. The spinning machine may be an open-end spinning machine.

[0088] In each spinning unit 2, the yarn storage device 11 has a function of pulling out yarn Y from the air-jet spinning device 7. However, the yarn Y may be pulled out from the air-jet spinning device 7 by a delivery roller and a nip roller. When the yarn Y is pulled out from the air-jet spinning device 7 by a delivery roller and a nip roller, instead of the yarn storage device 11, a slack tube or a mechanical compensator, for example, configured to absorb slack of the yarn Y using suction airflow may be provided.

[0089] In the spinning machine 1, the respective devices are disposed such that yarn Y supplied from the upper side is wound in the lower side in the height direction. However, the respective devices may be disposed such that yarn supplied from the lower side is wound in the upper side.

[0090] In the spinning machine 1, at least one of the bottom rollers of each draft device 6 and the corresponding traverse guide 23 are driven by power from the second end frame 5 (i.e., driven centrally for a plurality of spinning units 2). However, the respective units (e.g., the draft device, the air-jet spinning device, the winding device) of each spinning unit 2 may be driven independently in each spinning unit 2.

[0091] In the travelling direction of yarn Y, the tension sensor 9 may be provided upstream of the yarn monitoring device 8. The unit controller 10 may be provided to each of the spinning units 2. In each spinning unit 2, the waxing device 12, the tension sensor 9, and the yarn monitoring device 8 may be omitted.

[0092] In FIG. 1, the spinning machine 1 is illustrated in which each package P is wound in a cheese shape. However, the package may be wound in a cone shape. In the case of a cone-shaped package, slack of yarn is generated by traversing the yarn, but this slack can be absorbed by the yarn storage device 11. The materials and shapes of the respective components are not limited to those described above, and various types of materials and shapes may be used.

Claims

1. A spinning machine (1) comprising:

a draft device (6) including a plurality of rotatable roller pairs (14, 15, 16, 17) and configured to draft a fiber bundle (S) with the roller pairs

- (14,15,16,17);
 an air-jet spinning device (7) being movable to a spinning position and to a receded position that is more distant from the draft device (6) than the spinning position and configured to twist the fiber bundle (F) drafted by the draft device (6) to generate yarn (Y) by injecting air into a spinning chamber (73) at the spinning position; and a control unit (10) configured to control operations of the draft device (6) and the air-jet spinning device (7), **characterized in that** when the fiber bundle (F) is split, the control unit (10) is adapted to change a drafting ratio to a ratio different from a drafting ratio for a first drafting operation of drafting the fiber bundle (S) in the draft device (6) to cause the draft device (6) to perform a second drafting operation of drafting the fiber bundle (S), and then to cause at least one splitting operation to be performed among splitting operations of stopping rotation of at least one of the roller pairs (14,15,16,17), stopping injection of the air in the air-jet spinning device (7), and moving the air-jet spinning device (7) from the spinning position to the receded position.
2. The spinning machine (1) according to claim 1, wherein the control unit (10) is adapted to increase the drafting ratio to a ratio higher than the drafting ratio for the first drafting operation to cause the draft device (6) to perform the second drafting operation, and then to cause the splitting operation to be performed.
 3. The spinning machine (1) according to claim 1, wherein the control unit (10) is adapted to reduce the drafting ratio to a ratio lower than the drafting ratio for the first drafting operation to cause the draft device to perform the second drafting operation, and then to cause the splitting operation to be performed.
 4. The spinning machine (1) according to any one of claims 1 to 3, wherein the control unit (10) is adapted to cause the fiber bundle (S) to be drafted in the second drafting operation at a drafting ratio such that a count of the yarn (Y) generated by the air-jet spinning device (7) falls within a range higher than Ne 15 and equal to or lower than Ne 45.
 5. The spinning machine (1) according to claim 2, wherein the control unit (10) is adapted to cause the draft device (6) to perform the second drafting operation when the count of the yarn (Y) generated by the air-jet spinning device (7) is equal to or lower than Ne 15.
 6. The spinning machine (1) according to any one of claims 1 to 5, further comprising a yarn detecting device (8) configured to detect a yarn defect of the yarn (Y), wherein the control unit (10) is adapted to cause the draft device (6) to perform the second drafting operation when a yarn defect of the yarn (Y) has been detected by the yarn detecting device (8).
 7. The spinning machine (1) according to any one of claims 1 to 6, further comprising:
 - a yarn catching device (27,28) configured to catch yarn ends of the yarn (Y) split; and
 - a yarn joining device (26) configured to perform yarn joining operation of yarn joining the yarn ends caught by the yarn catching device (27,28), wherein the yarn catching device (27, 28) is adapted to cut off at least a part of each of the yarn ends caught, and the yarn joining device (26) is adapted to join the yarn ends at least a part of each of which has been cut off by the yarn catching device (27,28).
 8. The spinning machine (1) according to any one of claims 1 to 7, wherein the roller pairs are a first roller pair (17), a second roller pair (16), a third roller pair (15), and a fourth roller pair (14) that are disposed in this order from a downstream side toward an upstream side in a path through which the fiber bundle (S) is drafted, and the control unit (10) is adapted to change, in the second drafting operation, a drafting ratio between the third roller pair (15) and the fourth roller pair (14) from the ratio for the first drafting operation.
 9. The spinning machine (1) according to claim 8, wherein the spinning machine (1) includes a plurality of spinning units (2), and each spinning unit (2) includes:
 - the first roller pair (17);
 - the second roller pair (16);
 - the third roller pair (15);
 - the fourth roller pair (14); and
 - the air-jet spinning device (7),
 the third roller pair (15) and the fourth roller pair (14) are capable of being driven and rotated independently in each spinning unit (2).
 10. The spinning machine (1) according to any one of claims 1 to 7, comprising a plurality of spinning units (2), each spinning unit (2) including at least three roller pairs (14,16,17) as the roller pairs and the air-jet spinning device (7), wherein

each of the at least three roller pairs (14,16,17) is capable of being driven and rotated independently in each spinning unit (2), and the control unit (2) is adapted to change any drafting ratio among the at least three roller pairs.

11. The spinning machine (1) according to any one of claims 1 to 10, further comprising an injection device (40) configured to inject air to an area between the draft device (6) and the air-jet spinning device (7), wherein the injection device (40) is adapted to inject air after the air-jet spinning device (7) starts moving from the spinning position to the receded position.
12. The spinning machine (1) according to any one of claims 1 to 11, wherein the control unit (10), after causing the second drafting operation to be performed, is adapted to cause the splitting operation to be performed after at least a part of the fiber bundle (F) drafted by the second drafting operation flows into the air-jet spinning device (7).
13. The spinning machine (1) according to any one of claims 1 to 12, wherein the control unit (10), after causing the second drafting operation to be performed, is adapted to cause at least one of the roller pairs (14, 15, 16, 17) to stop rotating, and then, after causing the air to stop being injected in the air-jet spinning device (7), to cause the air-jet spinning device (7) to start moving from the spinning position to the receded position.
14. The spinning machine (1) according to any one of claims 1 to 13, wherein the air-jet spinning device (7) includes:
 - a fiber guiding portion (71) configured to guide the fiber bundle (F) delivered from the draft device (6);
 - the spinning chamber (73) in which fibers of the fiber bundle (F) guided by the fiber guiding portion (71) are swirled by a swirling flow of the air;
 - a nozzle (74) through which the air injected into the spinning chamber (73) passes; and
 - a hollow guide shaft member (80) having a path (81) communicating with the spinning chamber (73) and guiding the yarn (Y) generated to outside.
15. A spinning method performed in a spinning machine (1) including: a draft device (6) including a plurality of rotatable roller pairs (14,15,16,17) and configured to draft a fiber bundle (S) with the roller pairs (14, 15, 16, 17); and an air-jet spinning device (7) being movable to a spinning position and to a receded position that is more distant from the draft device (6)

than the spinning position and configured to twist the fiber bundle (F) drafted by the draft device (6) to generate yarn (Y) by injecting air into a spinning chamber (73) at the spinning position, **characterized in that** when the fiber bundle (F) is split, a drafting ratio is changed to a ratio different from a drafting ratio for a first drafting operation of drafting the fiber bundle (S) in the draft device (6), the draft device (6) performs a second drafting operation of drafting the fiber bundle (S), and then at least one splitting operation is performed among splitting operations of stopping rotation of at least one of the roller pairs (14, 15, 16, 17), stopping injection of the air in the air-jet spinning device (7), and moving the air-jet spinning device (7) from the spinning position to the receded position.

16. The spinning method according to claim 15, wherein the drafting ratio is increased to become higher than the drafting ratio for the first drafting operation, the draft device (6) performs the second drafting operation, and then the splitting operation is performed.
17. The spinning method according to claim 15 or 16, wherein when a yarn defect of the yarn (Y) has been detected, when a count of the yarn (Y) generated by the air-jet spinning device (7) falls within a predetermined first count range, the fiber bundle (F) is split by performing the at least one splitting operation among splitting operations of stopping rotation of at least one of the roller pairs (14, 15, 16, 17), stopping injection of the air in the air-jet spinning device (7), and moving the air-jet spinning device (7) from the spinning position to the receded position, when the count of the yarn (Y) generated by the air-jet spinning device (7) falls within a predetermined second count range, the fiber bundle (F) is split by at least moving the air-jet spinning device (7) from the spinning position to the receded position and injecting air to an area between the draft device (6) and the air-jet spinning device (7) after the air-jet spinning device (7) starts moving toward the receded position, when the count of the yarn (Y) generated by the air-jet spinning device (7) falls within a predetermined third count range, the fiber bundle (F) is split by, after the second drafting operation has been performed, at least moving the air-jet spinning device (7) from the spinning position to the receded position and injecting air to an area between the draft device (6) and the air-jet spinning device (7) after the air-jet spinning device (7) starts moving toward the receded position, the first count range is a count range in which thickness of the yarn (Y) generated is smaller than a thick-

ness in the second count range, and
the second count range is a count range in which
the thickness of the yarn (Y) generated is smaller
than a thickness in the third count range.

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18. The spinning method according to claim 17, wherein
the first count range is equal to or higher than Ne 30,
the second count range is higher than Ne 15 and
lower than Ne 30, and
the third count range is equal to or lower than Ne 15.

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Fig.1

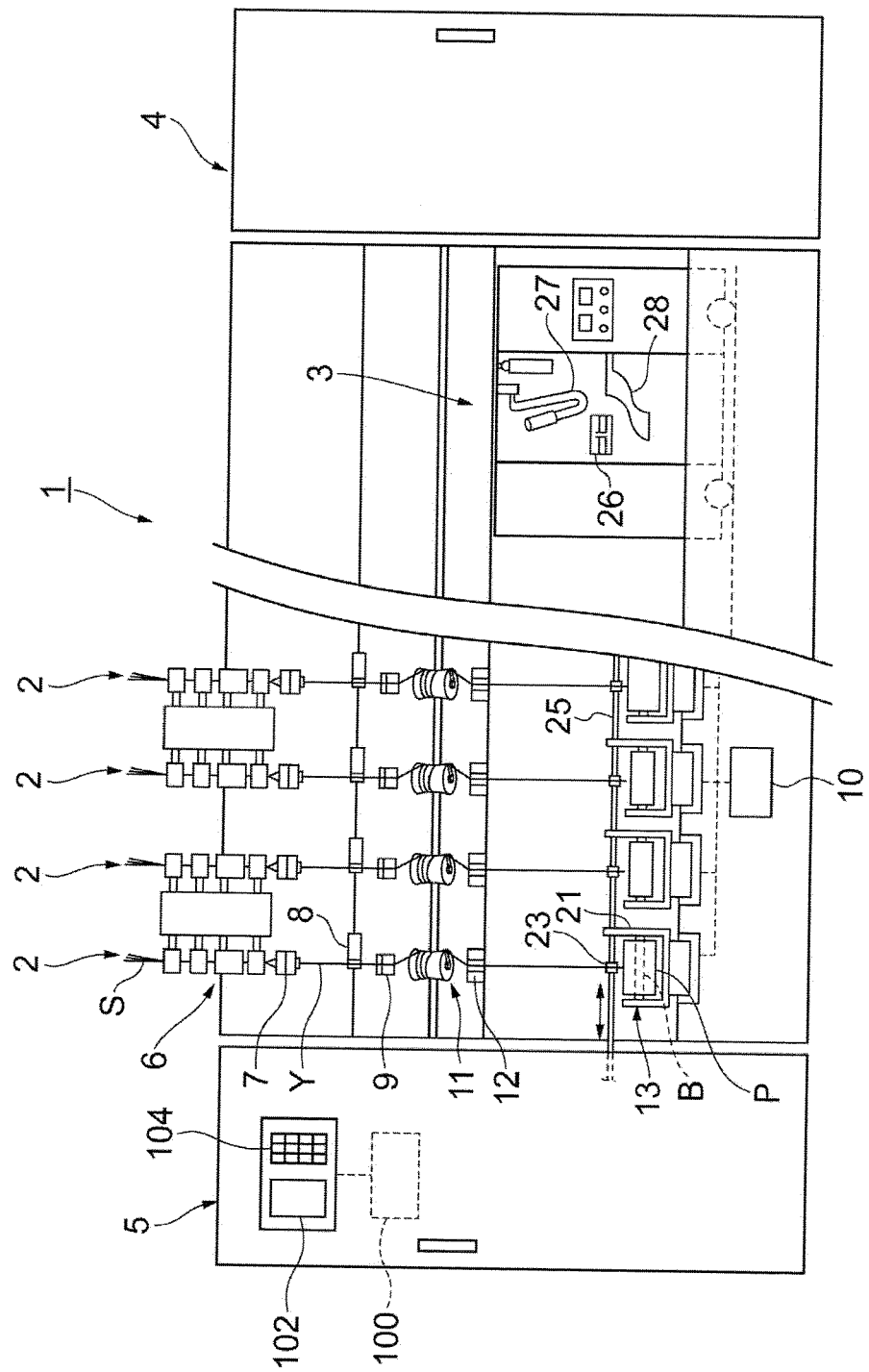


Fig.2

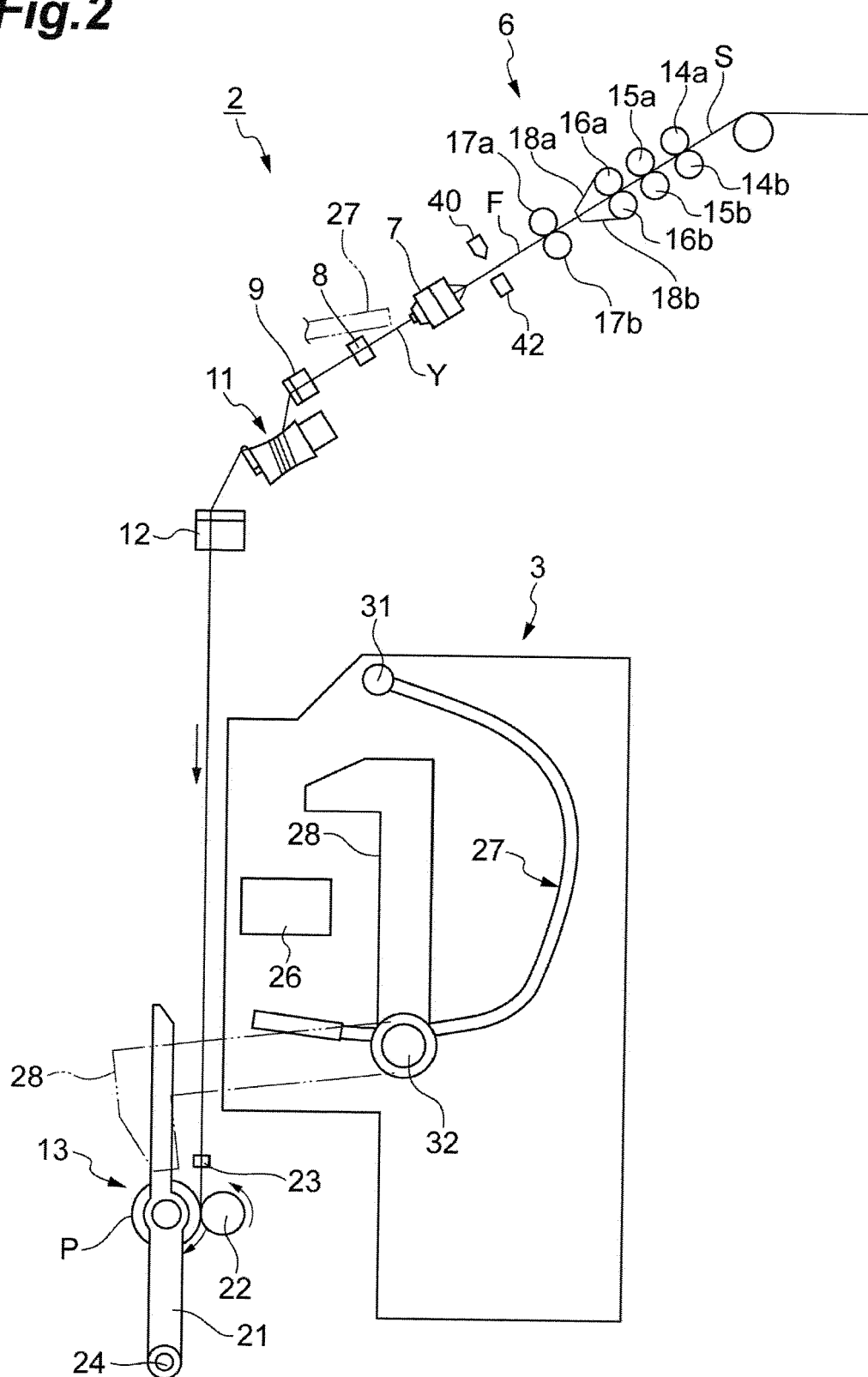


Fig.3

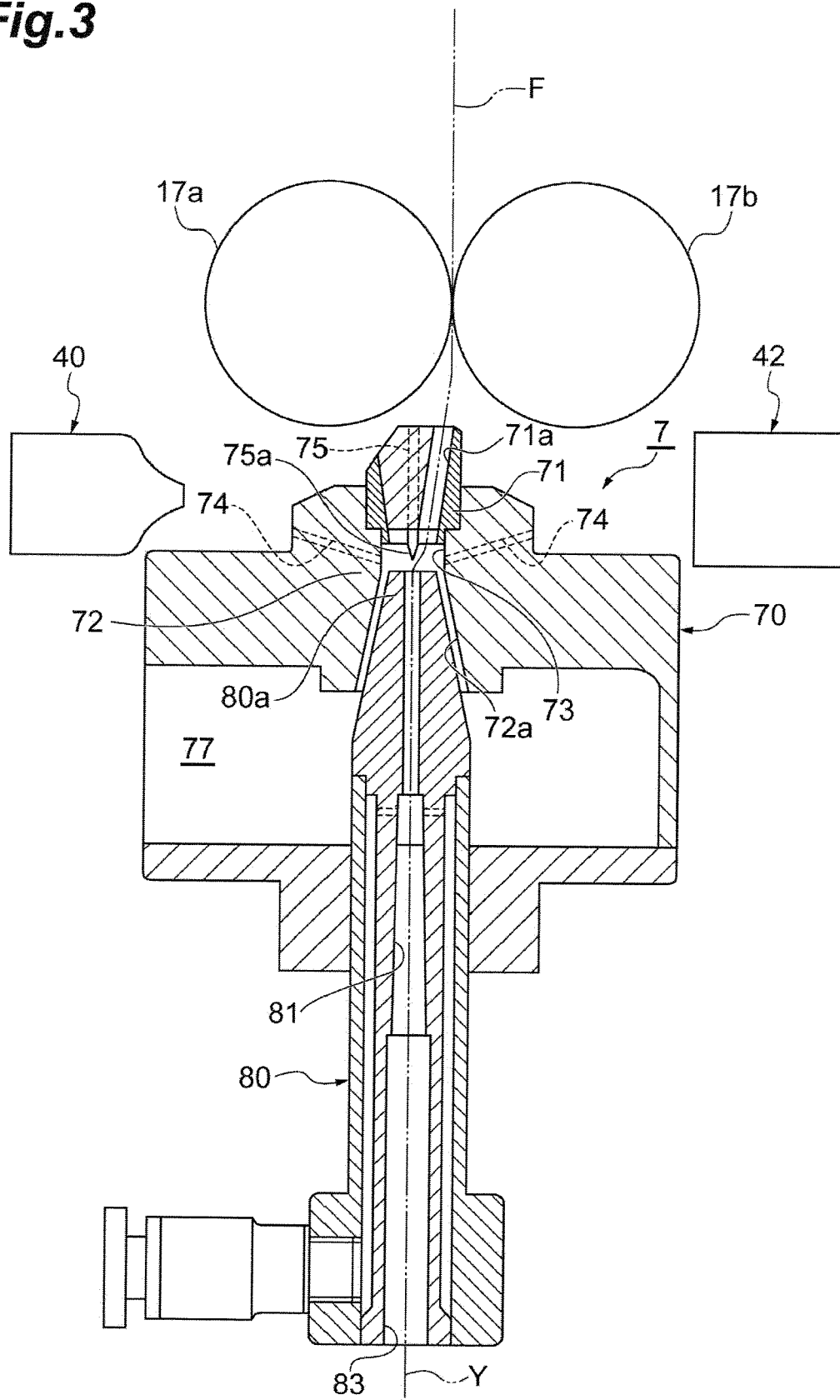


Fig.4

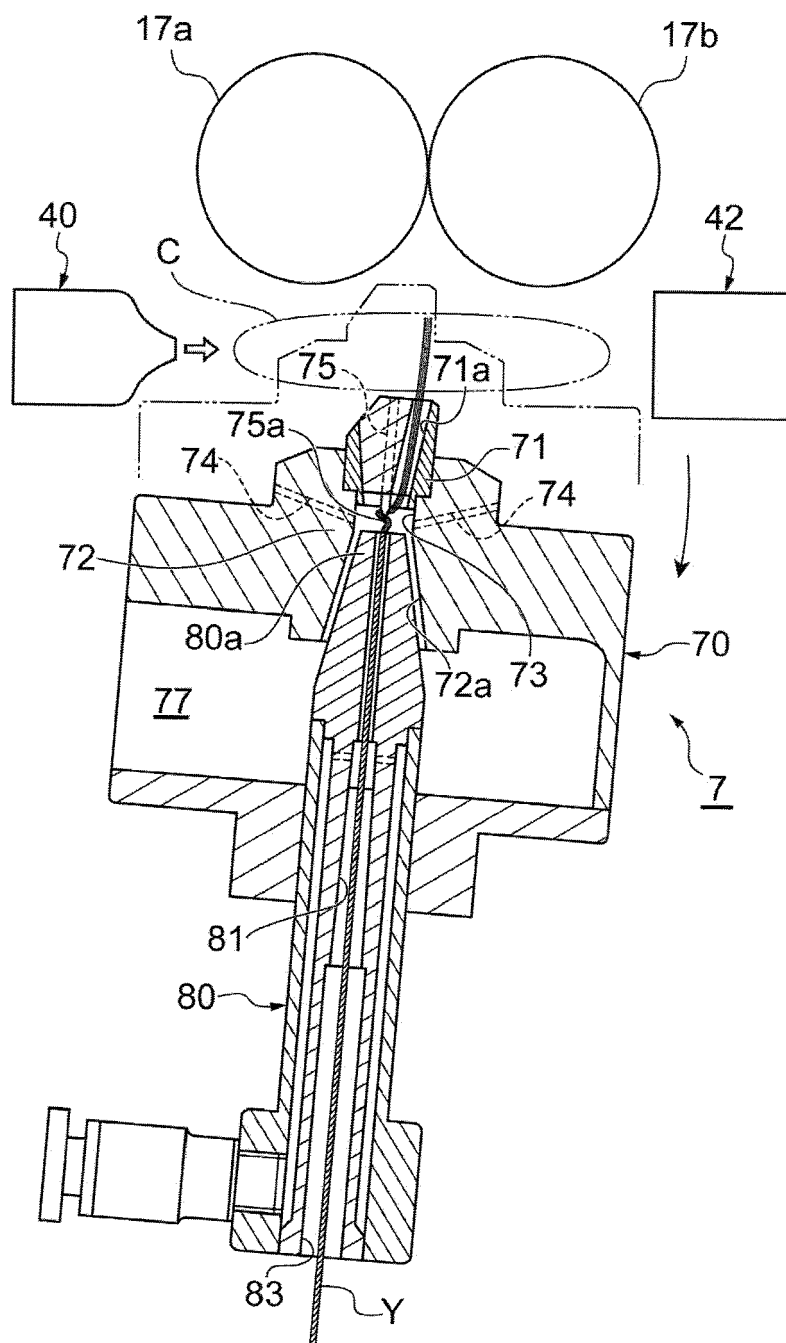


Fig.5

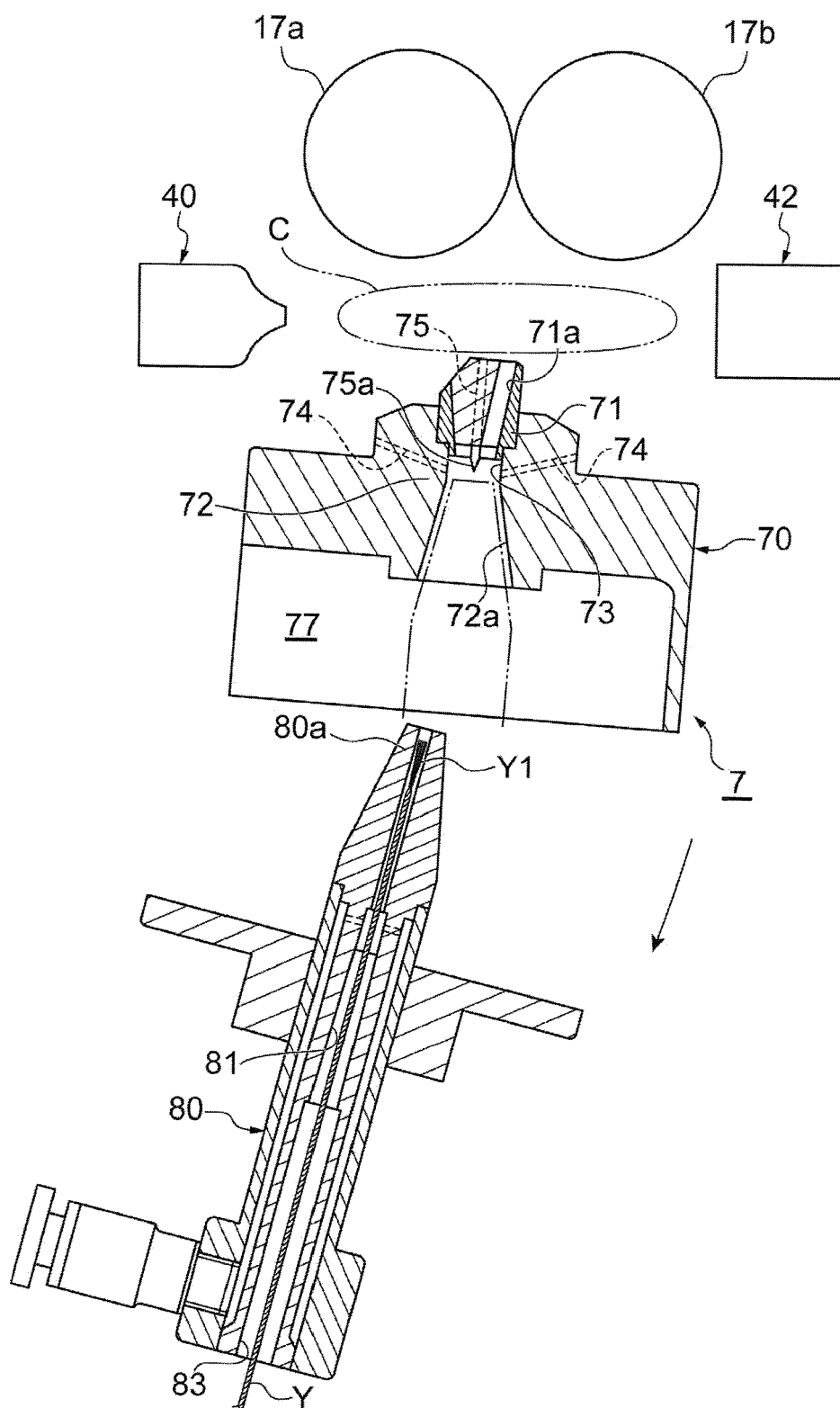
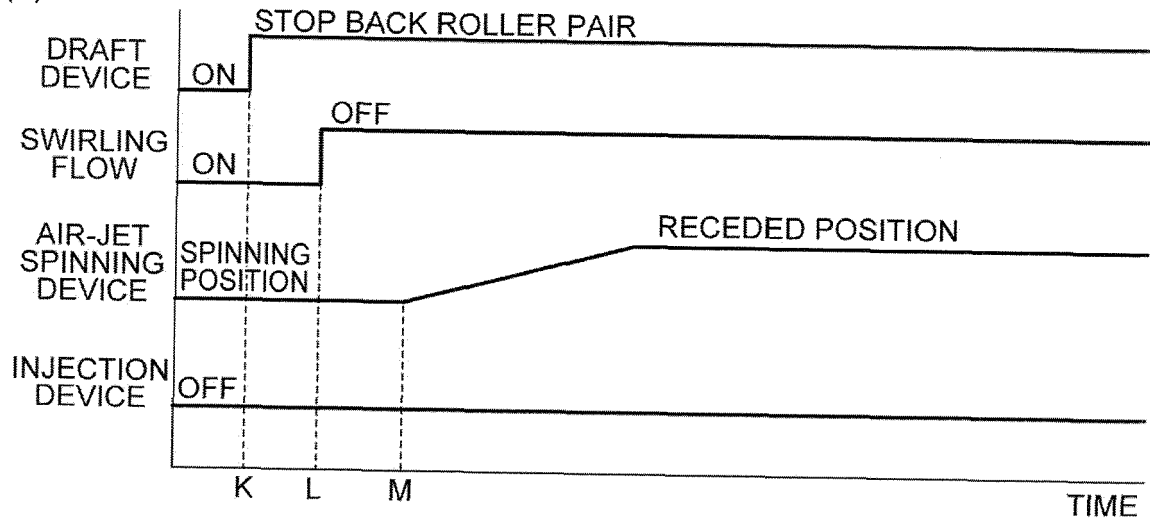
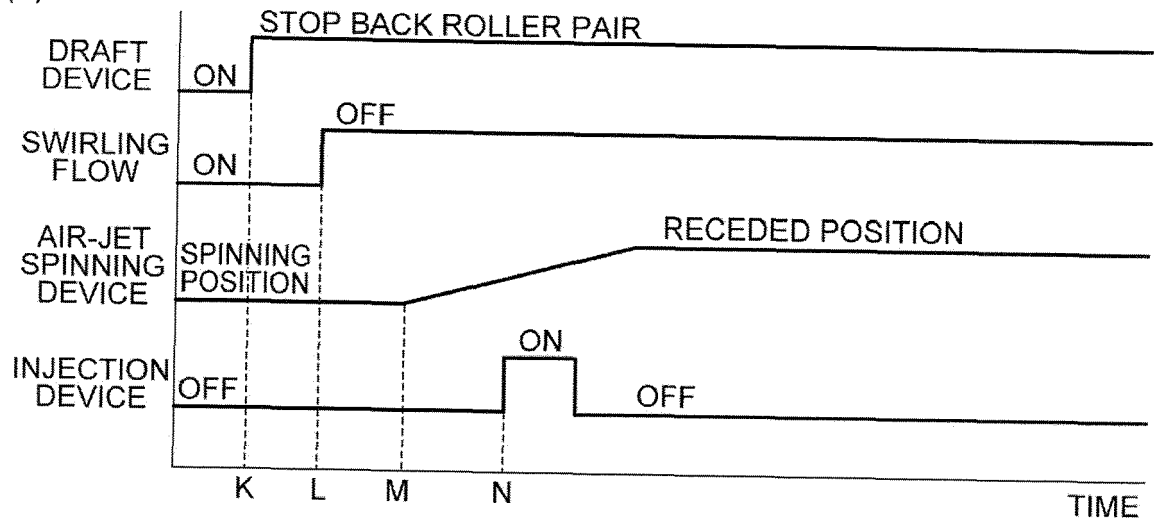


Fig.6

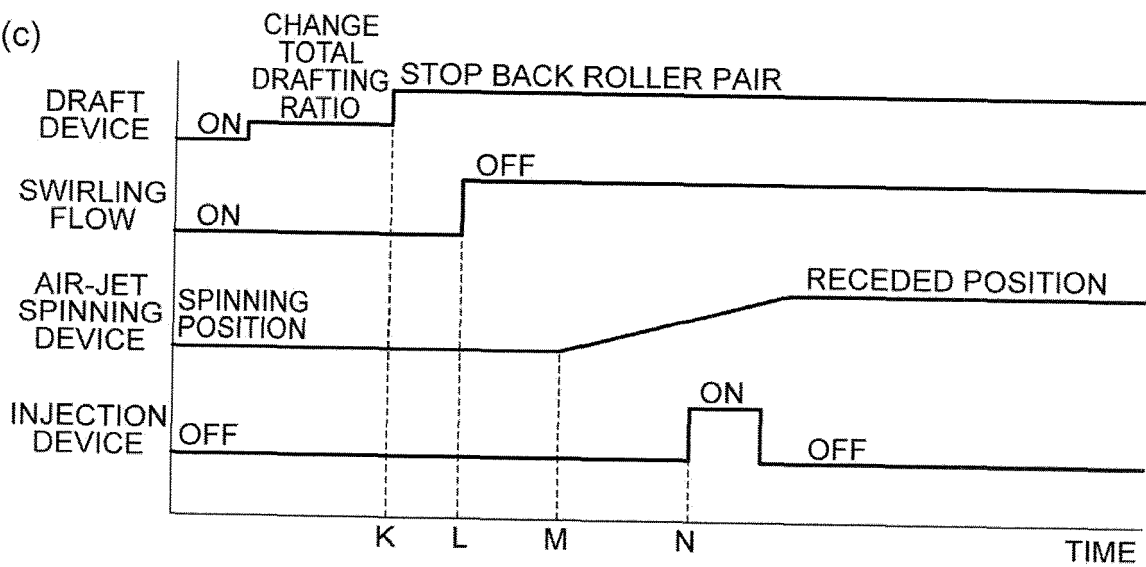
(a)



(b)



(c)





EUROPEAN SEARCH REPORT

Application Number
EP 17 20 3597

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			D01H
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 18 April 2018	Examiner Todarello, Giovanni
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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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18-04-2018

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