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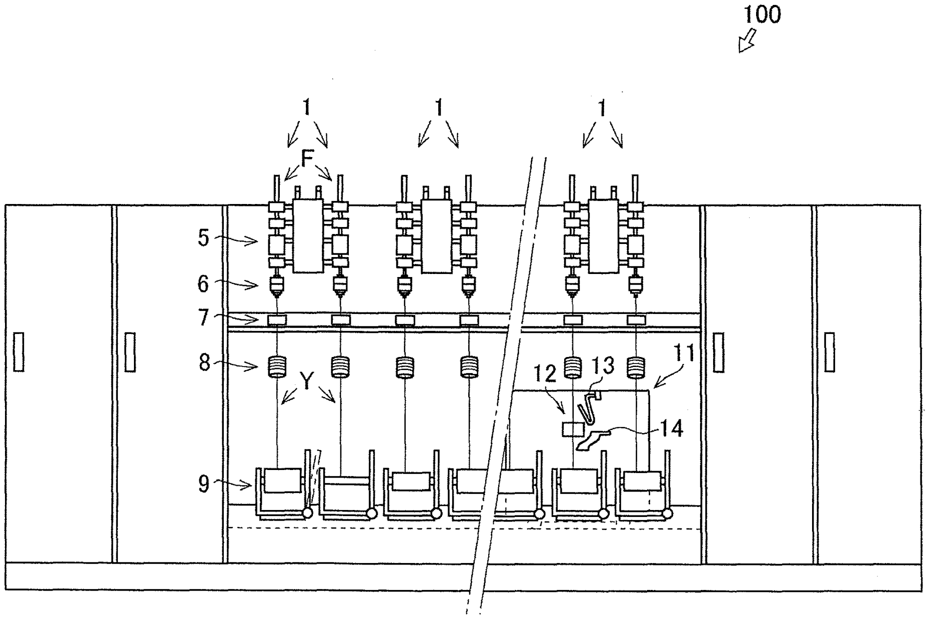
(54) **Spinning unit**

(57) A spinning unit 1 includes a draft device 5, a spinning device 6, a tension stabilizing device 8, a winding device 9, and a yarn defect detecting device 7. The draft device 5 drafts a fiber bundle F. The spinning device 6 produce a spun yarn Y from the fiber bundle F drafted by the draft device 5. The tension stabilizing device 8 stabilizes tension of the spun yarn Y produced by the spinning device 6. The winding device 9 winds a package 91 of the spun yarn Y fed from the tension stabilizing device 8. The yarn defect detecting device 7 can detect a yarn defect in the spun yarn Y. The yarn defect detecting device 7 is arranged between the spinning device 6 and the tension stabilizing device 8.

FIG. 1



EP 2 309 042 A2

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to technology of a spinning unit, and relates more particularly to technology of a spinning unit that can accurately detect a yarn defect in a spun yarn.

2. Description of the Related Art

[0002] A conventionally-known spinning unit produces a spun yarn by twisting a drafted fiber bundle, and forms a package by winding the spun yarn by a winding device. The spinning unit includes a yarn defect detecting device that can detect a yarn defect in a spun yarn. The spinning unit cuts off and removes a yarn defect detected by the yarn defect detecting device to adjust yarn quality (as disclosed in Patent Document 1, for example).

[0003] However, in the conventional spinning unit, a yarn feeding device for feeding a produced spun yarn is provided, and the yarn defect detecting device is arranged between the yarn feeding device and the winding device (as disclosed in Patent Document 2, for example). The winding device winds a package while traversing the spun yarn. Accordingly, in the spinning unit, a yarn path of the spun yarn may change. Consequently, there were cases where a detection signal from the yarn defect detecting device is unstable, which made it difficult to detect a yarn defect.

[0004] Another conventional spinning unit includes the above-described yarn feeding device, a tension stabilizing device which stabilizes tension of a spun yarn, and a yarn defect detecting device which is arranged between the yarn feeding device and the tension stabilizing device (as disclosed in Patent Document 3, for example). In the spinning unit, since fluctuations may generate in speed at which the yarn feeding device feeds a spun yarn, it had been necessary to maintain tension of the spun yarn high. Accordingly, there were cases where characteristics of a yarn defect in the spun yarn are hidden, which made it difficult for the yarn defect detecting device to detect the yarn defect. That is, high tension is constantly applied to the spun yarn between the yarn feeding device and the tension stabilizing device. Accordingly, characteristics of the yarn defect such as changes in hairiness or spinning failure had been absorbed by the spun yarn being pulled, which made it difficult for the yarn defect detecting device to detect the yarn defect.

[0005] Further, in another conventional spinning unit, by driving and rotating a friction roller that is arranged to make contact with a package, the package is driven and rotated (as disclosed in Patent Document 4, for example). However, in such a spinning unit, rotational speed of the friction roller may fluctuate due to some reason, or rotational speed of the package may fluctuate due to unevenness in friction force acting between the friction roller and the package. Accordingly, there were cases where tension acting upon the spun yarn changed suddenly, which caused the spun yarn to be cut off or yarn characteristics to be changed.

[0006]

[Patent Document 1] Japanese Unexamined Patent Application Publication No. 2000-303275
[Patent Document 2] Japanese Unexamined Patent Application Publication No. H11-268872
[Patent Document 3] Japanese Unexamined Patent Application Publication No. 2009-155757
[Patent Document 4] Japanese Unexamined Patent Application Publication No. 2004-169264

SUMMARY OF THE INVENTION

[0007] The present invention has been made to solve the above-described problems. It is an object of the present invention to improve accuracy of detecting a yarn defect by a yarn defect detecting device by preventing traverse operation of a spun yarn performed by a winding device from influencing the detection accuracy of the yarn defect detecting device, and by appropriately maintaining and stabilizing tension applied to the spun yarn.

[0008] According to an aspect of the present invention, a spinning unit includes a draft device, a spinning device, a tension stabilizing device, a winding device, and a yarn defect detecting device. The draft device drafts a fiber bundle. The spinning device produces a spun yarn from the fiber bundle drafted by the draft device. The tension stabilizing device stabilizes tension of the spun yarn produced by the spinning device. The winding device winds a package of the spun yarn fed from the tension stabilizing device. The yarn defect detecting device detects a yarn defect in the spun yarn, and is arranged between the spinning device and the tension stabilizing device.

[0009] Accordingly, even when the winding device winds a package of the spun yarn while traversing the spun yarn, a yarn path of the spun yarn in the yarn defect detecting device does not change. Consequently, the yarn defect detecting device can stably detect a yarn defect in the spun yarn. Further, tension applied to the spun yarn between the spinning device and the tension stabilizing device can be maintained at an appropriate level and stabilized. Consequently, characteristics of a yarn defect in the spun yarn can be prevented from being hidden. As a result, accuracy of detecting a yarn defect by the yarn defect detecting device can be improved, and quality of the spun yarn produced by the spinning unit can be improved.

[0010] The above-described tension stabilizing device includes a roller member and a unwinding member. The roller member winds the spun yarn around a peripheral surface thereof. The unwinding member unwinds the spun yarn wound around the roller member. The unwinding member appropriately adjusts unwinding speed of the spun yarn to stabilize tension of the spun yarn between the spinning device and the tension stabilizing device.

[0011] Accordingly, even when tension of the spun yarn fed from the tension stabilizing device fluctuates, tension of the spun yarn between the spinning device and the tension stabilizing device can be prevented from being influenced by such fluctuations. Consequently, accuracy of detecting a yarn defect by the yarn defect detecting device can be improved, and quality of the spun yarn produced by the spinning device can be improved.

[0012] The above-described spinning unit includes a first guide section and a second guide section. The first guide section is arranged between the spinning device and the yarn defect detecting device and regulates a yarn path of the spun yarn. The second guide section is arranged between the yarn defect detecting device and the tension stabilizing device and regulates a yarn path of the spun yarn. Accordingly, a yarn path in the yarn defect detecting device is stabilized. Consequently, accuracy of detecting a yarn defect by the yarn defect detecting device can be further improved, and quality of the spun yarn produced by the spinning unit can be improved.

[0013] The yarn defect detecting device measures yarn thickness of the spun yarn to detect the yarn defect. Consequently, a spun yarn with abnormal yarn thickness can be prevented from being wound into a package.

[0014] The above-described yarn defect detecting device detects standard deviation of yarn thickness of the spun yarn. Consequently, after measuring long-term data of yarn thickness of the spun yarn, the spun yarn can be wound into a package.

[0015] The above-described yarn defect detecting device includes a light source, a light receiving section, and a casing member. The light source irradiates light to the spun yarn. The light receiving section receives the light irradiated from the light source. The casing member holds the light source and the light receiving section. Accordingly, the yarn defect detecting device can be made by a simple configuration. Further, the yarn defect detecting device having such a configuration can accurately detect fluctuations in apparent thickness caused by hairiness of the spun yarn, and is advantageous for producing a high-quality package.

[0016] In the above-described spinning unit, when tension of the spun yarn fed from the tension stabilizing device is greater than a prescribed value, the unwinding member increases the unwinding speed of the spun yarn. When the tension of the spun yarn fed from the tension stabilizing device is at most the prescribed value, the unwinding member decreases the unwinding speed of the spun yarn.

[0017] Accordingly, even when the tension of the spun yarn fed from the tension stabilizing device increases, tension of the spun yarn between the spinning device and the tension stabilizing device can be prevented from being influenced by such increase. Further, even when the tension of the spun yarn fed from the tension stabilizing device decreases, the tension of the spun yarn between the spinning device and the tension stabilizing device can be prevented from being influenced by such decrease. Consequently, accuracy of detecting a yarn defect by the yarn defect detecting device can be improved, and quality of the spun yarn produced by the spinning unit can be improved.

[0018] The above-described tension stabilizing device includes a driving section which rotates the roller member. The driving device stabilizes the tension of the spun yarn between the spinning device and the tension stabilizing device by maintaining winding speed of the spun yarn at a prescribed value. Accordingly, winding speed of the spun yarn around the roller member can be maintained constant. Therefore, the tension of the spun yarn between the spinning device and the tension stabilizing device can be maintained at an appropriate level and can be stabilized. Furthermore, since the spun yarn is wound around the roller member a plurality of times, a sufficient contact length between the roller member and the spun yarn can be obtained, and the spun yarn can be prevented from slipping. Consequently, accuracy of detecting a yarn defect by the yarn defect detecting device can be improved, and quality of the spun yarn produced by the spinning unit can be improved.

[0019] The above-described tension stabilizing device temporarily accumulates the spun yarn by appropriately adjusting unwinding speed of the spun yarn with respect to the winding speed of the spun yarn. Consequently, even when the tension of the spun yarn fed from the tension stabilizing device increases, by feeding the accumulated spun yarn from the roller member, the tension of the spun yarn between the spinning device and the tension stabilizing device can be prevented from being influenced. Further, even when the tension of the spun yarn fed from the tension stabilizing device decreases, by winding the spun yarn around the roller member and accumulating the spun yarn, the tension of the spun yarn between the spinning device and the tension stabilizing device can be prevented from being influenced. Consequently, accuracy of detecting a yarn defect by the yarn defect detecting device can be improved, and quality of the spun yarn produced by the spinning unit can be improved.

[0020] The above-described yarn defect detecting device detects a yarn defect of the spun yarn immediately after the spun yarn is produced by the spinning device. Accordingly, the yarn defect in the spun yarn produced by the spinning device can be detected before such a spun yarn is influenced by the contact with other members or the like. Consequently, accuracy of detecting a yarn defect by the yarn defect detecting device can be improved, and quality of the spun yarn produced by the spinning unit can be improved.

[0021] The yarn defect detecting device detects a yarn defect under a spinning tension of the spinning device. Accordingly, the yarn defect detecting device can appropriately detect a spinning state of the spinning device.

Consequently, accuracy of detecting a yarn defect by the yarn defect detecting device can be improved, and quality of the spun yarn produced by the spinning unit can be improved.

[0022] The above-described yarn defect detecting device is arranged at a position where tension is applied to the spun yarn only by the tension stabilizing device. Accordingly, tension of the spun yarn in the yarn defect detecting device can be maintained at an appropriate level and stabilized. Consequently, characteristics of a yarn defect in the spun yarn can be prevented from being hidden. As a result, accuracy of detecting a yarn defect by the yarn defect detecting device can be improved, and quality of the spun yarn produced by the spinning unit can be improved.

[0023] The above-described spinning device uses whirling airflow to twist the fiber bundle drafted by the draft device to produce the spun yarn. Accordingly, feeding of the spun yarn from the spinning device is stable. Further, tension of the spun yarn in the yarn defect detecting device can be maintained at an appropriate level and can be stabilized. Consequently, characteristics of a yarn defect in the spun yarn can be prevented from being hidden. As a result, accuracy of detecting a yarn defect by the yarn defect detecting device can be improved, and quality of the spun yarn produced by the spinning unit can be improved.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024]

Fig. 1 is a view illustrating a spinning machine 100 including a plurality of spinning units 1.

Fig. 2 is a view illustrating an overall structure of each spinning unit 1.

Fig. 3 is a view illustrating a spinning device 6 provided in the spinning unit 1.

Fig. 4 is a view illustrating a yarn defect detecting device 7 provided in the spinning unit 1.

Fig. 5 is a view illustrating a tension stabilizing device 8 provided in the spinning unit 1.

Fig. 6 is a schematic view illustrating an overall structure of a yarn splicing device 12.

Fig. 7 is a view illustrating an overall structure of a conventional first spinning unit 2.

Fig. 8A is a graph illustrating detection signal from the yarn defect detecting device 7 in which disturbances have been excluded. Fig. 8B is a graph illustrating detection signal from the yarn defect detecting device 7 of the conventional first spinning unit 2.

Fig. 9 is a view illustrating an overall structure of a conventional second spinning unit 3.

Fig. 10A is a graph illustrating detection signal from the yarn defect detecting device 7 in which disturbances have been excluded. Fig. 10B is a graph illustrating detection signal from the yarn defect detecting device 7 of the conventional second spinning unit 3.

Fig. 11 is a graph illustrating detection signal from the yarn defect detecting device 7 of the spinning unit 1.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0025] By referring to Fig. 1, a description will be made on a spinning machine 100 including a plurality of spinning units 1 according to an embodiment of the present invention. In the spinning machine 100, the plurality of spinning units 1 that produce a spun yarn Y from a fiber bundle (which will hereinafter be referred to as a "sliver") F are arranged next to one another. The spinning machine 100 also includes a yarn splicing cart 11, a drive device (not illustrated in the drawings), a control device, or the like.

[0026] In order to improve quality of the spun yarn Y produced by the spinning machine 100, quality of the spun yarn Y produced in each spinning unit 1 is required to be maintained stable at certain level. That is, average quality of the spun yarn Y produced in each spinning unit 1 is required to be maintained at certain level.

[0027] Accordingly, the spinning machine 100 confirms that standard deviation of yarn thickness of the spun yarn Y produced in each spinning unit 1 meets a prescribed standard. Further, the spinning machine 100 confirms that standard deviation of average yarn thickness of the spun yarn Y produced in each spinning unit 1 meets the prescribed standard. An SD value representing standard deviation of yarn thickness is obtained by the following formula:

[0028]

[Formula 1]

$$SD = \frac{1}{n}\sum_{i=1}^{n}(X_i - M)^2$$

[0029] Further, M in Formula 1 representing an average value of yarn thickness of the spun yarn Y is obtained by the following formula:

[0030]

[Formula 2]

$$M = \frac{1}{n}\sum_{i=1}^{n}X_i$$

[0031] To confirm quality of the spun yarn Y by such formulae and to form a package 91 in which yarn defects have been removed, accuracy of measuring yarn thickness of the spun yarn Y is required. Accordingly, detection accuracy is important in a yarn defect detecting device 7 that measures yarn thickness of the spun yarn Y in order to detect a yarn defect.

[0032] Further, a yarn defect in the spun yarn Y refers to a portion with abnormal yarn thickness of the spun yarn Y. For example, a portion that has reached at least a prescribed rate with respect to a yarn count, which is a target value of the spun yarn Y, will be defined as a thick yarn portion D1. A portion that has reached at most the prescribed rate with respect to the yarn count, which is the target value of the spun yarn Y, will be defined as a thin yarn portion D2.

[0033] First, by referring to Fig. 2, Fig. 3, Fig. 4, and Fig. 5, an overall structure of the spinning unit 1 according to the embodiment of the present invention will be described.

[0034] In each spinning unit 1, a sliver supplying unit 4, a draft device 5, a spinning device 6, a yarn defect detecting device (a yarn clearer, or a yarn-quality measuring device) 7, a tension stabilizing device (a yarn accumulating device) 8, and a winding device 9 are arranged in this order along a direction in which the sliver F and the spun yarn Y are fed. The sliver supplying unit 4 mainly supplies the accumulated sliver F. The draft device 5 drafts the sliver F to equalize thickness of the sliver F. The spinning device 6 twists the sliver F to produce the spun yarn Y. The yarn defect detecting device 7 measures yarn thickness of the spun yarn Y to detect a yarn defect. The tension stabilizing device 8 stabilizes tension of the spun yarn Y. The winding device 9 winds a package 91 of the spun yarn Y while traversing the spun yarn Y.

[0035] The sliver supplying unit 4 includes a sliver case 41 and a sliver guide (not illustrated in the drawings). The sliver case 41 accumulates the sliver F, which is a material for the spun yarn Y. The sliver guide guides the sliver F to the draft device 5.

[0036] The draft device 5 includes a plurality of pairs of draft rollers that draft and feed the sliver F. In the spinning unit 1, the draft device 5 includes four pairs of draft rollers. Specifically, in the draft device 5, a pair of back rollers 51, a pair of third rollers 52, a pair of middle rollers 53, and a pair of front rollers 54 are arranged along a direction in which the sliver F is fed.

[0037] The four pairs of draft rollers 51, 52, 53, and 54 include bottom rollers 51A, 52A, 53A, and 54A, and top rollers 51B, 52B, 53B, and 54B. The bottom rollers 51A, 52A, 53A, and 54A are rotated by a driving source (not illustrated in the drawings). The top rollers 51B, 52B, 53B, and 54B are respectively arranged to make contact with the bottom rollers 51A, 52A, 53A, and 54A, and are driven and rotated. Each of the bottom rollers 51A, 52A, 53A, and 54A is rotated in the same direction. Each of the top rollers 51B, 52B, 53B, and 54B is rotated in the same direction.

[0038] Accordingly, the sliver F, which is nipped by the bottom rollers 51A, 52A, 53A, and 54A and the top rollers 51B, 52B, 53B, and 54B, is fed following rotation of the pairs of draft rollers 51, 52, 53, and 54. Rotational speed of each pair of the draft rollers 51, 52, 53, and 54 is set to increase sequentially along a direction in which the sliver F is fed.

[0039] In such a structure, each time the sliver F passes through each pair of the draft rollers 51, 52, 53, and 54, the speed of the sliver F increases. Consequently, the sliver F is drafted between adjacent pairs of draft rollers 51, 52, 53, and 54.

[0040] The spinning device 6 is an air-jet spinning device that uses whirling airflow to twist the sliver F drafted by the draft device 5 to produce the spun yarn Y. As illustrated in Fig. 3, the spinning device 6 mainly includes a guiding member 61, a spindle member 63, and a nozzle member 64. The sliver F drafted by the draft device 5 is supplied to the guiding member 61. A spinning chamber 62 is formed between the spindle member 63 and the guiding member 61. The nozzle member 64 is provided around the spindle member 63 with a prescribed space between the nozzle member 64 and the spindle member 63. Further, the arrows in Fig. 3 indicate a direction in which the sliver F and the spun yarn Y are fed and also a direction in which the supplied air flows.

[0041] The guiding member 61 is a member which constitutes a portion of the spinning chamber 62. The guiding member 61 guides the sliver F drafted by the draft device 5 to the spinning chamber 62. In Fig. 3, a needle-shaped member is provided at the guiding member 61; however, the function of the needle-shaped member may be accomplished by a downstream end portion of the guiding member 61 without providing the needle-shaped member.

[0042] The spinning chamber 62 is a space including a substantially cylindrical space 62a and a substantially circular space 62b. The space 62a is provided between the guiding member 61 and the spindle member 63. The space 62b is provided between the spindle member 63 and the nozzle member 64. The space 62a is a space where a portion of each fiber of the sliver F is reversed (refer to the alternate long and double-short dashed line in Fig. 3). The space 62b is a space where the reversed fibers are whirled along airflow (refer to the alternate long and double-short dashed line in Fig. 3).

[0043] The spindle member 63 is a member which also constitutes a portion of the spinning chamber 62. The spindle member 63 feeds out the spun yarn Y twisted in the spinning chamber 62. The spindle member 63 is provided with a yarn passage 63a. The spindle member 63 is connected with the spinning chamber 62. The spun yarn Y is fed out through the yarn passage 63a.

[0044] The nozzle member 64 is a member which also constitutes a portion of the spinning chamber 62. The nozzle member 64 generates whirling airflow inside the spinning chamber 62. The nozzle member 64 is provided with a plurality of air injection holes 64a that are connected to the spinning chamber 62. By injecting air through the air injection holes 64a, whirling airflow is generated inside the spinning chamber 62.

[0045] In such a structure, a portion of each fiber of the sliver F can be reversed and whirled by the whirling airflow (refer to the alternate long and double-short dashed line in Fig. 3). The spun yarn Y, which has been twisted as described above, is fed from the spinning device 6. In the above-described spinning device 6, the sliver F is twisted not by a mechanical structure but by airflow. Accordingly, feeding of the spun yarn Y is stabilized, and tension of the fed spun yarn Y can be maintained at an appropriate level and can be stabilized. That is, the spinning device 6 controls tension to be generated in a spun yarn by resistance between airflow and a fiber without nipping and holding the sliver F mechanically. Consequently, spinning tension in the spinning device 6 is stabilized and is maintained constant.

[0046] The yarn defect detecting device 7 includes a light source 71, a light receiving section 72, a casing member 73, and a guiding member 74 (refer to Fig. 2). The light source 71 irradiates light to the spun yarn Y. The light receiving section 72 receives the light irradiated from the light source 71. The casing member 73 holds the light source 71 and the light receiving section 72. The guiding member 74 regulates a yarn path of the spun yarn Y. Further, the arrows in Fig. 4 indicate a direction of the light irradiated from the light source 71.

[0047] The light source 71 is a light-emitting diode which emits light by applying an electric voltage in a forward direction. A light-emitting diode is a semiconductor device which emits light by electroluminescence effects. The light source 71 is arranged capable of irradiating light to the spun yarn Y.

[0048] The light receiving section 72 is a phototransistor which can control an electric current with a light signal. A phototransistor is a semiconductor device which can control a collector current of a transistor with an amount of light received. The light receiving section 72 is arranged capable of receiving the light irradiated by the light source 71. The light receiving section 72 outputs an electric signal corresponding to the amount of light received as a detection signal.

[0049] The casing member 73 is a member which holds the light source 71 and the light receiving section 72 at a prescribed position. The casing member 73 is provided with a yarn passage 73a through which the spun yarn Y passes. The light source 71 and the light receiving section 72 are arranged to face each other across the spun yarn Y.

[0050] The guiding member 74 is a yarn hooking member which regulates a yarn path of the spun yarn Y at a prescribed position. The guiding member 74 includes a first guide and a second guide. The first guide is arranged upstream of the casing member 73. The second guide is arranged downstream of the casing member 73. The guiding member 74 stabilizes the yarn path in the yarn defect detecting device 7 (refer to Fig. 2).

[0051] An amount of light received by the light receiving section 72 is obtained by subtracting an amount of light blocked by the spun yarn Y from an amount of light irradiated to the spun yarn Y from the light source 71. Accordingly, the yarn defect detecting device 7 can measure yarn thickness of the spun yarn Y in accordance with the amount of light received by the light receiving section 72. Further, the yarn defect detecting device 7 can detect a yarn defect in the spun yarn Y by measuring an amount of light received that changes depending on yarn thickness.

[0052] The tension stabilizing device 8 maintains tension of the spun yarn Y at an appropriate level and stabilized the tension. As illustrated in Fig. 5, the tension stabilizing device 8 mainly includes a roller member (a yarn accumulating roller) 81, a driving section 82, and an unwinding member (a yarn hooking member) 83. The roller member 81 winds the spun yarn Y. The driving section 82 rotates the roller member 81. The unwinding member 83 unwinds the spun yarn Y wound around a peripheral surface of the roller member 81. Further, the arrows in Fig. 5 indicate a direction in which the spun yarn Y is fed.

[0053] The roller member 81 is a substantially cylindrical rotating body which winds the spun yarn Y by rotating. The roller member 81 is mounted on a rotating shaft 82a of the driving section 82, and is driven and rotated by the driving section 82. The spun yarn Y which has been guided to the tension stabilizing device 8 (i.e., the spun yarn Y which has been guided to the roller member 81) is wound around an outer peripheral surface of the roller member 81. Accordingly, the spun yarn Y wound around the roller member 81 a plurality of times has long contact length with the roller member 81. Consequently, slipping between the spun yarn Y and the roller member 81 can be prevented.

[0054] The roller member 81 will be further described in detail. In the roller member 81, a side where the unwinding member 83 is provided will be referred to as a tip end, and a side where the driving section 82 is provided will be referred to as a base end. The outer peripheral surface of the roller member 81 includes a base-end taper portion, a cylindrical portion, and a tip-end taper portion arranged in this order from the base end to the tip end thereof.

[0055] The cylindrical portion slightly tapers towards a tip end thereof, and also is flatly connected (without difference in level) with the taper portions at both ends. It is preferable that the spun yarn Y is wound around the outer peripheral surface of the roller member 81 at least 10 times without having an overlapped portion of the spun yarn Y so as to gain a sufficient ability of the roller member 81 to feed the spun yarn Y. Accordingly, the roller member 81 is formed in a size in which the spun yarn Y can be wound around the roller member 81 at least 10 times and then accumulated. A yarn accumulated amount detecting sensor (not illustrated in the drawings) is provided to face the roller member 81. The yarn accumulated amount detecting sensor detects an accumulated amount of the spun yarn Y wound around the roller member 81, and then transmits a detection signal to a unit controller (not illustrated in the drawings).

[0056] Each of the base-end taper portion and the tip-end taper portion is formed in a slightly tapered shape with a larger diameter at a corresponding end surface side. On the outer peripheral surface of the roller member 81, the base-end taper portion smoothly moves the supplied spun yarn Y from a larger diameter portion to a smaller diameter portion towards the cylindrical portion arranged between the base-end taper portion and the tip-end taper portion so as to orderly wind the spun yarn Y around a surface of the cylindrical portion. The tip-end taper portion has a function of preventing a sloughing phenomenon in which the spun yarn Y wound around the roller member 81 sloughs off all at once when the spun yarn Y is unwound from the roller member 81. The tip-end taper portion also has a function of sequentially rewinding the spun yarn Y from the smaller diameter portion to the larger diameter portion at the end surface side so as to smoothly pull out the spun yarn Y.

[0057] The driving section 82 is an electric motor which is driven by being supplied with electricity. The driving section 82 drives and rotates the roller member 81, and also constantly maintains rotational speed of the roller member 81 at a prescribed value. Accordingly, speed at which the spun yarn Y is wound around the roller member 81 can be maintained constant.

[0058] The unwinding member 83 is a yarn hooking member which assists the spun yarn Y wound around the roller member 81 to be unwound by rotating integrally with the roller member 81 or independently. One end portion of the unwinding member 83 is attached to a rotating shaft 84 provided on a central axis of the roller member 81. The other end portion of the unwinding member 83 is formed so as to be curved towards the outer peripheral surface of the roller member 81. The unwinding member 83 guides the spun yarn Y to the outer peripheral surface of the roller member 81 by hooking the spun yarn Y to such a curved portion. A basal portion of the rotating shaft 84 provided with the unwinding member 83 is configured such that resistance torque is generated against relative rotation by a permanent magnet mounted on one of the rotating shaft 84 and the roller member 81, and a magnetic hysteresis member mounted on the other thereof. Further, a method for applying resistance torque to between the unwinding member 83 and the roller member 81 is not limited to such a magnetic mechanism. For example, friction force or an electromagnetic mechanism can be used.

[0059] When tension of the spun yarn Y fed from the tension stabilizing device 8 (i.e., tension of the spun yarn Y unwound from the roller member 81) is low and weaker than the above-described resistance torque, the unwinding member 83 rotates integrally with the roller member 81. The unwinding member 83 winds the spun yarn Y hooked on the unwinding member 83 around the roller member 81. As described above, since the tension stabilizing device 8 unwinds the spun yarn Y from the roller member 81 while winding the spun yarn Y by the unwinding member 83, unwinding speed can be decreased.

[0060] Meanwhile, when tension of the spun yarn Y unwound from the roller member 81 is high and surpasses the above-described resistance torque, the unwinding member 83 rotates independently from the roller member 81. The unwinding member 83 unwinds the spun yarn Y from the roller member 81. As described above, since the tension stabilizing device 8 unwinds the spun yarn Y from the roller member 81 while unwinding the spun yarn Y by the unwinding member 83, the unwinding speed can be increased.

[0061] Further, as described above, the tension stabilizing device 8 can adjust unwinding speed with respect to speed at which the spun yarn Y is wound around the roller member 81. Consequently, the tension stabilizing device 8 can temporarily accumulate the spun yarn Y while winding the spun yarn Y around the roller member 81.

[0062] Accordingly, when the tension of the spun yarn Y unwound from the roller member 81 increases, the accumulated spun yarn Y is fed from the roller member 81. Further, when the tension of the spun yarn Y unwound from the roller member 81 decreases, the spun yarn Y is wound around the roller member 81 and is accumulated.

[0063] By such a structure, even when the tension of the spun yarn Y unwound from the roller member 81 fluctuates, tension of the spun yarn Y between the spinning device 6 and the tension stabilizing device 8 can be prevented from being influenced by such fluctuations.

[0064] The winding device 9 forms a substantially cylindrical package 81 by winding the spun yarn Y around a bobbin 92 while traversing the spun yarn Y in an axial direction of the bobbin 92. The package 91 or the bobbin 92 is driven and rotated by the driving force of the friction roller 93, and the spun yarn Y is around an outer peripheral surface of the package 91 or the bobbin 92.

[0065] As described above, the spinning unit 1 drafts the sliver F to equalize the thickness of the sliver F, and twists the drafted sliver F to produce the spun yarn Y. The spinning unit 1 winds such spun yarn Y to form a package 91.

[0066] As described above, in the spinning unit 1, the tension stabilizing device 8 is arranged downstream of the yarn defect detecting device 7. Accordingly, even when the winding device 9 winds the spun yarn Y while traversing the spun yarn Y, the tension stabilizing device 8 can absorb changes in a yarn path of the spun yarn Y. Further, even when the rotational speed of the friction roller 93 of the winding device 9 fluctuates, for example, the tension stabilizing device 8 can absorb changes in tension of the spun yarn Y. As described above, the yarn path of the spun yarn Y between the spinning device 6 and the tension stabilizing device 8 can be stabilized, and tension of the spun yarn Y can be maintained at an appropriate level and can be stabilized. Consequently, the spinning unit 1 can improve accuracy of detecting a yarn defect by the yarn defect detecting device 7.

[0067] Next, a description will be made on a reason why quality of the spun yarn Y can be improved by improving accuracy of detecting a yarn defect by the yarn defect detecting device 7.

[0068] As described above, the yarn defect detecting device 7 detect a yarn defect in the spun yarn Y by measuring an amount of light received that changes depending on yarn thickness. A cutting device (not illustrated in the drawings) is provided immediately upstream of the yarn defect detecting device 7. When detecting a yarn defect, the yarn defect detecting device 7 immediately cuts the spun yarn Y by the cutting device. Then, after the yarn defect has been cut off and removed, the cut-off spun yarns Y are spliced together by a yarn splicing device 12 and are rewound as a spun yarn Y.

[0069] That is, when the yarn defect detecting device 7 overlooks a yarn defect in the spun yarn Y, a package 91 is made of the spun yarn Y including the yarn defect. Meanwhile, when the yarn defect detecting device 7 mistakenly determines that a portion which is not a yarn defect is a yarn defect, an unnecessary cutting-off and splicing operation is performed. Therefore, it is important to improve accuracy of detecting a yarn defect by the yarn defect detecting device 7 in order to improve quality of the spun yarn Y. Further, it is also important to improve accuracy of detecting a yarn defect by the yarn defect detecting device 7 in order to improve productivity of the spun yarn Y produced by the spinning unit 1.

[0070] A description will be made on the operation of the spinning unit 1 of when the yarn defect detecting device 7 detects a yarn defect. When receiving a yarn defect detection signal from the yarn defect detecting device 7, a unit controller (not illustrated in the drawings) immediately cuts the spun yarn Y by the cutting device, and further stops the draft device 5, the spinning device 6, or the like. The unit controller transmits a control signal to the yarn splicing cart 11 and controls the yarn splicing cart 11 to travel to the spinning unit 1 in which the spun yarn Y has been cut off. Then, the unit controller restarts the spinning device 6 or the like, and controls the yarn splicing device 12 of the yarn splicing cart 11 to perform a yarn splicing operation. After the yarn splicing operation has been completed, the unit controller restarts a winding operation in the spinning unit 1.

[0071] The yarn splicing cart 11 includes the yarn splicing device 12, a suction pipe 13, and a suction mouth 14 (refer to Fig. 1). When a yarn breakage or a yarn cut occurs in one spinning unit 1, the yarn splicing cart 11 travels on rails (not illustrated in the drawings) provided at the lower part of the spinning machine 100 to such a spinning unit 1, and stops. The suction pipe 13 sucks and catches a yarn end fed from the spinning device 6 and guides the yarn end to the yarn splicing device 12 while swinging around a shaft in a vertical direction. The suction mouth 14 sucks and catches a yarn end from the package 91 supported by the winding device 9 and guides the yarn end to the yarn splicing device 12 while swinging around a shaft in a vertical direction. The yarn splicing device 12 splices the guided yarn ends together.

[0072] In the followings, an overall structure of the yarn splicing device 12 will described by referring to Fig. 6. Further, the arrows in Fig. 6 indicate a direction in which each member of the yarn splicing device 12 can move.

[0073] The yarn splicing device 12 mainly includes a first untwisting nozzle 121, a second untwisting nozzle 122, a yarn splicing nozzle 123, a pair of yarn handling levers 124, a first yarn end cutter 125a, a second yarn end cutter 125b, and a pair of yarn holding levers 127.

[0074] The first untwisting nozzle 121 sucks and untwists a yarn end YT (refer to the alternate long and short dashed line in Fig. 6) at the tension stabilizing device 8 side. The first untwisting nozzle 121 includes a first untwisting pipe 121b which exposes a first suction opening 121a. The first untwisting pipe 121b is connected with an untwisting air passage 221 through which untwisting air is injected into the first untwisting pipe 121b. The untwisting air passage 221 is connected with the vicinity of the first suction opening 121a of the first untwisting pipe 121b. The untwisting air passage 221 is slanted with respect to an axial direction of the first untwisting pipe 121b. The first untwisting nozzle 121 sucks the yarn end YT from the first suction opening 121a by the untwisting air injected through the untwisting air passage 221, and untwists fibers by spiral airflow formed in the first untwisting pipe 121b.

[0075] The second untwisting nozzle 122 sucks and untwists a yarn end YW (refer to the solid line in Fig. 6) at the winding device 9 side. The second untwisting nozzle 122 includes a second untwisting pipe 122b which exposes a second suction opening 122a. The second untwisting pipe 122b is connected with an untwisting air passage 222 through which untwisting air is injected into the second untwisting pipe 122b. The untwisting air passage 222 is connected with the vicinity of the second suction opening 122a of the second untwisting pipe 122b. The untwisting air passage 222 is slanted with respect to an axial direction of the second untwisting pipe 122b. The second untwisting nozzle 122 sucks the yarn end YW from the second suction opening 122a by the untwisting air injected through the untwisting air passage 222, and untwists fibers by spiral airflow formed in the second untwisting pipe 122b.

[0076] The yarn splicing nozzle 123 twists and splices the untwisted and raveled yarn end YT at the tension stabilizing device 8 side with the untwisted and raveled yarn end YW at the winding device 9 side. A storing section 123a and a guide slant section 123b are formed in the yarn splicing nozzle 123. The storing section 123a stores the yarn end YT at the tension stabilizing device 8 side and the yarn end YW at the winding device 9 side. The guide slant section 123b guides both yarn ends YT and YW to the storing section 123a. The yarn splicing nozzle 123 is connected with a yarn twisting air passage

223 through which yarn splicing air is injected into the yarn splicing nozzle 123. The yarn splicing nozzle 123 forms whirling airflow in the storing section 123a by the yarn splicing air injected through the yarn twisting air passage 223, and then twists and splices both yarn ends YT and YW together.

[0077] The yarn handling levers 124 positions each of the yarn end YT at the tension stabilizing device 8 side and the yarn end YW at the winding device 9 side at a prescribed position. The yarn handling levers 124 are located to face one another across the yarn splicing nozzle 123. Each of the yarn handling levers 124 is moved by a drive device (not illustrated in the drawings). By moving the yarn handling levers 124 before an untwisting operation, the tip ends of both yarn ends YT and YW are pulled to a prescribed position in the yarn splicing nozzle 123. By moving the yarn handling lever 124 to a further appropriate position after the untwisting operation, untwisted portions of both yarn ends YT and YW are placed at a prescribed position in the storing section 123a.

[0078] Before untwisting the yarn end YT at the tension stabilizing device 8 side, the first yarn end cutter 125a cuts the yarn end YT to an appropriate length. Before untwisting the yarn end YW at the winding device 9 side, the second yarn end cutter 125b cuts the yarn end YW to an appropriate length. The yarn end YT cut off by the first yarn end cutter 125a is fixed with a first clamp plate 126a. The yarn end YW cut off by the second yarn end cutter 125b is fixed with a second clamp plate 126b.

[0079] After the untwisted portions of both yarn ends YT and YW are placed at the prescribed position in the storing section 123a by the yarn handling lever 124, the yarn holding levers 127 fix the yarn ends YT and YW. The yarn holding levers 127 are moved along lateral surfaces of the yarn splicing nozzle 123 by a drive device (not illustrated in the drawings). The yarn holding levers 127 fix both yarn ends YT and YW such that both yarn ends YT and YW are nipped between the yarn holding levers 127 and the yarn splicing nozzle 123. Then, as described above, after yarn splicing air is injected into the yarn splicing nozzle 123, both yarn ends YT and YW are twisted and spliced together.

[0080] Further, in the present embodiment, the yarn splicing cart 11 includes the yarn splicing device 12. However, the yarn splicing device 12 may be provided in each spinning unit 1. Further, the structure of the yarn splicing device 12 is not limited to the above-described structure as long as the yarn splicing device 12 can splice a yarn end at a spinning device 6 side with a yarn end at the winding device 9 side.

[0081] The overall structures of the spinning unit 1 and the yarn splicing device 12 according to the embodiment of the present invention have been described above. Next, a description will be made on a conventional first spinning unit 2 and a conventional second spinning unit 3 in order to describe superiority of detection accuracy of the yarn defect detecting device 7 in the spinning unit 1. Further, like reference numerals will be used for like components of the above-described spinning unit 1. A description will be mainly made on different portions.

[0082] Fig. 7 is a view illustrating an overall structure of the conventional first spinning unit 2. In the conventional first spinning unit 2, a sliver supplying unit 4, a draft device 5, a spinning device 6, a yarn feeding device 10, a yarn defect detecting device 7, and a winding device 9 are arranged in this order along a direction in which the sliver F and the spun yarn Y are fed. The sliver supplying unit 4 mainly supplies the accumulated sliver F. The draft device 5 drafts the sliver F to equalize thickness of the sliver F. The spinning device 6 twists the sliver F to produce the spun yarn Y. The yarn feeding device 10 feeds the produced spun yarn Y. The yarn defect detecting device 7 measures yarn thickness of the spun yarn Y to detect a yarn defect. The winding device 9 winds a package 91 of the spun yarn Y while traversing the spun yarn Y.

[0083] The yarn feeding device 10 feeds the spun yarn Y produced by the spinning device 6 to the winding device 9. The yarn feeding device 10 includes a delivery roller 101 and a nip roller 102, or the like. The spun yarn Y nipped by the delivery roller 101 and the nip roller 102 is fed following rotation of the delivery roller 101 and the nip roller 102.

[0084] The conventional first spinning unit 2 is not provided with the tension stabilizing device 8, which is a different aspect from the spinning unit 1 according to the embodiment of the present invention. The yarn defect detecting device 7 is arranged between the yarn feeding device 10 and the winding device 9. Accordingly, the yarn defect detecting device 7 detects a yarn defect before the spun yarn Y fed from the yarn feeding device 10 reaches the winding device 9.

[0085] However, when winding a package 91 of the spun yarn Y, the winding device 9 needs to wind the spun yarn Y while traversing the spun yarn Y. The above-described conventional structure may influence accuracy of detecting a yarn defect by the yarn defect detecting device 7.

[0086] Specifically, the winding device 9 winds the spun yarn into the package 91 Y while traversing the spun yarn Y in an axial direction of the bobbin 92. Accordingly, the yarn path of the spun yarn Y in the yarn defect detecting device 7 may change. Consequently, there were cases where a detection signal from the yarn defect detecting device 7 is unstable, which made it difficult to detect a yarn defect in the spun yarn Y.

[0087] Further, the winding device 9 in the conventional first spinning unit 2 drives and rotates the friction roller 93 in order to rotate the package 91. Accordingly, when rotational speed of the friction roller 93 fluctuates, for example, tension of the spun yarn Y may change. Consequently, there were cases where a detection signal from the yarn defect detecting device 7 is unstable, which made it difficult to detect a yarn defect in the spun yarn Y.

[0088] With reference to Fig. 8, a detailed description will be made on problems in which detection of a yarn defect is made difficult due to unstableness of detection signals from the yarn defect detecting device 7 caused by changes in the yarn path of the spun yarn Y and changes in the tension of the spun yarn Y. Fig. 8A is a graph illustrating detection signal when using the yarn defect detecting device 7 in which disturbances have been excluded. Fig. 8B is a graph illustrating detection signal from the yarn defect detecting device 7 of the conventional first spinning unit 2. Further, a state in which disturbances have been excluded refers to a state in which all of disturbances influencing detection accuracy of the yarn defect detecting device 7, such as a traverse movement of the spun yarn Y performed by the winding device 9, are excluded.

[0089] Horizontal axes of Fig. 8A and Fig. 8B indicate a period of time that has elapsed since a prescribe point of time. That is, the horizontal axes indicate an arbitrary position in a length direction of the spun yarn Y that passes through the yarn defect detecting device 7. Vertical axes of Fig. 8a and Fig. 8b indicate voltage value, which is detection signal from the light receiving section 72 of the yarn defect detecting device 7. That is, the vertical axes indicate yarn thickness of the spun yarn Y detected by the yarn defect detecting device 7. Further, in the drawings, voltage value VA indicates average yarn thickness, voltage value VA-h indicates allowable maximum yarn thickness, and voltage value VA-1 indicates allowable minimum yarn thickness.

[0090] Fig. 8A and Fig. 8B are graphs illustrating changes in yarn thickness of the spun yarn Y measured at prescribed intervals in the length direction of the spun yarn Y that passes through the yarn defect detecting device 7. Fig. 8A and Fig. 8B indicate that a thick yarn portion D1 exists in a portion where the yarn thickness of the spun yarn Y surpasses the allowable maximum yarn thickness. Fig. 8A and Fig. 8B indicate that a thin yarn portion D2 exists in a portion where the yarn thickness of the spun yarn Y surpasses the allowable minimum yarn thickness.

[0091] Fig. 8A indicates changes in yarn thickness measured under a state in which all the disturbances have been excluded. Thus, it can be assumed that Fig. 8A indicates yarn thickness of the spun yarn Y without a margin of error. Fig. 8A indicates that the thick yarn portion D1, which is a portion where the yarn thickness of the spun yarn Y surpasses the allowable maximum yarn thickness, exists at a position L1 in the spun yarn Y. Fig. 8A indicates that the thin yarn portion D2, which is a portion where the yarn thickness of the spun yarn Y surpasses the allowable minimum yarn thickness, exists at a position L2 in the spun yarn Y.

[0092] Fig. 8B indicates changes in yarn thickness measured by the yarn defect detecting device 7 of the conventional first spinning unit 2. Thus, Fig. 8B includes relatively significant fluctuations in detection signal caused by changes in the yarn path of the spun yarn Y and/or changes in tension of the spun yarn Y in the yarn defect detecting device 7. Such significant fluctuations are caused by changes in an amount of light received in the light receiving section 72 due to changes in the yarn path of the spun yarn Y and/or changes in tension of the spun yarn Y. Further, changes in yarn thickness as indicated in Fig. 8B are not actually occurring in the spun yarn Y detected by the yarn defect detecting device 7.

[0093] In Fig. 8B, since a detection result of the yarn defect detecting device 7 surpasses the allowable maximum yarn thickness at the position L1 in the spun yarn Y, a determination is made that the thick yarn portion D1 exists at the position L1. However, since a detection result of the yarn defect detecting device 7 does not surpass the allowable minimum yarn thickness at the position L2 in the spun yarn Y, a determination is not made that the thick yarn portion D2 does not exist at the position L2. That is, a detection signal of a real yarn defect is overlooked.

[0094] Since the yarn path in the yarn defect detecting device 7 has changed at the position L2 of the spun yarn Y or the tension of the spun yarn Y has changed at the position L2 of the spun yarn Y, the yarn defect detecting device 7 has output a detection signal indicating that yarn thickness is thicker than an actual yarn thickness in the thin yarn portion D2. Thus, an erroneous determination is made that yarn thickness of the thin yarn portion D2 existed at the position L2 in the spun yarn Y does not surpass the minimum yarn thickness.

[0095] As described above, in the conventional first spinning unit 2, since the winding device 9 winds the spun yarn Y into the package 91 while traversing the spun yarn Y, the yarn path of the spun yarn Y in the yarn defect detecting device 7 changes. Further, when rotational speed of the friction roller 93 of the winding device 9 fluctuates, for example, tension of the spun yarn Y in the yarn defect detecting device 7 may change. Therefore, there were cases where detection signals from the yarn defect detecting device 7 become unstable due to such changes, which made it difficult to detect a yarn defect in the spun yarn Y.

[0096] Further, in the spinning machine 100, when differences arise among the yarn feeding devices 10 of each of the conventional first spinning units 2, the tension applied to the spun yarns Y between the yarn feeding devices 10 and the winding devices 9 may not be equal. Consequently, since unevenness is generated among the yarn spinning units 2, there were cases where it is difficult to maintain quality of the spun yarn Y at a constant level in the spinning machine 100 as a whole.

[0097] Fig. 9 is a view illustrating an overall structure of a conventional second spinning unit 3. In the conventional second spinning unit 3, a sliver supplying unit 4, a draft device 5, a spinning device 6, a yarn feeding device 10, a yarn defect detecting device 7, a tension stabilizing device 8, and a winding device 9 are arranged in this order along a direction in which the sliver F and the spun yarn Y are fed. The sliver supplying unit 4 mainly supplies the accumulated sliver F. The draft device 5 drafts the sliver F to equalize thickness of the sliver F. The spinning device 6 twists the sliver F to produce the spun yarn Y. The yarn feeding device 10 feeds the produced spun yarn Y. The yarn defect detecting device 7 measures yarn thickness of the spun yarn Y to detect a yarn defect. The tension stabilizing device 8 stabilizes tension of the spun yarn Y. The winding device 9 winds the spun yarn Y into the package 91 while traversing the spun yarn Y.

[0098] The conventional second spinning unit 3 is provided with the yarn feeding device 10, which is different from the spinning unit 1 according to the embodiment of the present invention, and the yarn defect detecting device 7 is arranged between the yarn feeding device 10 and the tension stabilizing device 8. Accordingly, the yarn defect detecting device 7 detects a yarn defect before the spun yarn Y fed from the yarn feeding device 10 reaches the tension stabilizing device 8.

[0099] In such a conventional structure, even when the winding device 9 winds the spun yarn Y into the package 91 while traversing the spun yarn Y, the yarn path of the spun yarn Y in the yarn defect detecting device 7 does not change. Further, when rotational speed of the friction roller 93 of the winding device 9 fluctuates, for example, tension of the spun yarn Y in the yarn defect detecting device 7 does not change. However, fluctuations may generate in speed at which the yarn feeding device 10 feeds the spun yarn Y. Therefore, it was necessary to maintain tension of the spun yarn Y high. Consequently, there were cases where even in the conventional second spinning unit 3, fluctuations in tension of the spun yarn Y influences accuracy of detecting a yarn defect by the yarn defect detecting device 7.

[0100] Specifically, the spun yarn Y nipped by the delivery roller 101 and the nip roller 102 is fed to the tension stabilizing device 8 by following rotation of the delivery roller 101 and the nip roller 102. There were cases where tension of the spun yarn Y between the yarn feeding device 10 and the tension stabilizing device 8 changes due to fluctuations in feeding speed of the yarn feeding device 10. Therefore, the tension stabilizing device 8 increased the tension of the spun yarn Y by pulling the spun yarn Y so as to improve detection accuracy of the yarn defect detecting device 7. However, characteristics of a yarn defect may be hidden due to the increase in the tension of the spun yarn Y. Consequently, there were cases where it was difficult to detect a yarn defect in the spun yarn Y by the yarn defect detecting device 7.

[0101] Next, with reference to Fig. 10, a description will be made on problems in which detection of a yarn defect by the yarn defect detecting device 7 is made difficult due to characteristics of a yarn defect being hidden by the increase in the tension of the spun yarn Y. Fig. 10A is a graph illustrating detection signal when using the yarn defect detecting device 7 in which disturbances have been excluded. Fig. 10B is a graph illustrating detection signal from the yarn defect detecting device 7 of the conventional second spinning unit 3. Further, as described above, a state in which disturbances have been excluded refers to a state in which all of disturbances influencing detection accuracy of the yarn defect detecting device 7 have been excluded.

[0102] Fig. 10A and Fig. 10B are graphs illustrating changes in yarn thickness of the spun yarn Y measured at prescribed intervals in the length direction of the spun yarn Y that passes through the yarn defect detecting device 7. In the same manner as the above-described Fig. 8A and Fig. 8B, Fig. 10A and Fig. 10B indicate that a thick yarn portion D1 exists in a portion where the yarn thickness of the spun yarn Y surpasses the allowable maximum yarn thickness. Fig. 10A and Fig. 10B indicate that a thin yarn portion D2 exists in a portion where the yarn thickness of the spun yarn Y surpasses the allowable minimum yarn thickness.

[0103] Fig. 10A indicates changes in yarn thickness measured under a state in which all the disturbances have been excluded. Thus, it can be assumed that Fig. 10A indicates yarn thickness of the spun yarn Y without a margin of error. Fig. 10A indicates that the thick yarn portion D1, which is a portion where the yarn thickness of the spun yarn Y surpasses the allowable maximum yarn thickness, exists at a position L1 in the spun yarn Y. Fig. 10A indicates that the thin yarn portion D2, which is a portion where the yarn thickness of the spun yarn Y surpasses the allowable minimum yarn thickness, exists at a position L2 in the spun yarn Y.

[0104] Fig. 10B indicates changes in yarn thickness measured by the yarn defect detecting device 7 of the conventional second spinning unit 3. Fig. 10B indicates equalization of the detection signals from the yarn defect detecting device 7 caused by the characteristics of a yarn defect being hidden due to the increase in the tension of the spun yarn Y. Such equalization has been caused by the equalization of the yarn thickness of the spun yarn Y including a yarn defect caused by the increase in tension of the spun yarn Y. Further, such equalization of the yarn thickness as illustrated in Fig. 10B is not actually occurring in the spun yarn Y detected by the yarn defect detecting device 7.

[0105] Accordingly, in Fig. 10B, since the detection result of the yarn defect detecting device 7 does not surpass the allowable maximum yarn thickness at the position L1 of the spun yarn Y, a determination is not made that the thick yarn portion D1 exists at the position L1 in the spun yarn Y. That is, a detection signal of a real yarn defect is overlooked. Further, since the detection result of the yarn defect detecting device 7 surpasses the allowable minimum yarn thickness at the position L2 in the spun yarn Y, a determination is made that the thin yarn portion D2 exists at the position L2 in the spun yarn Y.

[0106] As described above, the conventional second spinning unit 3 erroneously determines that the thick yarn portion D1 existing at the position L1 in the spun yarn Y does not surpass the allowable maximum yarn thickness. Such erroneous determination is made due to a fact that the spun yarn Y being pulled strongly and the thick yarn portion D1 existing in the position L1 in the spun yarn Y being stretched.

[0107] As described above, in the conventional second spinning unit 3, changes in the tension of the spun yarn Y are generated due to fluctuations in speed a which the yarn feeding device 10 feeds the spun yarn Y. Therefore, it was necessary to maintain the tension to be high by pulling the spun yarn Y. However, due to equalization of the detection signal from the yarn defect detecting device 7, it was difficult to detect a yarn defect in the spun yarn Y.

[0108] Further, in the spinning machine 100, when differences arise among the yarn feeding devices 10 of each of the conventional second spinning units 3, the tension applied to the spun yarn Y between the yarn feeding devices 10 and the tension stabilizing devices 8 may not be equal. Consequently, since unevenness is generated among the yarn spinning units 3, there were cases where it is difficult to maintain quality of the spun yarn Y at a constant level in the spinning machine 100 as a whole.

[0109] The problems in detection of a yarn defect in the conventional first spinning unit 2 and the conventional second spinning unit 3 have been described above. In the followings, with reference to Fig. 11, a detailed description will be made on the superiority of accuracy of detecting a yarn defect in the spinning unit 1 according to the embodiment of the present invention.

[0110] Fig. 11 is a graph illustrating detection signal from the yarn defect detecting device 7 of the spinning unit 1 according to the embodiment of the present invention. The dashed lines in Fig. 11 indicate the detection signal from the yarn defect detecting device 7 of the conventional first spinning unit 2 and the conventional second spinning unit 3. Fig. 11 is a graph illustrating changes in yarn thickness of the spun yarn Y measured at prescribed intervals in the length direction of the spun yarn Y passing through the yarn defect detecting device 7. Fig. 11 indicates that a thick yarn portion D1 exists in a portion where the yarn thickness of the spun yarn Y surpasses the allowable maximum yarn thickness. Fig. 11 indicates that a thin yarn portion D2 exists in a portion where the yarn thickness of the spun yarn Y surpasses the allowable minimum yarn thickness.

[0111] It is recognized from Fig. 11 that the yarn defect detecting device 7 have clearly detected characteristics of a yarn defect in the spun yarn Y. This is because a yarn path does not change by traverse movement of the spun yarn Y performed by the winding device 9, or tension of the spun yarn Y does not change by fluctuations in rotational speed of the friction roller 93 of the winding device 9, for example, as occurred in the conventional first spinning unit 2. Further, this is because the tension of the spun yarn Y is not necessary to be maintained high as in the conventional second spinning unit 3.

[0112] Accordingly, in Fig. 11, since the detection result of the yarn defect detecting device 7 surpasses the allowable maximum yarn thickness at the position L1 in the spun yarn Y, a determination is made that the thick yarn portion D1 exists at the position L1 in the spun yarn Y. Since the detection result of the yarn defect detecting device 7 surpasses the allowable minimum yarn thickness at the position L2 in the spun yarn Y, a determination is made that the thin yarn portion D2 exists at the position L2 in the spun yarn Y.

[0113] As described above, in the spinning unit 1 according to the embodiment of the present invention, a traverse operation of the spun yarn Y performed by the winding device 9 does not influence accuracy of detecting a yarn defect by the yarn defect detecting device 7. Further, accuracy of detecting a yarn defect by the yarn defect detecting device 7 can be improved by maintaining tension of the spun yarn Y at an appropriate level and stabilizing the tension. Consequently, the spinning unit 1 according to the embodiment of the present invention can improve quality of the spun yarn Y.

[0114] In the spinning unit 1 according to the embodiment of the present invention, the yarn feeding device 10 that feeds the spun yarn Y is not used. Therefore, differences do not arise in tension of the spun yarns Y in the yarn defect detecting devices 7 of the yarn spinning units 1 (i.e., tension of the spun yarns Y between the spinning device 6 and the tension stabilizing device 8 in the yarn spinning units 1) in the spinning machine 100. Accordingly, quality of the spun yarn Y can be maintained at a constant level.

[0115] As described above, the spinning unit 1 includes the draft device 5, the spinning device 6, the tension stabilizing device 8, the winding device 9, and the yarn defect detecting device 7. The draft device 5 drafts the fiber bundle F. The spinning device 6 produces the spun yarn Y from the fiber bundle F drafted by the draft device 5. The tension stabilizing device 8 stabilizes the tension of the spun yarn Y produced by the spinning device 6. The winding device 9 winds the package 91 of the spun yarn Y fed from the tension stabilizing device 8. The yarn defect detecting device 7 can detect a yarn defect in the spun yarn Y, and is arranged between the spinning device 6 and the tension stabilizing device 8.

[0116] The tension stabilizing device 8 includes the roller member 81 and the unwinding member 83. The roller member 81 winds the spun yarn Y. The unwinding member 83 unwinds the spun yarn Y wound around the roller member 81. The unwinding member 83 appropriately adjusts the unwinding speed of the spun yarn Y to stabilize the tension of the spun yarn Y between the spinning device 6 and the tension stabilizing device 8.

[0117] The spinning unit 1 includes the guiding member 74 having the first guide section and the second guide section. The first guide section is arranged between the spinning device 6 and the yarn defect detecting device 7, and regulates the yarn path of the spun yarn Y. The second guide section is arranged between the yarn defect detecting device 7 and the tension stabilizing device 8, and regulates the yarn path of the spun yarn Y.

[0118] The yarn defect detecting device 7 measures the yarn thickness of the spun yarn Y to detect the yarn defect. The yarn defect detecting device 7 detects standard deviation of yarn thickness of the spun yarn Y.

[0119] The yarn defect detecting device 7 includes the light source 71, the light receiving section 72, and the casing member 73. The light source 71 irradiates light to the spun yarn Y. The light receiving section 72 receives the light irradiated from the light source 71. The casing member 73 holds the light source 71 and the light receiving section 72.

[0120] When tension of the spun yarn Y fed from the tension stabilizing device 8 is greater than a prescribed value, the unwinding member 83 increases the unwinding speed of the spun yarn Y from the roller member 81. When the tension of the spun yarn Y fed from the tension stabilizing device 8 is at most the prescribed value, the unwinding member 83 decreases the unwinding speed of the spun yarn Y from the roller member 81.

[0121] The tension stabilizing device 8 includes the driving section 82 which rotates the roller member 81. The driving section 82 stabilizes the tension of the spun yarn Y between the spinning device 6 and the tension stabilizing device 8 by maintaining winding speed of the spun yarn Y at a prescribed value.

[0122] The tension stabilizing device 8 temporarily accumulates the spun yarn Y by appropriately adjusting unwinding speed of the spun yarn Y with respect to the winding speed of the spun yarn Y.

[0123] The yarn defect detecting device 7 detects a yarn defect of the spun yarn Y immediately after the spun yarn Y is produced by the spinning device 6. The yarn defect detecting device 7 detects a yarn defect of the spun yarn Y under a spinning tension of the spinning device 6. The yarn defect detecting device 7 is arranged at a position where tension is applied to the spun yarn Y only by the tension stabilizing device 8.

[0124] The spinning device 6 uses whirling airflow to twist the fiber bundle F drafted by the draft device 5 to produce the spun yarn Y.

Claims

1. A spinning unit **characterized by** comprising:

a draft device (5) which drafts a fiber bundle,
a spinning device (6) which produces a spun yarn from the fiber bundle drafted by the draft device (5),
a tension stabilizing device (8) which stabilizes tension of the spun yarn produced by the spinning device (6),
a winding device (9) which winds a package of the spun yarn fed from the tension stabilizing device (8), and
a yarn defect detecting device (7) which is arranged between the spinning device (6) and the tension stabilizing device (8) and detects a yarn defect in the spun yarn.

2. The spinning unit according to claim 1, **characterized in that** the tension stabilizing device (8) includes a roller member (81) for winding the spun yarn, and an unwinding member (83) for unwinding the spun yarn wound around the roller member (81); and
the unwinding member (83) appropriately adjusts unwinding speed of the spun yarn to stabilize tension of the spun yarn between the spinning device (6) and the tension stabilizing device (8).

3. The spinning unit according to claim 2, **characterized by** further comprising:

a first guide section (74) which is arranged between the spinning device (6) and the yarn defect detecting device (7) and regulates a yarn path of the spun yarn, and
a second guide section (74) which is arranged between the yarn defect detecting device (7) and the tension stabilizing device (8) and regulates a yarn path of the spun yarn.

4. The spinning unit according to claim 2 through claim 3, **characterized in that** the yarn defect detecting device (7) measures yarn thickness of the spun yarn to detect the yarn defect.

5. The spinning unit according to any one of claim 2 through claim 4, **characterized in that** the yarn defect detecting device (7) detects standard deviation of yarn thickness of the spun yarn.

6. The spinning unit according to any one of claim 2 through claim 5, **characterized in that** the yarn defect detecting device (7) includes:

a light source (71) which irradiates light to the spun yarn,
a light receiving section (72) which receives the light irradiated from the light source (71), and
a casing member (73) which holds the light source (71) and the light receiving section (72).

7. The spinning unit according to claim 2, **characterized in that** when tension of the spun yarn fed from the tension stabilizing device (8) is greater than a prescribed value, the unwinding member (83) increases the unwinding speed of the spun yarn, and when the tension of the spun yarn fed from the tension stabilizing device (8) is at most the prescribed value, the unwinding member (83) decreases the unwinding speed of the spun yarn.

8. The spinning unit according to any one of claim 2 through claim 7, **characterized in that** the tension stabilizing device (8) includes a driving section (82) which rotates the roller member (81), and
the tension stabilizing device (8) stabilizes the tension of the spun yarn between the spinning device

(6) and the tension stabilizing device (8) by maintaining winding speed of the spun yarn around the roller member (81) by the driving section (82).

9. The spinning unit according to any one of claim 2 through claim 8, **characterized in that** the tension stabilizing device (8) temporarily accumulates the spun yarn by appropriately adjusting unwinding speed of the spun yarn from the roller member (81) with respect to the winding speed of the spun yarn around the roller member (81).

10. The spinning unit according to any one of claim 2 through claim 9, **characterized in that** the yarn defect detecting device (7) detects a yarn defect of the spun yarn immediately after the spun yarn is produced by the spinning device (6).

11. The spinning unit according to any one of claim 2 through claim 10, **characterized in that** the yarn defect detecting device (7) detects a yarn defect of the spun yarn under a spinning tension of the spinning device (6).

12. The spinning unit according to any one of claim 2 through claim 11, **characterized in that** the yarn defect detecting device (7) is arranged at a position where tension is applied to the spun yarn only by the tension stabilizing device (8).

13. The spinning unit according to any one of claim 2 through claim 12, **characterized in that** the spinning device (6) uses whirling airflow to twist the fiber bundle drafted by the draft device (5) to produce the spun yarn.

FIG. 1

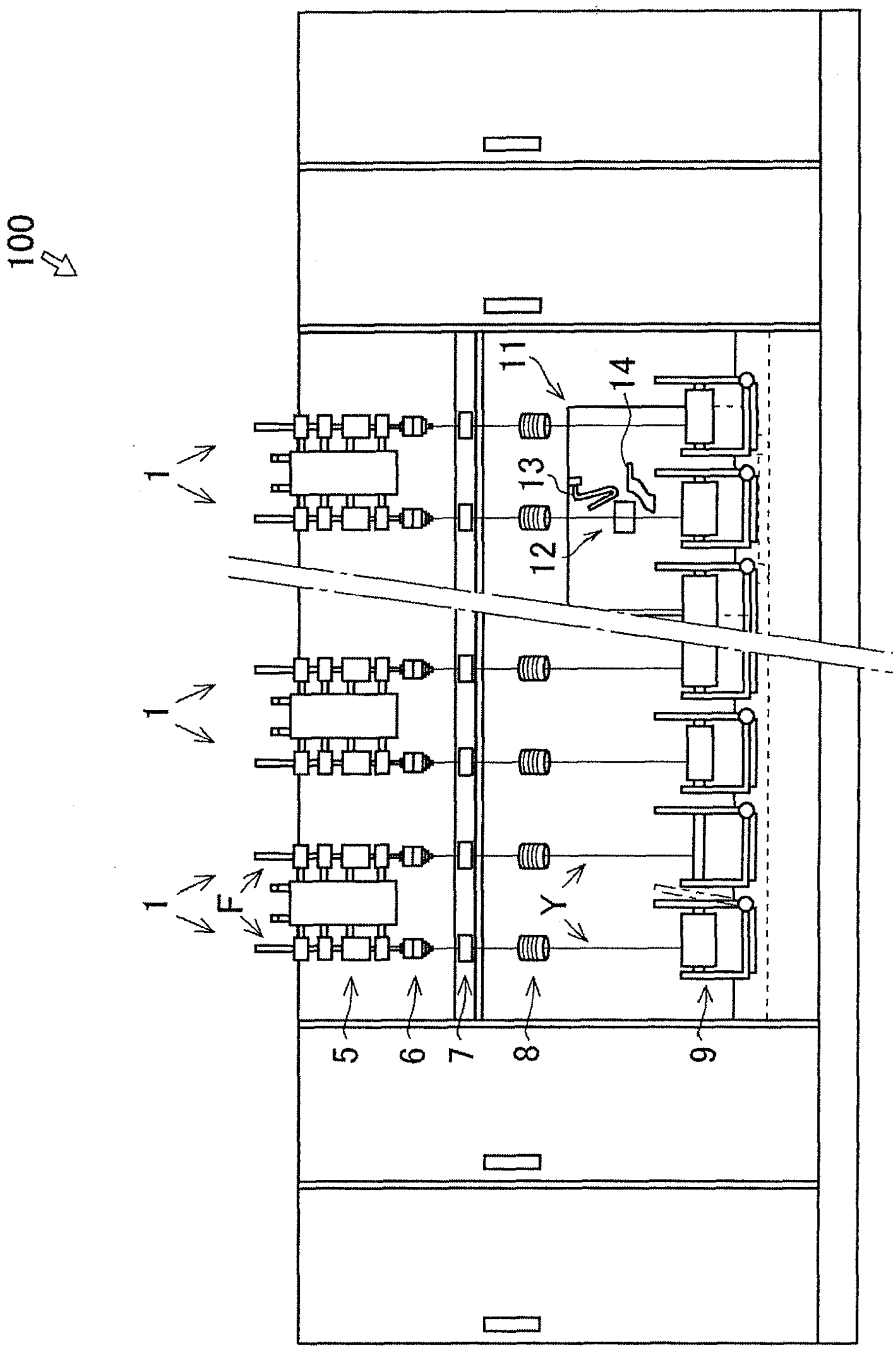
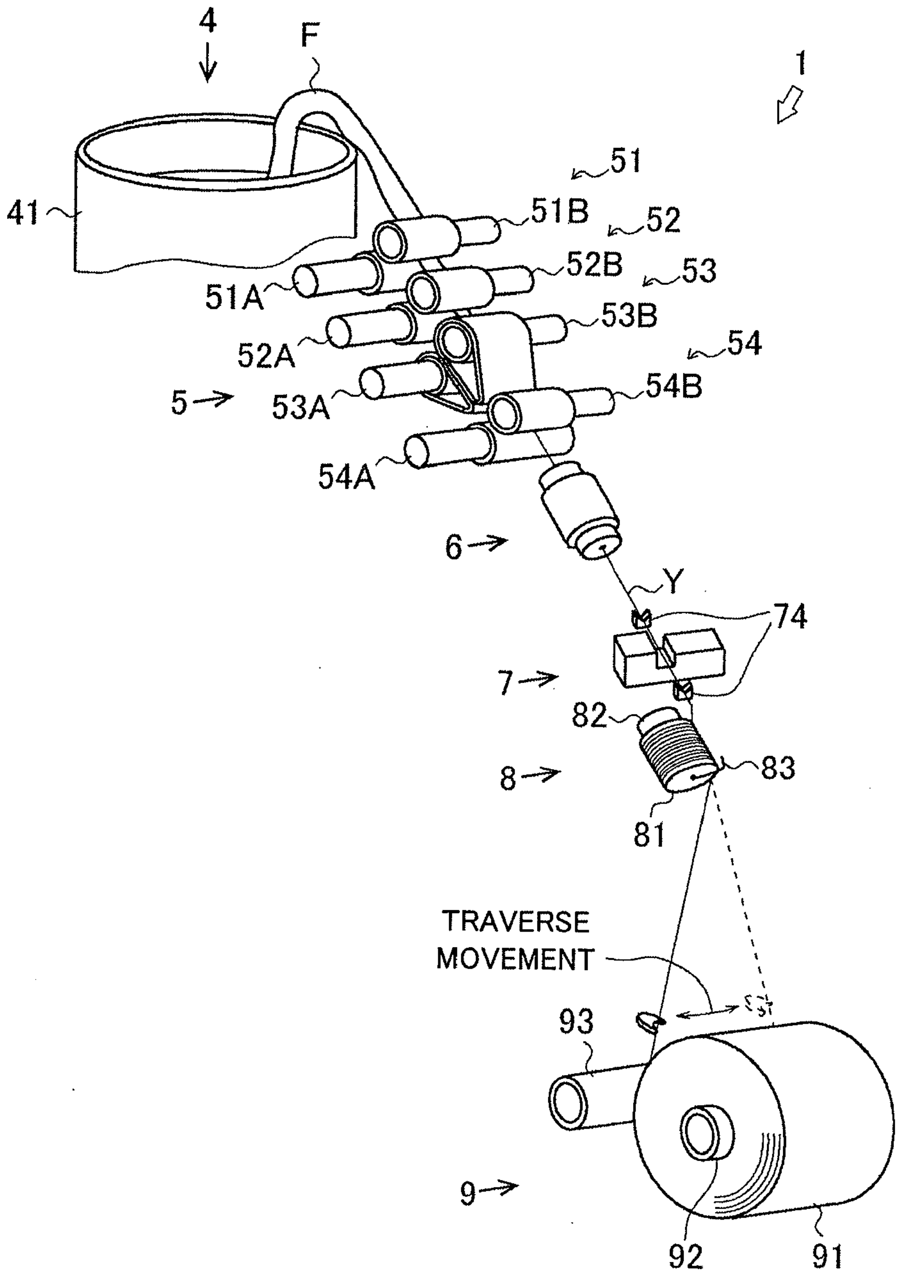


FIG. 2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F
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52B
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51A
53B
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54
5
53A
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54A
6
Y
74
7
82
8
83
81
TRAVERSE
MOVEMENT
93
9
92
91

FIG. 3

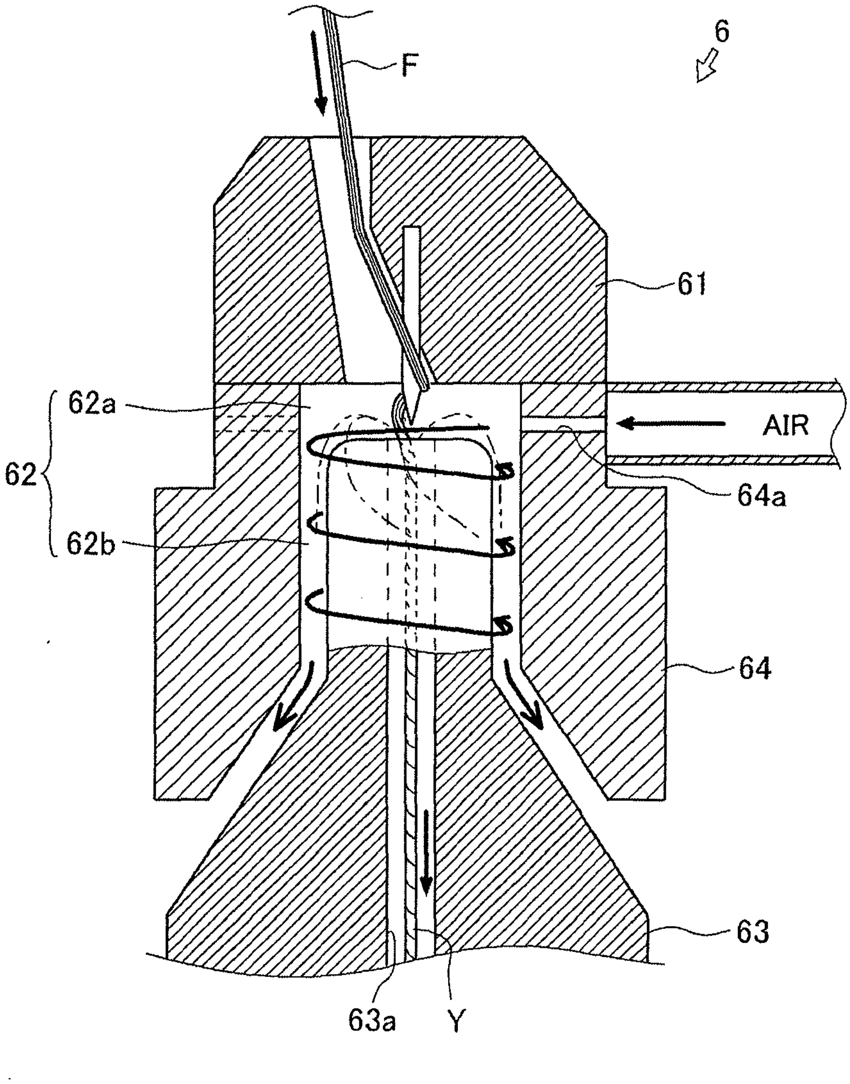


FIG. 4

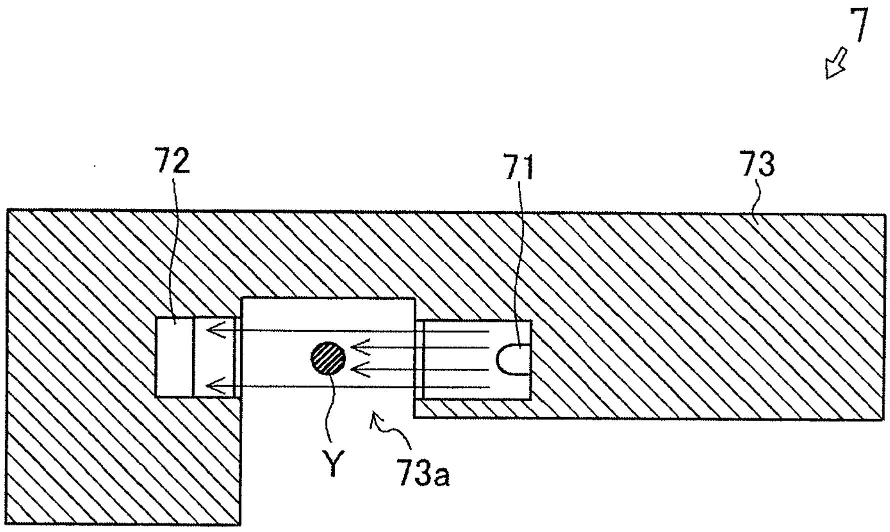


FIG. 5

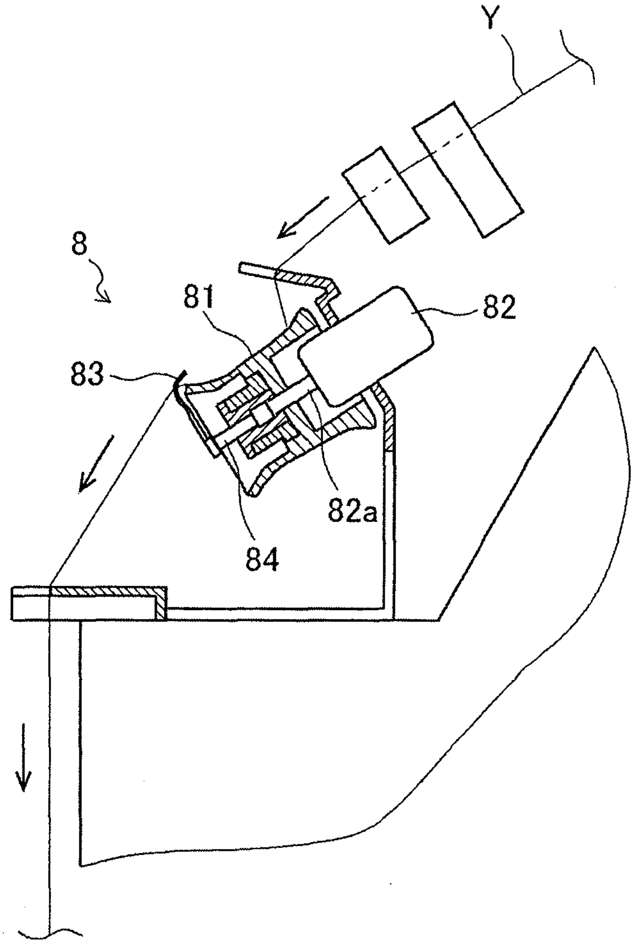
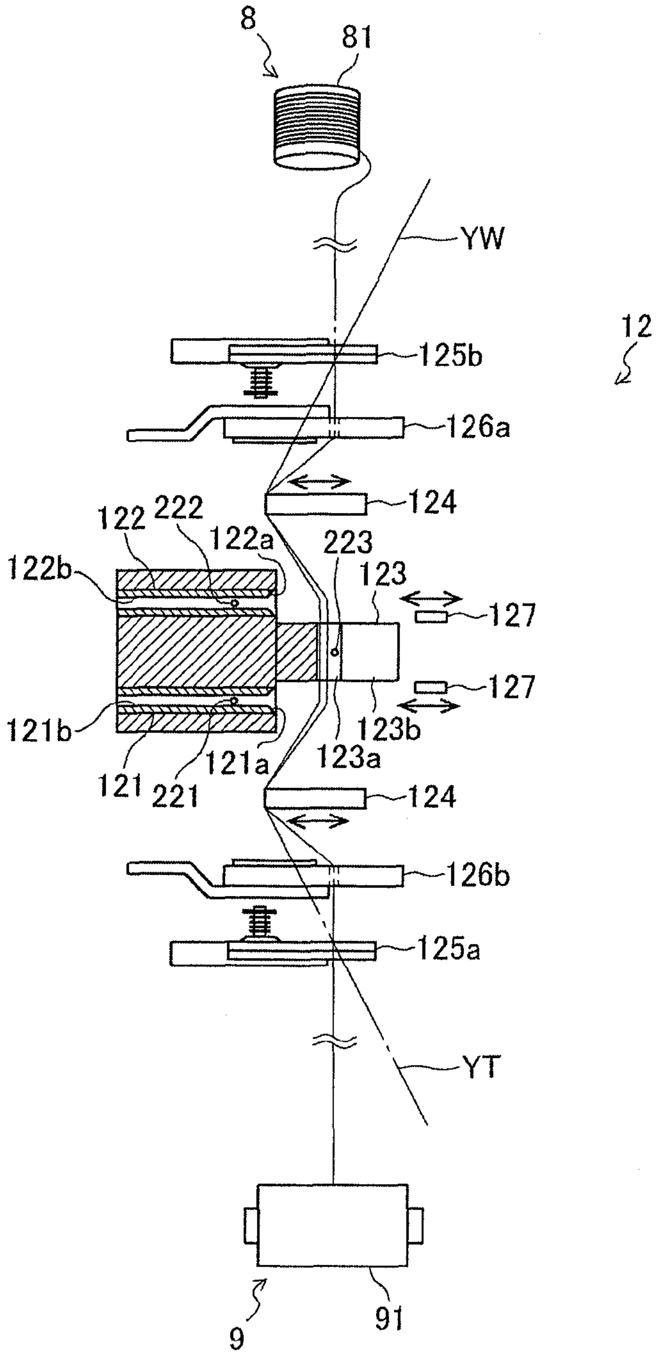


FIG. 6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122a
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123
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123b
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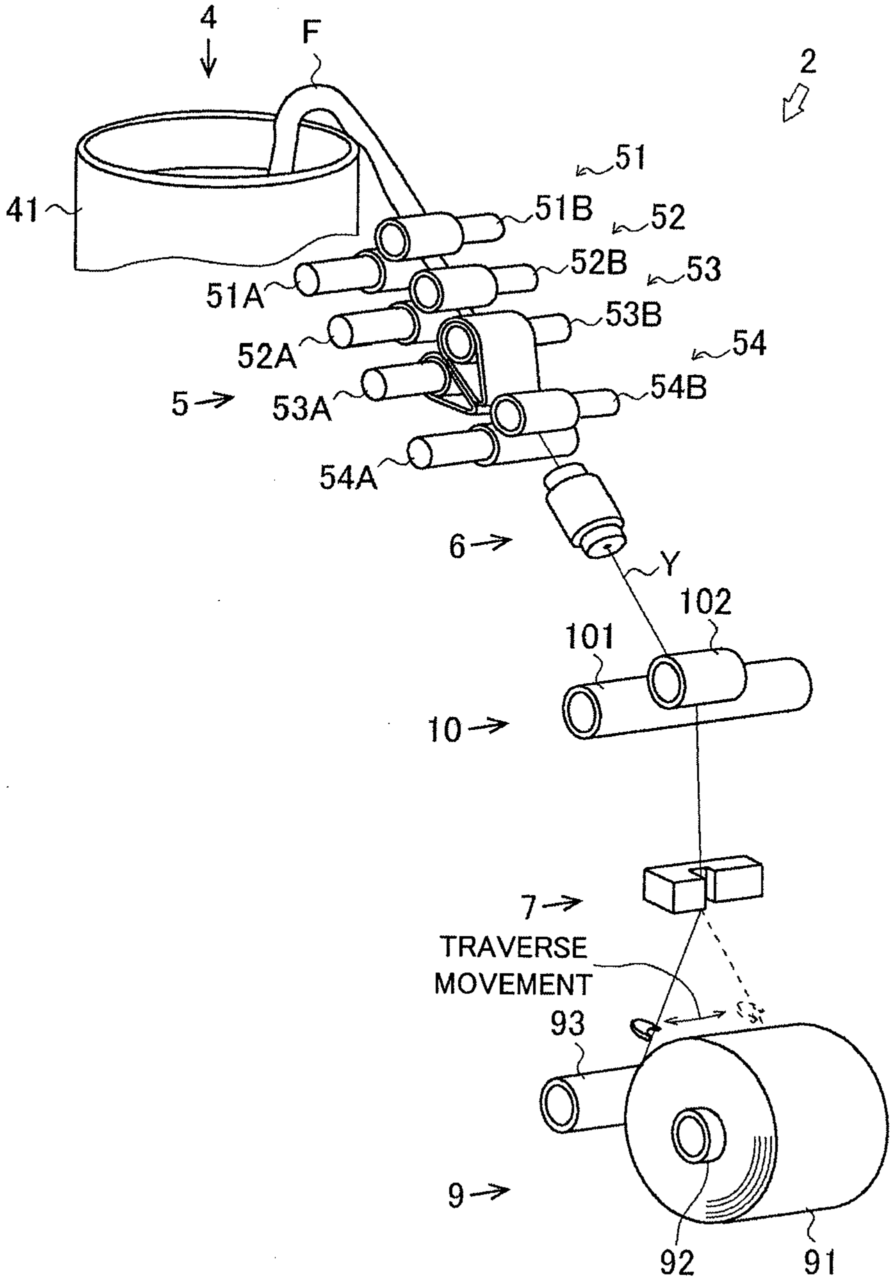
123a
121
221
124
126b
125a
YT
9
91

FIG. 7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6
Y
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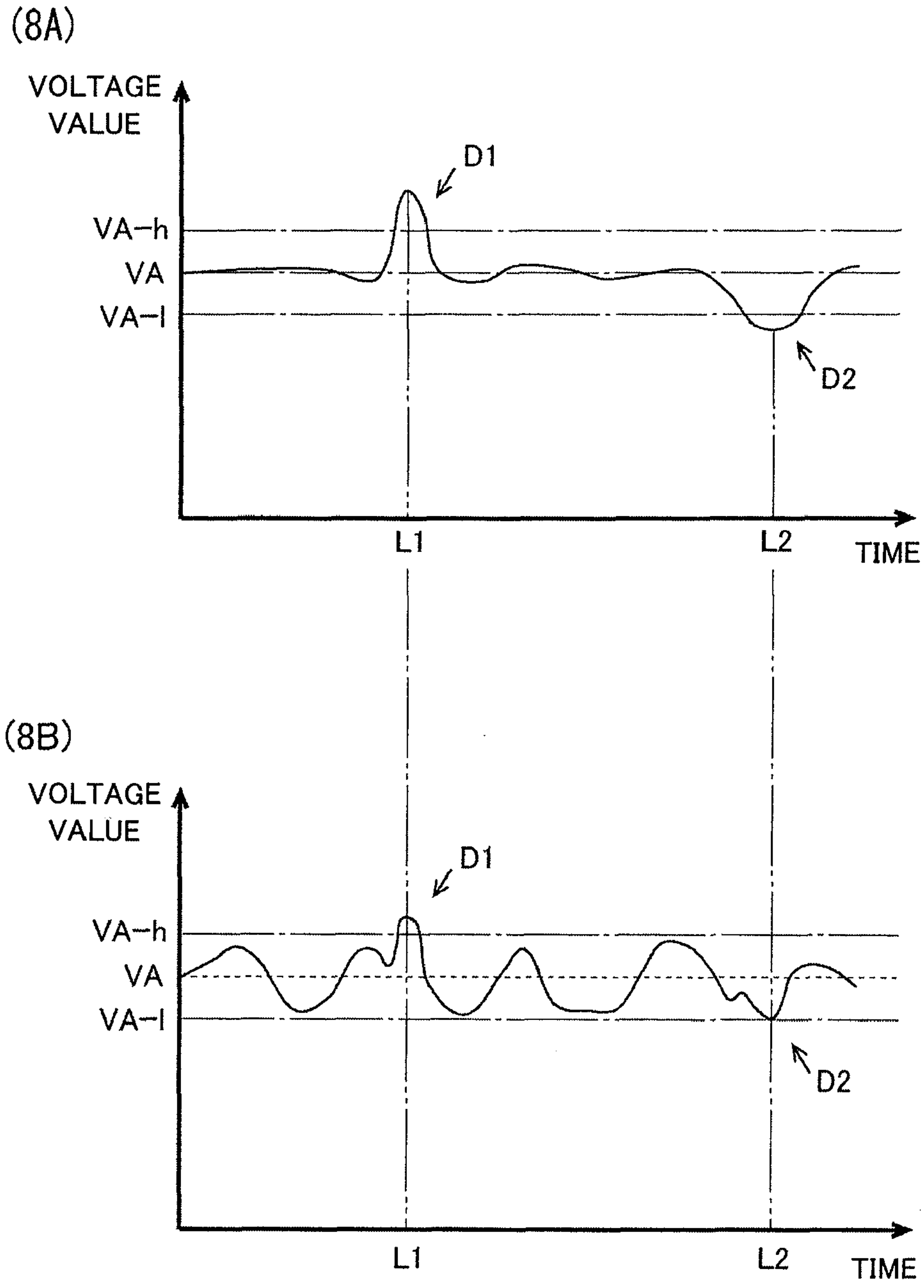
10
7
TRAVERSE
MOVEMENT
93
9
92
91

FIG. 8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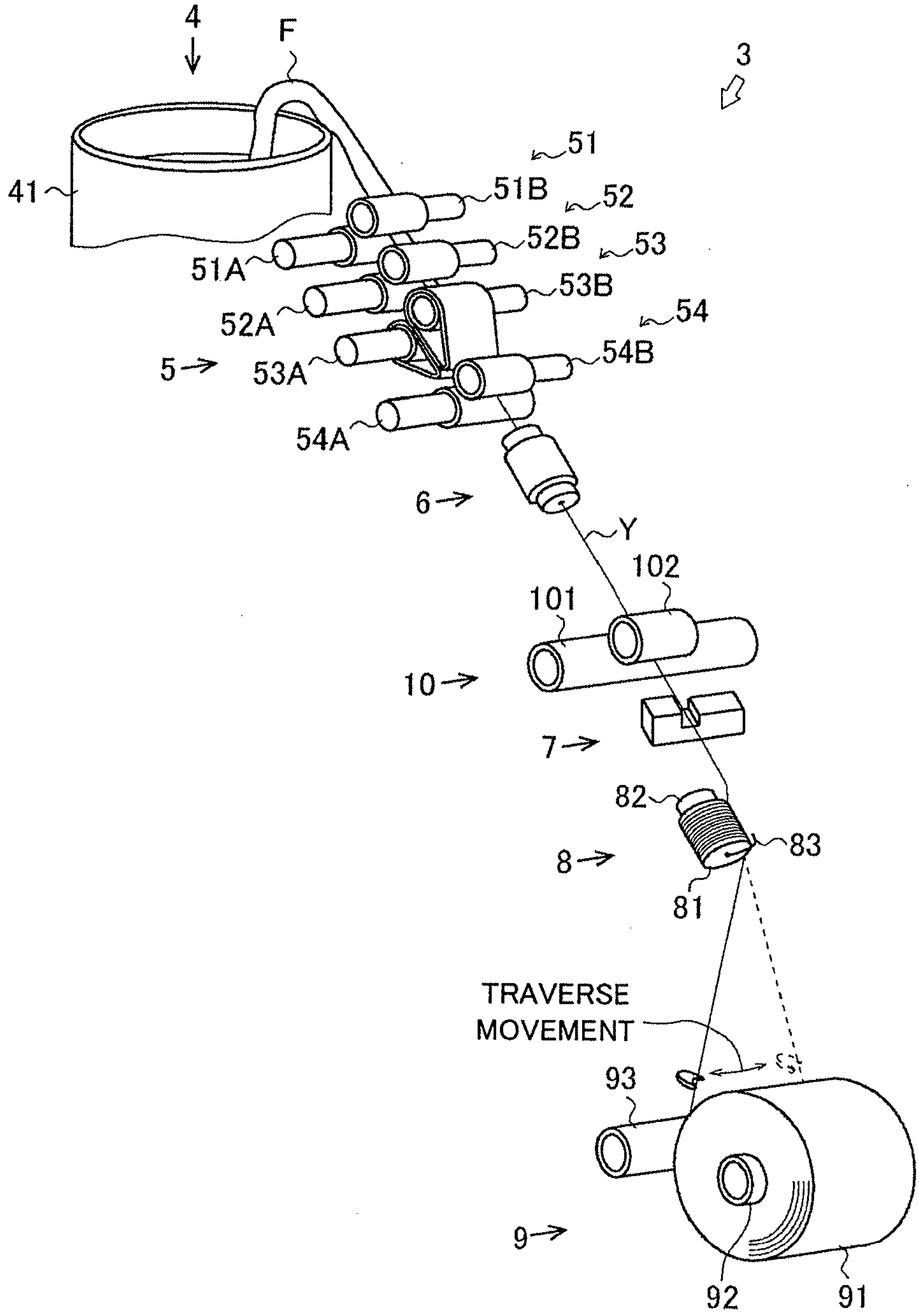
VOLTAGE VALUE
D1
VA-h
VA
VA-l
D2
L1
L2
TIME
(8B)
VOLTAGE VALUE
D1
VA-h
VA
VA-l
D2
L1
L2
TIME

FIG. 9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53A
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6
Y
102
101
10
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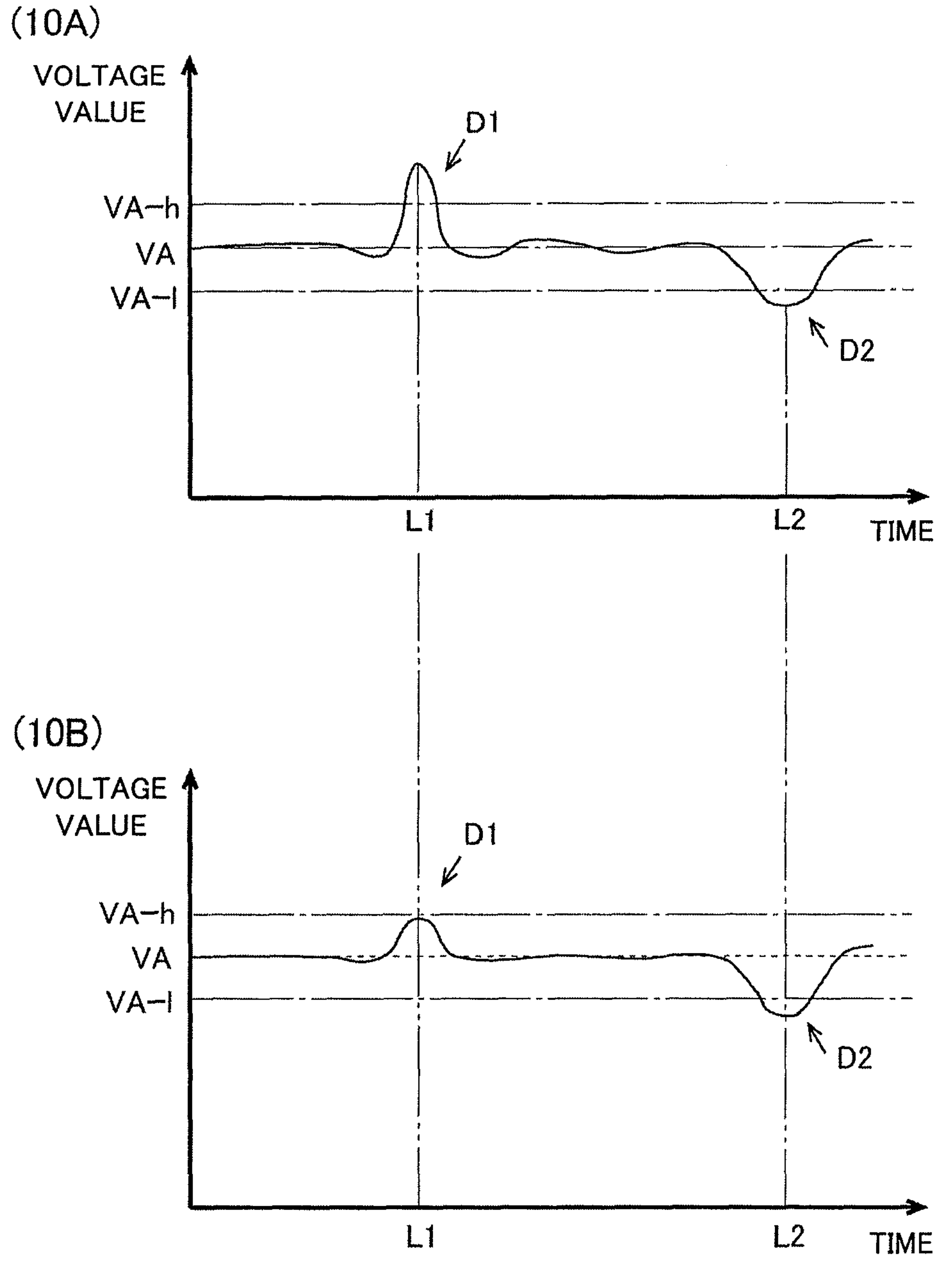
82
83
8
81
TRAVERSE
MOVEMENT
93
9
92
91

FIG. 10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VOLTAGE VALUE
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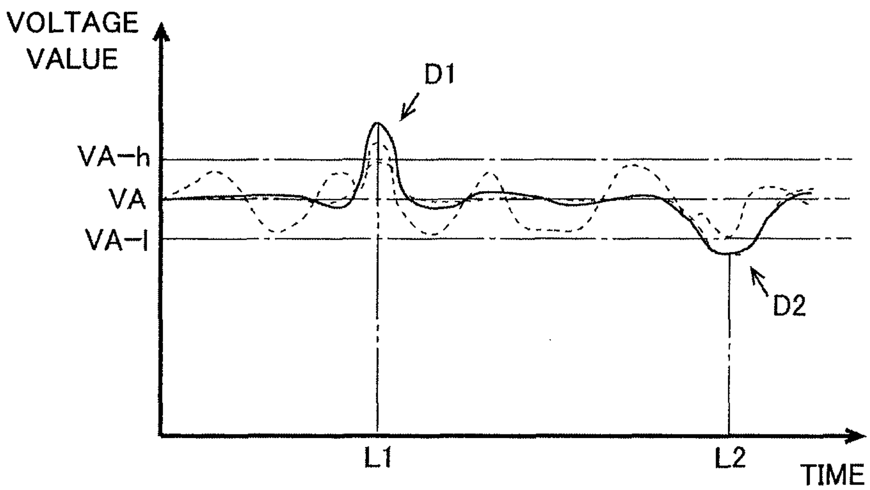
VA-h
VA
VA-l
D2
L1
L2
TIME
(10B)
VOLTAGE VALUE
D1
VA-h
VA
VA-l
D2
L1
L2
TIME

FIG. 11



REFERENCES CITED IN THE DESCRIPTION

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