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that the yarn is wound onto the winding device with adjustment of the tension added to the spun material in the yarn forming unit. The control unit adjusts the tension by controlling a device of the yarn forming unit disposed at least in an upstream side or in a downstream side from a position at which the spun material is twisted in the direction in which the yarn travel.

Description

TECHNICAL FIELD

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

BACKGROUND

[0002] The spinning machine described in Japanese Unexamined Patent Publication No. 2013-049932 is known as a conventional spinning machine. The spinning machine described in Japanese Unexamined Patent Publication No. 2013-049932 includes a spinning device generating yarn, a winding device winding yarn generated by the spinning device into a package, and a detecting unit detecting the tension of traveling yarn between the spinning device and the winding device.

SUMMARY

[0003] Tension of traveling yarn is one of factors affecting the quality of yarn, and appropriate control on the tension of yarn wound into a package by the winding device can thus improve the quality of the yarn.

[0004] An embodiment of the present disclosure aims to provide a spinning machine enabling improvement of the quality of yarn.

[0005] A spinning machine according to an embodiment of the present disclosure includes a yarn forming unit configured to form yarn from a spun material, a winding device configured to wind yarn formed by the yarn forming unit, a tension detecting unit configured to detect the tension of yarn in an upstream side from the winding device in a direction in which the yarn travels, and a control unit configured to control the yarn forming unit based on a result of detection by the tension detecting unit such that the yarn is wound onto the winding device with adjustment of the tension added to the spun material in the yarn forming unit. The control unit adjusts the tension by controlling a device of the yarn forming unit disposed at least in an upstream side or in a downstream side from a position at which the spun material is twisted in the direction in which the yarn travel.

[0006] A spinning machine according to an embodiment of the present disclosure can maintain the tension of yarn within a predetermined range by providing feedback control to devices based on the tension of yarn detected by the tension detecting unit. With this configuration, the spinning machine can improve the quality of yarn.

[0007] In an embodiment, the yarn forming unit may include a drafting device configured to draft a fiber bundle used as a spun material. The drafting device may include a plurality of pairs of rollers including a pair of front rollers disposed in a most downstream position in a direction in which the fiber bundle is drafted. The control unit may control the circumferential speed of the pair of front rollers

based on the result of detection by the tension detecting unit. The feed ratio of the fiber bundle changes with a change in the circumferential speed of the pair of front rollers of the drafting device. The change in the feed ratio can change the tension of the fiber bundle (the yarn) in the downstream side from the pair of front rollers. Consequently, in the spinning machine, effective control on the tension of yarn can be achieved by controlling the circumferential speed of the pair of front rollers based on a result of detection by the tension detecting unit.

[0008] In an embodiment, when the tension of yarn is detected below a predetermined range in a result of detection, the control unit may provide control of decreasing the current circumferential speed of the pair of front rollers until the tension of the yarn increases to the predetermined range. On the contrary, when the tension of the yarn is detected beyond the predetermined range in a result of detection, the control unit may provide control of increasing the current circumferential speed of the pair of front rollers until the tension of the yarn decreases to the predetermined range. An increase in the circumferential speed can decrease the tension of yarn, whereas a decrease in the circumferential speed of the pair of front rollers can increase the tension of yarn. The control unit controls the circumferential speed of the pair of front rollers based on a result of detection so as to maintain the tension of the yarn within a predetermined range.

[0009] In an embodiment, the yarn forming unit includes a yarn storage roller disposed upstream of the winding device in a direction in which the yarn travels and configured to store the yarn. The control unit may control the number of rotations per unit time of the yarn storage roller based on a result of detection by the tension detecting unit such that the tension of the yarn detected by the tension detecting unit falls within a predetermined range. A change in the number of rotations per unit time of the yarn storage roller changes the feed ratio of the yarn. The change in the feed ratio can change the tension of the yarn stored in the yarn storage roller. In the spinning machine, the tension of yarn is effectively controlled by controlling the number of rotations of the yarn storage roller based on a result of detection by the tension detecting unit.

[0010] In an embodiment, when the tension of yarn is detected below a predetermined range in the result of detection, the control unit may provide control of increasing the current number of rotations of the yarn storage roller until the tension of the yarn increases to the predetermined range. On the contrary, when the tension of yarn is detected beyond the predetermined range in a result of detection, the control unit may provide control of decreasing the current number of rotations of the yarn storage roller until the tension of the yarn decreases to the predetermined range. An increase in the number of rotations of the yarn storage roller can increase the tension of yarn, whereas a decrease in the number of rotations of the yarn storage roller can decrease the tension of yarn. The control unit controls the number of rotations

of the yarn storage roller based on a result of detection so as to maintain the tension of yarn within a predetermined range.

[0011] In an embodiment, the spinning machine may include an air spinning device configured to generate the yarn by applying swirling airflow to a fiber bundle, and the yarn storage roller may store the yarn while drawing the yarn generated by the air spinning device. With this configuration, the yarn storage roller can control the tension of yarn generated by the air spinning device, and consequently, yarn is generated in the air spinning device at optimum tension, which can improve the quality of the yarn.

[0012] A spinning machine according to an embodiment of the present disclosure includes a yarn forming unit including a core yarn supply device that includes a supporting unit configured to support a core yarn package with core yarn wound thereon and a tension adding unit configured to add tension to the core yarn unwound from the core yarn package, the yarn forming unit being configured to form yarn from a spun material including the core yarn, a winding device configured to wind the yarn formed by the yarn forming unit, a tension detecting unit configured to detect tension of the yarn in the upstream side from the winding device in a direction in which the yarn travels, and a control unit configured to control the tension adding unit based on a result of detection by the tension detecting unit such that the yarn is wound onto the winding device with adjustment of tension added to the spun material in the yarn forming unit.

[0013] The spinning machine according to an embodiment of the present disclosure can maintain the tension of yarn within a predetermined range by providing feedback control to devices based on the tension of yarn detected by the tension detecting unit. The spinning machine in this configuration can improve the quality of yarn including core yarn.

[0014] In an embodiment, the control unit may control the tension adding unit based on a result of detection by the tension detecting unit such that the tension of the yarn detected by the tension detecting unit falls within a predetermined range. This process can improve the quality of yarn wound by the winding device.

[0015] According to an embodiment of the present disclosure, the quality of yarn can be improved.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016]

FIG. 1 is a front view of a spinning machine according to an embodiment.

FIG. 2 is a side view of a spinning unit of the spinning machine of FIG. 1.

FIG. 3 is a block diagram illustrating the configuration of a part of the spinning unit.

FIG. 4 is a perspective view of a core yarn supply device in the spinning unit illustrated in FIG. 2.

FIG. 5A is a side view of a tension adding mechanism in the core yarn supply device illustrated in FIG. 4.

FIG. 5B is another side view of the tension adding mechanism in the core yarn supply device illustrated in FIG. 4.

FIG. 6 is a block diagram illustrating the configuration of a part of a spinning unit of a spinning machine according to another embodiment.

10 DETAILED DESCRIPTION

[0017] An embodiment will now be described with reference to the drawings. In the drawings, like numerals indicate like components, and overlapping description will be omitted.

[0018] As illustrated in FIG. 1, a spinning machine 1 includes a plurality of spinning units 2, a splicing carrier 3, a doffing carrier (not illustrated), 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 is cut or breaks in a spinning unit 2 for any reason, the splicing carrier 3 splices the yarn Y in the spinning unit 2. When the package P becomes a full roll, completes in a spinning unit 2, the doffing carrier doffs the package P and supplies a new bobbin B to the spinning unit 2.

[0019] The first end frame 4 accommodates therein a collection device and the like for collecting fiber waste, yarn waste, and others generated in the spinning unit 2. The second end frame 5 accommodates therein an air supply unit adjusting air pressure of compressed air (air) supplied to the spinning machine 1 and supplying air to the units in the spinning machine 1, a driving motor for supplying power to the units in the spinning unit 2, and others. The second end frame 5 includes a machine control device 100, a display screen 102, and an input key 104. The machine control device 100 intensively manages and controls the units of the spinning machine 1. The display screen 102 can display, for example, information on the settings and/or the status of the spinning unit 2. An operator performs necessary operations through the input key 104, thereby setting the spinning unit 2.

[0020] As FIGs. 1 and 2 illustrate, each spinning unit 2 includes, in the order from the upstream side in the direction in which the yarn Y travels, a drafting device 6, a core yarn supply device 7, an air spinning device 8, a yarn monitoring device 9, a tension sensor (a tension detecting unit) 10, a yarn storage device 11, a waxing device 12, and a winding device 13. In the embodiment, the drafting device 6, the core yarn supply device 7, and a yarn storage roller 11a (described later) of the yarn storage device 11 constitute a yarn forming unit forming the yarn Y from a spun material while adjusting the tension of the spun material. The drafting device 6, the core yarn supply device 7, and the yarn storage roller 11a of the yarn storage device 11 are disposed in at least one of the upstream side and the downstream side from a

position (the air spinning device 8) at which the spun yarn is twisted. A unit controller (the control unit) 15 is provided in every certain number of spinning units 2 and controls operations of the spinning units 2. The drafting device 6, the core yarn supply device 7, and the yarn storage device 11 in the spinning unit 2 are devices affecting the tension of the yarn Y.

[0021] The drafting device 6 drafts a sliver (a fiber bundle, a spun material) S. The drafting device 6 includes, in the order from the upstream side in the direction in which the sliver S travels, a pair of back rollers 16, a pair of third rollers 17, a pair of middle rollers 18, and a pair of front rollers 19. The pair of front rollers 19 are disposed in the most downstream position in a direction of drafting. Each pair of rollers 16, 17, 18, and 19 includes a bottom roller and a top roller. The bottom roller is driven and rotated by a driving motor installed in the second end frame 5. The top roller of the pair of middle rollers 18 includes an apron belt 18a. The bottom roller of the pair of middle rollers 18 includes an apron belt 18b.

[0022] The core yarn supply device 7 unwinds core yarn (a spun material) C from a core yarn package CP and supplies the core yarn C to the drafting device 6. Specifically, the core yarn supply device 7 supplies the core yarn C onto the traveling path of the fiber bundle F from between the pair of middle rollers 18 and the pair of front rollers 19, whereby the core yarn C is supplied to the air spinning device 8 together with the fiber bundle F.

[0023] The air spinning device 8 generates the yarn Y by twisting the fiber bundle F drafted by the drafting device 6 using swirling airflow. More specifically (although not illustrated in the drawings), the air spinning device 8 includes a spinning room, a fiber guiding unit, a swirling airflow generating nozzle, and a hollow guide shaft. The fiber guiding unit guides the fiber bundle F supplied from the drafting device 6 disposed in the upstream side to the spinning room. The swirling airflow generating nozzle is disposed around a path on which the fiber bundle F travels. Swirling airflow is generated in the spinning room with the swirling airflow generating nozzle spraying air. The swirling airflow reverses and swirls the fiber tips of a plurality of fibers included in the fiber bundle F. The hollow guide shaft guides the yarn Y from the spinning room to the outside of the air spinning device 8.

[0024] The yarn monitoring device 9 is disposed between the air spinning device 8 and the yarn storage device 11 and monitors information on traveling yarn Y. Specifically, the yarn monitoring device 9 detects whether the yarn Y has any defects based on the monitored information. Upon detection of a defect on the yarn, the yarn monitoring device 9 transmits a yarn defect detection signal to the unit controller 15. The yarn monitoring device 9 detects abnormality in the diameter of the yarn Y, a foreign matter contained in the yarn Y, and/or the like as a defect of the yarn Y. The yarn monitoring device 9 further detects yarn breakage and others.

[0025] The tension sensor 10 disposed between the

air spinning device 8 and the yarn storage device 11 measures the tension of traveling yarn Y and transmits a tension measuring signal (a result of detection) to the unit controller 15. When the unit controller 15 determines that abnormality has occurred based on at least one of a result of detection by the yarn monitoring device 9 and a result of detection by the tension sensor 10, the yarn Y is cut in the spinning unit 2. Specifically, air supply to the air spinning device 8 stops, generation of the yarn Y is terminated, and the yarn Y is accordingly cut. In another way, the yarn Y may be cut with a cutter separately provided.

[0026] The waxing device 12 disposed between the yarn storage device 11 and the winding device 13 applies wax to the yarn Y.

[0027] The yarn storage device 11 disposed between the air spinning device 8 and the winding device 13 eliminates slack from the yarn Y. The yarn storage device 11 has functions of stably drawing the yarn Y from the air spinning device 8, preventing the yarn Y from slacking by retaining the yarn Y delivered from the air spinning device 8, for example, in the yarn splicing operation of the splicing carrier 3, and preventing fluctuations in the tension of the yarn Y situated downstream of the yarn storage device 11 from spreading to the air spinning device 8.

[0028] The yarn storage device 11 includes the yarn storage roller 11a, a yarn threading member 11b, and a motor 11c. The yarn storage roller 11a stores the yarn Y with the yarn Y wound onto the outer peripheral surface of the yarn storage roller 11a. The yarn threading member 11b is disposed at the downstream end of the yarn storage roller 11a. Upon a start of storage of the yarn Y, the yarn threading member 11b hooks the yarn Y and winds the yarn onto the yarn storage roller 11a. During winding into the package P, the yarn threading member 11b adds tension to the yarn Y unwound from the yarn storage roller 11a. The motor 11c rotates the yarn storage roller 11a. As illustrated in FIG. 3, a motor driver 11d controls driving of the motor 11c. Specifically, the motor driver 11d controls driving of the motor 11c based on a signal output from the unit controller 15.

[0029] The winding device 13 winds the yarn Y onto the 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 swingably supported by a supporting shaft 24 and has the surface of the bobbin B or the surface of the package P contact with the surface of the winding drum 22 at appropriate pressure. The driving motor (not illustrated) installed in the second end frame 5 simultaneously drives the winding drums 22 of a plurality of spinning units 2. With this drive, the bobbin B or the package P of each spinning unit 2 is rotated in a direction of winding. The traverse guide 23 of each spinning unit 2 is mounted on a shaft 25 shared by a plurality of spinning units 2. With the driving motor in the second end frame 5 driving the shaft 25 in a direction of

the rotational axis of the winding drum 22 in a reciprocating manner, the traverse guide 23 has the yarn Y traverse a rotating bobbin B or package P at a certain width.

[0030] When the yarn Y is cut or breaks in a spinning unit 2 for any reason, the splicing carrier 3 runs to the spinning unit 2 and performs a splicing operation. The splicing carrier 3 includes a splicing device 26, a suction pipe 27, and a suction mouth 28. The suction pipe 27 is rotatably supported by a support shaft 31. The suction pipe 27 catches the yarn Y sent from the air spinning device 8 and guides the yarn Y to the splicing device 26. The suction mouth 28 is rotatably supported by a support shaft 32. The suction mouth 28 catches the yarn Y sent from the winding device 13 and guides the yarn Y to the splicing device 26. The splicing device 26 splices the guided pieces of the yarn Y with each other. Examples of the splicing device 26 include a splicer using compressed air and a knotter mechanically splicing the yarn Y.

[0031] In the splicing operation, the splicing carrier 3 rotates (reversely rotates) the package P in a reverse direction of winding. Specifically, the cradle arm 21 is moved by an air cylinder (not illustrated) so that the package P is separated from the winding drum 22, and a reverse rotating roller (not illustrated) installed to the splicing carrier 3 reversely rotates the package P.

[0032] The core yarn supply device 7 will now be described in detail. As illustrated in FIG. 2, the core yarn supply device 7 includes a package supporting unit (a supporting unit) 50, a core yarn supply unit 51, and a core yarn guiding unit 52.

[0033] The package supporting unit 50 supports the core yarn package CP with the center line of the core yarn package CP horizontally extending in the front-to-back direction. The core yarn package CP is formed with the core yarn C wound onto a core yarn bobbin CB. The core yarn C in this embodiment is, for example, multifilament yarn. The multifilament yarn is yarn formed by bundling a plurality of pieces of filament single yarn. The core yarn C is unwound from the core yarn package CP and is supplied to the core yarn supply unit 51 via a guide roller 53 guiding the core yarn C. The core yarn C may be another kind of yarn such as monofilament yarn and spun yarn.

[0034] The core yarn supply unit 51 has functions of adding tension to supplied core yarn C, adding slack to the core yarn C, and delivering the core yarn C (an end of the core yarn C). The core yarn guiding unit 52 is a cylindrical member guiding the core yarn C to the drafting device 6.

[0035] As illustrated in FIG. 4, the core yarn supply unit 51 includes a unit base 60, a tension adding mechanism 70, a slack adding mechanism 80, a core yarn monitoring device 82, and a core yarn delivery mechanism 84. In the following description, in the traveling path of the core yarn C in the core yarn supply unit 51, the core yarn package CP side is referred to as an upstream side,

whereas the core yarn guiding unit 52 side is referred to as a downstream side.

[0036] The unit base 60 supports, in the order from the upstream side in a direction in which the core yarn C is supplied, the tension adding mechanism 70, the slack adding mechanism 80, the core yarn monitoring device 82, and the core yarn delivery mechanism 84. A core yarn guide 61 guiding the core yarn C is disposed in the most upstream position on the unit base 60.

[0037] The tension adding mechanism 70 adds tension to the core yarn C in the downstream side from the core yarn guide 61. As illustrated in FIGs. 5A and 5B, the tension adding mechanism 70 includes a tension adding unit 71 and a retaining unit 72.

[0038] The tension adding unit 71 includes a fixed piece 73 and a movable piece 74. With the core yarn C alternately hooked to the fixed piece 73 and the movable piece 74, the core yarn C is bent a plurality of times in the tension adding unit 71. The number of bends of the core yarn C is, for example, 20 times or less (preferably, between twice and ten times, inclusively).

[0039] The fixed piece 73 is fixed to the unit base 60. The movable piece 74 is supported by a support shaft (not illustrated) provided to the fixed piece 73 and openable and closable (rotatable) with respect to the fixed piece 73. The movable piece 74 is pressed toward a direction opening with respect to the fixed piece 73 by a spring (not illustrated) provided to the fixed piece 73.

[0040] A plurality of shafts 73a are provided to the fixed piece 73 at certain intervals in a direction in which the core yarn C is supplied. A plurality of projections 74a projecting toward the fixed piece 73 are provided to the movable piece 74. When the movable piece 74 closes with respect to the fixed piece 73 (the state in FIG. 5B), the projections 74a are alternately positioned between the shafts 73a in the direction in which the core yarn C is supplied. Each projection 74a has a hole 74b through which the core yarn C passes at its leading end. The core yarn C is alternately hooked to the shafts 73a and the holes 74b.

[0041] As illustrated in FIG. 5A, the core yarn C is bent a plurality of times when the movable piece 74 opens with respect to the fixed piece 73. In this process, tension is added to the core yarn C. Specifically, higher tension is added to the core yarn C with the movable piece 74 opening with respect to the fixed piece 73 at a larger angle, and the state of the tension adding unit 71 under this condition is referred to as a tension added state. As illustrated in FIG. 5B, the core yarn C is substantially linear when the movable piece 74 closes with respect to the fixed piece 73. In this process, no tension is added to the core yarn C (or lower tension than the tension in the tension added state is added to the core yarn C). The state of the tension adding unit 71 under this condition is referred to as a no-tension added state.

[0042] The retaining unit 72 opens and closes the movable piece 74 with respect to the fixed piece 73. As illustrated in FIGs. 5A and 5B, the retaining unit 72 includes

a retaining member 75 and an actuator 76. As illustrated in FIG. 3, the unit controller 15 controls driving of the actuator 76.

[0043] The actuator 76 has the retaining member 75 abut with or separated from the movable piece 74. More specifically, the retaining member 75 has a front end 75a abutting with the movable piece 74 from the opposite side of the fixed piece 73, and the position of the front end 75a is moved by the actuator 76.

[0044] When the front end 75a moves down, the movable piece 74 is pushed by the front end 75a and closes with respect to the fixed piece 73. This process turns the tension adding unit 71 to the no-tension added state. When the front end 75a moves up, the movable piece 74 opens with respect to the fixed piece 73 with the pressing force of the spring. This process turns the tension adding unit 71 to the tension added state.

[0045] The slack adding mechanism 80 adds slack to the core yarn C in the downstream side from the tension adding mechanism 70. More specifically, the position of a front-end guiding unit of the slack adding mechanism 80 moves from a position including the traveling path (the continuous line in FIG. 4) of the core yarn C to another position (the position indicated by the double chain line in FIG. 4) away from the traveling path of the core yarn C before the core yarn delivery mechanism 84 starts delivering the core yarn C. This process adds slack to the core yarn C. The core yarn monitoring device 82 detects the presence of the core yarn C between the core yarn guide 61 and the core yarn delivery mechanism 84. In FIG. 4, the core yarn monitoring device 82 is disposed downstream of the slack adding mechanism 80 in the direction in which the core yarn C is supplied. The core yarn monitoring device 82 may be disposed upstream of the tension adding mechanism 70. The core yarn delivery mechanism 84 is disposed downstream of the core yarn monitoring device 82 and delivers the core yarn C (an end of the core yarn C) to the drafting device 6 when the spinning operation starts.

[0046] A method of controlling the tension of the yarn Y with the yarn storage device 11 will now be described.

[0047] When the spinning unit 2 of the spinning machine 1 starts the spinning operation, the tension sensor 10 measures the tension of traveling yarn Y and transmits a tension measuring signal to the unit controller 15. The unit controller 15 rotates the yarn storage roller 11a at the number of initial rotations set for each lot. The number of initial rotations is preset such that the tension of the yarn Y detected by the tension sensor 10 falls within a predetermined range. The "predetermined range" may be a range having a certain width or may be a value without a range.

[0048] The unit controller 15 receives the tension measuring signal and determines whether the tension of the yarn Y indicated by the tension measuring signal falls within a predetermined range. The range for the tension of the yarn Y is input, for example, through the input key 104 of the machine control device 100 and set. The range

for the tension of the yarn Y may be automatically set based on a set lot.

[0049] If the unit controller 15 determines that the tension of the yarn Y is out of the predetermined range, the unit controller 15 controls the number of rotations per unit time (hereinafter simply referred to as "the number of rotations") of the yarn storage roller 11a. In this embodiment, the unit controller 15 controls the tension of the yarn Y by changing the number of rotations of the yarn storage roller 11a without changing the drafting speed (for example, the circumferential speed of the pair of front rollers 19) of the drafting device 6. The drafting operation by the drafting device 6, the spinning operation by the air spinning device 8, and the winding operation by the winding device 13 are continuing in parallel with the control.

[0050] Specifically, if the tension of the yarn Y is below the predetermined range, the unit controller 15 increases the number of rotations (rpm) of the yarn storage roller 11a from the number of initial rotations. More specifically, the unit controller 15 outputs a signal to the motor driver 11d and increases the number of rotations of the motor 11c. This process changes the feed ratio (the difference in the delivery speed of the yarn Y between the yarn storage roller 11a and the pair of front rollers 19) of the yarn Y determined based on the number of rotations of the yarn storage roller 11a and the circumferential speed of the pair of front rollers 19. Specifically, the delivery speed of the yarn Y drawn from the air spinning device 8 by the yarn storage roller 11a becomes higher than the delivery speed of the yarn Y delivered from the pair of front rollers 19 to the air spinning device 8. The tension of the yarn Y increases with the change in the feed ratio. When the unit controller 15 determines that the tension of the yarn Y has increased to the predetermined range based on the tension measuring signal, the unit controller 15 completes the control of increasing the number of rotations of the yarn storage roller 11a and controls the number of rotations of the yarn storage roller 11a so that the tension of the yarn Y is maintained within the predetermined range.

[0051] On the contrary, if the tension of the yarn Y is beyond the predetermined range, the unit controller 15 decreases the number of rotations of the yarn storage roller 11a from the number of initial rotations. With this operation, the delivery speed of the yarn Y drawn from the air spinning device 8 by the yarn storage roller 11a becomes lower than the delivery speed of the yarn Y delivered from the pair of front rollers 19 to the air spinning device 8, which accordingly changes the feed ratio of the yarn Y. The tension of the yarn Y decreases with the change in the feed ratio. When the unit controller 15 determines that the tension of the yarn Y has decreased to the predetermined range based on the tension measuring signal, the unit controller 15 completes the control of decreasing the number of rotations of the yarn storage roller 11a and controls the number of rotations of the yarn storage roller 11a so that the tension of the yarn Y is maintained within the predetermined range.

[0052] If the unit controller 15 determines that the tension of the yarn Y is out of the predetermined range and further determines that the tension of the yarn Y is at a value causing abnormality on the yarn Y (for example, the tension at the value is low enough to form a weak portion on the yarn Y), the unit controller 15 terminates the spinning operation instead of controlling the number of rotations of the yarn storage roller 11a.

[0053] A method of controlling the tension of the yarn Y with the core yarn supply device 7 will now be described.

[0054] When the spinning unit 2 of the spinning machine 1 starts the spinning operation, the tension sensor 10 measures the tension of traveling yarn Y and transmits a tension measuring signal to the unit controller 15. The unit controller 15 controls the actuator 76 such that the initial tension is added to the core yarn C by the tension adding mechanism 70. The initial tension is preset such that the tension of the yarn Y detected by the tension sensor 10 falls within a predetermined range. The unit controller 15 controls the actuator 76 so as to have the front end 75a positioned at the initial position. With this process, the initial tension is added to the core yarn C.

[0055] The unit controller 15 receives the tension measuring signal and determines whether the tension of the yarn Y indicated by the tension measuring signal falls within a predetermined range. If the unit controller 15 determines that the tension of the yarn Y is out of the predetermined range, the unit controller 15 controls the tension added to the core yarn C by the tension adding mechanism 70. Specifically, if the tension of the yarn Y is below the predetermined range, the unit controller 15 controls the actuator 76 such that the front end 75a moves above the initial position and that the movable piece 74 opens with respect to the fixed piece 73. The tension added to the core yarn C increases with the move of the front end 75a. When the unit controller 15 determines that the tension of the yarn Y has increased to the predetermined range based on the tension measuring signal, the unit controller 15 completes the control of increasing the tension added by the tension adding mechanism 70 and controls the tension adding mechanism 70 such that the tension of the yarn Y is maintained within the predetermined range.

[0056] If the tension of the yarn Y is beyond the predetermined range, the unit controller 15 controls the actuator 76 such that the front end 75a moves below the initial position and that the movable piece 74 closes with respect to the fixed piece 73. The tension added to the core yarn C decreases with the move of the front end 75a. When the unit controller 15 determines that the tension of the yarn Y has decreased to the predetermined range based on the tension measuring signal, the unit controller 15 completes the control of decreasing the tension added by the tension adding mechanism 70 and controls the tension adding mechanism 70 such that the tension of the yarn Y is maintained within the predetermined range.

[0057] If the unit controller 15 determines that the tension of the yarn Y is out of the predetermined range and further determines that the tension of the yarn Y is at a value causing abnormality on the yarn Y, the unit controller 15 terminates the spinning operation instead of controlling the tension adding mechanism 70.

[0058] The tension of the yarn Y may be controlled by controlling at least one of the yarn storage device 11 and the core yarn supply device 7. In other words, the tension of the yarn Y may be controlled by controlling the number of rotations of the yarn storage roller 11a or may be controlled by controlling the tension added to the core yarn C by the tension adding mechanism 70. In another way, the tension of the yarn Y may be controlled by controlling both the yarn storage roller 11a and the tension adding mechanism 70 of the core yarn supply device 7. In any of these cases, the drafting operation by the drafting device 6, the spinning operation by the air spinning device 8, and the winding operation by the winding device 13 are continuing in parallel with the control.

[0059] As described above, in the spinning machine 1 according to the embodiment, devices affecting the tension of the yarn Y are controlled based on a result of detection by the tension sensor 10 such that the tension of the yarn Y falls within a predetermined range. The spinning machine 1 can maintain the tension of the yarn Y within a predetermined range by providing feedback control to the devices based on the tension of the yarn Y detected by the tension sensor 10. The spinning machine 1 in this configuration can thus improve the quality of the yarn Y.

[0060] In this embodiment, the unit controller 15 controls the number of rotations of the yarn storage roller 11a based on the tension measuring signal transmitted from the tension sensor 10 such that the tension of the yarn Y detected by the tension sensor 10 falls within a predetermined range. A change in the number of rotations per unit time of the yarn storage roller 11a changes the feed ratio. The change in the feed ratio accordingly changes the tension of the yarn Y stored in the yarn storage roller 11a. Consequently, in the spinning machine 1, the tension of the yarn Y is effectively controlled by controlling the number of rotations of the yarn storage roller 11a based on the tension measuring signal transmitted from the tension sensor 10.

[0061] Specifically, if the tension of the yarn Y is detected below a predetermined range in the tension measuring signal, the unit controller 15 increases the number of rotations per unit time of the yarn storage roller 11a until the tension of the yarn Y increases to the predetermined range. On the contrary, if the tension of the yarn Y is detected beyond the predetermined range in the tension measuring signal, the unit controller 15 decreases the number of rotations per unit time of the yarn storage roller 11a until the tension of the yarn Y decreases to the predetermined range. An increase in the number of rotations of the yarn storage roller 11a can increase the tension of the yarn Y, whereas a decrease in the number

of rotations of the yarn storage roller 11a can decrease the tension of the yarn Y. Consequently, the unit controller 15 controls the number of rotations of the yarn storage roller 11a based on the tension measuring signal, thereby maintaining the tension of the yarn Y within the predetermined range.

[0062] In this embodiment, the yarn storage roller 11a stores the yarn Y while drawing the yarn Y generated by the air spinning device 8, which means that no delivery rollers or nip rollers for drawing the yarn Y from the air spinning device 8 are disposed between the air spinning device 8 and the yarn storage roller 11a. This configuration enables control of the tension of the yarn Y generated by the air spinning device 8 using the yarn storage roller 11a. Consequently, the yarn Y is generated by the air spinning device 8 at optimum spinning tension, which can improve the quality of the yarn.

[0063] With the configuration that the yarn Y is drawn from the air spinning device 8 by the delivery roller and the nip roller, the yarn Y may slip on the delivery roller. Slip of the yarn Y may result in instable control on the tension of the yarn Y. In this embodiment, the yarn Y is drawn from the air spinning device 8 by the yarn storage roller 11a. The yarn storage roller 11a draws the yarn Y from the air spinning device 8 by winding the yarn Y onto the outer peripheral surface of the yarn storage roller 11a. This configuration enables more accurate control on the tension of the yarn Y. Consequently, the yarn Y is generated by the air spinning device 8 at optimum spinning tension, which can improve the quality of the yarn.

[0064] In this embodiment, the spinning machine 1 includes the core yarn supply device 7 having the package supporting unit 50 supporting the core yarn package CP with the core yarn C wound thereon and the tension adding mechanism 70 adding tension to the core yarn C unwound from the core yarn package CP. The unit controller 15 controls the tension sensor 10 based on the tension measuring signal transmitted from the tension sensor 10 such that the tension of the yarn Y detected in the tension adding mechanism 70 falls within a predetermined range. This configuration can improve the quality of the yarn Y wound by the winding device 13.

[0065] Another embodiment will now be described. In the spinning machine 1 according to another embodiment, as illustrated in FIG. 6, a bottom roller of the pair of front rollers 19 (hereinafter may be referred to as a "front bottom roller") is driven and rotated by a driving motor 20 installed in each spinning unit 2. A motor driver 20a controls driving of the driving motor 20. The motor driver 20a controls driving of the driving motor 20 based on a signal output from the unit controller 15. The bottom roller of each pair of back rollers 16, third rollers 17, and middle rollers 18 may be driven and rotated by the driving motor installed in each spinning unit 2 or may be driven and rotated by a driving motor installed in the second end frame 5.

[0066] A method of controlling the tension of the yarn Y with the pair of front rollers 19 will now be described.

[0067] When the spinning unit 2 of the spinning machine 1 starts the spinning operation, the tension sensor 10 measures the tension of traveling yarn Y and transmits a tension measuring signal to the unit controller 15. The unit controller 15 rotates the pair of front rollers 19 of the drafting device 6 at the initial speed set for each lot. The initial speed is preset such that the tension of the yarn Y detected by the tension sensor 10 falls within a predetermined range.

[0068] The unit controller 15 receives the tension measuring signal and determines whether the tension of the yarn Y indicated by the tension measuring signal falls within the predetermined range. If the unit controller 15 determines that the tension of the yarn Y is out of the predetermined range, the unit controller 15 controls the circumferential speed of the pair of front rollers 19 (the front bottom roller). In this embodiment, the unit controller 15 controls the tension of the yarn Y by changing the circumferential speed of the front bottom roller without changing the number of rotations of the yarn storage roller 11a. The drafting operation by the drafting device 6, the spinning operation by the air spinning device 8, and the winding operation by the winding device 13 are continuing in parallel with the control.

[0069] Specifically, if the tension of the yarn Y is below the predetermined range, the unit controller 15 decreases the circumferential speed of the pair of front rollers 19 from the initial speed. More specifically, the unit controller 15 outputs a signal to the motor driver 20a of the driving motor 20 and decreases the number of rotations (rpm) of the driving motor 20.

[0070] This process changes the feed ratio of the yarn Y determined based on the number of rotations of the yarn storage roller 11a and the circumferential speed of the pair of front rollers 19. Specifically, the speed of the yarn Y delivered from the pair of front rollers 19 to the air spinning device 8 becomes lower than the speed of the yarn Y drawn from the air spinning device 8 by the yarn storage roller 11a, which changes the feed ratio of the yarn Y and accordingly increases the tension of the yarn Y. When the unit controller 15 determines that the tension of the yarn Y has increased to the predetermined range based on the tension measuring signal, the unit controller 15 completes the control of decreasing the circumferential speed of the front bottom roller and controls the circumferential speed of the front bottom roller so that the tension of the yarn Y is maintained within the predetermined range.

[0071] If the tension of the yarn Y is beyond the predetermined range, the unit controller 15 increases the circumferential speed of the pair of front rollers 19 from the initial speed. This operation makes the speed of the yarn Y delivered from the pair of front rollers 19 to the air spinning device 8 higher than the speed of the yarn Y drawn from the air spinning device 8 by the yarn storage roller 11a, which changes the feed ratio of the yarn Y. The tension of the yarn Y decreases with the change in the feed ratio. When the unit controller 15 determines

that the tension of the yarn Y has decreased to the predetermined range based on the tension measuring signal, the unit controller 15 completes the control of increasing the circumferential speed of the front bottom roller and controls the circumferential speed of the front bottom roller so that the tension of the yarn Y is maintained within the predetermined range.

[0072] In such a configuration that at least one of respective bottom rollers of the pair of back rollers 16, the pair of third rollers 17, and the pair of middle rollers 18 is driven and rotated by the driving motor installed in each spinning unit 2, the circumferential speed of at least the pair of back rollers 16, the pair of third rollers 17, or the pair of middle rollers 18 may be controlled in addition to the control of the circumferential speed of the pair of front rollers 19.

[0073] In this embodiment, the unit controller 15 controls the circumferential speed of the pair of front rollers 19 based on the tension measuring signal transmitted from the tension sensor 10. The feed ratio changes with the change in the circumferential speed of the pair of front rollers 19 of the drafting device 6. The change in the feed ratio can change the tension of the fiber bundle F (the yarn Y) in the downstream side from the pair of front rollers 19. Consequently, the spinning machine 1 can effectively control the tension of the yarn Y by controlling the circumferential speed of the pair of front rollers 19 based on the tension measuring signal transmitted from the tension sensor 10.

[0074] Specifically, if the tension of the yarn Y is detected below a predetermined range in the tension measuring signal, the unit controller 15 decreases the circumferential speed of the pair of front rollers 19 from the initial speed until the tension of the yarn Y increases to the predetermined range. If the tension of the yarn Y is detected beyond the predetermined range in the tension measuring signal, the unit controller 15 increases the circumferential speed of the pair of front rollers 19 from the initial speed until the tension of the yarn Y decreases to the predetermined range. The tension of the yarn Y can be decreased by increasing the circumferential speed of the pair of front rollers 19, whereas the tension of the yarn Y can be increased by decreasing the circumferential speed of the pair of front rollers 19. The unit controller 15 controls the circumferential speed of the pair of front rollers 19 based on the tension measuring signal and maintains the tension of the yarn Y within the predetermined range.

[0075] The tension of the yarn Y may be controlled by controlling at least one of the drafting device 6, the core yarn supply device 7, and the yarn storage device 11. In another way, the tension of the yarn Y may be controlled by controlling both the pair of front rollers 19 of the drafting device 6 and the yarn storage device 11. In still another way, the tension of the yarn Y may be controlled by controlling both the pair of front rollers 19 of the drafting device 6 and the tension adding mechanism 70 of the core yarn supply device 7. Furthermore, the tension of the

yarn Y may be controlled by controlling these three devices, which are the pair of front rollers 19 of the drafting device 6, the tension adding mechanism 70 of the core yarn supply device 7, and the yarn storage roller 11a of the yarn storage device 11.

[0076] An embodiment has been described as above; however the embodiment is not limited thereto.

[0077] In the above-described embodiment, the feedback control based on a result of detection by the tension sensor 10 is provided in parallel with the winding operation of the package P. If the tension of the yarn Y detected by the tension sensor 10 does not fall within a predetermined range even with the feedback control over a certain period, the spinning operation and the winding operation in the spinning unit 2 may be stopped. In at least one of the drafting device 6, the yarn storage device 11, and the tension adding mechanism 70, a limited range may be set for the amount (such as the number of rotations of the pair of front rollers 19 and/or the yarn storage roller 11a and the amount of tension added by the tension adding mechanism 70) to be controlled in the feedback control. In this case, if the controlled amount is out of the limited range, the spinning operation and the winding operation of the spinning unit 2 may be stopped. When the spinning operation and the winding operation are stopped from any of the above-described reasons, the display screen 102 and/or a display unit (not illustrated) installed to each spinning unit 2 may make a display informing that an error has been caused.

[0078] In the above-described embodiment, such a configuration has been described as an example that the spinning unit 2 of the spinning machine 1 includes the core yarn supply device 7; however, the core yarn supply device 7 may not be installed to the spinning unit 2.

[0079] In the above-described embodiment, such a configuration has been described as an example that the tension adding unit 71 of the tension adding mechanism 70 in the core yarn supply device 7 adds tension to the yarn Y by bending the core yarn C a plurality of times. In the tension adding mechanism 70, instead of controlling the actuator 76, the tension added to the core yarn C by the tension adding unit 71 may be adjusted by controlling the degree at which the movable piece 74 opens with respect to the fixed piece 73 by electrically adjusting the contact angle of a spring (not illustrated). The mechanism for adding tension to the core yarn C is not limited thereto. As an example of mechanisms to add tension to the core yarn C, a yarn path of the core yarn C may be bent with a disk. Tension may be added to the core yarn C in any position in the upstream side from the core yarn guiding unit 52.

[0080] In the above-described embodiment, such an exemplary configuration has been described that the tension sensor 10 measures the tension of traveling yarn Y between the air spinning device 8 and the yarn storage device 11; however, the position of the tension sensor 10 is not limited thereto. The tension sensor 10 may measure the tension of the yarn Y at any position between

the air spinning device 8 and the winding device 13.

[0081] In the above-described embodiment, the unit controller 15 serves as a control unit controlling the yarn forming unit and the winding device 13 based on a result of detection by the tension sensor 10 such that the yarn Y is wound with adjustment of the tension added by the yarn forming unit. Instead of the unit controller 15, the machine control device 100 may serve as the control unit.

[0082] The air spinning device 8 may further include a needle retained by the fiber guiding unit and projecting into the spinning room so as to prevent twist of the fiber bundle from spreading upstream of the air spinning device. In another case, instead of using the needle, the air spinning device may prevent twist of the fiber bundle from spreading upstream of the air spinning device using an end in the downstream side of the fiber guiding unit. Instead of the above configuration, the air spinning device may include a pair of air jet nozzles for twisting the fiber bundle in respective directions opposite to each other. The spinning machine may be an open-end spinning machine.

[0083] In the spinning unit 2, the yarn storage device 11 has a function of drawing the yarn Y from the air spinning device 8; however, the yarn Y may be drawn from the air spinning device 8 by a delivery roller and a nip roller. In this case, the yarn storage device 11 can be omitted. Furthermore, a slack tube absorbing slack of the yarn Y with suction airflow, a mechanical compensator, or the like may replace the yarn storage device 11. In a configuration using a delivery roller, the unit controller 15 controls the circumferential speed of the delivery roller when the unit controller 15 determines that the tension of the yarn Y is out of a predetermined range. The change in the circumferential speed of the delivery roller changes the feed ratio of the yarn Y. The change in the feed ratio can change the tension of the yarn Y drawn by the delivery roller. Consequently, in the spinning machine, the tension of the yarn Y is controlled by controlling the circumferential speed of the delivery roller based on a result of detection by the tension sensor 10.

[0084] The devices in the spinning machine 1 are disposed in a manner that the yarn Y supplied in the upper side are wound in the lower side in the height direction. The devices may be disposed such that the yarn supplied in the lower side is wound in the upper side.

[0085] In the spinning machine 1, the traverse guide 23 is driven by power from the second end frame 5 (in other words, driven by power shared by a plurality of spinning units 2). Instead of this configuration, the devices (such as the air spinning device and the winding device) of each spinning unit 2 may be driven on a per-spinning unit 2 basis.

[0086] Furthermore, the tension sensor 10 may be disposed upstream of the yarn monitoring device 9 in a direction in which the yarn Y travels. The unit controller 15 may be provided in each spinning unit 2. The yarn monitoring device 9 and the waxing device 12 may be omitted from each spinning unit 2.

[0087] FIG. 1 illustrates the spinning machine 1 winding the yarn into the package P in a cheese-like shape; however, the spinning machine 1 can wind yarn into a package in a corn-like shape. In the case with a package in a corn-like shape, although the yarn traverse causes slack on the yarn, the slack can be absorbed by the yarn storage device 11. Materials and shapes of the components are not limited to those described above, and various materials and shapes may be employed. Instead of the spinning machine 1 including the air spinning device 8, a ring spinning frame may be usable. The ring spinning frame is a spinning machine forming yarn from a fiber bundle (a spun material) and winds the yarn onto a spinning bobbin. A yarn forming unit in the ring spinning frame corresponds to the pair of front rollers of the drafting device and/or the tension adding unit of the core yarn supply device. If a ring spinning frame is used as a spinning machine, the ring spinning frame may include a core yarn supply device or may not include the same. If the ring spinning frame includes a core yarn supply device, a fiber bundle and/or core yarn are used as a spun material.

[0088] At least a part of the above-described embodiments may be combined as appropriate.

[0089] A spinning machine according to an embodiment of the present disclosure includes a yarn forming unit forming yarn from a spun material while adjusting the tension of the spun material, a winding device winding the yarn formed by the yarn forming unit, a tension detecting unit detecting the tension of the yarn in the upstream side from the winding device in a direction in which the yarn travels, and a control unit controlling the yarn forming unit and the winding device based on a result of detection by the tension detecting unit such that the yarn is wound with adjustment of the tension added by the yarn forming unit.

[0090] A spinning machine according to an embodiment of the present disclosure can maintain the tension of yarn within a predetermined range by providing feedback control to devices based on the tension of the yarn detected by a tension detecting unit. The spinning machine in this configuration can improve the quality of yarn.

[0091] A spinning machine according to an embodiment of the present disclosure includes a core yarn supply device having a supporting unit supporting a core yarn package with core yarn wound thereon and a tension adding unit adding tension to the core yarn unwound from the core yarn package. A control unit may control the operation of a yarn forming unit based on a result of detection by a tension detecting unit. A winding device may wind yarn including core yarn. This configuration enables winding of yarn while forming the yarn including core yarn with higher quality.

Claims

1. A spinning machine (1) comprising:

a yarn forming unit (6, 11a) configured to form yarn from a spun material;
 a winding device (13) configured to wind the yarn formed by the yarn forming unit (6, 11a);
 a tension detecting unit (10) configured to detect tension of the yarn in an upstream side from the winding device (13) in a direction in which the yarn travels; and
 a control unit (15) configured to control the yarn forming unit (6, 11a) based on a result of detection by the tension detecting unit (10) such that the yarn is wound onto the winding device (13) with adjustment of tension added to the spun material in the yarn forming unit (6, 11a), wherein

the control unit (15) adjusts the tension by controlling a device of the yarn forming unit (6, 11a) disposed at least in an upstream side or a downstream side from a position at which the spun material is twisted in the direction in which the yarn travels.

2. The spinning machine (1) according to claim 1, further comprising: a drafting device (6) configured to draft a fiber bundle used as the spun material, wherein the drafting device (6) includes a plurality of pairs of rollers including a pair of front rollers (19) disposed in a most downstream position in a direction in which the fiber bundle is drafted, and the control unit (15) controls a circumferential speed of the pair of front rollers (19) based on the result of detection by the tension detecting unit (10).
3. The spinning machine (1) according to claim 2, wherein when the tension of the yarn is detected below a predetermined range in the result of detection, the control unit (15) provides control of decreasing a current circumferential speed of the pair of front rollers (19) until the tension of the yarn increases to the predetermined range, and when the tension of the yarn is detected beyond the predetermined range in the result of detection, the control unit (15) provides control of increasing a current circumferential speed of the pair of front rollers (19) until the tension of the yarn decreases to the predetermined range.
4. The spinning machine (1) according to any one of claims 1 to 3, wherein the yarn forming unit includes a yarn storage roller (11a) disposed upstream of the winding device (13) in the direction in which the yarn travels and configured to store the yarn, and the control unit (15) controls the number of rotations per unit time of the yarn storage roller (11a) based on the result of detection by the tension detecting

unit (10) such that tension of the yarn detected by the tension detecting unit (10) falls within the predetermined range.

5. The spinning machine (1) according to claim 4, wherein when tension of the yarn is detected below a predetermined range in the result of detection, the control unit (15) provides control of increasing the current number of rotations of the yarn storage roller (11a) until the tension of the yarn increases to the predetermined range, and when tension of the yarn is detected beyond the predetermined range in the result of detection, the control unit (15) provides control of decreasing the current number of rotations of the yarn storage roller (11a) until the tension of the yarn decreases to the predetermined range.
6. The spinning machine (1) according to claim 4 or 5, further comprising: an air spinning device (7) configured to generate the yarn by applying swirling airflow to a fiber bundle, wherein the yarn storage roller (11a) stores the yarn while drawing the yarn generated by the air spinning device (7).
7. A spinning machine (1) comprising: a yarn forming unit including a core yarn supply device (7) that includes a supporting unit (50) configured to support a core yarn package with core yarn wound thereon and a tension adding unit (71) configured to add tension to the core yarn unwound from the core yarn package, the yarn forming unit being configured to form yarn from a spun material including the core yarn; a winding device (13) configured to wind the yarn formed by the yarn forming unit; a tension detecting unit (10) configured to detect tension of the yarn in an upstream side from the winding device (13) in a direction in which the yarn travels; and a control unit (15) configured to control the tension adding unit (71) based on a result of detection by the tension detecting unit (10) such that the yarn is wound onto the winding device (13) with adjustment of tension added to the spun material in the yarn forming unit.
8. The spinning machine (1) according to claim 7, wherein the control unit (15) controls the tension adding unit based on the result of detection by the tension detecting unit (10) such that tension of the yarn detected by the tension detecting unit (10) falls within a predetermined range.

Fig.1

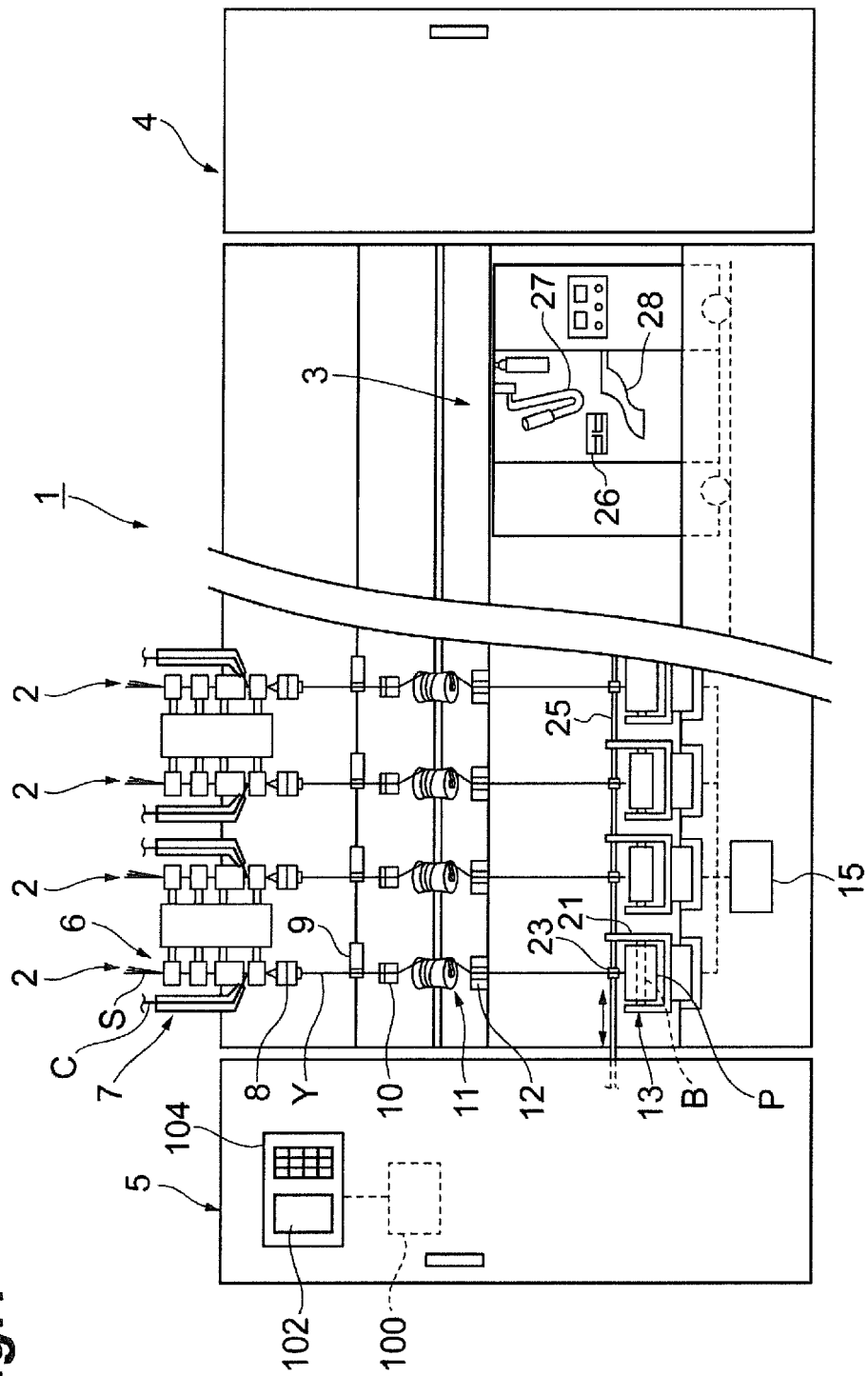


Fig.2

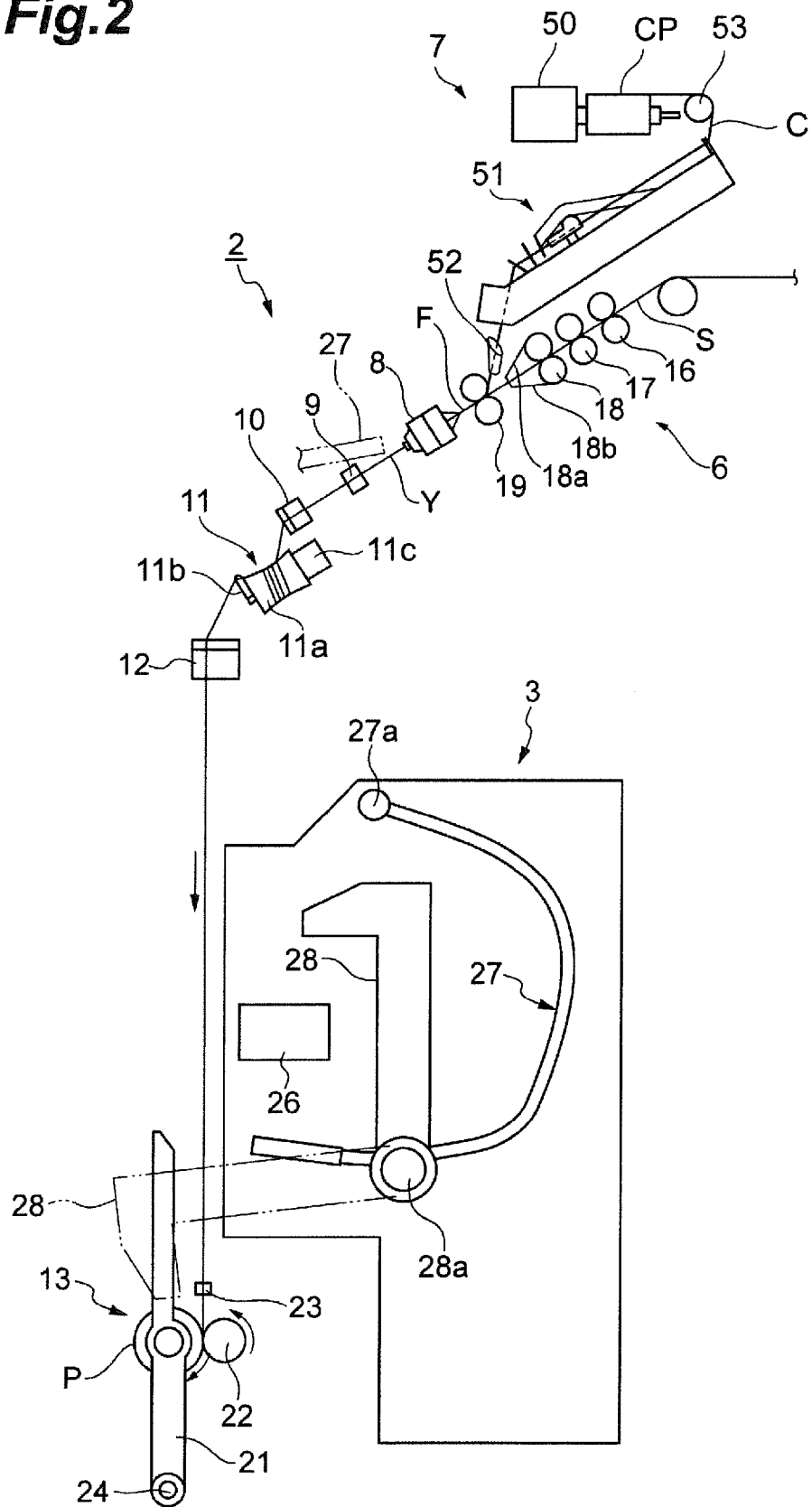
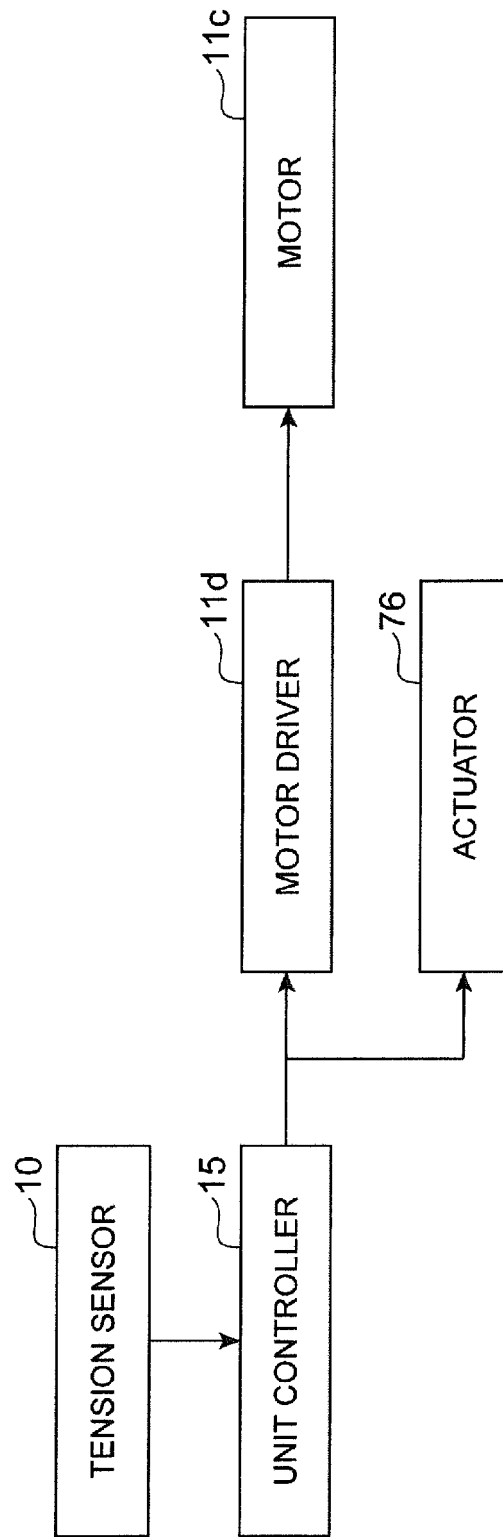
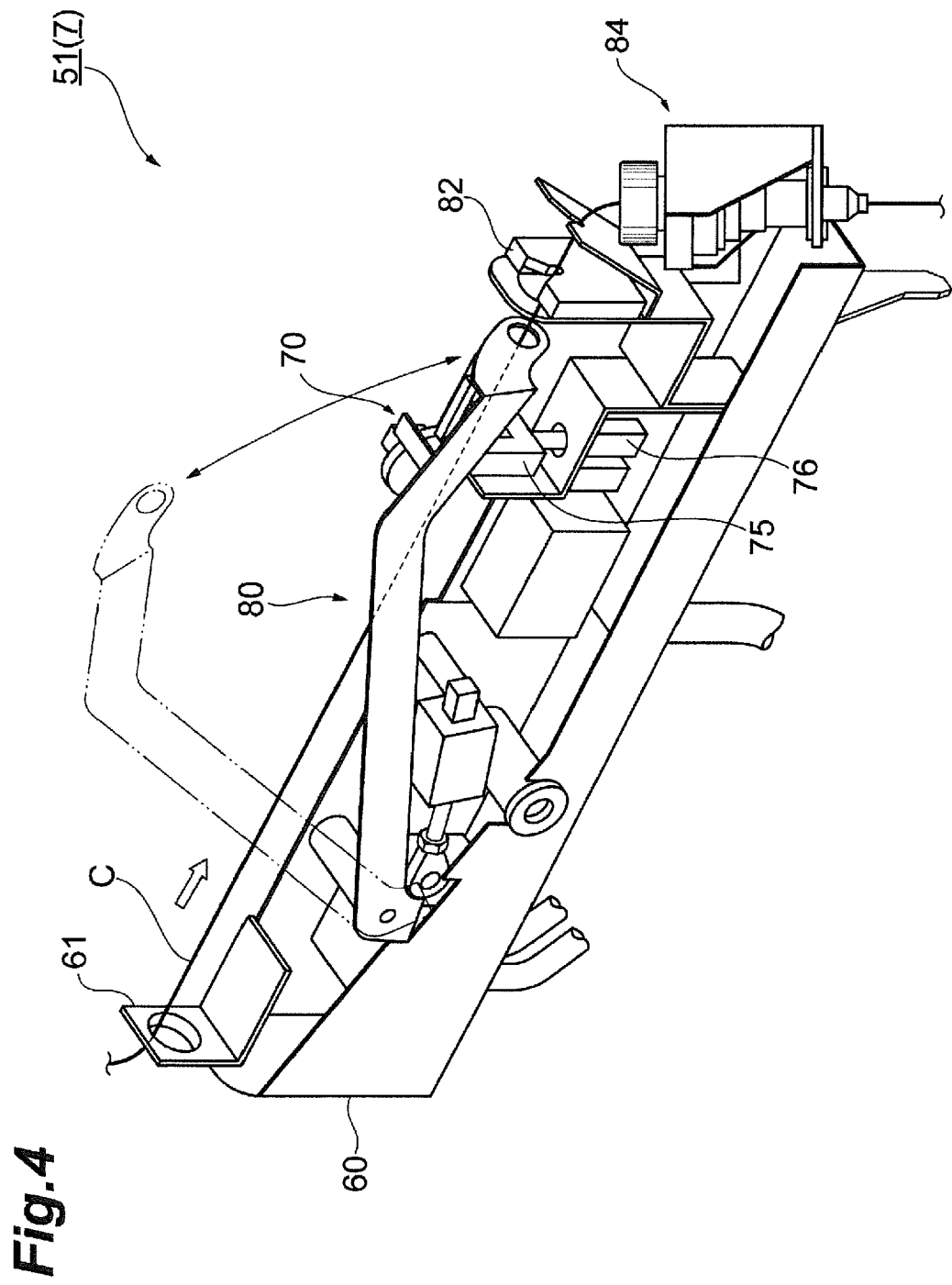


Fig.3





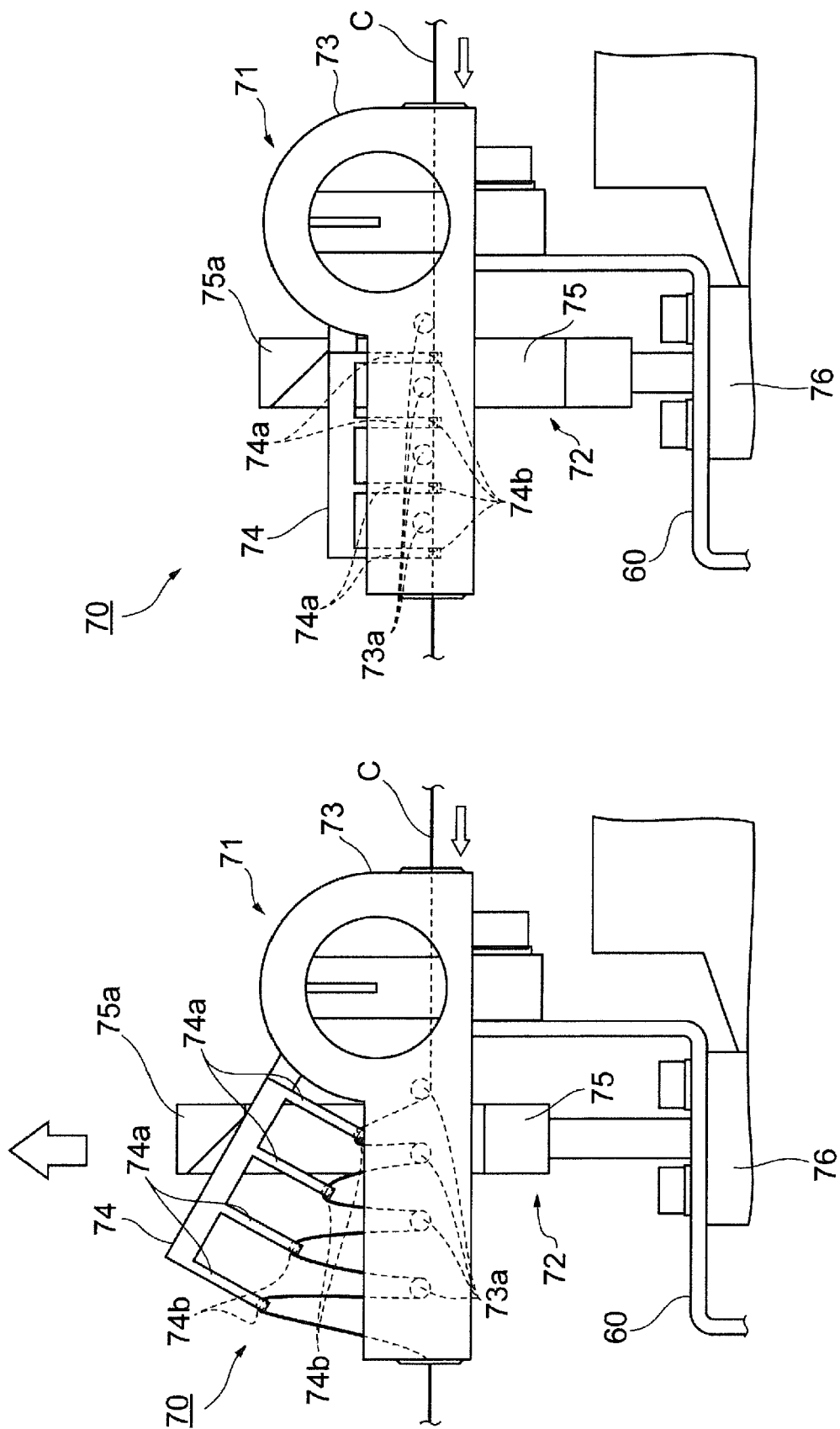
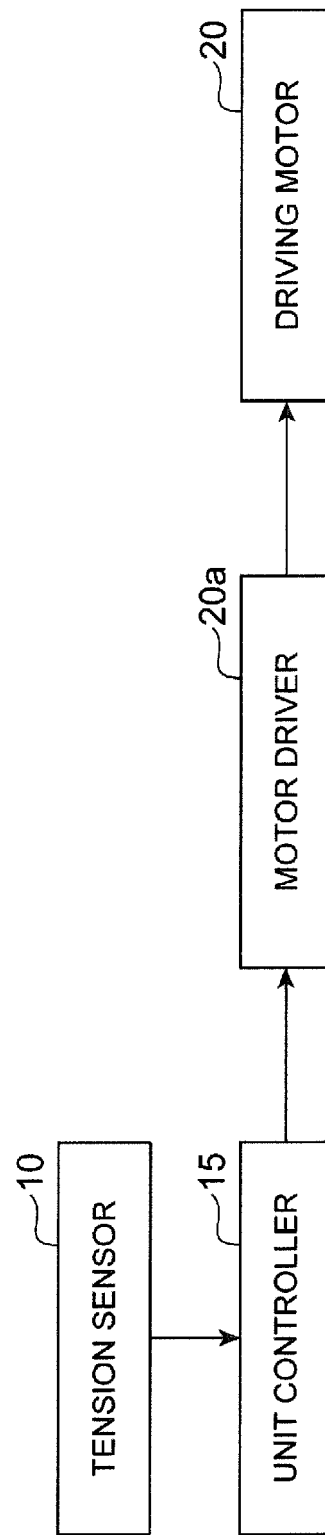


Fig. 5B

Fig. 5A

Fig.6



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