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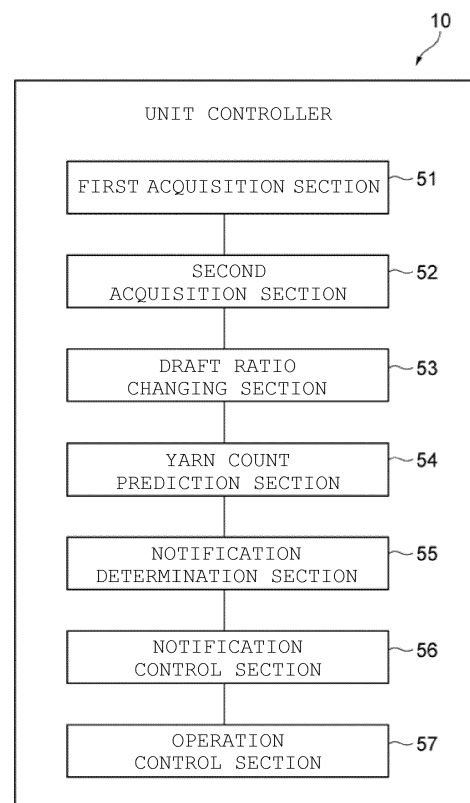
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(54) **SPINNING METHOD, SPINNING MACHINE, AND SPINNING PROGRAM**

(57) A spinning method is executed by a spinning machine (1) in which a yarn (Y) is produced by drafting a fiber bundle (S) by a draft device (6) and spinning the drafted fiber bundle (S) by a pneumatic spinning device (7). The spinning method includes: a first acquiring step of acquiring fiber bundle information indicating a status of the pre-drafted fiber bundle (S); a second acquiring step of acquiring yarn information indicating a status of the produced yarn (Y); and a changing step of changing a total draft ratio of a drafting operation performed in the draft device (6) in accordance with the fiber bundle information acquired in the first acquiring step and the yarn information acquired in the second acquiring step.

FIG. 3



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Description

BACKGROUND OF THE INVENTION

5 1. Field of the Invention

[0001] The present invention relates to a spinning method, a spinning machine, and a spinning program.

10 2. Description of the Related Art

[0002] There is a spinning machine in which a yarn is produced by drafting a fiber bundle by a draft device, and spinning the drafted fiber bundle by a spinning device. A spinning machine provided with such a draft device is described in, for example, JP 2014-9422 A.

[0003] In the spinning machine as described above, yarn quality can be further improved by setting a total draft ratio of the draft device more appropriately.

BRIEF SUMMARY OF THE INVENTION

[0004] An object of the present invention is to provide a spinning method, a spinning machine, and a spinning program that can further improve yarn quality.

[0005] A spinning method according to the present invention is executed in a spinning machine in which a yarn is produced by drafting a fiber bundle by a draft device and spinning the drafted fiber bundle by a spinning device. The spinning method includes: a first acquiring step of acquiring fiber bundle information indicating a status of a pre-drafted fiber bundle; a second acquiring step of acquiring, as the yarn information, tension of the produced yarn; and a changing step of changing a total draft ratio of a drafting operation of the draft device, in accordance with the fiber bundle information acquired in the first acquiring step and the yarn information acquired in the second acquiring step.

[0006] In this spinning method, since the total draft ratio is changed in accordance with two types of information that are the fiber bundle information and the yarn information, the total draft ratio may be set more appropriately. Therefore, according to this spinning method, the yarn quality can be further improved.

[0007] In the spinning method, in the changing step, the total draft ratio may be changed by changing a rotational speed of at least one of a back bottom roller of the draft device, a front bottom roller of the draft device, or a withdrawal roller adapted to withdraw the yarn from the spinning device. According to this spinning method, the total draft ratio can be appropriately changed.

[0008] In the spinning method, in the second acquiring step, thickness of the yarn and/or mass of the yarn may be acquired as the yarn information. According to this spinning method, since the total draft ratio is changed in accordance with the fiber bundle information, the information indicating tension of the yarn, and thickness of the yarn and/or mass of the yarn, the total draft ratio may be set even more appropriately.

[0009] In the spinning method, in the changing step, when the fiber bundle information indicates an increase in mass of the fiber bundle and the yarn information indicates an increase in thickness of the yarn or an increase in mass of the yarn, the total draft ratio may be increased, and when the fiber bundle information indicates a decrease in mass of the fiber bundle and the yarn information indicates a decrease in thickness of the yarn or a decrease in mass of the yarn, the total draft ratio may be reduced. According to this spinning method, it is possible to appropriately determine how to change the total draft ratio.

[0010] The spinning method may include an operation controlling step of controlling a drafting operation of the draft device and a spinning operation of the spinning device. The changing step may be executed while continuing the drafting operation of the draft device and the spinning operation of the spinning device in the operation controlling step. According to this spinning method, even if the total draft ratio is changed, the yarn can be continuously produced in the spinning machine, and productivity of the spinning machine can be maintained.

[0011] In the spinning method, in the changing step, at least in one of cases where a status in which a fluctuation amount of the fiber bundle information is equal to or greater than a fiber bundle lower-limit fluctuation amount and is equal to or smaller than a first fiber bundle fluctuation amount lasts for a first fiber bundle length or longer, or where a status in which a fluctuation amount of the yarn information is equal to or greater than a yarn lower-limit fluctuation amount and is equal to or smaller than a first yarn fluctuation amount lasts for a first yarn length or longer, the total draft ratio may be changed. According to this spinning method, in accordance with the fluctuation amount of the fiber bundle information and the fluctuation amount of the yarn information, when a status in which the fluctuation amount is equal to or smaller than the first fiber bundle fluctuation amount or equal to or smaller than the first yarn fluctuation amount lasts, the total draft ratio may be changed. As a result, by performing the drafting operation with the changed total draft ratio, a difference in quality of the yarn to be produced before and after the change can be kept within a certain range.

[0012] In the spinning method, in the operation controlling step, at least in one of cases where a status in which the fluctuation amount of the fiber bundle information acquired in the first acquiring step exceeds the first fiber bundle fluctuation amount lasts for the first fiber bundle length or longer, or where a status in which the fluctuation amount of the yarn information acquired in the second acquiring step exceeds the first yarn fluctuation amount lasts for the first yarn length or longer, the drafting operation of the draft device and the spinning operation of the spinning device may be stopped. According to this spinning method, when a status in which the fluctuation amount is large lasts, it is possible to stop continuous production of yarn with low quality, by stopping the drafting operation and the spinning operation.

[0013] In the spinning method, the spinning machine may further include a yarn information detecting device adapted to detect the yarn information. The yarn information detecting device may judge that the yarn includes a yarn defect when judging, in accordance with the detected yarn information, that a status in which a fluctuation amount of the yarn information exceeds a second yarn fluctuation amount is lasting for a second yarn length or greater; the second yarn fluctuation amount may be greater than the first yarn fluctuation amount; the second yarn length may be shorter than the first yarn length; and in the operation controlling step, the drafting operation of the draft device and the spinning operation of the spinning device may be stopped when the yarn information detecting device judges that there is the yarn defect. According to this spinning method, for example, when a yarn defect having a large fluctuation amount and a short length is detected, the drafting operation and the spinning operation can be stopped. As a result, such a short yarn defect can be removed while the drafting operation and the spinning operation are stopped.

[0014] In the spinning method, the spinning machine further includes a tension notification device adapted to notify fluctuation in tension of the produced yarn. The spinning method may further include a tension notification controlling step of executing notification by the tension notification device when the fiber bundle information acquired in the first acquiring step indicates no change in mass of the fiber bundle and the yarn information acquired in the second acquiring step indicates an increase in tension of the yarn, or when the fiber bundle information acquired in the first acquiring step indicates a decrease in mass of the fiber bundle and the yarn information acquired in the second acquiring step indicates an increase in the tension of the yarn. According to this spinning method, it is possible to notify an operator that an abnormality is occurring in the tension of the produced yarn.

[0015] The spinning method may further include a first determining step of determining whether or not to execute notification, in accordance with the fiber bundle information acquired in the first acquiring step and the yarn information acquired in the second acquiring step. According to this spinning method, it is possible to appropriately determine whether or not to execute notification.

[0016] The spinning method may further include a first yarn count predicting step of predicting a predicted yarn count, which is a yarn count of the yarn to be produced by the spinning device, in accordance with the fiber bundle information acquired in the first acquiring step. In the first determining step, a determination may be carried out as to whether or not notification of occurrence of a fiber loss is necessary, in accordance with the predicted yarn count predicted in the first yarn count predicting step and an acquired yarn count, which is a yarn count of the yarn indicated by the yarn information acquired in the second acquiring step.

[0017] According to the spinning method, it is possible to prevent production of abnormal yarn in advance.

[0018] In the spinning method, in the first determining step, when the predicted yarn count and the acquired yarn count do not match, a determination may be made that the notification of occurrence of the fiber loss is necessary. According to this spinning method, when a fiber loss occurs, notification can be executed that a fiber loss has occurred.

[0019] The spinning method may further include a second determining step of determining whether or not to execute notification, in accordance with the fiber bundle information acquired in the first acquiring step and setting information of the yarn to be produced that has been set in the spinning machine. According to this spinning method, since it is possible to determine whether or not notification is necessary in accordance with the fiber bundle information and the setting information, the determination can be performed with high accuracy.

[0020] The spinning method may further include a second yarn count predicting step of predicting a predicted yarn count, which is a yarn count of the yarn to be produced by the spinning machine, in accordance with the fiber bundle information acquired in the first acquiring step. In the second determining step, in accordance with the predicted yarn count predicted in the second yarn count predicting step and a set yarn count, which is a yarn count of the yarn set in the spinning machine as the setting information of the yarn, a determination may be carried out as to whether or not notification of occurrence of an error in supplying of the fiber bundle to the spinning machine or notification of occurrence of fall-off of the fiber bundle in a drawing machine adapted to produce the fiber bundle is necessary. According to this spinning method, it is possible to appropriately determine whether or not to notify occurrence of the error in supplying of the fiber bundle or whether or not to notify occurrence of the fall-off of the fiber bundle in the drawing machine.

[0021] In the spinning method, in the second determining step, when determining that the notification of occurrence of fall-off of the fiber bundle is necessary, a determination may be further carried out, in accordance with a decrease rate of the predicted yarn count with respect to the set yarn count, as to in which drawing process among a plurality of drawing processes performed by the drawing machine, the fall-off of the fiber bundle has occurred. A status (mass) of the produced fiber bundle varies depending on in which drawing process the fall-off of the fiber bundle has occurred.

Therefore, according to this spinning method, by using the decrease rate of the predicted yarn count with respect to the set yarn count, a determination can be made as to in which drawing process the fall-off of the fiber bundle has occurred.

[0022] In the spinning method, in the second determining step, when the predicted yarn count is greater than the set yarn count, a determination may be made that the notification of occurrence of the fall-off of the fiber bundle is necessary, and when the predicted yarn count is less than the set yarn count, a determination may be made that the notification of occurrence of the error in supplying of the fiber bundle to the spinning machine is necessary. According to this spinning method, it is possible to appropriately determine whether or not the notification of occurrence of the fall-off of the fiber bundle is necessary and whether or not the notification of occurrence of the error in supplying of the fiber bundle is necessary.

[0023] The spinning machine may further include a notification device adapted to execute notification, and the spinning method may further include a notification controlling step of executing notification by the notification device when a determination is made that the notification is necessary as a result of the determination as to whether or not the notification is necessary. According to this spinning method, it is possible to notify an operator that a situation requiring notification has occurred.

[0024] The spinning method may further include an operation controlling step of controlling a drafting operation of the draft device and a spinning operation of the spinning device. In the operation controlling step, the drafting operation of the draft device and the spinning operation of the spinning device may be stopped when a determination is made in the first determining step that the notification is necessary. According to this spinning method, it is possible to prevent continuous production of the yarn when a determination is made that the notification is necessary.

[0025] A spinning machine according to the present invention includes: a draft device adapted to draft a fiber bundle; a fiber bundle information detecting device adapted to detect fiber bundle information indicating a status of the pre-drafted fiber bundle, and/or a fiber bundle information receiving device adapted to receive the fiber bundle information; a spinning device adapted to produce a yarn by spinning the fiber bundle drafted by the draft device; a yarn information detecting device adapted to detect yarn information indicating tension of the yarn produced by the spinning device; a winding device adapted to wind the yarn produced by the spinning device; and a control part adapted to execute any one of the spinning methods described above. The control part is adapted to acquire the fiber bundle information detected by the fiber bundle information detecting device and/or received by the fiber bundle information receiving device in the first acquiring step, and to acquire the yarn information detected by the yarn information detecting device in the second acquiring step.

[0026] This spinning machine can set the total draft ratio more appropriately by changing the total draft ratio using two types of information that are the fiber bundle information and the yarn information. Therefore, according to this spinning machine, yarn quality can be further improved.

[0027] A spinning program according to the present invention causes a computer to execute, in a spinning machine adapted to produce a yarn by drafting a fiber bundle by a draft device and spinning the drafted fiber bundle by a spinning device, processes of: acquiring fiber bundle information indicating a status of the pre-drafted fiber bundle; acquiring yarn information indicating tension of the produced yarn; and changing a total draft ratio of a drafting operation executed by the draft device, in accordance with the acquired fiber bundle information and yarn information.

[0028] According to this spinning program, it is possible to set the total draft ratio more appropriately by changing the total draft ratio using two types of information that are the fiber bundle information and the yarn information. Therefore, according to this spinning program, yarn quality can be further improved.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029]

FIG. 1 is a front view illustrating a spinning machine according to an embodiment;
 FIG. 2 is a side view illustrating a spinning unit of FIG. 1;
 FIG. 3 is a block diagram illustrating a functional configuration of a unit controller;
 FIG. 4 is a list showing each pattern example when a draft ratio changing section controls a total draft ratio in accordance with a yarn thickness acquired by a second acquisition section;
 FIG. 5 is a list showing each pattern example when the draft ratio changing section controls a total draft ratio in accordance with mass of a yarn acquired by the second acquisition section;
 FIG. 6 is a list showing each pattern example when the draft ratio changing section controls a total draft ratio in accordance with yarn tension acquired by the second acquisition section;
 FIG. 7 is a flowchart showing a flow of a notification controlling process related to a fiber bundle performed by the unit controller; and
 FIG. 8 is a diagram illustrating a spinning program according to an embodiment.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0030] Embodiments of the present invention will be hereinafter described with reference to the drawings. The same reference numerals are denoted on the same components in the description of the drawings, and the redundant description will be omitted.

[0031] As illustrated in FIG. 1, a spinning machine 1 according to the present embodiment performs a spinning method to produce a yarn Y by drafting a fiber bundle S and spinning the drafted fiber bundle S. The spinning machine 1 includes a plurality of spinning units 2, a yarn joining cart 3, a doffing cart (not illustrated), a first end frame 4, and a second end frame 5. The plurality of spinning units 2 are arranged in a row. Each of the spinning units 2 is adapted to produce a yarn Y and to wind the yarn Y around a package P. The yarn joining cart 3 is adapted to perform a yarn joining operation in a spinning unit 2 when the yarn Y is cut, or is broken for some reason in such a spinning unit 2. The doffing cart is adapted to doff the package P and to supply a new bobbin B to a spinning unit 2 when the package P is fully-wound in the spinning unit 2.

[0032] The first end frame 4 accommodates a collecting device or the like adapted to collect a fly waste (such as a fiber waste or a yarn waste) generated in the spinning units 2. The second end frame 5 accommodates an air supplying section adapted to adjust air pressure of compressed air (air) supplied to the spinning machine 1 and to supply the air to each section of the spinning machine 1, a drive motor adapted to supply power to each section of the spinning unit 2, and the like. The second end frame 5 is provided with a machine control device 100, a display screen (a tension notification device, a notification device) 102, and an input key 104. The machine control device 100 is adapted to intensively manage and control each section of the spinning machine 1. The display screen 102 is capable of displaying information and the like relating to at least one of set contents or a status of the spinning units 2. An operator can perform a setting operation of the spinning units 2 by performing an appropriate operation with the input key 104. Note that the display screen 102 may be a touch panel display, and the touch panel display may be operated instead of the input keys 104.

[0033] The machine control device 100 is an electronic control unit (a computer) adapted to perform various types of arithmetic processing, control processing of each section, and the like. The machine control device 100 includes: for example, a processor (e.g., a central processing unit (CPU)) that executes various programs and the like; a storage section configured by a read only memory (ROM), a random access memory (RAM), a hard disk, and the like; a communication section adapted to control communication between with each section; and the like.

[0034] As illustrated in FIGS. 1 and 2, each spinning unit 2 includes a draft device 6, a pneumatic spinning device (a spinning device) 7, a yarn monitoring device (a yarn information detecting device) 8, a tension sensor (a yarn information detecting device) 9, a yarn accumulating device 11, a waxing device 12, and a winding device 13 in this order from upstream in a travelling direction of the yarn Y. A unit controller (control part) 10 is provided for every predetermined number of the spinning units 2. Similarly to the machine control device 100, for example, the unit controller 10 is an electronic control unit (a computer) having: a processor that executes various programs and the like; a storage section 58 (see FIG. 8) configured by a ROM, a RAM, a hard disk, and the like; a communication section adapted to control communication between with each section; and the like.

[0035] To the draft device 6, the fiber bundle S drawn from a can K is supplied via a creel device 40. The creel device 40 is provided with a fiber bundle sensor (a fiber bundle information detecting device) 20. The fiber bundle sensor 20 acquires fiber bundle information indicating a status of the fiber bundle S to be drafted by the draft device 6. In the present embodiment, a capacitive sensor that allows the fiber bundle S to pass through an electric field, to detect a temporal change in mass of the fiber bundle S (hereinafter referred to as "fiber bundle mass") is used as the fiber bundle sensor 20. The fiber bundle sensor 20 transmits the detected temporal change of the fiber bundle mass to the unit controller 10 as the fiber bundle information.

[0036] The fiber bundle mass may change, for example, when maintenance of a drawing machine that has produced the fiber bundle S is inappropriate, when the can K storing the fiber bundle S has been left for a long time, when there is a change in a raw material itself of the fiber bundle S, or when a storage environment (temperature and humidity) of the can K has changed.

[0037] The draft device 6 drafts (stretches) the fiber bundle (sliver) S to be supplied to the pneumatic spinning device 7. The draft devices 6 are arranged in a row in accordance with arrangement of the spinning units 2. The draft device 6 includes a pair of back rollers 14, a pair of third rollers 15, a pair of middle rollers 16, and a pair of front rollers 17 in this order from upstream in a travelling direction of the fiber bundle S.

[0038] The pair of back rollers 14 include a back bottom roller 14a and a back top roller 14b. The back bottom roller 14a and the back top roller 14b are rollers for drafting the fiber bundle S, and are opposed to each other with a travelling path for traveling of the fiber bundle S (hereinafter simply referred to as a "travelling path") interposed in between. The pair of third rollers 15 include a third bottom roller 15a and a third top roller 15b. The third bottom roller 15a and the third top roller 15b are rollers for drafting the fiber bundle S, and are opposed to each other with the travelling path interposed in between. The pair of middle rollers 16 include a middle bottom roller 16a and a middle top roller 16b. The middle

bottom roller 16a and the middle top roller 16b are rollers for drafting the fiber bundle S, and are opposed to each other with the travelling path interposed in between. The pair of front rollers 17 include a front bottom roller 17a and a front top roller 17b. The front bottom roller 17a and the front top roller 17b are rollers for drafting the fiber bundle S, and are opposed to each other with the travelling path interposed in between.

[0039] The back bottom roller 14a is rotated by a drive motor (hereinafter referred to as "back bottom roller drive motor") provided for each spinning unit 2. The third bottom roller 15a is also rotated by another drive motor provided for each spinning unit 2. The middle bottom rollers 16a and the front bottom rollers 17a are respectively rotated by respective drive motors in the second end frame 5. In the second end frame 5, there are provided a drive motor that drives the middle bottom rollers 16a of the plurality of spinning units 2 all at once, and a drive motor that drives the front bottom rollers 17a of the plurality of spinning units 2 all at once. The back bottom roller 14a, the third bottom roller 15a, the middle bottom roller 16a, and the front bottom roller 17a are rotated at mutually different rotational speeds so as to be faster in the downstream side rollers. An apron belt 18a is provided for the middle bottom roller 16a. An apron belt 18b is provided for the middle top roller 16b.

[0040] The draft device 6 can change a total draft ratio of the draft device 6 for drafting the fiber bundle S, by changing a rotational speed of the back bottom roller drive motor. The draft device 6 changes the total draft ratio by changing the rotational speed of the back bottom roller drive motor in accordance with an instruction from the unit controller 10. The total draft ratio can be expressed by the following formula.

$$\text{Total draft ratio} = (\text{amount or number of fibers before being introduced into pair of back rollers}) / (\text{amount or number of fibers after being drafted by pair of front rollers})$$

[0041] As an alternative embodiment, the total draft ratio may be expressed by the following formulas.

$$\text{Total draft ratio} = (\text{amount or number of fibers before being introduced into pair of back rollers}) / (\text{amount or number of fibers after being unwound from yarn accumulating roller})$$

$$\text{Total draft ratio} = (\text{amount or number of fibers before being introduced into pair of back rollers}) / (\text{amount or number of fibers after being processed by pair of delivery rollers})$$

[0042] As illustrated in FIGS. 1 and 2, the pneumatic spinning device 7 is adapted to produce the yarn Y by twisting a fiber bundle F, which has been drafted by the draft device 6, with whirling airflow. The pneumatic spinning device 7 is disposed downstream of the draft device 6 in a travelling direction of the fiber bundle F and the yarn Y during spinning.

[0043] The yarn monitoring device 8 monitors the travelling yarn Y between the pneumatic spinning device 7 and the yarn accumulating device 11, and detects yarn information indicating a status of the produced yarn Y. The yarn monitoring device 8 transmits the detected yarn information to the unit controller 10. Further, the yarn monitoring device 8 detects the presence or absence of a yarn defect in accordance with the yarn information. When detecting the 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 the yarn defect, for example, a yarn breakage of the yarn Y, an abnormality in thickness of the yarn Y (hereinafter referred to as "yarn thickness"), or a foreign substance contained in the yarn Y. In the present embodiment, the yarn monitoring device 8 detects a yarn thickness (apparent thickness) as the yarn information. As such a yarn monitoring device 8, an optical sensor may be used that irradiates the yarn Y with light to detect a temporal change in the yarn thickness on the basis of a change in a received light amount. That is, in the present embodiment, the yarn monitoring device 8 detects a temporal change (change over time) in the yarn thickness as the yarn information.

[0044] The tension sensor 9 is adapted to measure tension of the travelling yarn Y between the pneumatic spinning device 7 and the yarn accumulating device 11, and to transmit a tension measurement signal to the unit controller 10. When the unit controller 10 determines presence of an abnormality in accordance with at least any one of detection results of the yarn monitoring device 8 and the tension sensor 9, the yarn Y is cut in the spinning unit 2.

[0045] The yarn accumulating device 11 is adapted to store the yarn Y between the pneumatic spinning device 7 and the winding device 13. The yarn accumulating device 11 has a function of stably withdrawing the yarn Y from the

pneumatic spinning device 7. The yarn accumulating device 11 has a function of preventing slackening of the yarn Y by accumulating the yarn Y fed from the pneumatic spinning device 7 at the time of the yarn joining operation or the like by the yarn joining cart 3, and a function of preventing propagation of fluctuation in the tension of the yarn Y at downstream of the yarn accumulating device 11 to the pneumatic spinning device 7. The waxing device 12 is adapted to apply wax to the yarn Y between the yarn accumulating device 11 and the winding device 13.

[0046] The winding device 13 is adapted to wind the yarn Y around a bobbin B to form 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 is adapted to rotatably support the bobbin B. A drive motor (not illustrated) provided in the second end frame 5 is adapted to simultaneously drive the winding drums 22 each provided in the plurality of the spinning units 2. The traverse guide 23 is provided on a shaft 25 shared by the plurality of the spinning units 2. By the drive motor in the second end frame 5 driving the shaft 25 to reciprocate in a rotation axis direction of the winding drum 22, the traverse guide 23 traverses the yarn Y in a predetermined width.

[0047] After the yarn Y is cut, or is broken for some reason in one spinning unit 2, the yarn joining cart 3 travels to the spinning unit 2 to perform the yarn joining operation. The yarn joining cart 3 includes a yarn joining device 26, a suction pipe 27, and a suction mouth 28. The suction pipe 27 is swingably supported by a supporting shaft 31, and is adapted to catch the yarn Y from the pneumatic spinning device 7 and to guide the caught yarn Y to the yarn joining device 26. The suction mouth 28 is swingably supported by a supporting shaft 32, and is adapted to catch the yarn Y from the winding device 13 and to guide the caught yarn Y to the yarn joining device 26. The yarn joining device 26 is adapted to join the guided yarns Y together. The yarn joining device 26 is a splicer using compressed air, a knitter adapted to join the yarns Y together in a mechanical manner, or the like. The yarn joining device 26 may be configured to perform yarn joining by reversely feeding the yarn Y from the package P to the pneumatic spinning device 7, and restarting the drafting operation of the draft device 6 and the spinning operation of the pneumatic spinning device 7.

[0048] Next, details of various kinds of control performed by the unit controller 10 will be described. The unit controller 10 controls an operation of each section of the spinning unit 2. In the following, among various kinds of control performed by the unit controller 10, total draft ratio change control, and notification control relating to the fiber bundle S or the yarn Y will be described.

[0049] As illustrated in FIG. 3, the unit controller 10 functionally includes a first acquisition section 51, a second acquisition section 52, a draft ratio changing section 53, a yarn count prediction section 54, a notification determination section 55, a notification control section 56, an operation control section 57, and the storage section 58 (see FIG. 8).

[0050] The first acquisition section 51 acquires, from the fiber bundle sensor 20, fiber bundle information (the fiber bundle mass) indicating a status of the fiber bundle S before being drafted by the draft device 6. As described above, the first acquisition section 51 executes a first acquiring step of acquiring the fiber bundle information indicating a status of the pre-drafted fiber bundle S.

[0051] The second acquisition section 52 acquires tension from the tension sensor 9 as yarn information indicating a status of the yarn Y produced by the pneumatic spinning device 7.

[0052] The second acquisition section 52 may acquire yarn thickness as the yarn information, from the yarn monitoring device 8.

[0053] As described above, the second acquisition section 52 executes the second acquiring step of acquiring the yarn information indicating a status of the produced yarn Y.

[0054] The draft ratio changing section 53 changes a total draft ratio of the drafting operation performed by the draft device 6. The draft ratio changing section 53 changes the total draft ratio by outputting a control signal to the draft device 6 and controlling a rotational speed of the back bottom roller drive motor. Details of the total draft ratio change control will be described later.

[0055] In accordance with the fiber bundle mass acquired by the first acquisition section 51, the yarn count prediction section 54 predicts a predicted yarn count, which is a yarn count of the yarn Y to be produced by the pneumatic spinning device 7. For example, in accordance with fiber bundle mass acquired by the first acquisition section 51, a total draft ratio set in the draft device 6, a spinning condition in the pneumatic spinning device 7, and the like, the yarn count prediction section 54 can predict a predicted yarn count by a known method. Thus, in accordance with the fiber bundle mass (the fiber bundle information) acquired by the first acquisition section 51, the yarn count prediction section 54 executes a yarn count predicting step (a first yarn count predicting step, a second yarn count predicting step) of predicting the predicted yarn count of the yarn Y to be produced by the pneumatic spinning device 7.

[0056] The notification determination section 55 determines whether or not notification relating to the fiber bundle S or the yarn Y is necessary. Details of processing performed by the notification determination section 55 will be described later.

[0057] The notification control section 56 displays various kinds of information on the display screen 102, to perform various notifications to an operator. The notification control section 56 performs notification when a determination is made that the notification to the operator is necessary. In this way, the notification control section 56 executes a notification controlling step of performing notification by the display screen 102.

[0058] The operation control section 57 executes an operation controlling step of controlling the drafting operation of the draft device 6 and the spinning operation of the pneumatic spinning device 7.

[0059] [Total draft ratio change control] First, total draft ratio change control performed by the unit controller 10 will be described. In accordance with a change in the fiber bundle mass (the fiber bundle information) acquired by the fiber bundle sensor 20 and a change in the yarn thickness (the yarn information) detected by the yarn monitoring device 8,

the draft ratio changing section 53 changes a total draft ratio of the drafting operation performed by the draft device 6. **[0060]** Specifically, the draft ratio changing section 53 transmits a control signal to the draft device 6 so as to change the total draft ratio. By the draft device 6 changing a rotational speed of the back bottom roller drive motor in accordance with this control signal, the total draft ratio is changed. In this way, the draft ratio changing section 53 executes a changing step of changing the total draft ratio of the drafting operation performed in the draft device 6.

[0061] When the fiber bundle mass (the fiber bundle information) indicates an increase and the yarn thickness (the yarn information) indicates an increase, the draft ratio changing section 53 increases the total draft ratio. In the present embodiment, the draft ratio changing section 53 increases the total draft ratio by increasing the rotational speed of the back bottom roller drive motor. Accordingly, a draft length (length to be stretched) of the fiber bundle S by the draft device 6 becomes long, and mass per unit length of the yarn Y produced by the pneumatic spinning device 7 becomes small (the yarn count of the yarn Y becomes large).

[0062] When the fiber bundle mass (the fiber bundle information) indicates a decrease and the yarn thickness (the yarn information) indicates a decrease, the draft ratio changing section 53 reduces the total draft ratio. In the present embodiment, the draft ratio changing section 53 reduces the total draft ratio by reducing the rotational speed of the back bottom roller drive motor. Accordingly, a draft length of the fiber bundle S by the draft device 6 becomes short, and mass per unit length of the yarn Y produced by the pneumatic spinning device 7 becomes large (the yarn count of the yarn Y becomes small).

[0063] The fiber bundle mass and the yarn thickness are always detected by the fiber bundle sensor 20 and the yarn monitoring device 8, respectively. Therefore, the first acquisition section 51 can always acquire the fiber bundle mass detected by the fiber bundle sensor 20, and the second acquisition section 52 can always acquire the yarn thickness detected by the yarn monitoring device 8. Thus, the draft ratio changing section 53 can always execute the total draft ratio change control in accordance with the change in the fiber bundle mass and the change in the yarn thickness that have been acquired.

[0064] The draft device 6 may change the total draft ratio during drafting of the fiber bundle S without interrupting the drafting operation. Therefore, even if the total draft ratio is changed by the draft ratio changing section 53, the operation control section 57 does not interrupt the drafting operation of the draft device 6 and the spinning operation of the pneumatic spinning device 7 from before the change of the total draft ratio to after the change. That is, from before the total draft ratio is changed to after the total draft ratio is changed by the draft ratio changing section 53, the operation control section 57 can continue the drafting operation of the draft device 6 and the spinning operation of the pneumatic spinning device 7. In this way, the draft ratio changing section 53 can always adjust the yarn count of the yarn Y produced by the spinning unit 2, by changing the total draft ratio.

[0065] However, the total draft ratio change control is not limited to being always performed. For example, the draft ratio changing section 53 may execute the total draft ratio change control at a predetermined timing such as when yarn breakage and/or yarn cut occurs. The operation control section 57 may interrupt the drafting operation of the draft device 6 and the spinning operation of the pneumatic spinning device 7 when the draft ratio changing section 53 changes the total draft ratio.

[0066] The draft ratio changing section 53 executes the total draft ratio change control when at least one of the fiber bundle mass or the yarn thickness has fluctuated (deviated from a desired value) over a long period of time. Even if at least one of the fiber bundle mass or the yarn thickness has fluctuated over a long period of time, the draft ratio changing section 53 does not execute the total draft ratio change control when the fluctuation amount is large. In this case, the operation control section 57 stops the drafting operation of the draft device 6 and the spinning operation of the pneumatic spinning device 7. Note that, here, the case where "the fiber bundle mass fluctuates over a long period of time" is, for example, a case where the fiber bundle mass fluctuates over about 1 m to 2 m in the length of the fiber bundle S. In addition, the case where "the yarn thickness fluctuates over a long period of time" is, for example, a case where the yarn thickness fluctuates over about 200 m to 400 m in the length of the yarn Y when the total draft ratio is 200 times.

[0067] Specifically, the draft ratio changing section 53 executes the total draft ratio change control described above at least in one of cases where a status in which a fluctuation amount (a deviation amount) of fiber bundle mass is equal to or larger than a fiber bundle lower-limit fluctuation amount and equal to or smaller than a first fiber bundle fluctuation amount lasts for a first fiber bundle length or longer, or where a status in which a fluctuation amount (a deviation amount) of yarn thickness is equal to or larger than a yarn lower-limit fluctuation amount and equal to or smaller than a first yarn fluctuation amount lasts for a first yarn length or more. In this case, the draft device 6 drafts the fiber bundle S with the changed total draft ratio, and the pneumatic spinning device 7 spins the drafted fiber bundle F to produce the yarn Y. For fiber bundle mass and yarn thickness serving as a reference for obtaining the fluctuation amount (the deviation

amount) of the fiber bundle mass and the yarn thickness, the fiber bundle mass and the yarn thickness when the yarn Y of a desired yarn count is obtained at a time of production of the yarn Y may be used, or a preset value may be used.

[0068] The fiber bundle lower-limit fluctuation amount and the yarn lower-limit fluctuation amount are set in order to prevent the total draft ratio from being changed by a minute fluctuation such as noise. Further, the fiber bundle lower-limit fluctuation amount and the yarn lower-limit fluctuation amount may be set to prevent the total draft ratio from being changed by a minute fluctuation that does not require change of the total draft ratio.

[0069] The draft ratio changing section 53 does not execute the total draft ratio change control described above at least in one of cases where a status in which the fluctuation amount of the fiber bundle mass exceeds the first fiber bundle fluctuation amount lasts for the first fiber bundle length or longer, or where a status in which the fluctuation amount of the yarn thickness exceeds the first yarn fluctuation amount lasts for the first yarn length or longer. In this case, the operation control section 57 stops the drafting operation of the draft device 6 and the spinning operation of the pneumatic spinning device 7. That is, the operation control section 57 stops the drafting operation of the draft device 6 and the spinning operation of the pneumatic spinning device 7 at least in one of cases where a status in which the fluctuation amount of the fiber bundle mass exceeds the first fiber bundle fluctuation amount lasts for the first fiber bundle length or longer, or where a status in which the fluctuation in the yarn thickness exceeds the first yarn fluctuation amount lasts for the first yarn length or longer.

[0070] When the yarn monitoring device 8 judges that there is a yarn defect (such as slub or long (long defect)), the operation control section 57 stops the drafting operation of the draft device 6 and the spinning operation of the pneumatic spinning device 7. As a result, the yarn Y is cut in the spinning unit 2. Thereafter, the yarn joining cart 3 removes the yarn defect and joins the yarn, and the production of the yarn Y is restarted. Note that, depending on the configuration of the spinning unit 2, the yarn defect may be removed by the spinning unit 2.

[0071] A description will be made on a difference between the yarn Y whose yarn count is adjusted by changing the total draft ratio and the yarn Y detected by the yarn monitoring device 8 as a yarn defect (a yarn defect of a thickness abnormality such as slub or long). The yarn defect detected by the yarn monitoring device 8 here is a portion where the yarn thickness has fluctuated in the short term, unlike the status of the yarn Y that is dealt with by changing the total draft ratio when a fluctuation occurs over a long period of time.

[0072] Specifically, the yarn monitoring device 8 judges that there is a yarn defect when a status in which the fluctuation amount (the deviation amount) of the acquired yarn thickness exceeds the second yarn fluctuation amount lasts for the second yarn length or longer. The second yarn fluctuation amount of the yarn thickness and the second yarn length of the length of the yarn Y are set for each type of yarn defects, such as slub and long. The yarn monitoring device 8 detects the yarn defect by comparing the second yarn fluctuation amount and the second yarn length set for each type of yarn defects, with the fluctuation amount of the acquired yarn thickness.

[0073] A description will be made on a relationship between the first yarn fluctuation amount and the first yarn length used for judging a change of the total draft ratio, and the second yarn fluctuation amount and the second yarn length used for judging the yarn defect. The second yarn fluctuation amount is larger than the first yarn fluctuation amount. That is, a fluctuation amount of the yarn thickness detected as the yarn defect is larger than a fluctuation amount of the yarn thickness subject to the change of the total draft ratio. The second yarn length is shorter than the first yarn length. That is, a length of a fluctuation portion of the yarn thickness detected as the yarn defect is shorter than a length of a fluctuation portion of the yarn thickness subject to the change of the total draft ratio.

[0074] In this way, yarn defects which a fluctuation amount of the yarn thickness is large and a length of the fluctuation portion is short are removed. That is, when such a yarn defect is detected, the draft ratio changing section 53 does not change the total draft ratio.

[0075] When a small fluctuation occurs in the fiber bundle mass or the yarn thickness over a long period of time, the total draft ratio is changed. This enables the spinning unit 2 to further improve the quality of the yarn Y wound around the package P.

[0076] The draft ratio changing section 53 may use a moving average of the fiber bundle mass acquired by the first acquisition section 51 within a predetermined time, as the fiber bundle mass used for the total draft ratio change control. This enables the draft ratio changing section 53 to reduce an influence of noise, such as when the fiber bundle S includes a sudden defect, for example.

[0077] The draft ratio changing section 53 may use an average value of the fiber bundle mass of the fiber bundles S supplied to the plurality of spinning units 2 in the spinning machine 1, as the fiber bundle mass used for the total draft ratio change control.

[0078] Next, using a table in FIG. 4, a description will be given to each pattern example when the draft ratio changing section 53 controls the total draft ratio in accordance with the fiber bundle mass acquired by the first acquisition section 51 and the yarn thickness acquired by the second acquisition section 52.

[0079] As shown in FIG. 4, for example, as in pattern A1, when the fiber bundle mass increases and the yarn thickness increases, the draft ratio changing section 53 increases the total draft ratio.

[0080] For example, as in pattern A2, when the fiber bundle mass does not change and the yarn thickness increases,

the draft ratio changing section 53 does not change the total draft ratio. As this case, for example, it can be assumed that the produced yarn Y is not sufficiently twisted. Therefore, the notification control section 56 may notify, by the display screen 102, that the twisting is not sufficient.

[0081] For example, as in pattern A3, when the fiber bundle mass does not change and the yarn thickness does not change, the draft ratio changing section 53 does not change the total draft ratio (a current state is maintained).

[0082] As in pattern A4, when the fiber bundle mass does not change and the yarn thickness decreases, the draft ratio changing section 53 does not change the total draft ratio. As this case, for example, it can be assumed that a fiber loss has occurred. The fiber loss is expressed by a difference when a fiber amount of the fiber bundle S supplied to the draft device 6 (a fiber amount upstream of the draft device 6) is compared with a fiber amount of the yarn Y outputted from the pneumatic spinning device 7 (fiber amount downstream of the pneumatic spinning device 7). For example, the fiber loss may be caused when fibers fall out without being spun in the pneumatic spinning device 7. As another example, a fiber loss may be caused when fibers fall out in the draft device 6 (e.g., fibers scatter in the pair of front rollers 17). As yet another example, a fiber loss may be caused when fibers fall out in a region including the draft device 6 and the pneumatic spinning device 7. When the yarn Y is produced by the pneumatic spinning device 7, even in a normal state, not all of the fibers in the fiber bundle S become the yarn Y, but a certain amount of fibers fall out without being spun. Such acceptable fall out of fibers does not correspond to the fiber loss in the present application.

[0083] For example, as in pattern A5, when the fiber bundle mass decreases and the yarn thickness decreases, the draft ratio changing section 53 reduces the total draft ratio.

[0084] [Alternative embodiment 1: The yarn monitoring device detects mass of the yarn.] In the above description, the yarn monitoring device 8 detects yarn thickness as the yarn information. Alternatively, the yarn monitoring device 8 may detect mass of the yarn Y (hereinafter referred to as "yarn mass") as the yarn information. As such a yarn monitoring device 8, there may be used a capacitive sensor that allows the yarn Y to pass through an electric field to detect a temporal change in the yarn mass on the basis of a change in capacitance. In this case, the second acquisition section 52 acquires yarn mass from the yarn monitoring device 8 as the yarn information. When the yarn monitoring device 8 detects the yarn mass, the draft ratio changing section 53 can execute the total draft ratio change control by replacing the above "yarn thickness increases" with "yarn mass increases" and "yarn thickness decreases" with "yarn mass decreases".

[0085] Next, using a table in FIG. 5, a description will be given to each pattern example when the draft ratio changing section 53 controls the total draft ratio in accordance with the fiber bundle mass acquired by the first acquisition section 51 and the yarn mass acquired by the second acquisition section 52.

[0086] As shown in FIG. 5, for example, as in pattern B1, when the fiber bundle mass increases and the yarn mass increases, the draft ratio changing section 53 increases the total draft ratio.

[0087] For example, as in pattern B2, when the fiber bundle mass does not change and the yarn mass does not change, the draft ratio changing section 53 does not change the total draft ratio (a current state is maintained).

[0088] For example, as in pattern B3, when the fiber bundle mass does not change and the yarn mass decreases, the draft ratio changing section 53 does not change the total draft ratio. As this case, for example, it can be assumed that a fiber loss has occurred in the pneumatic spinning device 7 or the like.

[0089] For example, as in pattern B4, when the fiber bundle mass decreases and the yarn mass decreases, the draft ratio changing section 53 reduces the total draft ratio.

[0090] In this way, the draft ratio changing section 53 can appropriately set the total draft ratio even when the yarn mass is used, and can further improve the yarn quality.

[0091] [Alternative embodiment 2: The total draft ratio is changed with use of yarn tension.] As described above, the tension sensor (the yarn information detecting device) 9 measures tension of the yarn Y (hereinafter referred to as "yarn tension") as the yarn information. The draft ratio changing section 53 can perform the total draft ratio change control by using the yarn tension (the yarn information) measured by the tension sensor 9, instead of the yarn information detected by the yarn monitoring device 8. In this case, the second acquisition section 52 acquires the yarn tension from the tension sensor 9 as yarn information. When the yarn tension is used as the yarn information, the draft ratio changing section 53 can execute the total draft ratio change control by replacing the above "yarn thickness increases" with "yarn tension increases" and "yarn thickness decreases" with "yarn tension decreases".

[0092] Next, using a table in FIG. 6, a description will be given to each pattern example when the draft ratio changing section 53 controls the total draft ratio in accordance with the fiber bundle mass acquired by the first acquisition section 51 and the yarn tension acquired by the second acquisition section 52.

[0093] As shown in FIG. 6, for example, as in pattern C1, when the fiber bundle mass increases and the yarn tension increases, the draft ratio changing section 53 increases the total draft ratio. As this case, for example, it can be assumed that the yarn Y has become thick due to the increase in the fiber amount in the fiber bundle S and the increase in the yarn tension.

[0094] For example, as in pattern C2, when the fiber bundle mass increases and the yarn tension does not change, the draft ratio changing section 53 does not change the total draft ratio. As this case, for example, it can be assumed

that the produced yarn Y is not sufficiently twisted. Therefore, the notification control section 56 may notify, by the display screen 102, that the twisting is not sufficient. For example, as in pattern C3, when the fiber bundle mass increases and the yarn tension decreases, the draft ratio changing section 53 does not change the total draft ratio. As this case, for example, it can be assumed that the produced yarn Y is not sufficiently twisted. Therefore, the notification control section

56 may notify, by the display screen 102, that the twisting is not sufficient.
[0095] For example, as in pattern C4, when the fiber bundle mass does not change and the yarn tension increases, the draft ratio changing section 53 does not change the total draft ratio. In this case, for example, the notification control section 56 may notify of the increase in the yarn tension, by the display screen 102. That is, when the fiber bundle information acquired by the first acquisition section 51 indicates no change in the fiber bundle mass, and the yarn information acquired by the second acquisition section 52 indicates an increase in the yarn tension, the notification control section 56 executes a tension notification controlling step of performing notification by the display screen (the tension notification device) 102.

[0096] For example, as in pattern C5, when the fiber bundle mass does not change and the yarn tension does not change, the draft ratio changing section 53 does not change the total draft ratio (a current state is maintained).

[0097] For example, as in pattern C6, when the fiber bundle mass does not change and the yarn tension decreases, the draft ratio changing section 53 does not change the total draft ratio. As this case, for example, it can be assumed that the produced yarn Y is not sufficiently twisted. Therefore, the notification control section 56 may notify, by the display screen 102, that the twisting is not sufficient.

[0098] For example, as in pattern C7, when the fiber bundle mass decreases and the yarn tension increases, the draft ratio changing section 53 does not change the total draft ratio. In this case, for example, the notification control section 56 may notify of the increase in the yarn tension, by the display screen 102. That is, when the fiber bundle information acquired by the first acquisition section 51 indicates a decrease in the fiber bundle mass, and the yarn information acquired by the second acquisition section 52 indicates an increase in the yarn tension, the notification control section 56 executes the tension notification controlling step of performing notification by the display screen (the tension notification device) 102.

[0099] For example, as in pattern C8, when the fiber bundle mass decreases and the yarn tension does not change, the draft ratio changing section 53 does not change the total draft ratio.

[0100] For example, as in pattern C9, when the fiber bundle mass decreases and the yarn tension decreases, the draft ratio changing section 53 reduces the total draft ratio. As this case, for example, it can be assumed that the yarn Y has become thin due to the decrease in the fiber amount of the fiber bundle S, and the yarn tension has decreased.

[0101] In this way, the draft ratio changing section 53 can appropriately set the total draft ratio even when the yarn tension is used, and can further improve the yarn quality.

[0102] [Alternative embodiment 3: Fiber bundle information is received from an information tag.] The first acquisition section 51 is not limited to acquiring fiber bundle information (the fiber bundle mass) from the fiber bundle sensor 20. For example, as illustrated in FIG. 2, the spinning unit 2 may be provided with a receiving device (a fiber bundle information receiving device) 30 adapted to receive fiber bundle information from an information tag Ka provided with respect to the can K. The information tag Ka may be embedded in the can K, or may be externally attached to an outer surface or the like of the can K. The information tag Ka may be embedded in a bottom portion of the can K, for example. The receiving device 30 receives the fiber bundle information from the information tag Ka in a contact manner or a noncontact manner. The first acquisition section 51 may acquire the fiber bundle information received by the receiving device 30 instead of the fiber bundle sensor 20.

[0103] In this case, the draft ratio changing section 53 can execute the total draft ratio change control by using the fiber bundle information received by the receiving device 30. When using a reception result of the receiving device 30, the draft ratio changing section 53 executes the total draft ratio change control when the can K is replaced. The replacement of the can K means, for example, that the can K which all of the stored fiber bundle S has been consumed by the spinning unit 2 is replaced with another can K (e.g., a can K in a state in which the fiber bundle S is fully stored). The draft ratio changing section 53 can execute the total draft ratio change control in accordance with a change in the fiber bundle mass before and after the replacement of the can K.

[0104] The draft ratio changing section 53 may determine, as the replacement timing of the can K, that the replacement of the can K has been performed when the fiber bundle sensor 20 detects a joint of the fiber bundle S or a break of the fiber bundle S, and execute the total draft ratio change control.

[0105] Alternatively, for example, the draft ratio changing section 53 may determine that the replacement of the can K has been performed when the fiber bundle information is read from the information tag Ka of the can K by the receiving device 30, and execute the total draft ratio change control.

[0106] The information tag Ka may include information on a raw material (such as cotton or polyester) of the fiber bundle S as the fiber bundle information. In this case, the receiving device 30 acquires information on the raw material of the fiber bundle S from the information tag Ka. In accordance with the acquired raw material of the fiber bundle S, parameters and the like for detecting the fiber bundle mass may be set (corrected) for the fiber bundle sensor 20.

Depending on the raw material of the fiber bundle S, for example, electricity passes in different ways between capacitor electrodes of the fiber bundle sensor 20. Therefore, by setting the fiber bundle sensor 20 in accordance with the raw material of the fiber bundle S, the detection accuracy of the fiber bundle mass in the fiber bundle sensor 20 is improved.

[0107] The draft ratio changing section 53 may perform the total draft ratio change control by using the detection result (the fiber bundle mass) of the fiber bundle sensor 20 set (corrected) in such a way. This enables the draft ratio changing section 53 to perform the total draft ratio change control more accurately.

[0108] In addition to receiving the fiber bundle information from the information tag Ka, the receiving device 30 may receive the fiber bundle information and the like from a controller or the like adapted to perform control on a drawing machine adapted to produce the fiber bundle S.

[0109] [Notification control relating to the fiber bundle or the yarn] Next, a description will be made on notification control relating to the fiber bundle S or the yarn Y performed by the unit controller 10.

[0110] First, notification control relating to the yarn Y will be described. The notification determination section 55 determines whether or not notification relating to the yarn Y is necessary, in accordance with the fiber bundle mass (the fiber bundle information) acquired by the first acquisition section 51 and the yarn thickness (the yarn information) acquired by the second acquisition section 52. The notification determination section 55 determines whether or not notification of occurrence of a fiber loss during production of the yarn Y is necessary, as determination as to whether or not notification relating to the yarn Y is necessary. In this way, the notification determination section 55 executes a first determining step of determining whether or not the notification is necessary, in accordance with the fiber bundle mass (the fiber bundle information) acquired by the first acquisition section 51 and the yarn thickness (the yarn information) acquired by the second acquisition section 52.

[0111] In accordance with the fiber bundle mass acquired by the first acquisition section 51, the yarn count prediction section 54 executes the first yarn count predicting step of predicting a predicted yarn count of the yarn Y to be produced when the fiber bundle S is spun by the pneumatic spinning device 7.

[0112] Next, in accordance with the predicted yarn count predicted by the yarn count prediction section 54 and the acquired yarn count, which is a yarn count of the yarn Y obtained in accordance with the yarn thickness acquired by the second acquisition section 52, the notification determination section 55 determines whether or not notification of occurrence of a fiber loss is necessary, as the first yarn count predicting step. When the predicted yarn count and the acquired yarn count do not match, the notification determination section 55 determines that the notification of occurrence of the fiber loss is necessary. When a fiber loss has occurred, the yarn Y to be produced becomes thin (the mass becomes small). The notification determination section 55 can calculate a yarn count of the yarn Y (the acquired yarn count) in accordance with the yarn thickness acquired by the second acquisition section 52, by a known method.

[0113] When determining whether or not the notification of occurrence of the fiber loss is necessary, the notification determination section 55 may use setting information of the yarn Y to be produced (the yarn count of the yarn Y to be produced) preset in the spinning machine 1 (the spinning unit 2), instead of the predicted yarn count predicted by the yarn count prediction section 54. Even when using the set yarn count, which is a yarn count of the yarn Y to be produced and has been set in the spinning machine 1, the notification determination section 55 can determine whether or not the notification of occurrence of the fiber loss is necessary.

[0114] When a determination is made that the notification of occurrence of the fiber loss is necessary, the notification control section 56 notifies that the fiber loss has occurred, by the display screen 102. Thus, when a determination is made that the notification of occurrence of the fiber loss is necessary by the notification determination section 55, the notification control section 56 executes the notification controlling step of performing notification by the display screen 102.

[0115] When a determination is made that the notification of occurrence of a fiber loss is necessary, the operation control section 57 stops the drafting operation of the draft device 6 and the spinning operation of the pneumatic spinning device 7, as the operation controlling step. This enables an operator to perform maintenance work and the like of the pneumatic spinning device 7.

[0116] Next, notification control relating to the fiber bundle S will be described. In accordance with the fiber bundle mass (the fiber bundle information) acquired by the first acquisition section 51 and the setting information of the yarn Y to be produced that has been set in the spinning machine 1 (the spinning unit 2), the notification determination section 55 executes a second determining step of determining whether or not notification relating to the fiber bundle S is necessary. As a determination as to whether or not the notification relating to the fiber bundle S is necessary, the notification determination section 55 determines whether or not notification of occurrence of an error in supplying of the fiber bundle S to the spinning machine 1 (the spinning unit 2) is necessary, and whether or not notification of occurrence of fall-off of the fiber bundle in the drawing machine adapted to produce the fiber bundle S is necessary. The error in supplying is a state in which the can K storing the fiber bundle S produced by the drawing machine is supplied to another spinning machine that is not an expected spinning machine.

[0117] Specifically, in accordance with the fiber bundle mass acquired by the first acquisition section 51, the yarn count prediction section 54 executes the second yarn count predicting step of predicting a predicted yarn count of the yarn Y to be produced when the fiber bundle S is spun by the pneumatic spinning device 7.

[0118] In accordance with the predicted yarn count predicted by the yarn count prediction section 54 and the set yarn count of the yarn Y to be produced preset in the spinning machine 1 as the setting information of the yarn Y, the notification determination section 55 determines whether or not the notification of occurrence of the error in supplying of the fiber bundle S to the spinning machine 1 is necessary, as the second determining step. When the predicted yarn count is thicker than the set yarn count, the notification determination section 55 determines that the notification of occurrence of the error in supplying of the fiber bundle S (can K) is necessary.

[0119] When a determination is made that the notification of occurrence of the error in supplying of the fiber bundle S is necessary, the notification control section 56 executes the notification controlling step of notifying that an error in supplying of the fiber bundle S has occurred, by the display screen 102.

[0120] When a determination is made that the notification of occurrence of the error in supplying of the fiber bundle S is necessary, the operation control section 57 stops the drafting operation of the draft device 6 and the spinning operation of the pneumatic spinning device 7. This enables the operator to perform a check operation and the like of the can K supplied to the spinning machine 1 (the spinning unit 2). Thus, when a determination is made that the notification of occurrence of the error in supplying of the fiber bundle S is necessary, the operation control section 57 can stop the drafting operation of the draft device 6 and the spinning operation of the pneumatic spinning device 7, as the operation controlling step.

[0121] When the predicted yarn count is larger than the set yarn count (yarn Y is thin), the notification determination section 55 determines that the notification of occurrence of the fall-off of the fiber bundle in the drawing machine adapted to produce the fiber bundle S is necessary, in the second determining step.

[0122] Before performing this notification, the notification determination section 55 further determines in which drawing process the fall-off of the fiber bundle has occurred, among the drawing processes performed a plurality of times by using the drawing machine. In the present embodiment, as an example, the spinning machine 1 is supplied with the fiber bundle S produced by repeating the drawing process three times of bundling eight fiber bundles, to produce one fiber bundle. In bundling the eight fiber bundles with the drawing machine, the fiber bundle may fall off. The notification determination section 55 determines such fall-off of the fiber bundle (the fiber bundle to be bundled). However, the number of fiber bundles bundled in the drawing machine is not limited to eight. Further, the number of times of the drawing process repeated when the fiber bundle S is produced is also not limited to three.

[0123] In accordance with a decrease rate of the predicted yarn count (mass) with respect to the set yarn count (mass), the notification determination section 55 further determines in which drawing process the fall-off of the fiber bundle has occurred, among the drawing processes performed a plurality of times by using the drawing machine, as the second determining step. When the decrease rate of the yarn mass is -1.5%, the notification determination section 55 determines that fall-off of the fiber bundle has occurred in the second drawing process among the drawing processes repeated three times. When the decrease rate of the yarn mass is -12.5%, the notification determination section 55 determines that fall-off of the fiber bundle has occurred in the third drawing process among the drawing processes repeated three times. When the decrease rate of the yarn mass exceeds -12.5%, the notification determination section 55 determines that the fiber amount of the fiber bundle S has decreased in the creel device 40. For example, a decrease in the fiber amount of the fiber bundle S may occur due to tearing of the fiber bundle S in the creel device 40, or the like. The notification determination section 55 can make the above determination by adding a predetermined margin to -1.5% and -12.5% used as the decrease rate. The values of -1.5% and -12.5% used as the decrease rate are values when the drawing process of bundling eight fiber bundles is repeated three times.

[0124] When a determination is made that the notification of occurrence of the fall-off of the fiber bundle in the drawing machine is necessary, the notification control section 56 notifies that fall-off of the fiber bundle has occurred in the drawing machine, by the display screen 102.

[0125] When notifying that the fall-off of the fiber bundle has occurred in the drawing machine, the notification control section 56 notifies in which drawing process the fall-off of the fiber bundle has occurred. When a determination is made that a decrease in the fiber amount of the fiber bundle S has occurred due to the creel device 40, the notification control section 56 notifies, by the display screen 102, that a decrease in the fiber amount of the fiber bundle S has occurred in the creel device 40. In this way, when a determination is made by the notification determination section 55 that the notification of the fall-off of the fiber bundle in the drawing process or the decrease in the fiber amount of the fiber bundle S in the creel device 40 is necessary, the notification control section 56 executes the notification controlling step of performing notification by the display screen 102.

[0126] When a determination is made that the notification of the fall-off of the fiber bundle in the drawing process or the decrease in the fiber amount of the fiber bundle S in the creel device 40 is necessary, the operation control section 57 can stop the drafting operation of the draft device 6 and the spinning operation of the pneumatic spinning device 7, as the operation controlling step. This enables the operator to perform a check operation and the like of the drawing machine or the creel device 40.

[0127] When performing the notification control relating to the fiber bundle S or the yarn Y, the first acquisition section 51 is not limited to acquiring the fiber bundle mass detected by the fiber bundle sensor 20. The first acquisition section

51 may acquire the fiber bundle mass received by the receiving device 30 described above.

[0128] Next, with reference to a flowchart of FIG. 7, a description will be given to a flow of a notification controlling process relating to the fiber bundle S or the yarn Y performed by the unit controller 10. The process shown in FIG. 7 is started at the same time as the production of the yarn Y in the spinning machine 1 is started.

[0129] As shown in FIG. 7, the notification determination section 55 determines whether or not the predicted yarn count predicted by the yarn count prediction section 54 matches the set yarn count set in the spinning machine 1 (S101). When the yarn counts match (S101: YES), the notification determination section 55 determines whether or not the yarn thickness (the acquired yarn count) acquired by the second acquisition section 52 matches the predicted yarn count predicted by the yarn count prediction section 54 (S102). When the yarn counts match (S102: YES), the process returns to S101 again and the above-described process is repeated. The case where the yarn counts match in the determination of S102 is a case where the yarn Y is appropriately produced.

[0130] When the yarn counts do not match in the determination in S102 (S102: NO), the notification determination section 55 determines that the notification of occurrence of the fiber loss is necessary. As a result, the notification control section 56 notifies occurrence of the fiber loss (S103). Then, the operation control section 57 stops operations of the draft device 6 and the pneumatic spinning device 7 (S104).

[0131] When the yarn counts do not match in the determination of S101 (S101: NO), the notification determination section 55 determines whether or not the predicted yarn count is a thicker yarn count than the set yarn count (S105). When the predicted yarn count is thicker (S105: YES), the notification determination section 55 determines that the notification of occurrence of the error in supplying of the fiber bundle S (can K) is necessary. As a result, the notification control section 56 notifies occurrence of an error in supplying of the fiber bundle S (can K) (S106).

[0132] When the predicted yarn count is thinner in the determination of S105 (S105: NO), the notification determination section 55 calculates a decrease rate of the predicted yarn count (mass) with respect to the set yarn count (mass) (S107).

[0133] When the decrease rate is -1.5% (S107: -1.5%), the notification determination section 55 determines that fall-off of the fiber bundle has occurred in the second drawing process. As a result, the notification control section 56 notifies that fall-off of the fiber bundle has occurred in the second drawing process (S108).

[0134] When the decrease rate is -12.5% (S107: -12.5%), the notification determination section 55 determines that fall-off of the fiber bundle has occurred in the third drawing process. As a result, the notification control section 56 notifies that fall-off of the fiber bundle has occurred in the third drawing process (S109).

[0135] When the decrease rate exceeds -12.5% (S107: more than -12.5%), the notification determination section 55 determines that the fiber amount of the fiber bundle S has decreased in the creel device 40. As a result, the notification control section 56 notifies that a decrease in the fiber amount of the fiber bundle S has occurred in the creel device 40 (S110).

[0136] Next, a description will be given to a spinning program D for executing a spinning method performed by the spinning machine 1. As illustrated in FIG. 8, the spinning program D is stored in the storage section 58 of the unit controller 10. The storage section 58 is a non-transitory computer-readable storage medium adapted to store the spinning program D. The unit controller 10 realizes the spinning method described above by having the spinning program D being read and executed by a processor. The spinning program D includes a first acquisition module D1, a second acquisition module D2, a change module D3, an operation control module D4, a tension notification control module D5, a first determination module D6, a first yarn count prediction module D7, a second determination module D8, a second yarn count prediction module D9, and a notification control module D10.

[0137] The processes realized by executing the first acquisition module D1, the second acquisition module D2, and the change module D3 are similar to the processes of the first acquiring step, the second acquiring step, and the changing step described above, respectively. The processes realized by executing the operation control module D4, the tension notification control module D5, the first determination module D6, and the first yarn count prediction module D7 are similar to the processes of the operation controlling step, the tension notification controlling step, the first determining step, and the first yarn count predicting step described above, respectively. The processes realized by executing the second determination module D8, the second yarn count prediction module D9, and the notification control module D10 are similar to the processes of the second determining step, the second yarn count predicting step, and the notification controlling step described above, respectively.

[0138] The spinning program D may be provided, for example, by being fixedly recorded on a tangible recording medium such as a CD-ROM, a DVD-ROM, or a semiconductor memory. Alternatively, the spinning program D may be provided as a data signal via a communication network.

[0139] As described above, according to the spinning method executed by the spinning machine 1, the first acquisition section 51 acquires the fiber bundle information in the first acquiring step, and the second acquisition section 52 acquires the yarn information in the second acquiring step. The draft ratio changing section 53 changes the total draft ratio in the changing step. Consequently, in this spinning method, the total draft ratio is changed using two types of information: the fiber bundle information indicating a status of the pre-drafted fiber bundle S, and the yarn information indicating a status of the produced yarn Y, and the total draft ratio may be set more appropriately. Therefore, according to this spinning

method, the yarn quality can be further improved.

[0140] In the changing step, when the fiber bundle information indicates an increase in the fiber bundle mass, and the yarn information indicates an increase the yarn thickness or an increase in the yarn mass, the draft ratio changing section 53 increases the total draft ratio. In addition, in the changing step, when the fiber bundle information indicates a decrease in the fiber bundle mass, and the yarn information indicates a decrease in the yarn thickness or a decrease in the yarn mass, the draft ratio changing section 53 reduces the total draft ratio. This enables the draft ratio changing section 53 to appropriately determine how to change the total draft ratio in the changing step.

[0141] When executing the operation controlling step, from before the total draft ratio is changed to after the total draft ratio is changed by the draft ratio changing section 53, the operation control section 57 continues the drafting operation of the draft device 6 and the spinning operation of the pneumatic spinning device 7. According to this spinning method, even if the total draft ratio is changed, the yarn Y can be continuously produced in the spinning machine 1, and productivity of the spinning machine 1 can be maintained.

[0142] In the changing step, at least in one of cases where a status in which a fluctuation amount of the fiber bundle information is equal to or greater than a fiber bundle lower-limit fluctuation amount and is equal to or smaller than a first fiber bundle fluctuation amount lasts for a first fiber bundle length or longer, or where a status in which a fluctuation amount of the yarn information is equal to or greater than a yarn lower-limit fluctuation amount and is equal to or smaller than a first yarn fluctuation amount lasts for a first yarn length or longer, the draft ratio changing section 53 changes the total draft ratio. According to this spinning method, in accordance with the fluctuation amount of the fiber bundle information and the fluctuation amount of the yarn information, when a status in which the fluctuation amount is equal to or smaller than the first fiber bundle fluctuation amount or equal to or smaller than the first yarn fluctuation amount lasts, the total draft ratio may be changed by the draft ratio changing section 53. As a result, by performing the drafting operation with the changed total draft ratio, a difference in quality of the yarn Y produced before and after the change can be kept within a certain range.

[0143] In the operation controlling step, at least in one of cases where a status in which the fluctuation amount of the fiber bundle information acquired by the first acquisition section 51 exceeds the first fiber bundle fluctuation amount lasts for the first fiber bundle length or longer, or where a status in which the fluctuation amount of the yarn information acquired by the second acquisition section 52 exceeds the first yarn fluctuation amount lasts for the first yarn length or longer, the operation control section 57 stops the drafting operation of the draft device 6 and the spinning operation of the pneumatic spinning device 7. According to this spinning method, when a status in which the fluctuation amount is large lasts, the operation control section 57 can stop continuous production of the yarn Y with low quality, by stopping the drafting operation and the spinning operation.

[0144] In accordance with the detected yarn information, the yarn monitoring device 8 judges that there is a yarn defect when a status in which a fluctuation amount of the yarn information exceeds a second yarn fluctuation amount lasts for the second yarn length or longer. When the yarn monitoring device 8 judges that there is a yarn defect, the operation control section 57 stops the drafting operation of the draft device 6 and the spinning operation of the pneumatic spinning device 7 in the operation controlling step. In this case, the operation control section 57 can stop the drafting operation and the spinning operation when, for example, a yarn defect having a large fluctuation amount and a short length is detected. As a result, such a short yarn defect can be removed while the drafting operation and the spinning operation are stopped.

[0145] When the fiber bundle information acquired by the first acquisition section 51 indicates no change in the fiber bundle mass, and the yarn information acquired by the second acquisition section 52 indicates an increase in the yarn tension, or when the fiber bundle information acquired by the first acquisition section 51 indicates a decrease in the fiber bundle mass, and the yarn information acquired by the second acquisition section 52 indicates an increase in the yarn tension, the notification control section 56 performs notification by the display screen 102, in the tension notification controlling step. This enables the notification control section 56 to notify the operator that an abnormality has occurred in the tension of the produced yarn Y.

[0146] In the first determining step, the notification determination section 55 determines whether or not notification is necessary, in accordance with the fiber bundle information acquired by the first acquisition section 51 and the yarn information acquired by the second acquisition section 52. This enables the notification determination section 55 to appropriately determine whether or not the notification is necessary.

[0147] The yarn count prediction section 54 predicts a predicted yarn count of the yarn Y to be produced by the spinning machine 1, in accordance with the fiber bundle information acquired by the first acquisition section 51 in the first yarn count predicting step. In the first determining step, in accordance with the predicted yarn count predicted by the yarn count prediction section 54 and the acquired yarn count of the yarn Y indicated by the yarn information acquired by the second acquisition section 52, the notification determination section 55 determines whether or not notification of occurrence of a fiber loss is necessary.

[0148] In the first determining step, when the predicted yarn count and the acquired yarn count do not match, the notification determination section 55 determines that the notification of occurrence of the fiber loss is necessary. This

enables notification of occurrence of a fiber loss when the fiber loss occurs.

[0149] In the second determining step, in accordance with the fiber bundle information acquired by the first acquisition section 51 and the setting information of the yarn Y to be produced that has been set in the spinning machine 1, the notification determination section 55 determines whether or not notification is necessary. This enables the notification determination section 55 to determine whether or not notification is necessary in accordance with the fiber bundle information and the setting information, enabling the determination to be performed with high accuracy.

[0150] In the second yarn count predicting step, the yarn count prediction section 54 predicts a predicted yarn count of the yarn Y to be produced by the spinning machine 1, in accordance with the fiber bundle information acquired by the first acquisition section 51.

[0151] In the second determining step, in accordance with the predicted yarn count predicted by the yarn count prediction section 54 and the set yarn count of the yarn Y set in the spinning machine 1 as the setting information of the yarn Y, the notification determination section 55 determines whether or not notification of occurrence of an error in supplying of the fiber bundle S to the spinning machine 1 is necessary, and whether or not notification of occurrence of fall-off of the fiber bundle in the drawing machine is necessary. This enables the notification determination section 55 to appropriately determine whether or not the notification of occurrence of the error in supplying of the fiber bundle S is necessary or whether or not the notification of occurrence of the fall-off of the fiber bundle in the drawing machine is necessary.

[0152] In the second determining step, when a determination is made that the notification of the fall-off of the fiber bundle is necessary, the notification determination section 55 further determines, in accordance with a decrease rate of the predicted yarn count with respect to the set yarn count, in which drawing process the fall-off of the fiber bundle has occurred, among the drawing processes performed a plurality of times by using the drawing machine. A status (mass) of the produced fiber bundle S varies depending on in which drawing process the fall-off of the fiber bundle has occurred. Therefore, by using the decrease rate of the predicted yarn count with respect to the set yarn count, the notification determination section 55 can determine in which drawing process the fall-off of the fiber bundle has occurred.

[0153] In the second determining step, the notification determination section 55 determines that the notification of occurrence of the fall-off of the fiber bundle is necessary when the predicted yarn count is larger than the set yarn count, and determines that the notification of occurrence of the error in supplying of the fiber bundle S to the spinning machine 1 is necessary when the predicted yarn count is less than the set yarn count. In this case, the notification determination section 55 can appropriately determine whether or not the notification of occurrence of fall-off of the fiber bundle is necessary and whether or not the notification of occurrence of the error in supplying of the fiber bundle S is necessary.

[0154] When a determination is made that the notification is necessary as a result of the determination as to whether or not the notification is necessary, the notification control section 56 performs the notification by the display screen 102 in the notification controlling step. This enables the notification control section 56 to notify the operator that a situation requiring notification has occurred.

[0155] In the operation controlling step, when a determination is made that the notification is necessary as a result of the determination as to whether or not the notification is necessary, the operation control section 57 stops the drafting operation of the draft device 6 and the spinning operation of the pneumatic spinning device 7. In this case, the operation control section 57 can prevent continuous production of the yarn Y when a determination is made that the notification is necessary.

[0156] An embodiment of the present invention has been described above, but the present invention is not limited to the above-described embodiment. For example, the notification control section 56 may perform notification by using a notification device other than the display screen 102. For example, the notification control section 56 may perform notification by using a notification device such as a display screen or a lamp provided in each spinning unit 2.

[0157] The draft ratio changing section 53 is not limited to changing the total draft ratio by controlling driving of the back bottom roller drive motor. For example, the back bottom roller 14a, the third bottom roller 15a, the middle bottom roller 16a, and the front bottom roller 17a included in the draft device 6 may be driven independently for each spinning unit 2. In this case, the draft ratio changing section 53 may change the total draft ratio in the draft device 6 by controlling a rotational speed of the front bottom roller 17a. Further, the draft ratio changing section 53 may change the total draft ratio in the draft device 6 by controlling rotational speeds of the back bottom roller 14a and the front bottom roller 17a. By changing the total draft ratio in this way, the spinning machine 1 can optimize the yarn quality. Note that the draft ratio changing section 53 may change the total draft ratio by controlling a rotational speed of a withdrawal roller (a friction roller (a yarn accumulating roller) or a delivery roller) that withdraws the yarn Y from the draft device 6.

[0158] In a case of the draft device 6 having above-described configuration, a draft ratio other than the total draft ratio may be changed by changing a rotational speed of the drive motor that drives the third bottom roller 15a and/or the drive motor that drives the middle bottom roller 16a.

[0159] In the spinning unit 2, each device is arranged such that the yarn Y supplied on an upper side is wound on a lower side in a machine height direction, but each device may be arranged such that the yarn Y supplied on the lower side is wound on the upper side. FIG. 1 illustrates that the spinning machine 1 winds a cheese package P, but the

spinning machine 1 can also wind a conical package P.

[0160] In the spinning unit 2, the yarn accumulating device 11 has a function of withdrawing the yarn Y from the pneumatic spinning device 7, but the yarn Y may be withdrawn from the pneumatic spinning device 7 with a delivery roller and a nip roller. In a case of withdrawing the yarn Y from the pneumatic spinning device 7 with the delivery roller and the nip roller, a slack tube using suction airflow and/or a mechanic compensator, or the like may be provided instead of the yarn accumulating device 11.

[0161] In the travelling direction of the yarn Y, the tension sensor 9 may be arranged upstream of the yarn monitoring device 8. The unit controller 10 may be provided for every spinning unit 2. In the spinning unit 2, the waxing device 12 may be omitted.

[0162] Note that, in the above-described embodiment, the spinning machine 1 performs the total draft ratio change control and the notification control relating to the fiber bundle S or the yarn Y, but may exclusively perform the notification control relating to the fiber bundle S or the yarn Y. The spinning machine 1 may exclusively perform one notification control of the notification control relating to the fiber bundle S and the notification control relating to the yarn Y. In this case, the notification method for the notification control executed by the spinning machine 1, and the spinning machine 1 can be represented by the following items.

[Item 1] A notification method executed by a spinning machine in which a yarn is produced by drafting a fiber bundle by a draft device, and spinning the drafted fiber bundle by a spinning device, the notification method including:

a first acquiring step of acquiring fiber bundle information indicating a status of the pre-drafted fiber bundle;
a second acquiring step of acquiring yarn information indicating a status of the produced yarn; and
a first determining step of determining whether or not to execute notification, in accordance with the fiber bundle information acquired in the first acquiring step and the yarn information acquired in the second acquiring step.

[Item 2] The notification method according to the item 1, further including a first yarn count predicting step of predicting a predicted yarn count, which is a yarn count of the yarn to be produced by the spinning device, in accordance with the fiber bundle information acquired in the first acquiring step,

in which, in the first determining step, a determination is carried out as to whether or not notification of occurrence of a fiber loss is necessary, in accordance with the predicted yarn count predicted in the first yarn count predicting step and an acquired yarn count, which is a yarn count of the yarn indicated by the yarn information acquired in the second acquiring step.

[Item 3] The notification method according to the item 2, in which, in the first determining step, a determination is made that the notification of occurrence of the fiber loss is necessary when the predicted yarn count and the acquired yarn count do not match.

[Item 4] A notification method executed by a spinning machine in which a yarn is produced by drafting a fiber bundle by a draft device, and spinning the drafted fiber bundle by a spinning device, the notification method including:

a first acquiring step of acquiring fiber bundle information indicating a status of the pre-drafted fiber bundle; and
a second determining step of determining whether or not to execute notification, in accordance with the fiber bundle information acquired in the first acquiring step and setting information of the yarn to be produced that has been set in the spinning machine.

[Item 5] The notification method according to any one of the item 1 through the item 3, further including a second determining step of determining whether or not to execute notification, in accordance with the fiber bundle information acquired in the first acquiring step and setting information of the yarn to be produced that has been set in the spinning machine.

[Item 6] The notification method according to the item 4 or 5, further including a second yarn count predicting step of predicting a predicted yarn count, which is a yarn count of the yarn to be produced by the spinning device, in accordance with the fiber bundle information acquired in the first acquiring step,

in which, in the second determining step, in accordance with the predicted yarn count predicted in the second yarn count predicting step and a set yarn count that is a yarn count of the yarn set in the spinning machine as the setting information of the yarn, a determination is carried out as to whether or not notification of occurrence of an error in supplying of the fiber bundle to the spinning machine or notification of occurrence of fall-off of the fiber bundle in a drawing machine adapted to produce the fiber bundle is necessary.

[Item 7] The notification method according to the item 6, in which, in the second determining step, when determining that the notification of occurrence of fall-off of the fiber bundle is necessary, a determination is further made, in accordance with a decrease rate of the predicted yarn count with respect to the set yarn count, as to in which drawing process among a plurality of drawing processes performed by the drawing machine, the fall-off of the fiber bundle

has occurred.

[Item 8] The notification method according to the item 6 or 7, in which, in the second determining step, when the predicted yarn count is greater than the set yarn count, a determination is made that the notification of occurrence of fall-off of the fiber bundle is necessary, and

when the predicted yarn count is less than the set yarn count, a determination is made that the notification of occurrence of an error in supplying of the fiber bundle to the spinning machine is necessary.

[Item 9] The notification method according to any one of the item 1 through the item 8, in which, the spinning machine further includes a notification device adapted to execute notification,

the notification method further including a notification controlling step of executing notification by the notification device when a determination is made that notification is necessary as a result of the determination as to whether or not the notification is necessary.

[Item 10] The notification method according to any one of the item 1 through the item 9, further including an operation controlling step of controlling a drafting operation of the draft device and a spinning operation of the spinning device, in which, in the operation controlling step, when a determination is made that notification is necessary as a result of the determination as to whether or not the notification is necessary, the drafting operation of the draft device and the spinning operation of the spinning device are stopped.

[Item 11] A spinning machine including:

a draft device adapted to draft a fiber bundle;

a fiber bundle information detecting device adapted to detect fiber bundle information indicating a status of the pre-drafted fiber bundle, and/or a fiber bundle information receiving device adapted to receive the fiber bundle information;

a spinning device adapted to produce a yarn by spinning the fiber bundle drafted by the draft device;

a yarn information detecting device adapted to detect yarn information indicating a status of the yarn produced by the spinning device;

a winding device adapted to wind the yarn produced by the spinning device; and

a control part adapted to execute the notification method according to any one of the item 1 through the item 10, in which, the control part is adapted to acquire the fiber bundle information detected by the fiber bundle information detecting device and/or received by the fiber bundle information receiving device in the first acquiring step, and to acquire the yarn information detected by the yarn information detecting device in the second acquiring step.

[Item 12] A spinning program for causing a computer to execute, in a spinning machine adapted to produce a yarn by drafting a fiber bundle by a draft device and spinning the drafted fiber bundle by a spinning device, processes of:

acquiring fiber bundle information indicating a status of the pre-drafted fiber bundle;

acquiring yarn information indicating a status of the produced yarn; and

determining whether or not notification is necessary in accordance with the fiber bundle information and the yarn information that have been acquired.

[Item 13] A spinning program for causing a computer to execute, in a spinning machine adapted to produce a yarn by drafting a fiber bundle by a draft device and spinning the drafted fiber bundle by a spinning device, processes of:

acquiring fiber bundle information indicating a status of the pre-drafted fiber bundle; and

determining whether or not notification is necessary, in accordance with the acquired fiber bundle information and setting information of the yarn to be produced that has been set in the spinning machine.

[0163] At least a part of the embodiment and various alternative embodiments described above may be optionally combined.

Claims

1. A spinning method executed in a spinning machine (1) in which a yarn (Y) is produced by drafting a fiber bundle (S) by a draft device (6) and spinning the drafted fiber bundle (F) by a spinning device (7), the spinning method comprising:

a first acquiring step of acquiring fiber bundle information indicating a status of the pre-draft fiber bundle (S);

a second acquiring step of acquiring as yarn information, tension of the produced yarn (Y); and

a changing step of changing a total draft ratio of a drafting operation of the draft device (6) in accordance with the fiber bundle information acquired in the first acquiring step and the yarn information acquired in the second acquiring step.

- 5 **2.** The spinning method as claimed in claim 1, wherein, in the changing step, the total draft ratio is changed by changing a rotational speed of at least one of a back bottom roller (14a) of the draft device (6), a front bottom roller (17a) of the draft device (6), or a withdrawal roller (11) adapted to withdraw the yarn (Y) from the spinning device (7).
- 10 **3.** The spinning method as claimed in claim 1 or 2, wherein, in the second acquiring step, thickness of the yarn (Y) and/or mass of the yarn (Y) is acquired as the yarn information.
- 15 **4.** The spinning method as claimed in any one of claim 1 through claim 3, wherein, in the changing step, when the fiber bundle information indicates an increase in mass of the fiber bundle (S) and the yarn information indicates an increase in thickness of the yarn (Y) or an increase in mass of the yarn (Y), the total draft ratio is increased, and
when the fiber bundle information indicates a decrease in the mass of the fiber bundle (S) and the yarn information indicates a decrease in the thickness of the yarn (Y) or a decrease in the mass of the yarn (Y), the total draft ratio is reduced.
- 20 **5.** The spinning method as claimed in any one of claim 1 through claim 4, comprising an operation controlling step of controlling the drafting operation of the draft device (6) and the spinning operation of the spinning device (7), wherein the changing step is executed while continuing the drafting operation of the draft device (6) and the spinning operation of the spinning device (7) in the operation controlling step.
- 25 **6.** The spinning method as claimed in claim 5, wherein, in the changing step, when a status in which a fluctuation amount of the fiber bundle information is equal to or greater than a fiber bundle lower-limit fluctuation amount and is equal to or smaller than a first fiber bundle fluctuation amount lasts for a first fiber bundle length or longer, and a status in which a fluctuation amount of the yarn information is equal to or greater than a yarn lower-limit fluctuation amount and is equal to or smaller than a first yarn fluctuation amount lasts for a first yarn length or longer, the total
30 draft ratio is changed.
- 35 **7.** The spinning method as claimed in claim 6, wherein, in the operation controlling step, at least in one of cases where a status in which the fluctuation amount of the fiber bundle information acquired in the first acquiring step exceeds the first fiber bundle fluctuation amount lasts for the first fiber bundle length or longer, or where a status in which the fluctuation amount of the yarn information acquired in the second acquiring step exceeds the first yarn fluctuation amount lasts for the first yarn length or longer, the drafting operation of the draft device (6) and the spinning operation of the spinning device (7) are stopped.
- 40 **8.** The spinning method as claimed in claim 6 or claim 7, wherein the spinning machine (1) comprises a yarn information detecting device (8, 9) adapted to detect the yarn information, the yarn information detecting device (8, 9) being adapted to judge that the yarn (Y) includes a yarn defect when judging, in accordance with the detected yarn information, that a status in which the fluctuation amount of the yarn information exceeds a second yarn fluctuation amount is lasting for a second yarn length or greater;
the second yarn fluctuation amount is greater than the first yarn fluctuation amount;
45 the second yarn length is shorter than the first yarn length; and
in the operation controlling step, the drafting operation of the draft device (7) and the spinning operation of the spinning device (6) are stopped.
- 50 **9.** The spinning method as claimed in any one of claim 1 through claim 8, wherein the spinning machine (1) comprises a tension notification device (102) adapted to notify fluctuation in tension of the produced yarn (Y), the spinning method comprising a tension notification controlling step of executing notification by the tension notification device (102) when the fiber bundle information acquired in the first acquiring step indicates no change in mass of the fiber bundle (S) and the yarn information acquired in the second acquiring step indicates an increase in tension of the yarn (Y), or when the fiber bundle information acquired in the first acquiring step indicates a decrease in mass of the fiber bundle (S) and the yarn information acquired in the second acquiring step indicates an increase
55 in the tension of the yarn (Y).
- 10.** The spinning method as claimed in claim 1, comprising a first determining step of determining whether or not to

execute notification in accordance with the fiber bundle information acquired in the first acquiring step and the yarn information acquired in the second acquiring step.

5 11. The spinning method as claimed in claim 10, comprising a first yarn count predicting step of predicting a predicted yarn count in accordance with the fiber bundle information acquired in the first acquiring step, the predicted yarn count being a yarn count of the yarn (Y) to be produced by the spinning device (7),
 10 wherein, in the first determining step, a determination is carried out as to whether or not notification of occurrence of a fiber loss is necessary in accordance with the predicted yarn count predicted in the first yarn count predicting step and an acquired yarn count, the acquired yarn count being a yarn count of the yarn indicated by the yarn information acquired in the second acquiring step.

12. The spinning method as claimed in claim 11, wherein, in the first determining step, a determination is made that the notification of occurrence of the fiber loss is necessary when the predicted yarn count and the acquired yarn count do not match.

13. The spinning method as claimed in any one of claim 1, 10 through 12, comprising a second determining step of determining whether or not to execute notification in accordance with the fiber bundle information acquired in the first acquiring step and setting information of the yarn (Y) to be produced that has been set in the spinning machine (1).

14. The spinning method as claimed in claim 13, comprising a second yarn count predicting step of predicting a predicted yarn count in accordance with the fiber bundle information acquired in the first acquiring step, the predicted yarn count being a yarn count of the yarn (Y) to be produced by the spinning device (7),
 25 wherein, in the second determining step, a determination is carried out, in accordance with the predicted yarn count predicted in the second yarn count predicting step and a set yarn count that is a yarn count of the yarn (Y) set in the spinning machine (1) as the setting information of the yarn (Y), as to whether or not notification of occurrence of an error in supplying of the fiber bundle (S) to the spinning machine (1) or notification of occurrence of fall-off of the fiber bundle (S) in a drawing machine adapted to produce the fiber bundle (S) is necessary.

15. The spinning method as claimed in claim 14, wherein, in the second determining step, when determining that the notification of occurrence of fall-off of the fiber bundle is necessary, a determination is further made as to in which drawing process among a plurality of drawing processes performed by the drawing machine, the fall-off of the fiber bundle has occurred.

16. The spinning method as claimed in claim 14 or 15, wherein, in the second determining step,
 35 when the predicted yarn count is greater than the set yarn count, a determination is made that the notification of occurrence of fall-off of the fiber bundle is necessary, and
 when the predicted yarn count is less than the set yarn count, a determination is made that the notification of occurrence of an error in supplying of the fiber bundle (S) to the spinning machine (1) is necessary.

17. The spinning method as claimed in any one of claim 10 through claim 16, wherein the spinning machine (1) comprises a notification device (102) adapted to execute a notification, the spinning method comprising a notification control step of executing the notification by the notification device (102) when a determination is made that the notification is necessary as a result of the determination as to whether or not the notification is necessary.

18. The spinning method as claimed in any one of claim 10 through claim 17, comprising an operation controlling step of controlling the drafting operation of the draft device (6) and the spinning operation of the spinning device (7),
 45 wherein, in the operation controlling step, the drafting operation of the draft device (6) and the spinning operation of the spinning device (7) are stopped when a determination is made in the first determining step that the notification is necessary.

19. A spinning machine (1) comprising:

a draft device (6) adapted to draft a fiber bundle (S);

a fiber bundle information detecting device (20) adapted to detect fiber bundle information indicating a status of the pre-drafted fiber bundle (S), and/or a fiber bundle information receiving device (30) adapted to receive the fiber bundle information;

a spinning device (7) adapted to produce a yarn (Y) by spinning the fiber bundle (F) drafted by the draft device (6);

a yarn information detecting device (9) adapted to detect yarn information indicating tension of the yarn (Y)

produced by the spinning device (7);

a winding device (13) adapted to wind the yarn (Y) produced by the spinning device (7); and

a control part (10; 100) adapted to execute the spinning method as claimed in any one of claim 1 through claim 18, wherein the control part (10; 100) is adapted to acquire the fiber bundle information detected by the fiber bundle information detecting device (20) and/or received by the fiber bundle information receiving device (30) in the first acquiring step, and to acquire the yarn information detected by the yarn information detecting device (9) in the second acquiring step.

20. A spinning program (D) for causing a computer to execute, in a spinning machine (1) adapted to produce a yarn (Y) by drafting a fiber bundle (S) by a draft device (6) and spinning the drafted fiber bundle (F) by a spinning device (7), processes of:

acquiring fiber bundle information indicating a status of the pre-drafted fiber bundle (S);

acquiring yarn information indicating tension of the produced yarn (Y); and

changing a total draft ratio of a drafting operation executed by the draft device (6) in accordance with the fiber bundle information and the yarn information that have been acquired.

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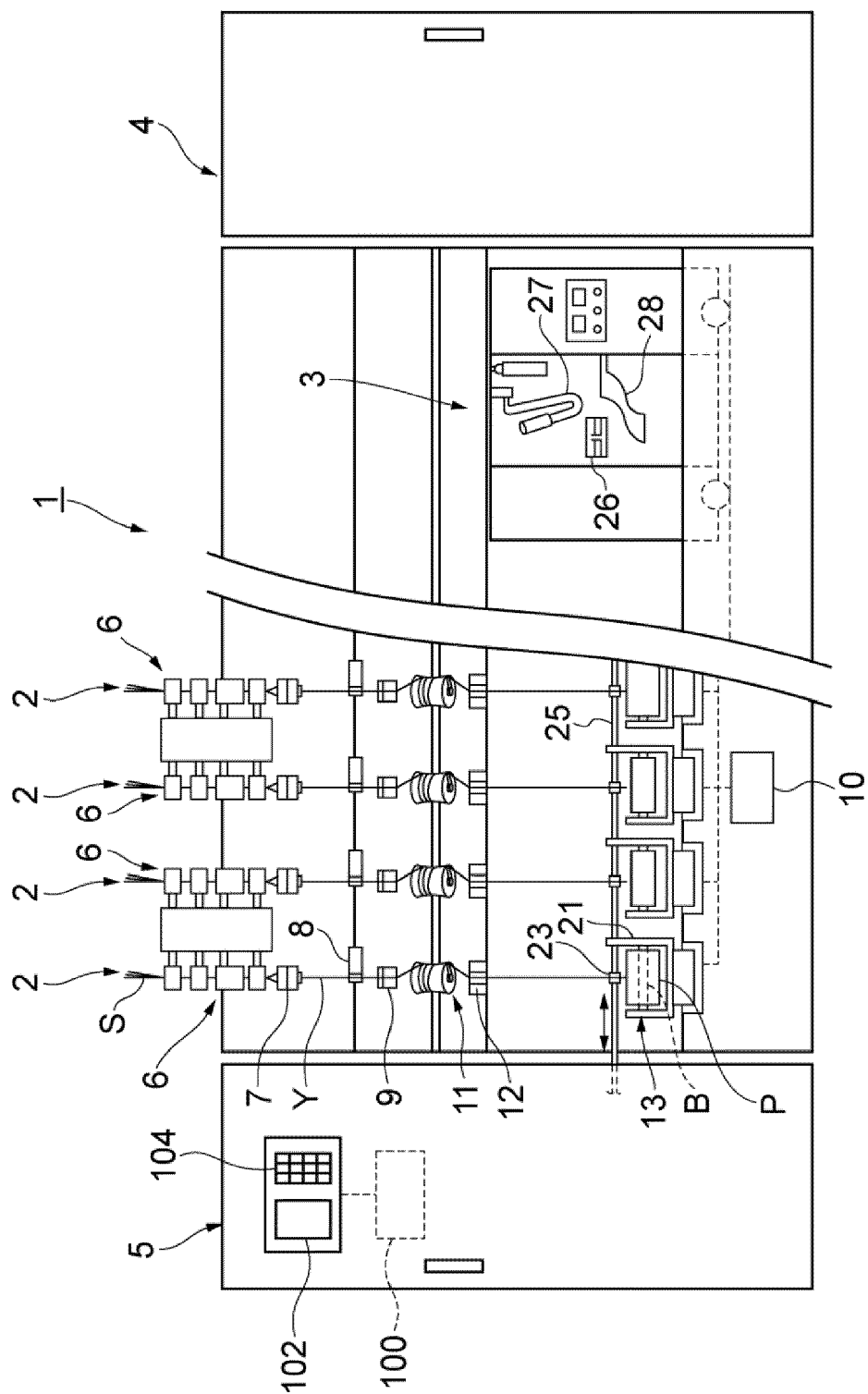


FIG. 2

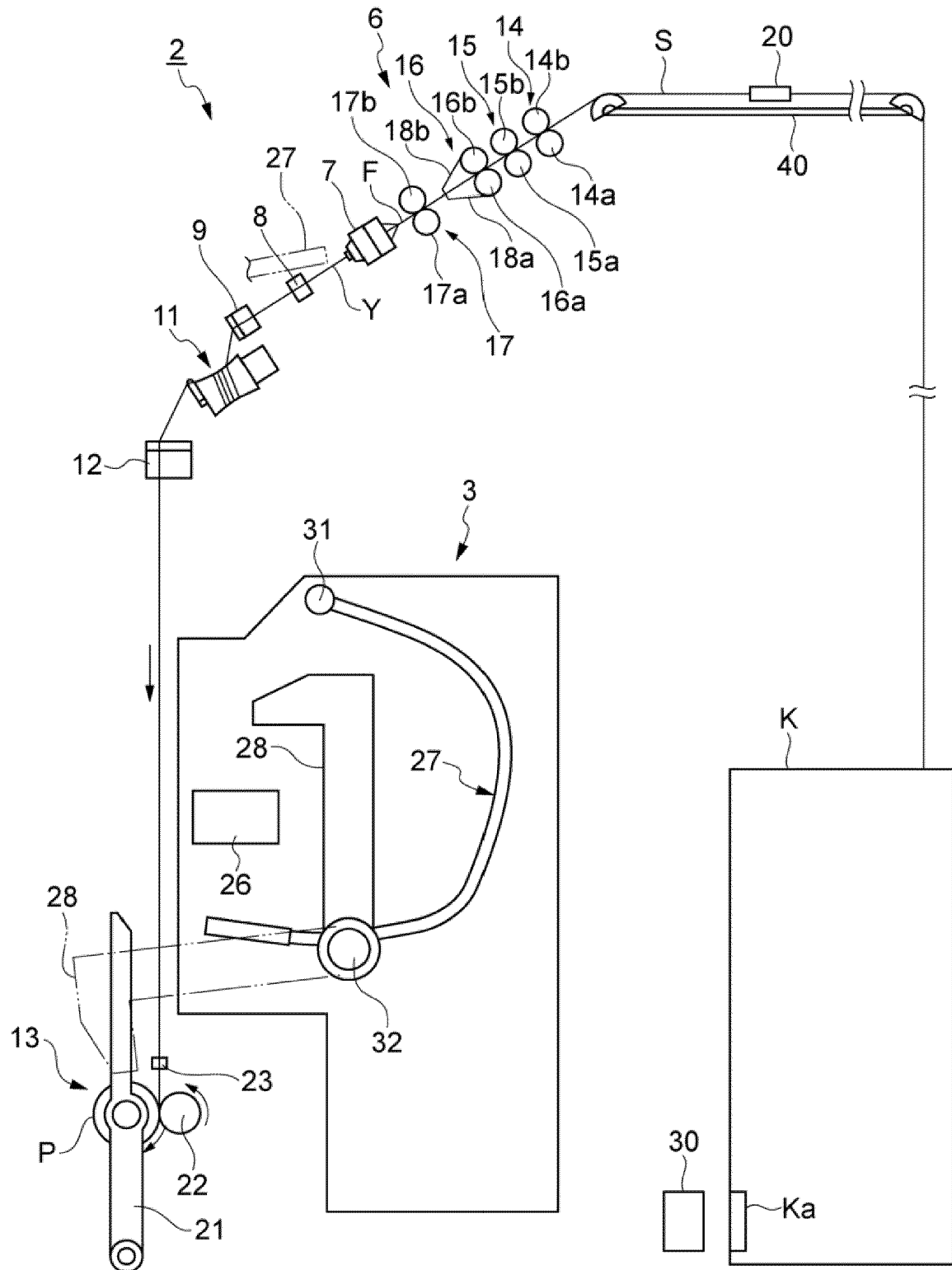


FIG. 3

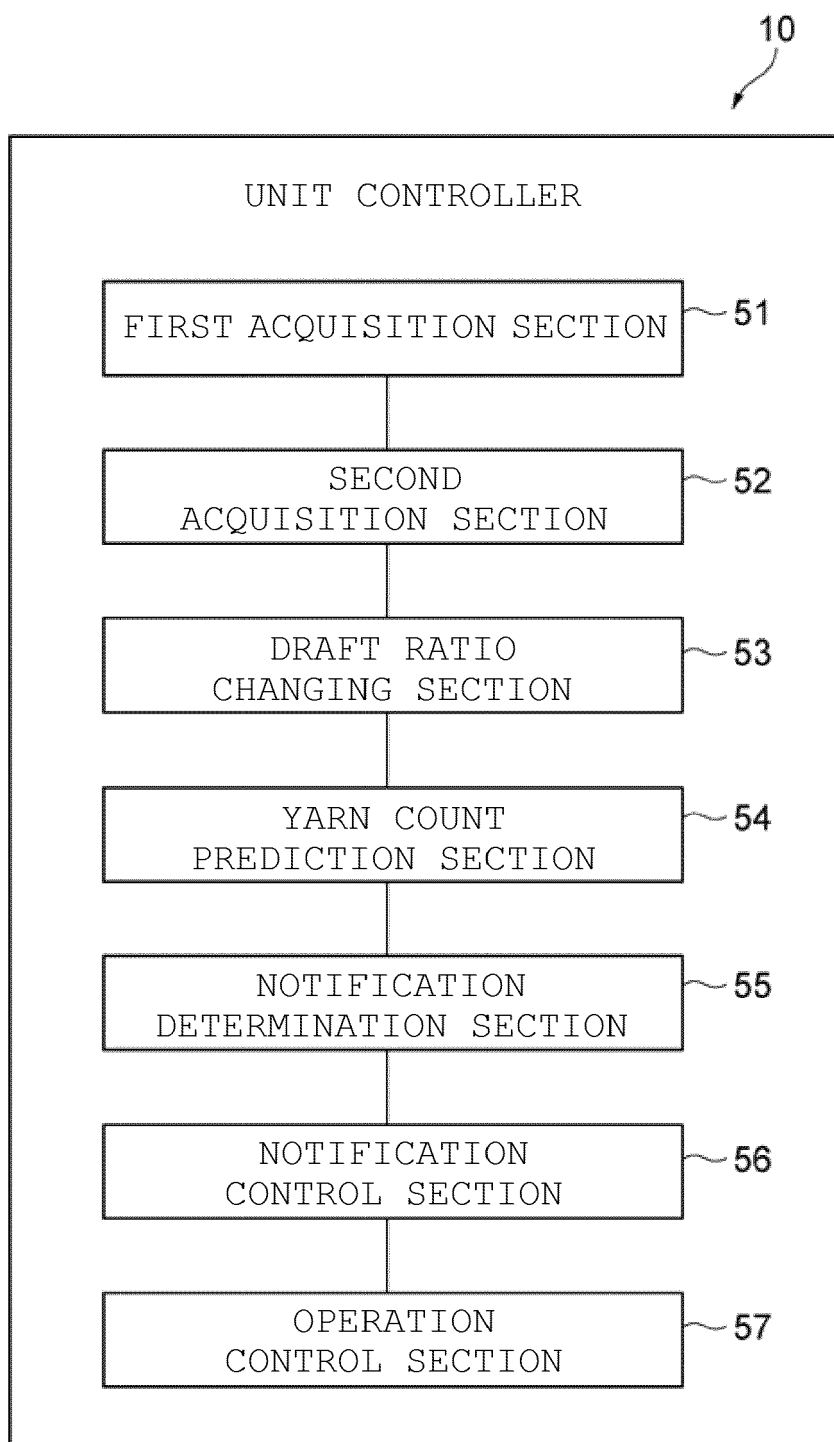


FIG. 4

PATTERN	FIBER BUNDLE MASS	YARN THICKNESS	TOTAL DRAFT RATIO
A1	INCREASE	INCREASE	INCREASE
A2	NO CHANGE	INCREASE	NO CHANGE
A3	NO CHANGE	NO CHANGE	NO CHANGE
A4	NO CHANGE	DECREASE	NO CHANGE
A5	DECREASE	DECREASE	REDUCE

FIG. 5

PATTERN	FIBER BUNDLE MASS	YARN MASS	TOTAL DRAFT RATIO
B1	INCREASE	INCREASE	INCREASE
B2	NO CHANGE	NO CHANGE	NO CHANGE
B3	NO CHANGE	DECREASE	NO CHANGE
B4	DECREASE	DECREASE	REDUCE

FIG. 6

PATTERN	FIBER BUNDLE MASS	YARN TENSION	TOTAL DRAFT RATIO
C1	INCREASE	INCREASE	INCREASE
C2	INCREASE	NO CHANGE	NO CHANGE
C3	INCREASE	DECREASE	NO CHANGE
C4	NO CHANGE	INCREASE	NO CHANGE
C5	NO CHANGE	NO CHANGE	NO CHANGE
C6	NO CHANGE	DECREASE	NO CHANGE
C7	DECREASE	INCREASE	NO CHANGE
C8	DECREASE	NO CHANGE	NO CHANGE
C9	DECREASE	DECREASE	REDUCE

FIG. 7

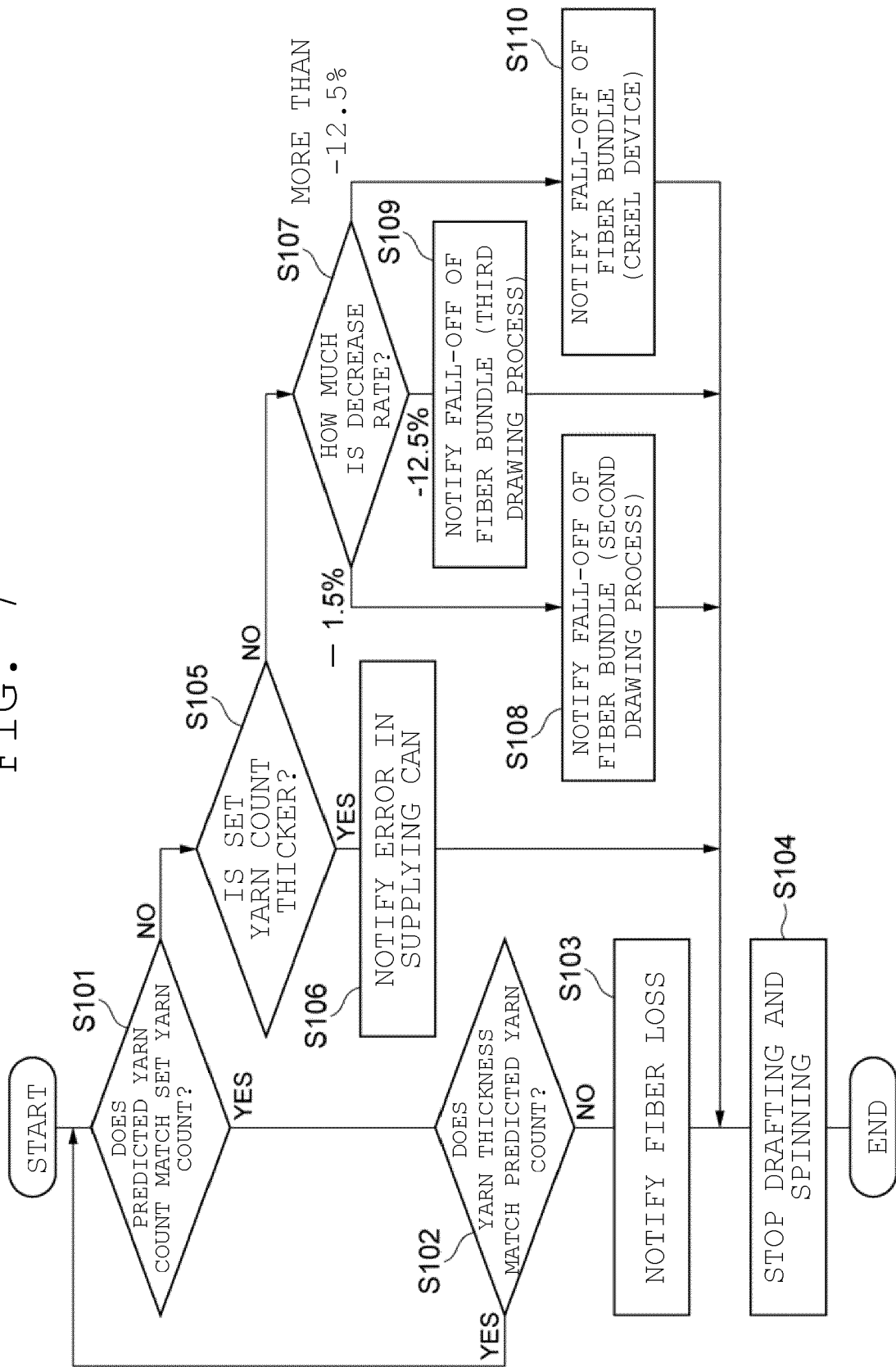
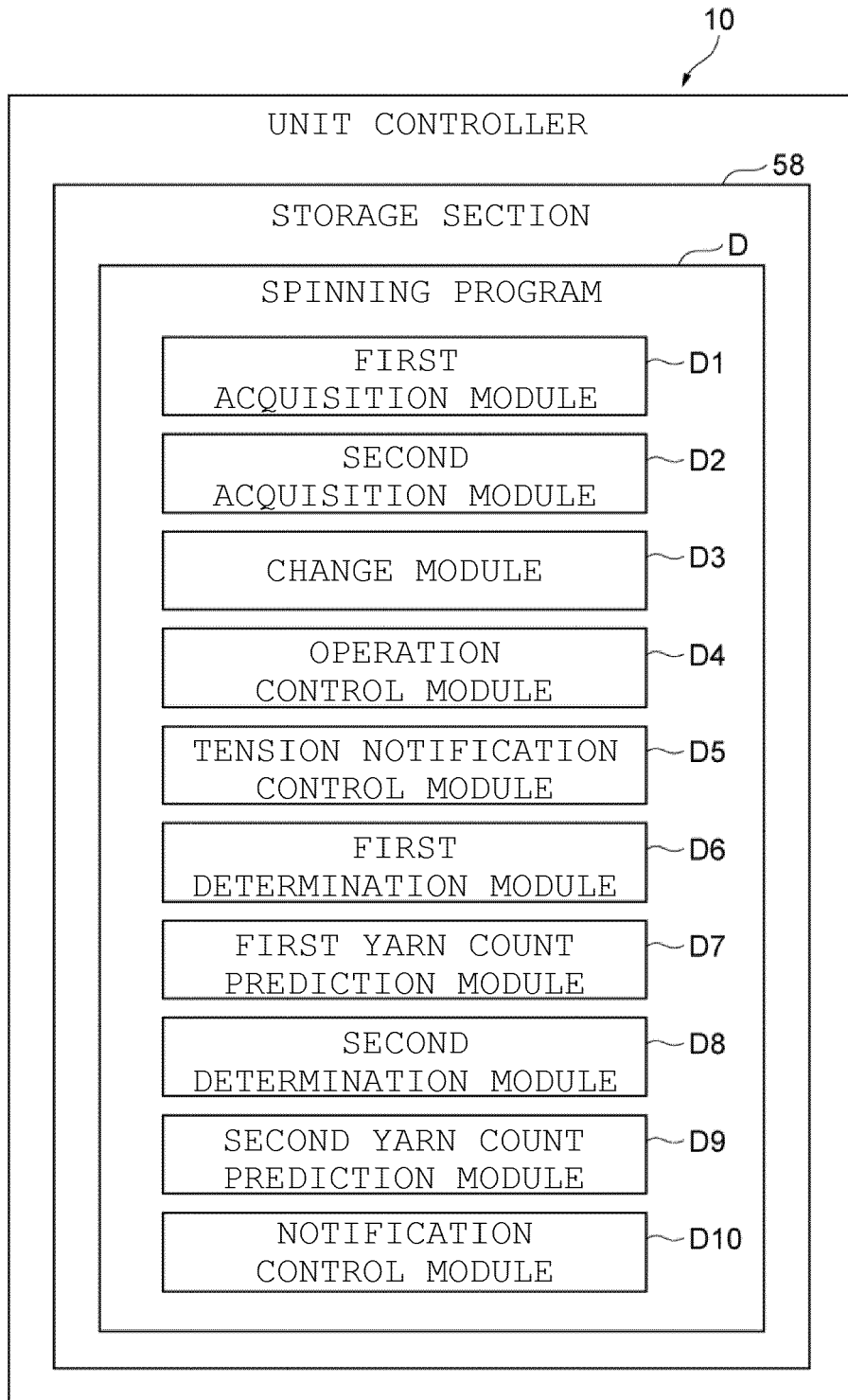


FIG. 8





EUROPEAN SEARCH REPORT

Application Number
EP 19 21 4403

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X,D	EP 2 687 627 A1 (MURATA MACHINERY LTD [JP]) 22 January 2014 (2014-01-22)	3	INV.
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Munich		10 June 2020	Todarello, Giovanni
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