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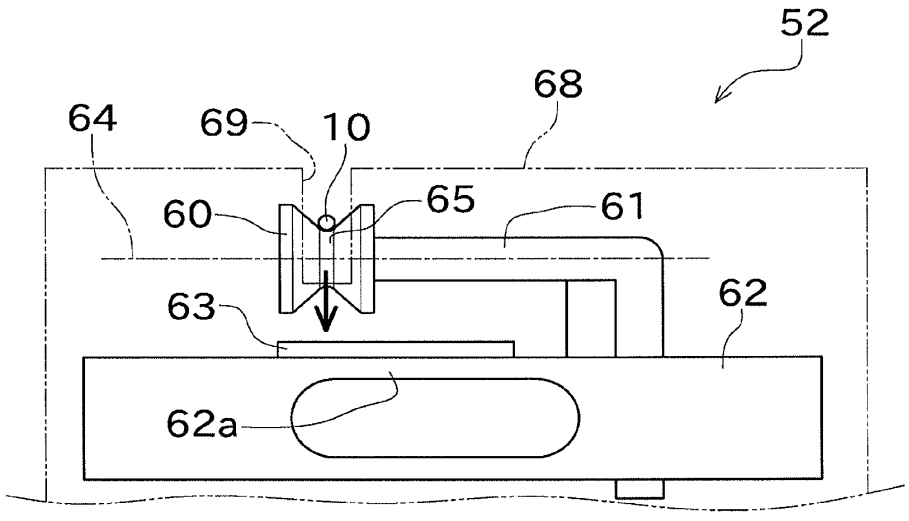
(54) Spinning machine

(57) A spinning sensor (52) detects a tension of a spun yarn (10) travelling between a spinning device and a winding device. The spinning sensor (52) includes a yarn guide (60) making contact with the travelling spun yarn 10, and a strain sensor to output a signal according to a force applied to the yarn guide 60. The yarn guide 60 has a substantially arcuate cross-sectional contour at a cross section perpendicular to an axial line (64) at least at a portion making contact with the spun yarn (10). A direction parallel to a yarn path of the spun yarn (10) located upstream of the yarn guide (60) is a Y-axial direction. A direction parallel to an axial direction of a draft roller is an X-axial direction. A direction perpendicular to the Y-axial and the X-axial directions is a Z-axial direction. When viewed in the Z-axial direction, an axial line (64) of the yarn guide (60) is inclined with respect to the Y-axial direction.

FIG. 4



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a structure of a spinning machine for detecting a tension of a travelling spun yarn.

2. Description of the Related Art

[0002] A spinning machine that produces a spun yarn by applying a twist to a fiber and winds the spun yarn into a package is well known. Such a spinning machine is described in e.g. Japanese Unexamined Patent Application Publication No. 2006-132035 (Patent Document 1). The spinning machine described in Patent Document 1 produces a spun yarn by generating a whirling airflow in a spinning chamber with a compressed air ejected from an air spinning nozzle and by applying a twist to a fiber bundle using the whirling airflow.

[0003] With the structure described in Patent Document 1, if yarn wastes accumulate in the spinning chamber or an air injecting nozzle is clogged with yarn wastes, the whirling airflow in a whirling chamber becomes unstable. Consequently, a yarn with weakly-twisted fibers (weak yarn) could be produced. Strength of a portion of the weak yarn is weak, which results in a defected yarn. Accordingly, if the weak yarn is wound into a package, quality of the packages lowers. Thus, a spinning machine that can reliably detect an occurrence of a weak yarn and also promptly remove the detected weak yarn has been demanded.

[0004] The spinning machine described in Patent Document 1 has a pressure detecting means for detecting that fibers have accumulated in space for releasing air. In Patent Document 1, the pressure detecting means can reliably detect a state which is prone to produce a weak yarn, which prevents degradation of the package quality caused by to the weak yarn. However, the spinning machine described in Patent Document 1 is not configured to detect a weak yarn itself. Therefore, if a weak yarn is actually produced, the spinning machine fails to promptly detect and remove the produced weak yarn. Accordingly, the structure in Patent Document 1 is incapable of completely reliably preventing the weak yarn from being wound into a package.

[0005] Japanese Unexamined Patent Application Publication No. 2004-36010 (Patent Document 2) discloses a structure of a spinning machine for detecting a weak yarn in a spun yarn by detecting a tension of the travelling spun yarn. A portion of the weak yarn has a weak tension, and therefore, a tension thereof is lower than a portion of a properly twisted yarn. By detecting the tension of the spun yarn as described above, a weak yarn included in the travelling spun yarn can be promptly detected, and consequently the portion of the detected weak yarn can be promptly removed.

SUMMARY OF THE INVENTION

[0006] The means for detecting a yarn tension described in Patent Document 2 has a yarn guide supported by a strain sensor. Patent Document 2 discloses a structure in which a guiding member for bending a travelling path of a spun yarn is arranged so as to maintain a contact angle of the spun yarn with respect to the yarn guide within a predetermined range. In Patent Document 2, by maintaining the predetermined contact angle, a stable measurement of a yarn tension is ensured.

[0007] However, the arrangement of the guiding member for bending a spun yarn as described in Patent Document 2 could cause an adverse effect on quality of the spun yarn. Therefore, with the structure of bending the spun yarn with the guiding member as described in Patent document 2, an increase in a contact angle of a spun yarn with respect to the yarn guide is limited.

[0008] An object of the present invention is to provide a structure of a spinning machine capable of accurately detecting a tension of a spun yarn.

[0009] According to an aspect of the present invention, the spinning machine includes a spinning device, a winding device, and a first detecting section. The spinning device produces a spun yarn. The winding device winds the spun yarn produced by the spinning device into a package. The first detecting section detects a tension of a spun yarn traveling between the spinning device and the winding device. The first detecting section includes a yarn guide adapted to make contact with the travelling spun yarn and a detector arranged to output a signal according to a force applied to the yarn guide. The yarn guide has a substantially arcuate cross-sectional contour at a cross section perpendicular to an axial line of the yarn guide at least at a portion making contact with the spun yarn. The yarn guide is arranged such that the spun yarn makes contact with the yarn guide while being inclined with respect to the axial line.

[0010] Compared with a conventional structure in which the yarn guide is arranged perpendicular to the yarn path, a contact angle of the spun yarn with respect to the yarn guide can be increased by arranging the yarn guide inclined with respect to a yarn path of the spun yarn. Accordingly, a tension change of the spun yarn can be reliably detected.

[0011] The above-described spinning machine preferably includes a draft device adapted to draft a fiber bundle and to supply the drafted fiber bundle to the spinning device with draft rollers. A direction parallel to a yarn path of the spun yarn located upstream of the yarn guide is defined as a first direction, a direction parallel to an axial direction of the draft rollers is defined as a second direction, and a direction perpendicular to a plane formed by the first direction and the second direction is defined as a third direction. When viewed in the third direction, the axial line of the yarn guide is inclined with respect to the

first direction.

[0012] Accordingly, a large contact angle of the spun yarn travelling in the first direction with respect to the yarn guide can be obtained.

[0013] The above-described spinning machine preferably includes a bending guide adapted to bend the yarn path of the spun yarn.

[0014] Accordingly, the contact angle of the spun yarn with respect to the yarn guide can further be made large, which leads to a more reliable detection of a subtle change in tension of the spun yarn.

[0015] The above-described spinning machine preferably includes a yarn accumulating device adapted to draft out and accumulate the spun yarn that is spun from the spinning device. The yarn accumulating device is arranged to function as the bending guide.

[0016] The yarn accumulating device also functions as a bending guide as described above, and hence the number of components used in the spinning machine can be also reduced. In addition, since an additional bending guide for bending the yarn path of the spun yarn is not necessary to be provided, the spun yarn is not damaged with the extra guide.

[0017] In the above-described spinning machine, the first detecting section is preferably arranged between the spinning device and the yarn accumulating device in a yarn travelling direction.

[0018] Accordingly, the first detecting section can directly detect a tension of a spun yarn spun with the spinning device. Thus, since an abnormality in a spun yarn can be detected close to a position where the abnormality has occurred, a weak yarn can be promptly detected.

[0019] In the above-described spinning machine, the winding device preferably winds the spun yarn from the yarn accumulating device into a package.

[0020] The yarn accumulating device is arranged between the first detecting section and the winding device, and serves as a buffer so that a change in a winding tension of the winding device does not propagate to the first detecting section. Therefore, the first detecting section can accurately detect a tension of a spun yarn produced with the spinning device without being affected by the winding tension.

[0021] The above-described spinning machine also preferably includes a yarn accumulating device upstream guide adapted to guide the spun yarn to the yarn accumulating device.

[0022] Accordingly, the spun yarn can be reliably guided to the yarn accumulating device.

[0023] In the above spinning machine, the yarn accumulating device upstream guide also preferably functions as a cover to externally cover the yarn guide and the detector of the first detecting section.

[0024] Accordingly, a guide provided upstream of a yarn accumulating device of a conventional spinning device can be omitted.

[0025] In the above-described spinning machine, a slit is preferably formed on the cover to externally expose the yarn guide. When viewed in the first direction, a longitudinal direction of the slit is inclined with respect to the third direction.

[0026] That is, the cover is arranged such that a dimension of the yarn guide exposed with the slit is small when viewed from the front of the spinning machine. Thus, when cleaning air is blown against the cover even from the front of the spinning machine, the air does not blow directly against the yarn guide, which can prevent damage thereto.

[0027] In the above-described spinning machine, the axial line of the yarn guide is preferably inclined with respect to all of the first, the second, and the third directions.

[0028] That is, the yarn guide is arranged to be three-dimensionally inclined. Accordingly, a larger contact angle of the spun yarn with respect to the yarn guide can be obtained, and a subtle tension change of the spun yarn can more reliably be detected.

[0029] The above-described spinning machine preferably includes an abnormality detecting section. The spinning device is an air-jet spinning machine which includes a fiber guiding section, a nozzle block in which an air injecting nozzle is formed, and a hollow guide shaft, and produces a spun yarn by spinning a fiber bundle drafted by the draft device in a spinning chamber using a whirling airflow. The abnormality detecting section detects an abnormality in tension of the spun yarn in accordance with a detection result of the first detecting section.

[0030] That is, if the air-jet spinning device has abnormality, a spun yarn with a low tension (weak yarn) is produced. Thus, by detecting a tension of the spun yarn, an abnormality in the spinning device can be detected.

[0031] In the above-described spinning machine, when a detection result of the first detecting section indicates a decrease in a tension of the spun yarn, the abnormality detecting section preferably detects as an abnormality of the air-jet spinning device, at least one of clogging of fibers in the air injecting nozzle, accumulation of fibers in the spinning chamber, winding of fibers around the hollow guide shaft, and accumulation of an oiling agent over the hollow guide shaft.

[0032] Once the nozzle is clogged with fibers, a volume of the whirling airflow in the spinning chamber decreases. As a result, the fibers fail to whirl at high speed in the spinning chamber, and thus a twist of the produced spun yarn becomes weak. Alternatively, if fibers are accumulated in the spinning chamber, if fibers are wound around the hollow guide shaft, or if an oiling agent is accumulated over the hollow guide shaft, the fibers in the spinning chamber fail to whirl at high speed. Consequently, the twist of the produced spun yarn becomes weak. Since the weakly-twisted yarn is fluffy (soft and light), the tension thereof is low. Therefore, by detecting a tension decrease, an abnormality in the air jet spinning device can be detected.

[0033] The above-described spinning machine also preferably includes a cutting means, a suction device, and a yarn joining section. When the abnormality detect-

ing section detects an abnormality in a spun yarn, the cutting means cuts the spun yarn between the spinning device and the winding device. When the spun yarn is cut with the cutting means, the suction device sucks a yarn end of the spun yarn from the spinning device and a yarn end of the spun yarn from the winding device, and removes the abnormal portion of the spun yarn. The yarn joining section joins yarn ends of the spun yarn sucked by the suction device.

[0034] The first detecting section detects an abnormality in the spun yarn at a position located close to where the abnormality has occurred as described above. Therefore, when an abnormality occurs in the spun yarn, the abnormality can be detected and removed promptly. Thus, since a length of the spun yarn that needs to be sucked and removed with the suction device can be made short, a yarn joining operation performed by a yarn joining device can be efficiently carried out. As a result, productivity of the spinning machine can be improved.

[0035] The above-described spinning machine also preferably includes a second detecting section adapted to detect a thickness abnormality in the spun yarn spun with the spinning device.

[0036] Accordingly, an abnormality of both the tension and the thickness of the spun yarn can be detected, and consequently any abnormality in the spun yarn can be detected more accurately.

[0037] The above-described spinning machine also preferably includes a core yarn supplying device adapted to supply a core yarn, which is to be a core of the spun yarn, to the spinning device, and a core yarn detecting section adapted to detect a presence or an absence of the core yarn in the spun yarn in accordance with a detection result of the first detecting section.

[0038] The presence or the absence of the core yarn can be detected in accordance with a detection result of the first detecting section.

[0039] In the above-described spinning machine, the yarn guide preferably includes a reduced-diameter portion on a certain portion in the axial direction thereof, and the spun yarn travels on the reduced-diameter portion.

[0040] Accordingly, the spun yarn can travel without falling from the yarn guide. Therefore, the first detecting section can reliably detect the tension of the spun yarn.

BRIEF DESCRIPTION OF THE DRAWINGS

[0041]

Fig. 1 is a front view illustrating an overall structure of a spinning machine according to one embodiment of the present invention.

Fig. 2 is a side view of a spinning unit.

Fig. 3 is a sectional view of a spinning device.

Fig. 4 is a plan view of a spinning sensor.

Fig. 5 is a side view of the spinning sensor.

Figs. 6A and 6B are views for describing effects of an inclined arrangement of a yarn guide.

Fig. 7 is a view illustrating the spinning sensor and its periphery viewed in Z-axial direction.

Fig. 8 is a view illustrating the spinning sensor and its periphery viewed in X-axial direction.

Fig. 9 is a view illustrating the spinning sensor and its periphery viewed from downstream in Y-axial direction.

Fig. 10 is a view illustrating a cover of the spinning sensor viewed in the Y-axial direction.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0042] A fine spinning machine (spinning machine) according to one embodiment of the present invention will be described with reference to the drawings. The fine spinning machine 1 illustrated in Fig. 1 as a spinning machine includes a plurality of spinning units 2 arranged in line, a yarn joining cart 3, a blower box 80 and a motor box 5.

[0043] As illustrated in Fig. 2, each spinning unit 2 mainly includes a draft device 7, a spinning device 9, a yarn accumulating device 12, and a winding device 13, all of which are arranged in this order from upstream to downstream. Herein, "upstream" and "downstream" respectively refer to upstream and downstream in a travelling direction of a spun yarn at the time of spinning. Each spinning unit 2 spins a fiber bundle 8 fed from the draft device 7 with the spinning device 9 to produce a spun yarn 10, and winds the spun yarn 10 with the winding device 13 to form a package 45.

[0044] The draft device 7 is provided close to an upper end of a housing 6 of the fine spinning machine 1. The draft device 7 includes the following four draft rollers arranged in this order from the upstream: a back roller 16, a third roller 17, a middle roller 18 provided with a rubber apron belt 18, and a front roller 20. Each draft roller is driven to rotate at a predetermined rotation speed. Each rotation axis of four draft rollers is arranged along a horizontal direction of the draft device 7 (a horizontal direction in Fig. 1, a direction orthogonal to a paper surface in Fig. 2, that is, a direction perpendicular to a travelling direction). The draft device 7 includes opposed rollers arranged facing the draft rollers.

[0045] The draft device 7 conveys a sliver (raw material for a fiber bundle) 15 supplied from a sliver case (not illustrated) through a sliver guide (not illustrated), while nipping the sliver 15 between the rotating draft rollers and the opposed rollers, to stretch (draft) the sliver 15 to be a fiber bundle 8 with a prescribed width.

[0046] The spinning device 9 is arranged immediately downstream of the front roller 20. The fiber bundle 8 drafted with the draft device 7 is supplied to the spinning device 9. The spinning device 9 applies twists to the fiber bundle 8 supplied from the draft device 7 to produce the spun yarn 10. In an embodiment of the present invention, an air-jet spinning device that twists the fiber bundle 8 using a whirling airflow is adopted as the spinning device

9. As illustrated in Fig. 3, the spinning device 9 mainly includes a nozzle block 35, a hollow guide shaft 23 and a fiber guiding section 22.

[0047] A spinning chamber 26 is formed between the nozzle block 35 and the hollow guide shaft 23. An air injecting nozzle 27 for injecting air into the spinning chamber 26 is formed in the nozzle block 35. A yarn guide opening 21 for introducing the fiber bundle 8 into the spinning chamber 26 is formed in the fiber guiding section 22. The air injecting nozzle 27 is configured to be capable of injecting air into the spinning chamber 26 so as to generate the whirling airflow. The fiber bundle 8 supplied from the draft device 7 is guided into the spinning chamber 26 by the fiber guiding section 22 having the yarn guide opening 21. In the spinning chamber 26, the fiber bundle 8 is swung around the hollow guide shaft 23 with the whirling airflow and consequently twists are applied to the fiber bundle 8 to produce the spun yarn 10. The twisted spun yarn 10 passes through a yarn path 29 formed at an axial center of the hollow guide shaft 23, and is transported from a downstream yarn outlet (not illustrated) of the hollow guide shaft 23 out of the spinning device 9.

[0048] The yarn guide opening 21 is provided with a guide needle 22a whose tip end is positioned towards the inside of the spinning chamber 26. The fiber bundle 8 introduced from the yarn guide opening 21 is guided into the spinning chamber 26 so as to be wound around the guide needle 22a. Accordingly, a state of the fiber bundle 8 to be introduced into the spinning chamber 26 is stabilized. Since the fiber bundle 8 is guided while being wound around the guide needle 22a, even if twists are applied to the fibers in the spinning chamber 26, the twists are prevented from propagating upstream of the fiber guiding section 22, which prevents the twists by the spinning device 9 from affecting the draft device 7. However, the guide needle 22a may be omitted, and a downstream edge of the fiber guiding section 22 may be configured to function as the guide needle 22a.

[0049] The winding device 13 is provided downstream of the spinning device 9. The winding device 13 includes a cradle arm 71 supported to be swingable around a supporting axis 73. The cradle arm 71 can rotatably support a bobbin 48 around which the spun yarn 10 is wound.

[0050] The winding device 13 includes a winding drum 72 and a traverse device 75. The winding drum 72 is configured to be driven while making contact with an outer peripheral surface of the bobbin 48 or an outer peripheral surface of the package 45 which is formed by winding the spun yarn 10 around the bobbin 48. The traverse device 75 includes a traverse guide 76 that can engage with the spun yarn 10. By driving the winding drum 72 with an electric motor (not illustrated) while reciprocating the traverse guide 76 with a driving means (not illustrated), the package 45 making contact with the winding drum 72 is rotated and the spun yarn 10 is traversed to form the package 45.

[0051] As illustrated in Figs. 1 and 2, the yarn joining cart 3 includes a yarn joining device 43 and a suction device (a suction pipe 44 and a suction mouth 46). When a yarn breakage or a yarn cut occurs in one spinning unit 2, the yarn joining cart 3 runs on a rail 41 to the relevant spinning unit 2 and stops thereat. While swinging vertically around a shaft as a center, the suction pipe 44 sucks and catches a yarn end from the spinning device 9, and guides the yarn end to the yarn joining section 43. While swinging vertically around a shaft as a center, the suction mouth 46 sucks and catches a yarn end from the package 45 supported by the winding device 13, and guides the yarn end to the yarn joining section 43. The yarn joining section 43 joins the guided yarn ends.

[0052] A yarn accumulating device 12 is arranged between the spinning device 9 and the winding device 13. As illustrated in Fig. 2, the yarn accumulating device 12 includes a yarn accumulating roller 14 and an electric motor 25 adapted to rotate the yarn accumulating roller 14.

[0053] The yarn accumulating roller 14 can wind and temporarily accumulate a certain amount of the spun yarn 10 on its outer peripheral surface. By rotating the yarn accumulating roller 14 at a prescribed speed while the spun yarn 10 is wound around the outer peripheral surface thereof, the yarn accumulating device 12 can draw out the spun yarn 10 from the spinning device 9 at the prescribed speed and convey the spun yarn 10 to the downstream. Since the yarn accumulating device 12 is configured to temporarily accumulate the spun yarn 10 on the outer peripheral surface of the yarn accumulating roller 14, the yarn accumulating device 12 functions as a buffer. Accordingly, it is possible to prevent a failure that may occur when a spinning speed of the spinning device 9 does not match with a winding speed of the winding device 13 due to some reason (for example, slackening of the spun yarn 10 or the like).

[0054] Between the spinning device 9 and the yarn accumulating device 12, a spinning sensor (first detecting section) 52 and a yarn quality measuring device (second detecting section) 57 are arranged. The spun yarn 10 spun with the spinning device 9 passes through the yarn quality measuring device 57 and the spinning sensor 52 before being wound with the yarn accumulating device 12.

[0055] The yarn quality measuring device 57 monitors a thickness of the travelling spun yarn 10 with a capacitive sensor (not illustrated). When detecting a defect in the spun yarn 10 (e.g. a portion with an abnormal yarn thickness), the yarn quality measuring device 57 transmits a yarn defect detection signal to a unit controller (not illustrated). The yarn quality measuring device 57 is not limited to such a capacitive sensor, and may be configured to monitor the thickness of the spun yarn 10 with an optical sensor.

[0056] The spinning sensor 52 is provided immediately downstream of the yarn quality measuring device 57. The spinning sensor 52 detects a tension of the travelling spun yarn 10 and transmits the sensing result to the unit

controller. By monitoring the tension detected by the spinning sensor 52, the unit controller detects an abnormal portion, such as a weak yarn. Thus, it can be said that the unit controller is an abnormality detecting section. For example, the strength of the spun yarn 10 is weak at a weak yarn portion, and the tension of the weak yarn portion is low. Since the unit controller monitors tension changes of the spun yarn 10 in accordance with a detection result of the spinning sensor 52, the unit controller can detect a weak yarn.

[0057] In the embodiment of the present invention, the spinning unit 2 includes the yarn quality measuring device 57 for detecting a thickness abnormality of the spun yarn 10 and the spinning sensor 52 for detecting a tension abnormality of the spun yarn 10, and therefore abnormalities of the spun yarn 10 can be reliably detected.

[0058] As described above, the yarn accumulating device 12 functions as a buffer, and consequently changes in a winding tension of the winding device 13 can be prevented from propagating upstream of the yarn accumulating device 12. In the embodiment of the present invention, the yarn quality measuring device 57 and the spinning sensor 52 are arranged upstream of the yarn accumulating device 12, and accordingly abnormalities of the spun yarn 10 can be detected without being affected by changes in the winding tension of the winding device 13.

[0059] When an abnormal portion of the spun yarn 10 is detected by the yarn quality measuring device 57 or the spinning sensor 52, the unit controller identifies the cause for the abnormality and displays the cause with an appropriate display means. For example, when the yarn quality measuring device 57 detects thickness unevenness of the spun yarn 10 in a particular cycle, a defect may have occurred in a rotating member (specifically, a draft roller). When a thickness unevenness in a particular cycle is detected, the unit controller detects the defect in the draft roller and displays the defect with the display means.

[0060] For example, when the whirling airflow generated in the spinning device 9 becomes unstable, a weak yarn of the spun yarn 10 is produced. An abnormality in the spinning device 9 (e.g. clogging of fibers in the air injecting nozzle 27, accumulation of fibers in the spinning chamber 26, and/or accumulation of an oiling agent over the hollow guide shaft 23) may be considered as a cause of unstable whirling airflow. When the unit controller detects a weak yarn in accordance with a tension decrease detected by the spinning sensor 52, the unit controller identifies at least any one of clogging of fibers in the air injecting nozzle 27, accumulation of fibers in the spinning chamber 26, and accumulation of an oiling agent over the hollow guide shaft 23 as the cause for the weak yarn, and displays the identified cause on the display means.

[0061] By displaying the cause on the display means when an abnormality of the spun yarn 10 is detected as described above, an operator of the fine spinning machine 1 can promptly perform maintenance on the abnormal portion.

[0062] When the unit controller detects an abnormality in the spun yarn 10 in accordance with a detection result of the yarn quality measuring device 57 or the spinning sensor 52, the unit controller stops the air injecting nozzle 27 to inject air. Accordingly, since spinning of the spun yarn 10 with the spinning device 9 is stopped, the strength of the spun yarn 10 weakens at a position of the spinning device 9, and the spun yarn 10 is cut as it is torn off. Thus, the spinning device 9 is a means for cutting the spun yarn 10.

[0063] The spun yarn 10 located downstream of the cut position is once wound into the package 45. The spun yarn 10 wound into the package 45 includes the abnormal portion detected by the yarn quality measuring device 57 or the spinning sensor 52. Further, the unit controller stops the draft device 7 and also stops a winding operation of the winding device 13. Then, the unit controller transmits a control signal, and the yarn joining cart 3 travels to the spinning unit 2 in which the abnormality of the spun yarn 10 has been detected.

[0064] The yarn joining cart 3 sucks and catches a yarn end from the spinning device 9 and a yarn end from the package 45 with the suction pipe 44 and the suction mouth 45. At this time, the abnormal portion wound into the package 45 is sucked and drawn out by the suction mouth 46. Accordingly, the detected abnormal portion is removed. Then, the suction pipe 44 and the suction mouth 46 guide the caught yarn ends to the yarn joining device 43, and the yarn joining device 43 performs a yarn joining operation.

[0065] The abnormal portion of the spun yarn 10 is removed with the above yarn joining operation, and then winding of the spun yarn 10 into the package can be resumed.

[0066] As described above, most causes for the abnormality in the spun yarn 10 (mainly weak yarns) detected by the spinning sensor 52 may be a malfunction of the spinning device 9. In the embodiment of the present invention, since the spinning sensor 52 is provided immediately downstream of the spinning device 9, an abnormality of the spun yarn 10 (weak yarn) can be detected close to a position where the abnormality has occurred (a position of the spinning device 9). Since an occurrence of a weak yarn can be promptly detected, a length of the spun yarn 10 that needs to be sucked and removed by the suction mouth 46 is also shortened. Thus, efficiency of the yarn joining operation by the yarn joining cart 3 improves, which eventually improves productivity of the entire fine spinning machine 1.

[0067] A structure of the spinning sensor 52 included in the fine spinning machine 1 according to the embodiment of the present invention will be described hereinafter.

[0068] As illustrated in Figs. 4 and 5, the spinning sensor 52 includes a yarn guide 60, a supporting arm 61, a base portion 62 and a strain sensor (detector) 63. As illustrated in Fig. 5, the spinning sensor 52 is arranged

such that the travelling spun yarn 10 makes contact with the yarn guide 60.

[0069] The yarn guide 60 is made of an abrasion resistant material, such as ceramic, and is formed substantially columnar. An axial line 64 of the substantially columnar yarn guide 60 is shown in Fig. 4. Since the yarn guide 60 is formed substantially columnar, at a cross section orthogonal to the axis line 64 of the columnar yarn guide 60 (refer to Fig. 5), a contour shape of a portion where the yarn guide 60 makes contact with the spun yarn 10 is circular. Thus, since no sharp portion is included in the portion where the yarn guide 60 makes contact with the spun yarn 10, the yarn guide 60 can guide the spun yarn 10 without damaging the spun yarn 10.

[0070] As illustrated in Fig. 4, a reduced-diameter portion 65 is formed at a center in the axis line 64 direction of the yarn guide 60. Since the reduced-diameter portion 65 is formed in the yarn guide 60, the spun yarn 10 traveling in contact with the yarn guide 60 travels along the reduced-diameter portion 65. Thus, a travelling path of the spun yarn 10 guided by the yarn guide 60 is stabilized, and the spun yarn 10 is prevented from derailing from the yarn guide 60.

[0071] The yarn guide 60 is attached to a tip of the supporting arm 61. The supporting arm 61 is a metal bar-like member formed in a substantially L-letter shape by being bent perpendicularly. The yarn guide 60 is fixed to one end portion of the supporting arm 61, and the other end portion thereof is fixed to the base portion 62. The base portion 62 is a metal member formed into a substantially rectangular parallelepiped. A strain sensor (strain gauge) 63 for detecting distortion of the base portion 62 is attached on a surface of the base portion 62. A thin portion 62a is formed in the base portion 62 so that the base portion 62 is easily deformed. The strain sensor 63 is attached on the thin portion 62a.

[0072] The force applied to the yarn guide 60 propagates to the based portion 62 through the supporting arm 61, and deforms the base portion 62. The distortion of the base portion 62 is detected by the strain sensor 63. The strain sensor 63 transmits an electric signal according to the detected distortion to the unit controller. Therefore, the unit controller can detect the force applied to the yarn guide 60 in accordance with the electric signal from the strain sensor 63. The spinning sensor 52 with the above structure can easily detect the force applied to the yarn guide 60 in a particular direction. For example, the spinning sensor 52 according to the embodiment of the present invention easily detects the force of the direction in which the yarn guide 60 approaches the base portion 62 (a force indicated with arrows in Figs. 4 and 5). This direction will be referred to as a detection direction of the spinning sensor 52.

[0073] A description will be made on a case in which the spun yarn 10 travels while being bent by making contact with the yarn guide 60 as illustrated in Fig. 5. Since the spun yarn 10 is tensioned, the spun yarn 10 attempts to return to a straight state. As a result, the spun yarn 10 presses the yarn guide 60, and the force thereto is detected by the strain sensor 63. The higher tension applied to the spun yarn 10 increases the force that the spun yarn 10 presses the yarn guide 60. Therefore, the strain sensor 63 of the spinning sensor 52 outputs an electric signal according to the tension applied to the travelling spun yarn 10. The above-described structure allows the unit controller to detect the tension applied to the spun yarn 10. In order to accurately detect the tension applied to the spun yarn 10, the direction in which the spun yarn 10 presses the yarn guide 60 preferably coincides with the detection direction as illustrated in Fig. 5.

[0074] When viewed in the axial line 64 direction of the yarn guide 60 (Fig. 5), a central angle of an arc portion where the spun yarn 10 makes contact with an outer periphery of the yarn guide 60 will be defined as a contact angle θ. When the tension applied to the spun yarn 10 is the same, the greater the contact angle θ is, the force applied to the yarn guide 60 is large. Therefore, the contact angle θ is preferably made large in order to detect a subtle change in the tension applied to the spun yarn 10.

[0075] Patent Document 2 discloses a structure in which guide members are provided upstream and downstream of the yarn tension detecting means, and by bending the yarn path by the guide members, a contact angle of the spun yarn with respect to a yarn guide of the yarn tension detecting means is maintained. However, if such extra guide members provided on the yarn path could affect the quality of the spun yarn. Further, an increase of the contact angle is limited with the structure in which a yarn path is bent with the guide members.

[0076] The fine spinning machine 1 according to the embodiment of the present invention is configured to be capable of providing the contact angle θ of the spun yarn 10 with respect to the yarn guide 60 to be as large as possible without installing an additional guide member described in e.g. Patent Document 2.

[0077] For the following description, a direction parallel to a yarn path of a spun yarn 10a located upstream of the yarn guide 60 will be referred to as Y-axial direction (a first direction), a direction parallel to a horizontal direction of the fine spinning machine 1 (a direction in which the spinning units 2 are arranged) (an axial direction of the draft roller) will be referred to as X-axial direction (a second direction), and a direction perpendicular to the Y-axial direction and the X-axial direction (more specifically, a direction perpendicular to a plane formed by the Y-axial direction and the X-axial direction) is specified as Z-axial direction (third direction).

[0078] As illustrated in Fig. 1, etc. of Patent Document 2, an axial direction of the yarn guide is conventionally arranged perpendicular to a yarn path of a spun yarn. Therefore, as illustrated in Fig. 6A, when viewed in the Z-axial direction, persons skilled in the art usually have an idea of arranging the yarn guide 60 such that the axial line 64 direction is perpendicular to the Y-axial direction. Such arrangement of the yarn guide 60 is defined as a standard position of the spinning sensor 52.

[0079] Inventors of the present invention considered arranging the yarn guide 60 to be inclined with respect to a yarn path of the spun yarn 10 as illustrated in Fig. 6B. That is, as a comparison between Figs. 6A and 6B clearly indicates, by arranging the axial line 64 of the yarn guide 60 to be inclined with respect to the yarn path of the spun yarn 10, the length of the spun yarn 10 making contact with the yarn guide 60 can be made long. Accordingly, compared with the spinning sensor arranged in the standard position as illustrated in Fig. 6A (conventional structure), the spinning sensor 52 arranged inclined with respect to the yarn path of the spun yarn 10 as illustrated in Fig. 6B has a greater contact angle θ of the spun yarn 10 with respect to the yarn guide 60.

[0080] In view of the above point, the spinning sensor 52 according to the embodiment of the present invention is arranged as described below. That is, as illustrated in Fig. 7, the spinning sensor 52 is arranged such that the spun yarn 10 makes contact with the yarn guide 60 while being inclined with respect to the axial line 64 of the yarn guide 60. More specifically, when viewed in the Z-axial direction (Fig. 7), the spinning sensor 52 is arranged such that the axial line 64 of the yarn guide 60 is inclined in a direction (Y-axial direction) of a yarn path of the spun yarn 10 located upstream of the yarn guide 60. Thus, it can be said that the spinning sensor 52 according to the embodiment of the present invention is arranged by being rotated around the Z axis from the standard position (a position perpendicular to the Y-axial direction of the axial line 64 in Fig. 6A).

[0081] Accordingly, compared with a conventional structure in which the axial line 64 of the yarn guide 60 is perpendicular to the Y-axial direction (a structure in Fig. 6A), the spinning sensor 52 according to the embodiment of the present invention can increase the contact angle θ of the spun yarn 10 with respect to the yarn guide 60. Thus, compared with the conventional structure, the spinning sensor 52 according to the embodiment of the present invention can detect a subtle tension change of the spun yarn 10, which improve the accuracy in detecting a weak yarn. Further, in the above-described structure, the yarn guide 60 is simply arranged inclined. Therefore, an extra guide member is not necessary to be provided to maintain the contact angle θ as described in Patent Document 2. Consequently, the spun yarn 10 is not damaged by an extra guide member.

[0082] As illustrated in Fig. 8, in the embodiment of the present invention, when viewed in the X-axial direction, an upstream end portion of the yarn accumulating roller 14 is located further beyond the yarn guide 60 in the Z-axial direction (a position towards the back side of the fine spinning machine 1). In other words, when viewed in the X-axial direction, the upstream end portion of the yarn accumulating roller 14 is located towards the back side of the fine spinning machine 1 than an extended line 66 which is an extended line of the yarn path of the spun yarn 10a located upstream of the yarn guide 60.

[0083] Since the yarn accumulating roller 14 is located towards the back side of the fine spinning machine 1 as described above, the travelling spun yarn 10 is bent largely at a position of the yarn guide 60 located immediately upstream of the yarn accumulating roller 14. By bending the spun yarn 10 guided by the yarn guide 60, the spun yarn 10 travels as if being wound onto the yarn guide 60, and the contact angle θ of the spun yarn 10 with respect to the yarn guide 60 can be made large. Accordingly, the detection accuracy of the spinning sensor 52 can further be improved.

[0084] As described above, in Patent Document 2, the guide members are provided in order to bend a yarn path of a spun yarn making contact with a yarn guide. In the embodiment of the present invention, the yarn accumulating roller 14 of the yarn accumulating device 12 bends the yarn path. Therefore, the yarn accumulating device 12 also serves as a guiding member described in Patent Document 2. The yarn accumulating device 12 according to the embodiment of the present invention functions as a bending guide (guide member) for increasing the contact angle θ of the spun yarn 10 with respect to the yarn guide 60. According to this structure, since the contact angle θ can be made large without providing an extra guide member, the yarn quality is not adversely affected by the additional guide member.

[0085] In the embodiment of the present invention, as illustrated in Fig. 8, when viewed in the X-axial direction, the spinning sensor 52 is arranged such that the detection direction thereof (a direction indicated with a bold arrow in Fig. 8) substantially coincides with a bisector of an angle formed by a yarn path of the spun yarn 10a located upstream of the yarn guide 60 and a yarn path of the spun yarn 10b located downstream of the yarn guide 60. Thus, when viewed in the X-axial direction, the detection direction of the spinning sensor 52 is inclined with respect to the Z-axial direction. Accordingly, since the detection direction of the spinning sensor 52 can be coincided with a direction in which the spun yarn 10 bent by the yarn guide 60 applies a force to the yarn guide 60, a tension change of the spun yarn 10 can be properly detected.

[0086] As illustrated in Fig. 9, when viewed in the Y-axial direction, the spun yarn 10b located downstream of the yarn guide 60 travels along a tangential direction of the yarn accumulating roller 14 when being wound onto the yarn accumulating roller 14. Thus, in the embodiment of the present invention, when viewed in the Y-axial direction, the spinning sensor 52 is inclined such that the detection direction of the spinning sensor 52 substantially coincides with the tangential direction of the yarn accumulating roller 14. Consequently, the spinning sensor 52 can properly detect a tension of the spun yarn 10 which passes through the yarn guide 60 and is wound onto the yarn accumulating roller 14.

[0087] When viewed in the Y-axial direction, the spinning sensor 52 is arranged inclined such that the detection direction coincides with a yarn path of the spun yarn 10 located downstream of the yarn guide 60 as described above. Therefore, when viewed in the Y-axial direction,

the axial line 64 of the yarn guide 60 is inclined with respect to the X-axial direction and the Z-axial direction.

[0088] As described above, in the fine spinning machine 1 according to the embodiment of the present invention, the axial line 64 of the yarn guide 60 provided in the spinning sensor 52 is arranged inclined to all of the X-axial direction, the Y-axial direction and the X-axial direction. That is, the yarn guide 60 of the spinning sensor 52 according to the embodiment of the present invention is three-dimensionally inclined. Accordingly, compared with the conventional structure (illustrated in Fig. 6A) in which the axial line 64 of the yarn guide 60 is arranged perpendicular to the yarn path, the contact angle θ of the spun yarn 10 with respect to the yarn guide 60 can be further increased, and the spinning sensor 52 can detect a tension change of the spun yarn 10 more accurately.

[0089] Further, in order to arrange the spinning sensor 52 to be three-dimensionally inclined as described above, the base portion 62 of the spinning sensor 52 is attached to the main body of the fine spinning machine 1 using an exclusive pedestal (not illustrated). Furthermore, in order to support the spinning sensor 52 in a three-dimensionally inclined state, the pedestal is formed in a complicated shape by being three-dimensionally twisted. Thus, in the embodiment of the present invention, the pedestal is made of resin, which can be easily molded.

[0090] Since the spun yarn 10 travels making contact with the yarn guide 60, the spinning sensor 52 is charged with electricity. In the embodiment of the present invention, the pedestal is formed of conductive resin including metal or carbon. Accordingly, since static electricity can be discharged from the charged spinning sensor 52, fluctuation in output signals of the spinning sensor 52 can be suppressed, and the detection accuracy of the spinning sensor 52 can further be improved.

[0091] Next, a cover 68 of the spinning sensor 52 according to the embodiment of the present invention will be described.

[0092] As illustrated in Fig. 10, the spinning sensor 52 according to the embodiment of the present invention includes the cover 68 that externally covers the yarn guide 60, the supporting arm 61, the base portion 62, the strain sensor 63 and the like. If the yarn guide 60 or the supporting arm 61 is externally exposed, an operator may carelessly touch and damage the yarn guide 60 or the supporting arm 61. Thus, by protecting the yarn guide 60 or the like with the cover 68 as described above, the spinning sensor 52 can be prevented from being damaged.

[0093] As illustrated in Fig. 10, a slit 69 is formed on the cover 68 to expose the yarn guide 60. Therefore, the travelling spun yarn 10 can make contact with the yarn guide 60 via the slit 69.

[0094] The slit 69 is formed narrow and long so that the spun yarn 10 can pass through. Therefore, the slit 69 itself functions to guide the travelling spun yarn 10. The followings are more detailed explanation. During a yarn joining operation by the yarn joining cart 3, the winding of the spun yarn 10 into the package 45 with the winding device 13 is suspended. Accordingly, during the yarn joining operation, the spun yarn 10 is not sufficiently tensioned. Therefore, during the yarn joining operation, the force in which the spun yarn 10 is pressed against the yarn guide 60 is weak, and the spun yarn 10 may fall from (the reduced-diameter portion 65 of) the yarn guide 60.

[0095] According to the above-described structure, the spun yarn 10 travelling in contact with the yarn guide 60 travels inside the narrow and long slit 69 formed on the cover 68. Thus, for example, even if the spun yarn 10 is about to fall from the yarn guide 60 during the yarn joining operation, the slit 69 can guide the yarn path of the spun yarn 10. That is, even during the yarn joining operation or the like, the slit 69 of the cover 68 can also guide the spun yarn 10 to the yarn accumulating device 12. Thus, in the embodiment of the present invention, the cover 68 of the spinning sensor 52 also serves as a yarn accumulating device upstream guide. In the conventional spinning device, a guide for guiding a spun yarn to a yarn accumulating device needs to be provided upstream of the yarn accumulating device. However, since the cover 68 also functions as said guide in the embodiment of the present invention, the guide can be omitted.

[0096] As described above, in the embodiment of the present invention, when viewed in the Y-axial direction, the axial line 64 of the yarn guide 60 is inclined with respect to the X axis and the Z axis. When viewed in the Y-axial direction, the cover 68 protecting the yarn guide 60 or the like is also arranged inclined. More specifically, as illustrated in Fig. 10, when viewed in the Y-axial direction, the cover 68 is arranged such that a longitudinal direction of the slit 69 is inclined with respect to the Z axis.

[0097] In a spinning plant provided with the fine spinning machine 1, air is blown with an air blower or the like from the front of the machine (that is, from the front side of the fine spinning machine 1, or from the Z-axial direction) to blow away yarn wastes and the like at the time of maintenance or cleaning of the fine spinning machine 1. A bold arrow in Fig. 10 indicates a direction in which the air is blown against the spinning sensor 52. During these operations, the air is strongly blown in order to blow away the yarn wastes or the like, and therefore, some components may be damaged with the power of the air. In the embodiment of the present invention, since the slit 69 is formed inclined with respect to the Z axis as described above, an exposed portion of the yarn guide 60 is small when viewed in the Z-axial direction. Thus, even when the air is blown to the spinning sensor 52 from the front of the fine spinning machine 1 (from the Z-axial direction), the power of the air that hits the yarn guide 60 can be weakened, and the yarn guide 60 can be prevented from being damaged by the air.

[0098] As described above, the fine spinning machine 1 according to the embodiment of the present invention includes the spinning device 9, the winding device 13,

and the spinning sensor 52. The spinning device 9 produces the spun yarn 10. The winding device 13 winds the spun yarn 10 produced with the spinning device 9 into the package 45. The spinning sensor 52 detects a tension of the spun yarn 10 travelling between the spinning device 9 and the winding device 13. The spinning sensor 52 includes the yarn guide 60 that makes contact with the travelling spun yarn 10, and the strain sensor 63 that outputs a signal according to the force applied to the yarn guide 60. The yarn guide 60 has a substantially arcuate cross-sectional contour at a cross section perpendicular to the axial line 64 at least at a portion making contact with the spun yarn 10. The yarn guide 60 is arranged such that the spun yarn 10 makes contact with the yarn guide 60 with the spun yarn 10 being inclined with respect to the axial line 64.

[0099] By arranging the yarn guide 60 inclined with respect to the yarn path of the spun yarn 10 as described, compared with the conventional structure in which the yarn guide 60 is arranged perpendicular to the yarn path, the contact angle θ of the spun yarn 10 with respect to the yarn guide 60 can be made large. Accordingly, a tension change of the spun yarn 10 can be detected reliably.

[0100] The fine spinning machine 1 according to the embodiment of the present invention includes the draft device 7 for drafting the fiber bundle 8 with the draft rollers and supplying the drafted fiber bundle 8 to the spinning device 9. The direction parallel to the yarn path of the spun yarn 10 located upstream of the yarn guide 60 is defined as the first direction. The direction parallel to the axial direction of the draft roller is defined as the second direction. The direction perpendicular to the plane formed by the first direction and the second direction is defined as the third direction. When viewed in the Z-axial direction, the axial line 64 of the yarn guide 60 is inclined with respect to the Y-axial direction.

[0101] Accordingly, the contact angle of the spun yarn 10a travelling in the Y-axial direction can be made large with respect to the yarn guide 60.

[0102] The fine spinning machine 1 according to the embodiment of the present invention includes the yarn accumulating device 12 for drawing the spun yarn 10 spun with the spinning device 9 and accumulating the spun yarn 10. The yarn accumulating device 12 functions as a bending guide for bending the yarn path of the spun yarn 10 viewed in the X-axial direction.

[0103] Accordingly, since the contact angle θ of the spun yarn 10 with respect to the yarn guide 60 can be further made large, a subtle change in the tension applied to the spun yarn 10 can be detected more reliably. Since the yarn accumulating device 12 also functions as the bending guide, the number of components used in the fine spinning machine 1 can be reduced. Further, since an additional bending guide is not necessary to be provided for bending the yarn path of the spun yarn 10, the spun yarn 10 is not damaged with the extra guide.

[0104] In the fine spinning machine 1 according to the embodiment of the present invention, the spinning sensor 52 is provided between the spinning device 9 and the yarn accumulating device 12 in the yarn travelling direction. The winding device 13 winds the spun yarn 10 drawn out of the yarn accumulating device 12 into the package 45.

[0105] Accordingly, the spinning sensor 52 can directly detect the tension of the spun yarn 10 spun with the spinning device 9. Thus, since an abnormality in the spun yarn 10 can be detected close to a position where the abnormality has occurred, the spinning sensor 52 can promptly detect a weak yarn. Further, since the yarn accumulating device 12 which functions as a buffer is arranged between the spinning sensor 52 and the winding device 13, changes in the winding tension of the winding device 13 does not propagate to the spinning sensor 52. Thus, the spinning sensor 52 can accurately detect the tension of the spun yarn 10 produced by the spinning device 9 without being affected by the winding tension.

[0106] In the fine spinning machine 1 according to the embodiment of the present invention, the cover 68 externally covering the yarn guide 60 and the strain sensor 63 of the spinning sensor 52 also functions as the yarn accumulating device upstream guide for guiding the spun yarn 10 to the yarn accumulating device 12.

[0107] Accordingly, the spun yarn 10 can be reliably guided to the yarn accumulating device 12. Since the cover 68 also serves as the yarn accumulating device upstream guide, a guide provided upstream of the yarn accumulating device in the conventional spinning machine can be omitted.

[0108] In the fine spinning machine 1 according to the embodiment of the present invention, the slit 69 is formed on the cover 68 so as to externally expose the yarn guide 60. When viewed in the Y-axial direction, the longitudinal direction of the slit 69 is inclined with respect to the Z-axial direction.

[0109] That is, when viewed from the front of the fine spinning machine 1 (the Z-axial direction), the cover 68 is arranged such that an area of the yarn guide 60 exposed via the slit 69 is small. Accordingly, even when air for cleaning is blown against the cover 68 from the front of the fine spinning machine 1, the air does not directly hit the yarn guide 60, and the yarn guide 60 is not damaged.

[0110] In the fine spinning machine 1 according to the embodiment of the present invention, the axial line 64 of the yarn guide 60 is inclined with respect to all of the Y-axial direction, the X-axial direction, and the Z-axial direction.

[0111] That is, the yarn guide 60 is three-dimensionally inclined. Thus, the contact angle θ of the spun yarn 10 with respect to the yarn guide 60 can further be made large, and a subtle tension change of the spun yarn 10 can be detected even more reliably.

[0112] The fine spinning machine 1 according to the embodiment of the present invention includes the unit controller as an abnormality detecting section. The spinning device 9 is the air-jet spinning device including the

fiber guiding section 22, the nozzle block 35 in which the air injecting nozzle 27 is formed, and the hollow guide shaft 23, and produces the spun yarn 10 by spinning the fiber bundle 8 drafted with the draft device 7 in the spinning chamber 26 with a whirling airflow. The unit controller detects an abnormality in the tension of the spun yarn 10 in accordance with the detection result of the spinning sensor 52.

[0113] That is, if an abnormality occurs in the air jet spinning device 9, a yarn with a low tension (weak yarn) is spun. Therefore, by detecting the tension of the spun yarn 10, an abnormality in the spinning device 9 can be detected.

[0114] In the fine spinning machine 1 according to the embodiment of the present invention, when the detection result of the spinning sensor 52 indicates a decrease in the tension of the spun yarn 10, the unit controller identifies, as an abnormality in the air-jet spinning device, at least one of clogging of fibers in the air injecting nozzle 27, accumulation of fibers in the spinning chamber 26, winding of fibers around the hollow guide shaft 23, and accumulation of an oiling agent over the hollow guide shaft 23.

[0115] That is, if the air injecting nozzle 27 is clogged with fibers, a volume of the whirling airflow in the spinning chamber 26 decreases. Consequently, since the fibers cannot be swung at high speed in the spinning chamber 26, twists of the produced spun yarn 10 becomes weak. Alternatively, if the fibers are accumulated in the spinning chamber 26, or if the fibers are wound around the hollow guide shaft 23, or if the oiling agent has accumulated over the hollow guide shaft 23, the fibers in the spinning chamber 26 cannot be swung at high speed. Consequently, the twists of the produced spun yarn 10 become weak. Since the state of the weakly-twisted yarn is fluffy (soft and light), the tension of such a spun yarn is low. Therefore, by detecting a decrease in tension, an abnormality in the air jet spinning device can be detected.

[0116] The fine spinning machine 1 according to the embodiment of the present invention further includes the suction pipe 44, the suction mouth 45 and the yarn joining device 43. When the unit controller detects an abnormality in the spun yarn 10, the spinning device 9 stops the spinning operation to cut off the spun yarn 10. When the spun yarn 10 is cut, the suction pipe 44 and the suction mouth 45 respectively suck a yarn end of the spun yarn 10 from the spinning device 9 and a yarn end of the spun yarn 10 from the winding device 13 to remove the abnormal portion of the spun yarn 10. The yarn joining device 43 joins yarn ends of the spun yarn 10 sucked by the suction pipe 44 and the suction mouth 45.

[0117] As described above, since the spinning sensor 52 detects an abnormality of the spun yarn 10 at a position located close to a position where the abnormality has occurred, when any abnormality occurs in the spun yarn 10, the abnormality can be promptly detected and the spun yarn 10 can be cut. Thus, since the length of the spun yarn 10 which needs to be removed with the suction mouth 46 can be made short, the yarn joining operation can be carried out efficiently by the yarn joining device 43. Consequently, productivity of the fine spinning machine 1 can also be improved.

[0118] The fine spinning machine 1 according to the embodiment of the present invention further includes the yarn quality measuring device 57 for detecting a thickness abnormality of the spun yarn 10 spun with the spinning device 9.

[0119] Accordingly, since abnormalities in both tension and thickness of the spun yarn 10 can be detected, abnormalities in the spun yarn 10 can be detected more accurately.

[0120] In the fine spinning machine 1 according to the embodiment of the present invention, the yarn guide 60 includes the reduced-diameter portion 65 at a certain portion in the axial line 64 direction, and the spun yarn 10 travels on the reduced-diameter portion 65.

[0121] Accordingly, the spun yarn 10 can travel without falling from the yarn guide 60. Thus, the spinning sensor 52 can reliably detect the tension of the spun yarn 10.

[0122] Alternative embodiments of the present invention will be described hereinafter. In the following description, like reference numerals are denoted to like elements for structures that are common with the above described embodiment, and the description thereof will be omitted.

[0123] In the alternative embodiment, the fine spinning machine 1 according to the above described embodiment of the present invention further includes a core yarn supplying device for supplying a core yarn.

[0124] The core yarn supplying device is configured to supply the core yarn to the spinning device 9. The fiber bundle 8 supplied from the draft device 7 meets with the core yarn and enters into the spinning device 9 together. In the spinning chamber 26 of the spinning device 9, the fiber bundle 8 is swung around the core yarn, and the fiber bundle 8 is wound around the core yarn. Accordingly, the spun yarn 10 with the core yarn is produced.

[0125] A spinning device including the core yarn supplying device is described in e.g. Japanese Unexamined Patent Application Publication No. 2007-254919 and is conventionally know. Therefore, a detailed description of such a spinning device will be omitted.

[0126] As described in Japanese Unexamined Paten Application Publication No. 2007-254919, the core yarn supplying device is provided above the draft device 7 and upstream of the spinning device 9. Therefore, the core yarn supplying device can be arranged by being additionally installed in the fine spinning machine 1 of the above described embodiment illustrated Fig. 1 or the like. Thus, the layout of the spinning sensor 52 and the like can be also employed in the alternative embodiment.

[0127] In the alternative embodiment, the unit controller detects a presence or an absence of the core yarn in accordance with the detection result of the spinning sensor 52. In other words, in the fine spinning machine 1 for producing the spun yarn 10 with the core yarn, if the core yarn is not properly supplied for some reasons, the

strength of the yarn is weaker than a normal spun yarn with a core yarn, and consequently a yarn tension detected by the spinning sensor 52 is also low. Thus, by monitoring a tension change of the spun yarn 10 detected by the spinning sensor 52, the unit controller can detect the presence or the absence of the core yarn. As described above, in the alternative embodiment, the unit controller also functions as the core yarn detecting section.

[0128] As already described, in the fine spinning machine 1 according to the present invention, by considering the arrangement of the spinning sensor 52, the contact angle θ of the spun yarn 10 with respect to the yarn guide 60 can be made large, and the detection accuracy of the spinning sensor 52 is improved. Thus, in the fine spinning machine 1 according to the alternative embodiment in which the core yarn is detected in accordance with the detection result of the spinning sensor 52, the presence or the absence of the core yarn can be precisely detected.

[0129] As described above, the fine spinning machine 1 according to the alternative embodiment of the present invention includes the core yarn supplying device for supplying the core yarn, which is to be a core of the spun yarn 10, to the spinning device 9. The unit controller detects the presence or the absence of the core yarn in the spun yarn 10 in accordance with the detection result of the spinning sensor 52.

[0130] As described above, the presence or the absence of the core yarn can be detected in accordance with the detection result of the spinning sensor 52.

[0131] Although a preferred embodiment and an alternative embodiment of the present invention have been described, the above structures can be modified as described below.

[0132] The spinning device is not limited to an air-jet spinning device, and the structure of the present invention may be applied to a spinning machine including other types of spinning devices. As described above, however, in the air-jet spinning device, a weak yarn is produced due to clogging in the air injection nozzle 27 or the like. Thus, the structure of the present invention capable of accurately detecting a weak yarn is preferably applied to a spinning machine including an air jet spinning device.

[0133] In the above embodiments, the unit controller functions as the abnormality detecting section or the core yarn detecting section. However, at least either one of the abnormality detecting section and the core yarn detecting section can be provided separately from the unit controller.

[0134] In the above embodiments, from the upstream side, the spinning device 9, the yarn quality measuring device 57, and the spinning sensor 52 are arranged in this order. However, the spinning device 9, the spinning sensor 52, and the yarn quality measuring device 57 may be arranged in this order. The yarn quality measuring device 57 may be omitted.

[0135] In the above-described embodiments, the spun yarn 10 is drawn out from the spinning device 9 by rotating the yarn accumulating roller 14 of the yarn accumulating device 12. Instead of this configuration, as described in e.g. Patent Document 1, a yarn feeding device may be arranged to draw out the spun yarn from the spinning device by rotating a delivery roller and a nip rollers while nipping the spun yarn.

[0136] The above embodiments are configured to cut off the spun yarn 10 by stopping a spinning operation of the spinning device 9 during a yarn joining operation. However, a cutter for cutting the spun yarn 10 may be additionally arranged.

[0137] The pedestal to three-dimensionally support the spinning sensor 52 is made of resin. However, the material is not limited to resin, and if possible, the pedestal may be made of metal. Further, if possible, the base portion 62 of the spinning sensor 52 may be attached directly to the main body of the fine spinning machine 1 without using the pedestal.

[0138] In embodiments of the invention, the yarn path of the spun yarn and the axial line of the yarn guide are arranged in an angle different from 90 degree so that the spun yarn is inclined with respect to the axial line.

Claims

1. A spinning machine comprising:

a spinning device (9) adapted to produce a spun yarn (10);
a winding device (13) adapted to wind the spun yarn (10) produced by the spinning device (9) into a package (45); and
a first detecting section (52) adapted to detect a tension of the spun yarn (10) travelling between the spinning device (9) and the winding device (13), the first detecting section (52) including a yarn guide (60) adapted to make contact with the travelling spun yarn (10) and a detector (63) adapted to output a signal according to a force applied to the yarn guide (60), wherein the yarn guide (60) has a substantially arcuate cross-sectional contour at a cross section substantially perpendicular to an axial line (64) of the yarn guide (60) at least at a portion making contact with the spun yarn (10), and is arranged such that the spun yarn (10) makes contact with the yarn guide (60) while being inclined with respect to the axial line (64).

2. The spinning machine according to claim 1, further comprising a draft device (7) adapted to draft a fiber bundle (8) by draft rollers (16, 17, 19, 20) and to supply the drafted fiber bundle (8) to the spinning device (9),
wherein provided that a first direction is a direction substantially parallel to a yarn path of the spun yarn (10) located upstream of the yarn guide (60), a sec-

ond direction is a direction substantially parallel to an axial direction of the draft rollers (16, 17, 19, 20), and a third direction is a direction substantially perpendicular to a plane formed by the first direction and the second direction,
when viewed in the third direction, the axial line (64) of the yarn guide (60) is arranged inclined with respect to the first direction.

3. The spinning machine according to claim 1 or claim 2, further comprising a bending guide adapted to bend a yarn path of the spun yarn (10).

4. The spinning machine according to claim 3, further comprising a yarn accumulating device (12) adapted to draw out and accumulate the spun yarn (10) that is spun with the spinning device (9), and arranged to function as the bending guide.

5. The spinning machine according to claims 4, wherein the first detecting section (52) is arranged between the spinning device (9) and the yarn accumulating device (12) in a yarn travelling direction of the spun yarn (10).

6. The spinning machine according to claim 5, wherein the winding device (13) is adapted to wind the spun yarn (10) drawn out of the yarn accumulating device (12) into the package (45).

7. The spinning machine according to any one of claim 4 through claim 6, further comprising a yarn accumulating device upstream guide adapted to guide the spun yarn (10) to the yarn accumulating device (12).

8. The spinning machine according to claim 7, wherein the yarn accumulating device upstream guide is adapted to function as a cover (68) to externally cover the yarn guide (60) and the detector (63) of the first detecting section (52).

9. The spinning machine according to claim 8, further comprising a draft device (7) adapted to draft the fiber bundle (8) by the draft rollers (16, 17, 19, 20) and to supply the drafted fiber bundle (8) to the spinning device (9),
wherein a slit (69) is formed on the cover (68) to expose the yarn guide (60) to an outside, and
provided that a first direction is a direction substantially parallel to a yarn path of the spun yarn (10) located upstream of the yarn guide (60), a second direction is a direction substantially parallel to an axial direction of the draft roller (16, 17, 19, 20), and a third direction is a direction substantially perpendicular to a plane formed by the first direction and the second direction,
when viewed in the first direction, a longitudinal direction of the slit (69) is inclined with respect to the third direction.

10. The spinning machine according to any one of claim 1 through claim 9, further comprising a draft device (7) adapted to draft the fiber bundle (8) by draft rollers (16, 17, 19, 20) and to supply the drafted fiber bundle (8) to the spinning device (9),
wherein provided that a first direction is a direction substantially parallel to a yarn path of the spun yarn (10) located upstream of the yarn guide (60), a second direction is a direction substantially parallel to an axial direction of the draft rollers (16, 17, 19, 20), and a third direction is a direction substantially perpendicular to a plane formed by the first direction and the second direction,
the axial line (64) of the yarn guide (60) is inclined with respect to all of the first direction, the second direction, and the third direction.

11. The spinning machine according to any one of claim 1 through claim 10, further comprising:

a draft device (7) adapted to draft a fiber bundle (8) and to supply the drafted fiber bundle (8) to the spinning device (9); and
an abnormality detecting section;
wherein the spinning device (9) includes a fiber guiding section (22), a nozzle block (35) in which an air injecting nozzle (27) is formed, and a hollow guide shaft (23), and is adapted to produce the spun yarn (10) by spinning the fiber bundle (8), which has been drafted by the draft device (7), in a spinning chamber (26) with a whirling airflow, and
the abnormality detecting section is adapted to detect an abnormality in a tension of the spun yarn (10) in accordance with a detection result of the first detecting section (52).

12. The spinning machine according to claim 11, wherein when a decrease in the tension of the spun yarn (10) is detected by the first detecting section (52), the abnormality detecting section is adapted to detect as an abnormality in the air-jet spinning device (9), at least one of clogging of fibers in the air injecting nozzle (27), accumulation of fibers in the spinning chamber (26), winding of fibers around the hollow guide shaft (23), and accumulation of an oiling agent over the hollow guide shaft (23).

13. The spinning machine according to claim 11 or claim 12, further comprising:

a cutting means for cutting the spun yarn (10) between the spinning device (9) and the winding device (13) upon detection of an abnormality of the spun yarn (10) by the abnormality detecting

section;
a suction device (44, 46) adapted to suck a yarn end of the spun yarn (10) from the spinning device (9) and a yarn end of the spun yarn (10) from the winding device (13) and to remove an abnormal portion of the spun yarn (10) upon cutting of the spun yarn (10) by the cutting means; and
a yarn joining section (43) adapted to join yarn ends of the spun yarn (10) sucked by the suction device (44, 46).

14. The spinning machine according to any one of claim 1 through claim 13, further comprising a second detecting section (57) adapted to detect a thickness abnormality of the spun yarn (10) that is spun with the spinning device (9).

15. The spinning machine according to any one of claim 1 through claim 14, further comprising:

a core yarn supplying device adapted to supply a core yarn, which is to be a core of the spun yarn (10), to the spinning device (9); and
a core yarn detecting section adapted to detect a presence or an absence of the core yarn in the spun yarn (10) in accordance with a detection result of the first detecting section (52).

16. The spinning machine according to any one of claim 1 through claim 15, wherein a reduced-diameter portion (65) is formed on a portion of the yarn guide (60) in a direction of the axial line (64), and the spun yarn (10) travels on the reduced-diameter portion (65).

FIG. 1

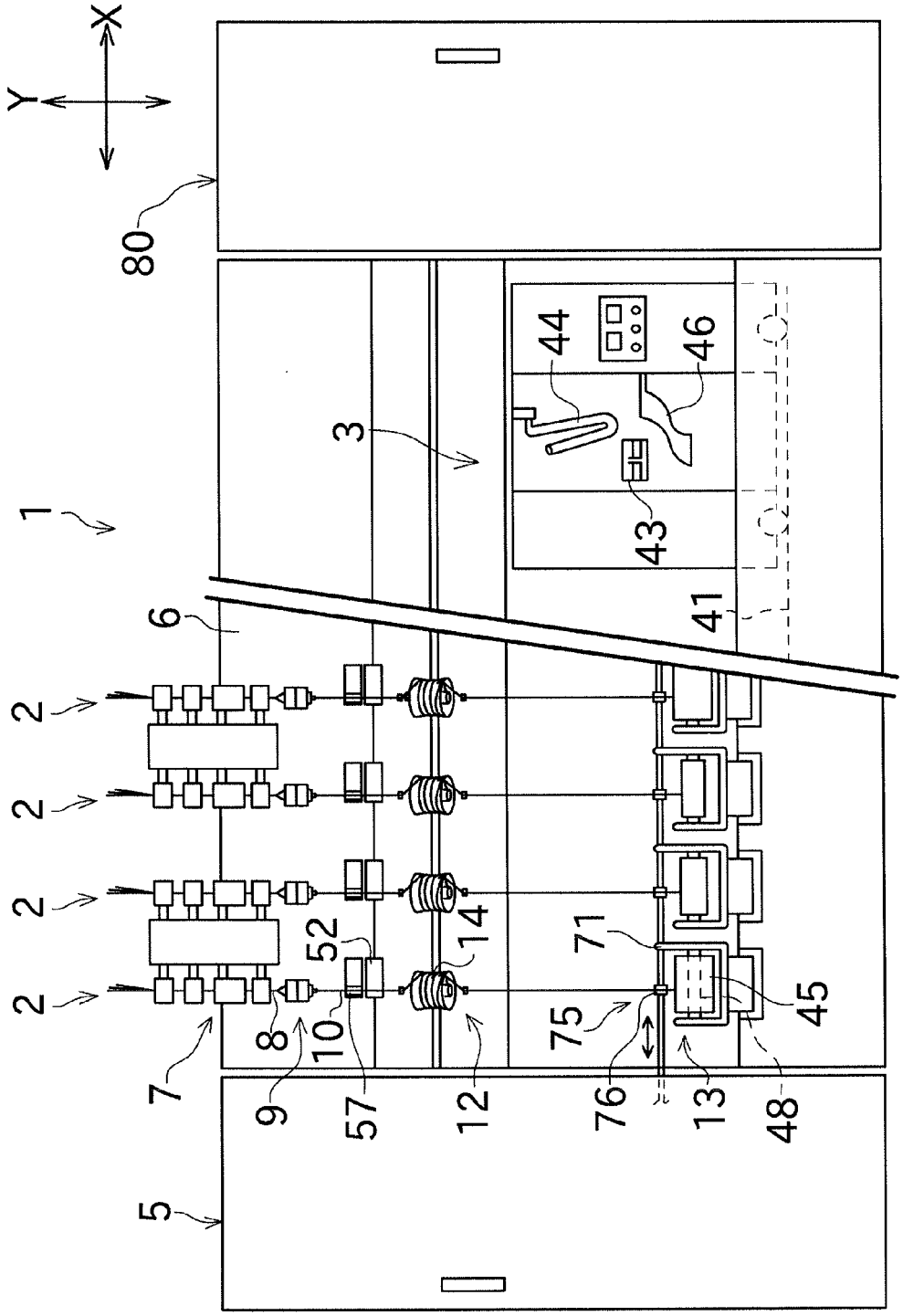
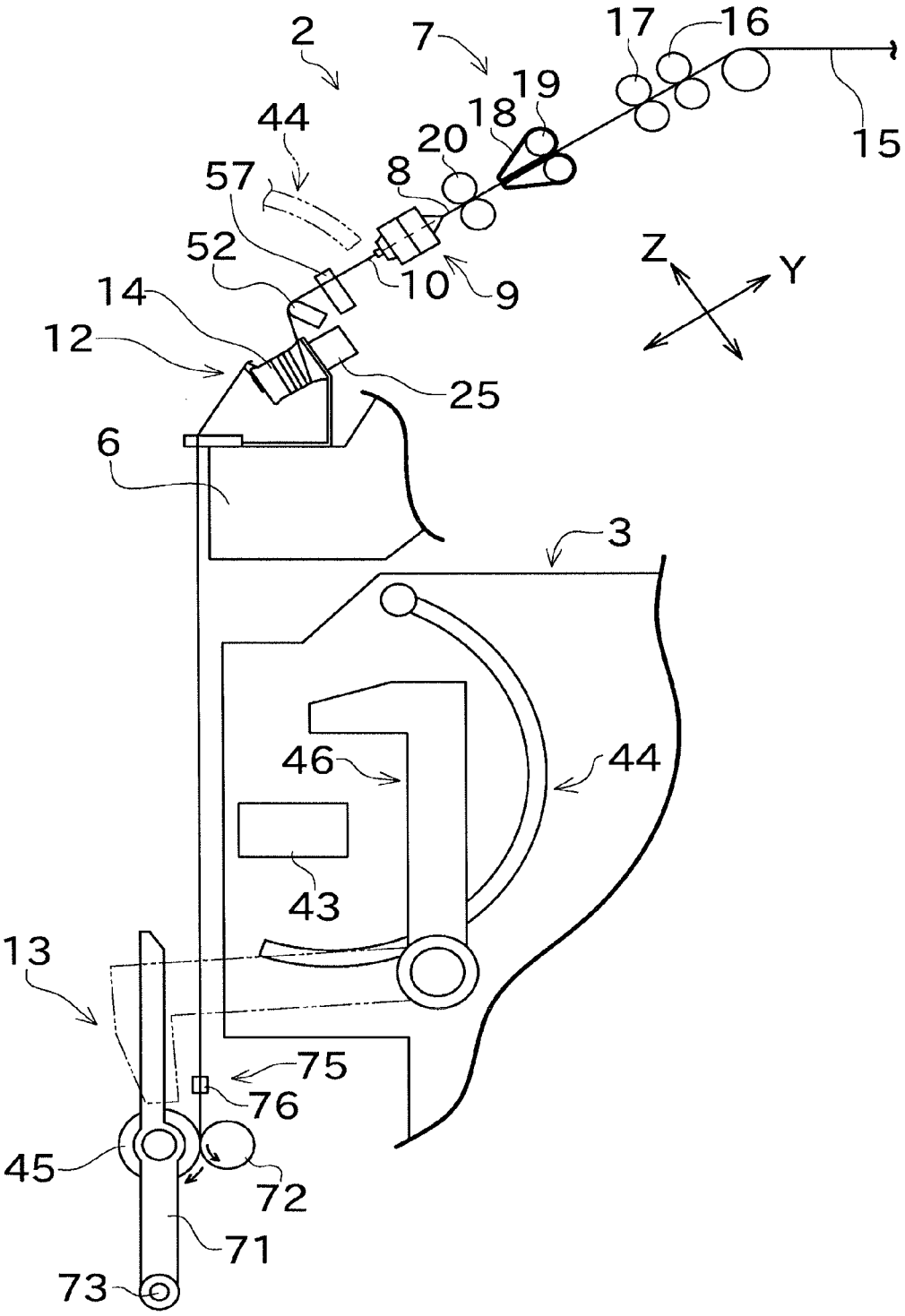


FIG. 2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Z
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FIG. 3

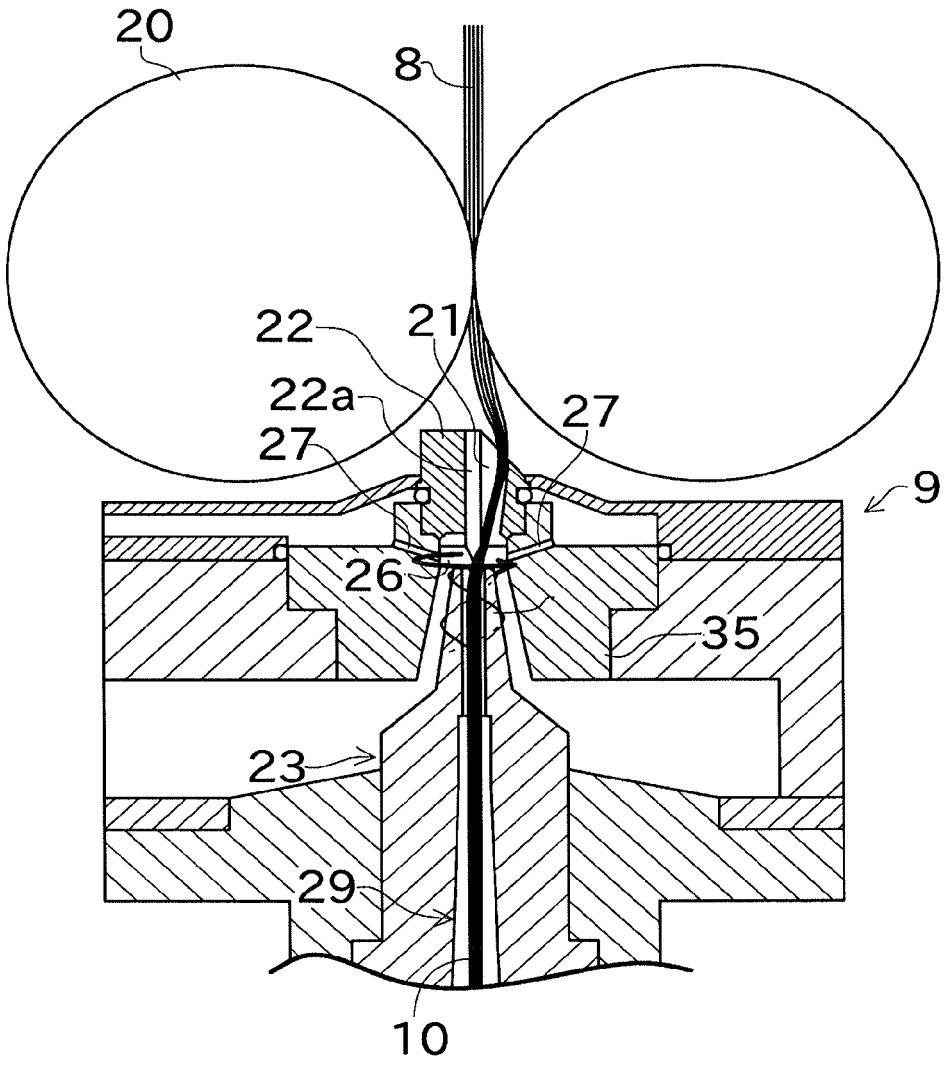


FIG. 4

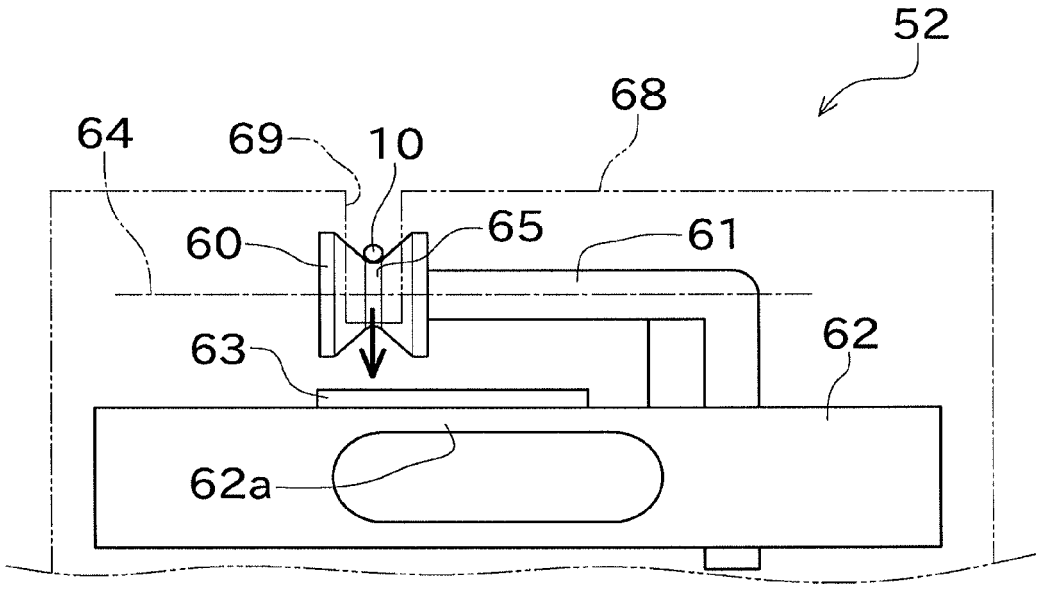


FIG. 5

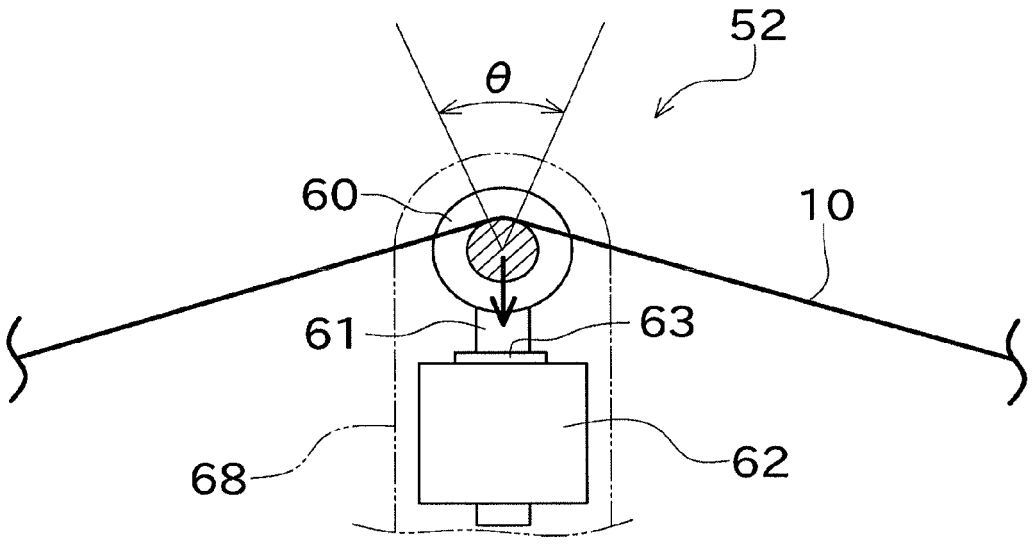


FIG. 6A

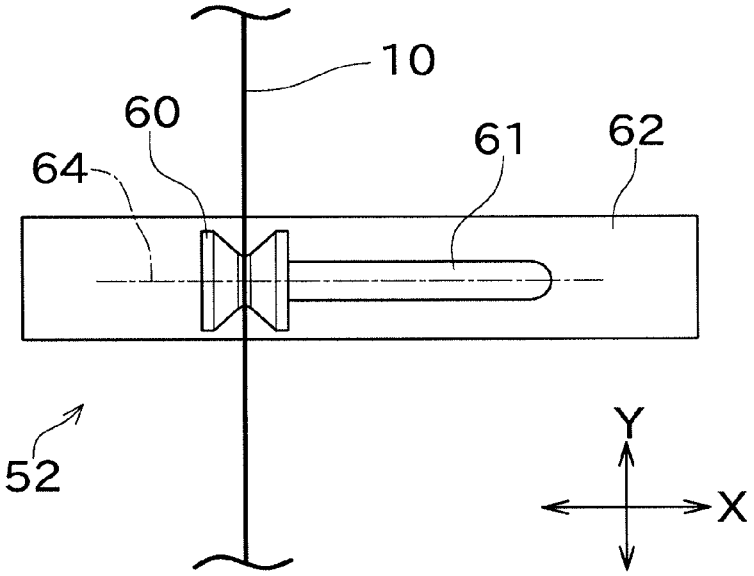


FIG. 6B

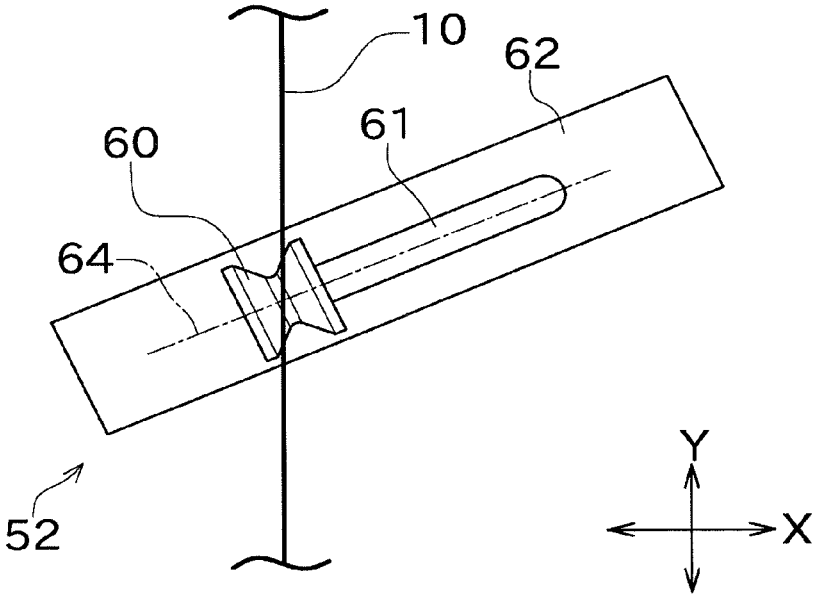


FIG. 7

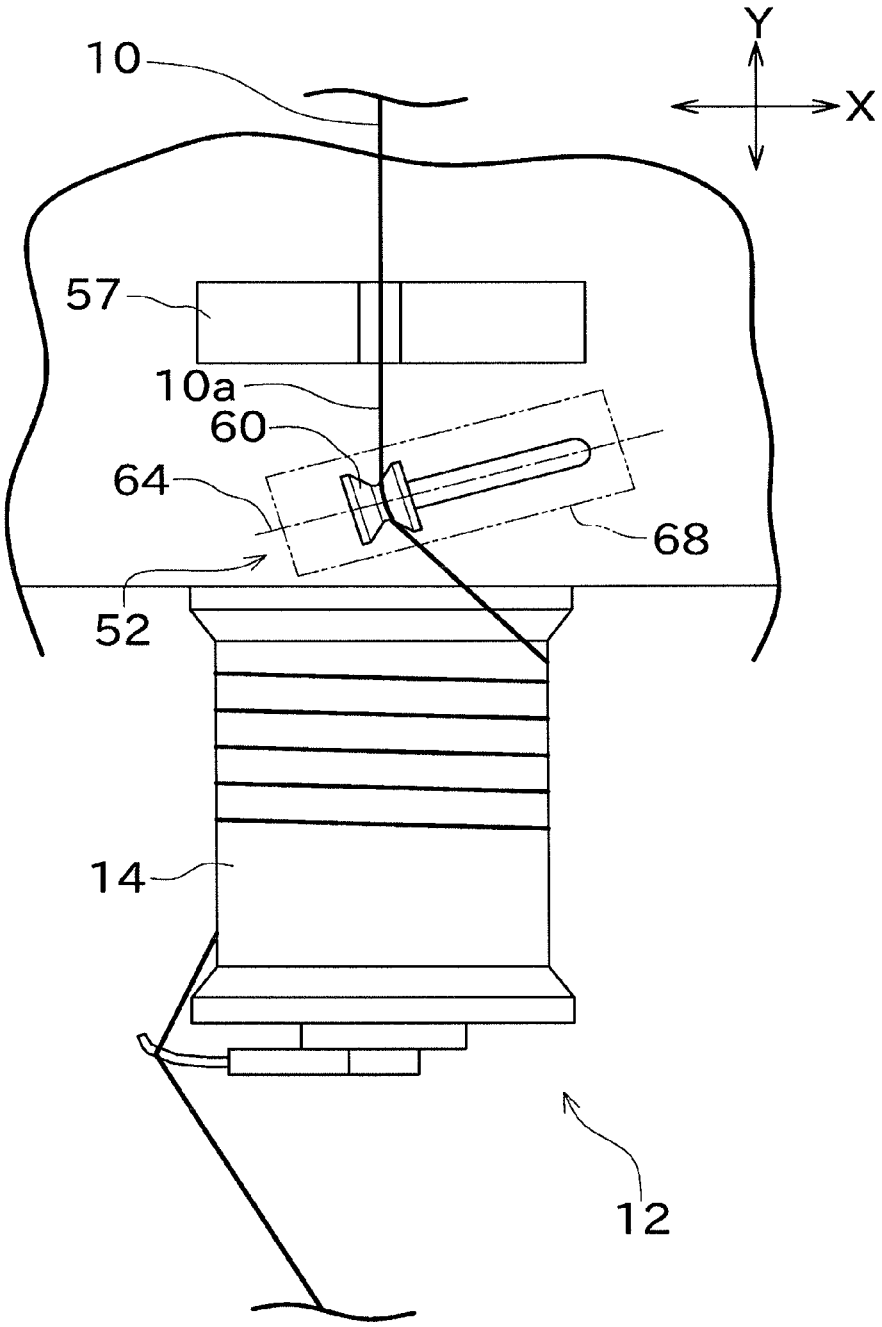


FIG. 8

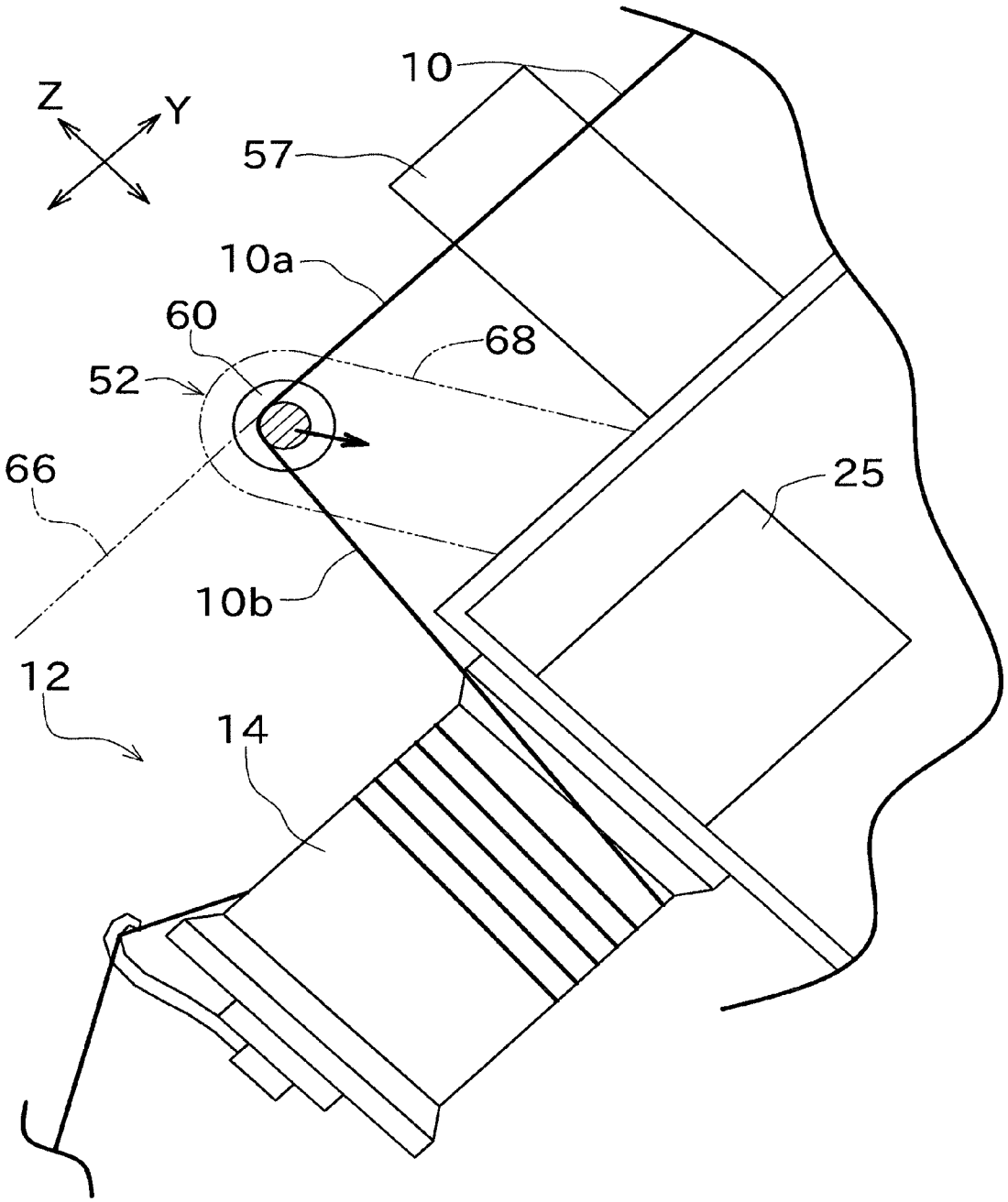


FIG. 9

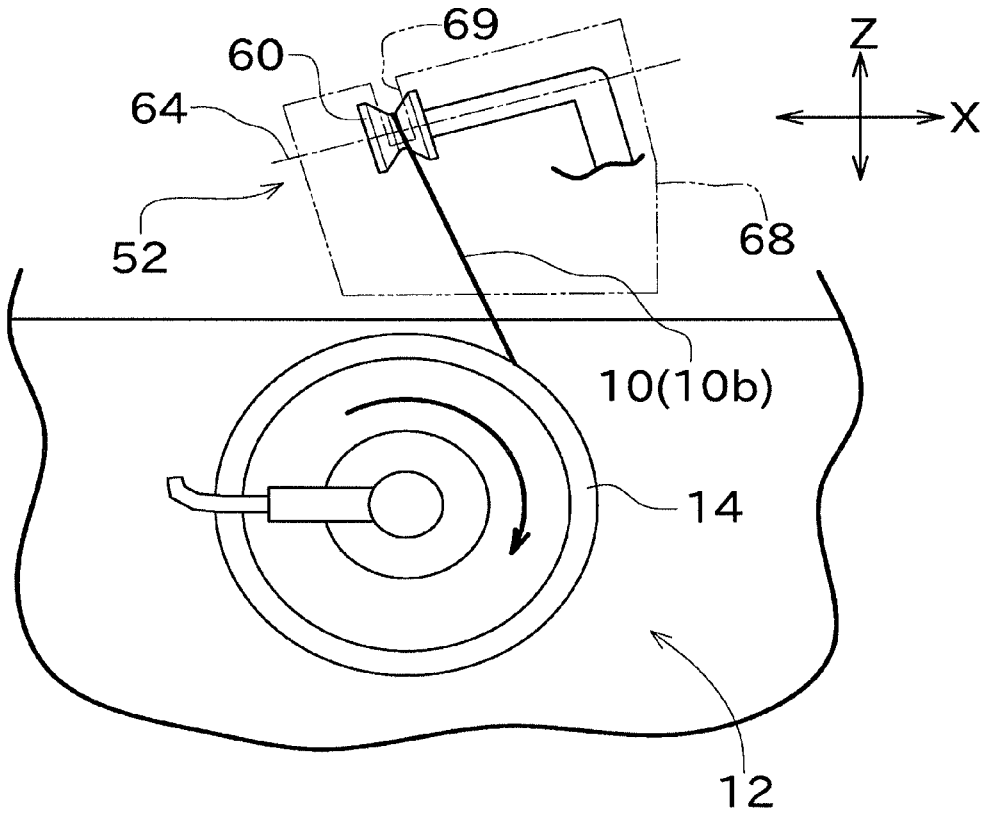
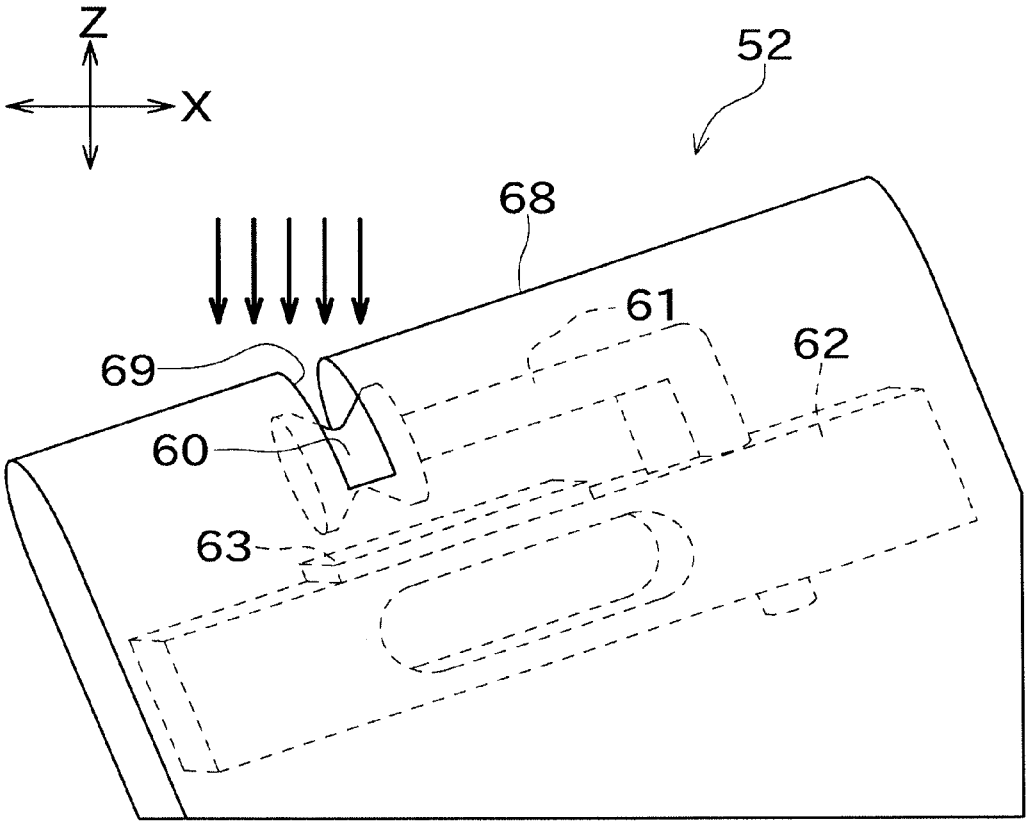


FIG. 10



REFERENCES CITED IN THE DESCRIPTION

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