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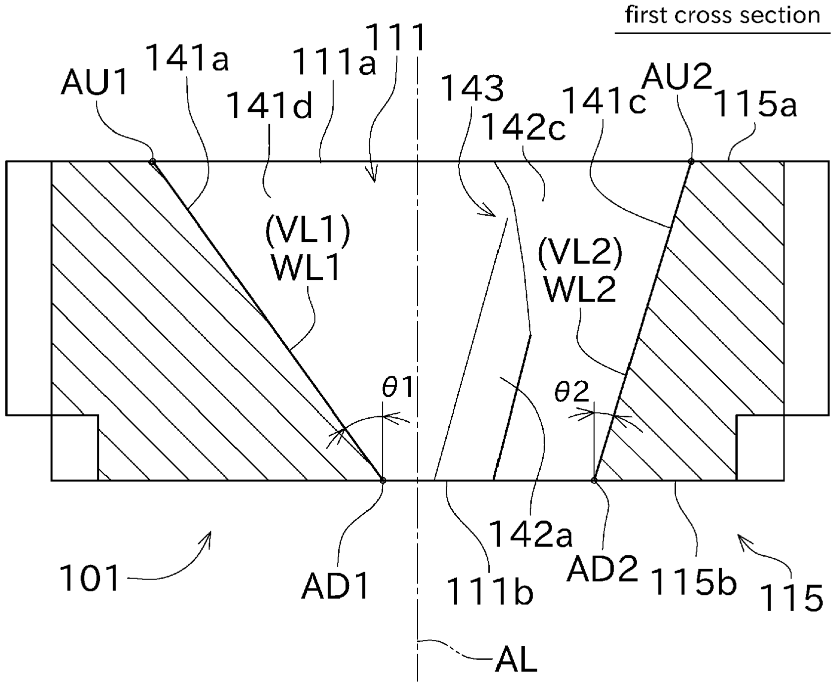
(54) **FIBER GUIDE, AIR SPINNING DEVICE, AND AIR SPINNING MACHINE**

(57) In a fiber guide 101, a first cross section of a distorted passage 111 cut along a plane parallel to an axial direction of the fiber guide 101 includes a first inner wall line WL1 and a second inner wall line WL2. A distance between a first upstream end point AU1 on the first inner wall line WL1 and a second upstream end point AU2 on the second inner wall line WL2 is longer than a distance between a first downstream end point AD1 on the first inner wall line WL1 and a second downstream end point AD2 on the second inner wall line WL2. A first virtual straight line VL1 connecting the first upstream end point AU1 and the first downstream end point AD1 is inclined at an inclination angle of 25° or more and 70° or less with respect to the axial direction of the fiber guide 101.

FIG. 6



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Description

TECHNICAL FIELD

[0001] The present invention relates to a fiber guide used in an air spinning device. In detail, this invention relates to a configuration of a fiber passage in the fiber guide.

BACKGROUND ART

[0002] In the following description, Japanese Unexamined Patent Application Publication No. 2021-42508 may be referred to as PTL 1.

[0003] Conventionally, an air spinning device for twisting fibers by making a swirling air flow formed in a spinning chamber to act on the fibers to generate spun yarn has been known. This air spinning device may include a fiber guide to guide the fibers into the spinning chamber. PTL 1 discloses an air spinning device equipped with the fiber guide.

[0004] A straight passage is formed in the fiber guide of PTL 1. A bundle of fibers can pass through this passage. A planar part is formed flatly between an upstream end and a downstream end of the passage. The planar part is arranged along a direction in which the passage extends.

SUMMARY OF THE INVENTION

[0005] There has been a long-felt need for a fiber guide that can guide the fiber bundle while converging the fiber bundle more suitably.

[0006] The present invention was made in view of the above circumstances, and the object is to provide a fiber guide that can reduce an amount of fiber waste generated and guide the fiber bundle while converging the fiber bundle suitably.

[0007] The problem to be solved is as described above, and the means to solve this problem and its effect will be described below.

[0008] According to the first aspect of the present invention, a fiber guide having the following configuration is provided. That is, this fiber guide has a fiber passage formed therein. A first cross section of the fiber guide obtained by cutting the fiber passage along a plane parallel to an axial direction of the fiber guide includes a first inner wall line and a second inner wall line. The first inner wall line corresponds to an inner wall surface of one side of the fiber passage. The second inner wall line corresponds to an inner wall surface opposite to the inner wall surface. A distance between a first upstream end point, corresponding to an upstream end of the fiber passage, on the first inner wall line and a second upstream end point, corresponding to an upstream end of the fiber passage, on the second inner wall line is longer than a distance between a first downstream end point, corresponding to a downstream end of the fiber passage, on the first inner wall line and a second downstream end point, corresponding to a downstream end of the fiber passage, on the second inner wall line. At least one of a first virtual straight line connecting the first upstream end point and the first downstream end point and a second virtual straight line connecting the second upstream end point and the second downstream end point is inclined at an inclination angle of 25° or more and 70° or less with respect to the axial direction of the fiber guide.

[0009] Accordingly, the fiber passage can be configured to guide the fibers downstream while suitably converging the fibers.

[0010] In the fiber guide described above, it is preferred that at least one of the first virtual straight line and the second virtual straight line is inclined at the inclination angle of 30° or more and 50° or less with respect to the axial direction of the fiber guide.

[0011] Accordingly, the fiber passage can be configured to guide the fibers downstream while converging the fiber bundle more suitably.

[0012] The fiber guide described above is preferably configured as follows. That is, the first inner wall line is formed as a straight line connecting the first upstream end point and the first downstream end point. The second inner wall line is formed as a straight line connecting the second upstream end point and the second downstream end point.

[0013] Accordingly, the fibers can be smoothly guided downstream.

[0014] In the fiber guide described above, it is preferred that an angle formed by the first virtual straight line and the axial direction of the fiber guide and an angle formed by the second virtual straight line and the axial direction of the fiber guide are different.

[0015] Accordingly, flexibility in the shape of a path through which the fibers pass can be increased.

[0016] The fiber guide described above is preferably configured as follows. That is, the first virtual straight line is inclined at an inclination angle of 25° or more and 70° or less with respect to the axial direction of the fiber guide. The second virtual straight line is parallel to or inclined at an inclination angle of less than 25° with respect to the axial direction of the fiber guide.

[0017] Accordingly, the fibers can be guided downstream while being suitably converged.

[0018] The fiber guide described above is preferably configured as follows. That is, a transverse section of the fiber passage obtained by cutting the fiber passage along a plane perpendicular to the axial direction of the fiber guide at a position bisecting an axial length of the fiber passage has a curved portion. The fiber passage located in the vicinity of the transverse section has a first portion with a smaller dimension perpendicular to the first cross section and a second portion with a larger dimension perpendicular to the first cross section, with the curved portion as a boundary. The first virtual straight line is closer to the first portion than the second virtual straight line.

[0019] Accordingly, the fibers can be transferred from the first portion to the second portion through the curved portion and can also be guided downstream while being suitably converged.

[0020] According to the second aspect of the present invention, a fiber guide having the following configuration is provided. That is, this fiber guide has a fiber passage formed therein. A second cross section of the fiber guide obtained by cutting the fiber passage along a plane parallel to an axial direction of the fiber guide includes a third inner wall line and a fourth inner wall line. The third inner wall line corresponds to an inner wall surface on one side of the fiber passage. The fourth inner wall line corresponds to an inner wall surface opposite to the inner wall surface. A distance between a third upstream end point, corresponding to an upstream end of the fiber passage, on the third inner wall line and a fourth upstream end point, corresponding to an upstream end of the fiber passage, on the fourth inner wall line is shorter than a distance between a third downstream end point, corresponding to a downstream end of the fiber passage, on the third inner wall line and a fourth downstream end point, corresponding to a downstream end of the fiber passage, on the fourth inner wall line. At least one of a third virtual straight line connecting the third upstream end point and the third downstream end point and a fourth virtual straight line connecting the fourth upstream end point and the fourth downstream end point is inclined at an inclination angle of 35° or more and 85° or less with respect to the axial direction of the fiber guide.

[0021] Accordingly, a configuration can be accomplished in which the inner wall surface of the fiber passage is less likely to inhibit inversion of fibers that are to be inverted by air spinning performed downstream of the fiber passage.

[0022] In the fiber guide described above, it is preferred that at least one of the third virtual straight line and the fourth virtual straight line is inclined at the inclination angle of 40° or more and 70° or less with respect to the axial direction of the fiber guide.

[0023] Accordingly, a configuration can be accomplished in which the inner wall surface of the fiber passage is further less likely to inhibit the inversion of fibers that are to be inverted by air spinning performed downstream of the fiber passage.

[0024] The fiber guide described above is preferably configured as follows. That is, an upstream opening located at the upstream end of the fiber passage is offset to one side with respect to an axis of the fiber guide. A portion of the inner wall surface of the fiber passage that is located opposite a direction in which the upstream opening is offset with respect to the axis of the fiber guide includes one or more planes.

[0025] Accordingly, the fibers can be properly guided downstream by the inner wall surface.

[0026] The fiber guide described above is preferably configured as follows. That is, the fiber guide includes an upstream end surface and a downstream end surface. In the upstream end surface, an upstream opening located at the upstream end of the fiber passage is formed. In the downstream end surface, a downstream opening located at the downstream end of the fiber passage is formed. A length between the upstream end surface and the downstream end surface is 1 mm or more and 5 mm or less.

[0027] Accordingly, the fiber guide can be made small.

[0028] The fiber guide described above is preferably configured as follows. That is, a spinning nozzle and a swirling chamber are integrally formed in the fiber guide. The spinning nozzle injects air that passes through the spinning nozzle. In the swirling chamber, a swirling air flow formed by the air injected from the spinning nozzle acts on fibers.

[0029] Accordingly, the number of parts can be reduced.

[0030] The aforementioned fiber guide is preferably configured as follows. That is, the fiber guide includes a chamfer portion. The chamfer portion is formed between an upstream end surface and a side surface, wherein an upstream opening located at the upstream end of the fiber passage is formed in the upstream end surface. An inclination angle of the chamfer portion with respect to the axial direction of the fiber guide is 50° or more and 70° or less.

[0031] Accordingly, the fiber guide can be placed in close proximity to a draft roller of a draft device.

[0032] According to a third aspect of the invention, an air spinning device having the following configuration is provided. That is, this air spinning device has the fiber guide and a hollow guide shaft body. The hollow guide shaft body guides fibers twisted by air injected from a spinning nozzle so that the fibers are guided downstream.

[0033] As a result, the fibers are guided downstream while being suitably converged in the fiber passage, and spinning is performed on the guided fiber bundle by the swirling air flow, thus generating yarn with good physical properties. In addition, fiber loss, which is dropping out of fibers without being spun in the air spinning process, can be reduced.

[0034] According to the fourth aspect of the invention, an air spinning machine having the following configuration is provided. That is, this air spinning machine includes the air spinning device, a drawing device, and a winding device. The drawing device draws out a yarn spun by the air spinning device. The winding device winds the yarn drawn out by the drawing device.

[0035] Accordingly, the air spinning machine can be realized in which the yarn of good physical properties can be wound and in which fiber loss is few.

BRIEF DESCRIPTION OF THE DRAWINGS

[0036]

FIG. 1 is a front view showing an air spinning machine equipped with an air spinning device according to one embodiment of the invention.

FIG. 2 is a side view showing a spinning unit and a yarn joining cart.

FIG. 3 is a cross-sectional view schematically showing a configuration of the spinning device.

FIG. 4 is a perspective view showing a configuration of a fiber guide.

FIG. 5 is a view of the fiber guide from an upstream side along its axial direction.

FIG. 6 is a view showing a first cross section of the fiber guide.

FIG. 7 is a view showing a second cross section of the fiber guide.

FIG. 8 is a view illustrating a transverse section of the fiber guide.

FIG. 9 is a cross-sectional view of a modification of the fiber guide.

FIG. 10 is a view showing a modification of the fiber guide.

FIG. 11 is a view showing a modification of the fiber guide.

EMBODIMENT FOR CARRYING OUT THE INVENTION

[0037] Next, an air spinning machine 1 equipped with an air spinning device 23 according to an embodiment of the invention will be described with reference to FIGS. 1 and 2.

[0038] As shown in FIG. 1, the air spinning machine 1 includes a blower box 3, a motor box 5, a plurality of spinning units 7, and a yarn joining cart 9. The plurality of spinning units 7 are lined up in a predetermined direction.

[0039] A blower 11 or the like which functions as a negative pressure source, is located in the blower box 3.

[0040] In the motor box 5, a drive source (not shown), a central control device 13, a display 15, and an operation unit 17 as disposed. The drive source in the motor box 5 includes a motor commonly used by the plurality of spinning units 7.

[0041] The central control device 13 centrally manages and controls various parts of the air spinning machine 1. As shown in FIG. 2, each of the spinning units 7 has a unit controller 19. The central control device 13 is connected to each spinning unit 7 via signal lines, which are not shown in the figure. Although each spinning unit 7 has the unit controller 19 in this embodiment, a predetermined number of spinning units 7 (for example, two or four) may be controlled by a single unit controller 19.

[0042] The display 15 can display settings for the spinning units 7 and/or information about the status of each spinning unit 7, etc.

[0043] Each of the spinning units 7 is mainly equipped with a draft device 21, the air spinning device 23, a yarn storage device 25, and a winding device 27, arranged in order from upstream to downstream. The terms "upstream" and "downstream" here mean upstream and downstream in a traveling direction of a sliver 32, a fiber bundle 34, or a spun yarn 30 during winding of the spun yarn (yarn) 30.

[0044] The draft device 21 is located near an upper end of a frame 36 of the air spinning machine 1. As shown in FIG. 2, the draft device 21 has four draft roller pairs. The four draft roller pairs are, a back roller pair 41, a third roller pair 43, a middle roller pair 45, and a front roller pair 47, arranged in order from upstream to downstream. Regarding the middle roller pair 45, an apron belt 49 is provided for each roller.

[0045] The draft device 21 stretches (drafts) the sliver 32 supplied from a sliver case which is not shown, by conveying the sliver 32 while nipping the sliver 32 between the rollers of each draft roller pair until a predetermined fiber amount (or thickness) is reached, thereby forming the fiber bundle 34. The fiber bundle 34 generated by the draft device 21 is fed to the air spinning device 23.

[0046] The air spinning device 23 applies twists to the fiber bundle 34 generated by the draft device 21 by applying a swirling air flow to the fiber bundle 34 to generate the spun yarn 30. The detailed configuration of the air spinning device 23 will be described later.

[0047] The spun yarn 30 generated by the air spinning device 23 is supplied to the yarn storage device 25. The yarn storage device 25 includes a yarn storage roller (drawing device) 53 and a motor 55, as shown in FIG. 2.

[0048] The yarn storage roller 53 is driven and rotated by the motor 55. The spun yarn 30 is wound around the yarn storage roller 53 to be stored temporarily. The yarn storage roller 53 rotates at a predetermined rotational speed with the spun yarn 30 wound around its outer circumference, thereby drawing the spun yarn 30 out from the air spinning device 23 at a predetermined speed and conveying the spun yarn 30 downstream.

[0049] Thus, the yarn storage device 25 functions as a kind of buffer for the spun yarn 30, since the spun yarn 30 can be temporarily stored on the outer circumference of the yarn storage roller 53. This can eliminate problems (for example, slackening of the spun yarn 30 or the like) caused by the spinning speed in the air spinning device 23 and the winding speed (traveling speed of the spun yarn 30 to be wound onto a package 73 described below) not matching for some reason.

[0050] A yarn monitoring device 59 is provided between the air spinning device 23 and the yarn storage device 25. The spun yarn 30 generated by the air spinning device 23 passes through the yarn monitoring device 59 before being stored by the yarn storage device 25.

[0051] The yarn monitoring device 59 monitors the quality of the travelling spun yarn 30 with an optical sensor to detect yarn defects in the spun yarn 30. The yarn defects may include, for example, abnormalities in a thickness of the spun yarn 30, foreign matter contained in the spun yarn 30 or the like. When the yarn monitoring device 59 detects a yarn defect in the spun yarn 30, the yarn monitoring device 59 sends a yarn defect detection signal to the unit controller 19. Instead of the optical sensor, the yarn monitoring device 59 may monitor the quality of the spun yarn 30 using, for example, a capacitive sensor. Instead of or in addition to these examples, the yarn monitoring device 59 may be configured to measure the tension of the spun yarn 30 as the quality of the spun yarn 30.

[0052] When the unit controller 19 receives the yarn defect detection signal from the yarn monitoring device 59, the unit controller 19 cuts the spun yarn 30 by stopping the drive of the air spinning device 23 and/or the draft device 21. In other words, the air spinning device 23 functions as a cutting unit that cuts the spun yarn 30 when the yarn monitoring device 59 detects the yarn defect. The spinning unit 7 may be equipped with a cutter for cutting the spun yarn 30.

[0053] The winding device 27 is equipped with a cradle arm 61, a winding drum 63, and a traverse guide 65. The cradle arm 61 is supported to be pivotable around a pivot axis 67 and can rotatably support a bobbin 71 (for example, a package 73) for winding the spun yarn 30. The winding drum 63 rotates in contact with the outer circumference of the bobbin 71 or package 73, thereby driving the package 73 in the winding direction. The winding device 27 drives the winding drum 63 by an electric motor which is not shown, while the traverse guide 65 is reciprocated by a drive means which is not shown. As a result, the winding device 27 winds the spun yarn 30 onto the package 73 while traversing the spun yarn 30.

[0054] As shown in FIG. 1, rails 81 are arranged on the frame 36 of the air spinning machine 1 along the direction in which the plurality of spinning units 7 are lined up. The yarn joining cart 9 is configured to travel on the rails 81. Accordingly, the yarn joining cart 9 can move with respect to the plurality of spinning units 7. The yarn joining cart 9 travels to the spinning unit 7 where a yarn break or yarn cut has occurred and performs yarn joining operation on the spinning unit 7.

[0055] The yarn joining cart 9 is equipped with traveling wheels 83, a yarn joining device 85, a suction pipe 87, and a suction mouth 89, as shown in FIG. 1. The yarn joining cart 9 is further equipped with a cart controller 91, shown in FIG. 2.

[0056] The suction pipe 87 is capable of capturing the spun yarn 30 generated by the air spinning device 23 during yarn-discharge spinning. Specifically, the suction pipe 87 can suck and capture the spun yarn 30 fed from the air spinning device 23 by generating a suction air flow at its tip. The suction mouth 89 can capture the spun yarn 30 wound onto the package 73 of the winding device 27. Specifically, the suction mouth 89 can suck and capture the spun yarn 30 from the package 73 supported by the winding device 27 by generating a suction air flow at its tip. Each of the suction pipe 87 and the suction mouth 89 rotates with the spun yarn 30 captured and guides the spun yarn 30 to a position where the spun yarn 30 can be introduced into the yarn joining device 85.

[0057] The yarn joining device 85 joins the spun yarn 30 from the air spinning device 23 guided by the suction pipe 87 and the spun yarn 30 from the package 73 guided by the suction mouth 89. In this embodiment, the yarn joining device 85 is a splicer device that twists yarn ends together by a swirling air flow. The yarn joining device 85 is not limited to the above splicer device, but, can also adopt for example, a mechanical knotter, etc..

[0058] The cart controller 91 shown in FIG. 2 is configured as a known computer having a CPU, ROM, RAM, etc., not shown. The cart controller 91 controls the yarn splicing operation performed by the yarn joining cart 9 by controlling the operation of the various parts provided in the yarn joining cart 9.

[0059] Next, referring to FIG. 3, the configuration of the air spinning device 23 will be described in detail.

[0060] As shown in FIG. 3, the air spinning device 23 has a fiber guide 101, a spindle (hollow guide shaft body) 102, a nozzle block 103, and a needle member 104.

[0061] The fiber guide 101 is a cylindrical member on which planar chamfers are formed on one side in the axial direction. An axis line AL of the cylindrical member of the fiber guide 101 coincides with an axial line of a spinning chamber 113 described below. In this specification, the axial direction of the fiber guide 101 means the direction of the axis line AL. The fiber guide 101 can be made of, for example, metal or ceramic.

[0062] The fiber guide 101 has a distorted passage (fiber passage) 111 through which the fiber bundle 34 can pass, and a through hole 112 extending along the axis line AL. The distorted passage 111 is connected to a spinning chamber (swirling chamber) 113 for air spinning. The needle member 104 is attached to the through hole 112.

[0063] The fiber bundle 34 generated by the draft device 21 is supplied to the fiber guide 101. The fiber bundle 34 is introduced into the fiber guide 101 from an upstream end (upstream opening) 111a of the distorted passage 111 and is guided through a downstream end (downstream opening) 111b to the spinning chamber 113. The fiber bundle 34 introduced into the fiber guide 101 is guided downstream while being wound around the needle member 104.

[0064] The fiber guide 101 has a block-shaped body part 115. The body part 115 is arranged so that its upstream end surface 115a faces the draft device 21 side and its downstream end surface (bottom surface) 115b faces the spindle 102 side.

[0065] The fiber guide 101 constitutes a part of the spinning chamber 113. Specifically, the downstream end surface 115b of the body part 115 is positioned to face an inner space of the nozzle block 103 described below, so that the spinning chamber 113 is formed.

[0066] The spindle 102 is disposed downstream of the fiber guide 101. The spindle 102 is formed as an elongated round bar extending along the direction in which the fiber bundle 34 travels. The spindle 102 is arranged so that its upstream end surface 102a faces the fiber guide 101 with the spinning chamber 113 therebetween.

[0067] The spindle 102 has a spinning passage 122 through which the fiber bundle 34 that has passed through the distorted passage 111 is guided. The spinning passage 122 is connected to the spinning chamber 113. The spinning passage 122 is constituted by a circular hole 126 formed in the spindle 102. The spinning passage 122 extends in a straight line in the spindle 102 along the longitudinal direction of the spindle 102. An upstream end 122a of the spinning passage 122 has an opening at the upstream end surface 102a of the spindle 102. The upstream end 122a of the spinning passage 122 is positioned to face the needle member 104. The center of the spinning passage 122 coincides with an axial center 108 of the spindle 102.

[0068] A conical tapered portion 124 is formed at the upstream end of the spindle 102. The tapered portion 124 is formed so that an outer diameter decreases from the downstream side to the upstream side.

[0069] The spindle 102 constitutes a part of the spinning chamber 113. Specifically, the outer circumference of the tapered portion 124 is disposed in the inner space of the nozzle block 103 to form the spinning chamber 113. The upstream end surface 102a of the spindle 102 is spaced at an appropriate distance from the body part 115 of the fiber guide 101.

[0070] The spinning chamber 113 is constituted by a space surrounded by the downstream end surface 115b of the body part 115 of the fiber guide 101, the outer circumference of the tapered portion 124 of the spindle 102, and an inner surface 103a of the nozzle block 103 described later.

[0071] The upstream end 122a of the spinning passage 122 is disposed at an appropriate distance from the downstream opening 111b of the distorted passage 111 in the direction in which the fiber bundle 34 travels, thus forming a space therebetween. The spinning chamber 113 described above includes this space.

[0072] After exiting the downstream opening 11 1b of the distorted passage 111, the fiber bundle 34 enters the upstream end 122a of the spinning passage 122 via the spinning chamber 113. The fiber bundle 34 pass through the spinning passage 122 and is fed out of the air spinning device 23.

[0073] The spindle 102 has a plurality of auxiliary nozzles, not shown. The plurality of auxiliary nozzles are arranged in a circumferential direction at equal intervals. Compressed air is injected from the plurality of auxiliary nozzles into the spinning passage 122, thereby generating a swirling air flow in the spinning passage 122. When viewed in a direction along the axial center 108 of the spindle 102, the direction of this swirling air flow is opposite to the swirling air flow generated by spinning nozzles 131.

[0074] The nozzle block 103 is located downstream of the fiber guide 101. The nozzle block 103 is arranged to cover the spindle 102. The nozzle block 103 can be made of metal or ceramic, for example. A gap is formed between the nozzle block 103 and the spindle 102 in the radial direction of the spindle 102.

[0075] A circular hole is formed in the nozzle block 103. The axial center of this circular hole coincides with the axial center 108 of the spindle 102. The inner surface 103a of the nozzle block 103 is formed to be circular when viewed in the direction of the axial center 108 of the spindle 102.

[0076] The nozzle block 103 has spinning nozzles 131 through which air can pass. The air spinning device 23 is capable of injecting air (compressed air) from the spinning nozzles 131 into the spinning chamber 113. The spinning nozzle 131 is formed as a through hole that extends in an inclined direction with respect to the axial center 108 of the spindle 102. Although the spinning nozzles 131 are depicted schematically in FIG. 3, the direction of the spinning nozzle 131 coincides with or is slightly inclined with respect to a tangential direction of the inner surface 103a of the nozzle block 103 when viewed in a direction along the axial center 108 of the spindle 102. One longitudinal end of the spinning nozzle 131 is connected to a compressed air supply which is not shown, and the other longitudinal end forms an opening at the spinning chamber 113.

[0077] When compressed air is injected from the spinning nozzles 131 into the spinning chamber 113, a swirling air flow is generated in the spinning chamber 113. As shown in FIG. 3, the direction of the spinning nozzle 131 is inclined so that as the injected air travels downstream, it approaches downstream in the traveling direction of the fiber bundle 34. Accordingly, with the injection of compressed air from the spinning nozzles 131, a negative pressure is generated near the upstream end of the spinning chamber 113, which results in a suction air flow at the upstream opening 111a of the fiber guide 101.

[0078] In this embodiment, a plurality of spinning nozzles 131 are formed in the nozzle block 103. The plurality of spinning nozzles 131 are arranged along the circumferential direction of the spinning chamber 113 at equal intervals. However, the number of spinning nozzles 131 is not limited and one or more nozzles can be disposed.

[0079] The air spinning device 23 can perform two types of spinning, normal spinning and yarn-discharge spinning. The normal spinning is spinning that is performed while the spun yarn 30 is wound downstream of the air spinning device 23. The yarn-discharge spinning is temporarily performed before the normal spinning, and is started when the spun yarn 30 is not coming out of the air spinning device 23. The yarn-discharge spinning is sometimes referred to as self-spinning because the air spinning device 23 performs spinning just by applying the swirling air flow.

[0080] When the air spinning device 23 performs yarn-discharge spinning, compressed air is injected from the auxiliary nozzles prior to an air injection from the spinning nozzles 131. Since the spinning passage 122 is formed so that the passage area increases as it approaches downstream, the injection of compressed air from the auxiliary nozzles forms a swirling air flow flowing downstream in the spinning passage 122. When the fiber bundle 34 is supplied from the draft device 21 in this state, the fiber bundle 34 is led from the distorted passage 111 through the spinning chamber 113 to the spinning passage 122. A portion of the fiber bundle 34 passing through the spinning passage 122 is slightly twisted by the action of the swirling air flow formed by the air injected from the auxiliary nozzles.

[0081] Compressed air is then injected from the spinning nozzles 131 to form a swirling air flow in the spinning chamber 113. This swirling air flow acts on the portion of the fiber bundle 34 passing through the spinning chamber 113.

[0082] The behavior of the fibers will be described below, focusing on the portion of the fiber bundle 34 passing through the spinning chamber 113. The downstream ends of the fibers in the traveling direction constituting the fiber bundle 34 in this portion are twisted and fixed to the core of the fiber bundle 34 in the spinning passage 122. On the other hand, since the upstream ends in the traveling direction are not twisted into the core, these free ends are moved away from the core by the swirling air flow in the spinning chamber 113 so as to open up, and the free ends swirl with their orientation inverted to be along the outer circumference of the tapered portion 124. As a result, the fibers wind around the core and the fiber bundle 34 is twisted, generating spun yarn 30. The spun yarn 30 thus generated travels downstream by the swirling air flow formed by the air injected from the auxiliary nozzles and is conveyed out from the air spinning device 23.

[0083] In the normal spinning, no air is injected from the auxiliary nozzles. In the normal spinning, the traveling of the spun yarn 30 from the air spinning device 23 is realized by the yarn storage roller 53 drawing the spun yarn 30 out from the air spinning device 23. The principle of the normal spinning is basically the same as the principle of the yarn-discharge spinning, whereby the fiber bundle 34 is twisted by action of the swirling air flow formed by the air injected from the spinning nozzle 131.

[0084] Next, the configuration of the fiber guide 101 will be described in detail with reference to FIGS. 4 through 7 and the like.

[0085] The fiber guide 101 is a hollow member formed in a substantial cylindrical shape. The axis line AL of the fiber guide 101 is positioned so that its extended line coincides with the axial center 108 of the spindle 102. In this embodiment, the fiber guide 101 is arranged to be inclined so that its upstream end is higher than its downstream end. Considering this, the upstream end surface of the fiber guide 101 may be referred to as the "top surface" and the downstream end surface may be referred to as the "bottom surface" in the following description. In the fiber guide 101 of this embodiment, the distance (length) L1 from the top surface to the bottom surface is 1 mm or more and 5 mm or less.

[0086] In this embodiment, in the height direction of the spinning unit 7, the draft device 21 and the air spinning device 23 are located on a higher side and the winding device 27 is located on a lower side. Instead of this configuration, the draft device 21 and the air spinning device 23 may be located on the lower side and the winding device 27 may be located on the higher side. In this case, the fiber guide 101 is arranged to be inclined so that its upstream end is lower than the downstream end, and its top surface is lower than the bottom surface.

[0087] The distorted passage 111 is formed in the fiber guide 101. An upstream opening 111a located at the upstream end of the distorted passage 111 is formed on the top surface of the fiber guide 101. A downstream opening 111b located at the downstream end is formed on the bottom surface of the fiber guide 101.

[0088] The upstream opening 111a of the distorted passage 111 is formed in a substantial elongated rectangular shape when viewed along the axis line AL. The downstream opening 111b of the distorted passage 111 at the bottom surface of the fiber guide 101 is formed in a substantial C-shape when viewed along the axis line AL. This downstream opening 111b is arranged to bypass the axis line AL.

[0089] The upstream opening 111a is arranged offset to one side relative to the axis line AL of the fiber guide 101, as shown in FIG. 5. The direction in which the upstream opening 1 11a is offset with respect to the axis line AL is indicated by an arrow OD1 in FIG. 5, etc.

[0090] FIG. 5 shows the fiber guide 101 viewed from the upstream side along the axis line AL. When viewed in this manner, the upstream opening 111a and the downstream opening 111b overlap partially. Therefore, a contour of the downstream opening 111b includes a portion that is visible through the upstream opening 111a and the distorted passage 111, and a portion that is not visible. In the following description, the portion of the downstream opening 111b that is visible through the distorted passage 111 when viewed from the upstream side along the axis line AL may be referred to as "first downstream opening portion" and the portion that is not visible may be referred to as "second downstream opening portion".

[0091] The first downstream opening portion is substantially formed as an elongated rectangle. The longitudinal direction of the rectangle of the first downstream opening portion coincides with the longitudinal direction of the rectangle of the upstream opening 111a. When viewed from the upstream side along the axis line AL, one of the four sides of the first downstream opening portion closest to the axis line AL and one of the four sides of the upstream opening 111a closest to the axis line AL substantially overlap.

[0092] The second downstream opening portion is formed as an elongated shape bent into a substantial L-shape. The longitudinal end of the second downstream opening portion is connected to the first downstream opening portion.

[0093] Focusing on the shape of the distorted passage 111, when viewed from the upstream side along the axis line AL, the distorted passage 111 has a first passage portion 141 that is visible through the upstream opening

111a and a second passage portion 142 that is not visible.

[0094] As shown in FIGS. 4 and 5, the first passage portion 141 is formed through the fiber guide 101 to be substantially parallel to the axis line AL of the fiber guide 101. The second passage portion 142 has a portion extending in a direction substantially opposite to the arrow OD1 described above as it approaches from the upstream end surface 115a to the downstream end surface 115b of the fiber guide 101.

[0095] The upstream opening 111a of the distorted passage 111 corresponds to an upstream opening of the first passage portion 141. In the downstream opening 111b of the distorted passage 111, the first downstream opening portion corresponds to a downstream opening of the first passage portion 141. The second downstream opening portion corresponds to a downstream opening of the second passage portion 142.

[0096] The first passage portion 141 is constituted by a first inner wall surface 141a, a second inner wall surface 141b, a third inner wall surface 141c, and a fourth inner wall surface 141d, as shown in FIG. 4. All four inner wall surfaces are formed in a planar shape. The four inner wall surfaces (in particular, the three inner wall surfaces not including the second inner wall surface 141b farthest from the axis line AL) function as guiding surfaces that actually make contact with the fiber bundle 34 and guide the fiber bundle 34.

[0097] The first inner wall surface 141a is located at one longitudinal end of the upstream opening 111a, and the third inner wall surface 141c is located at the other longitudinal end of the upstream opening 111a. The second inner wall surface 141b is located at one transverse end of the upstream opening 111a, and the fourth inner wall surface 141d is located at the other transverse end of the upstream opening 111a.

[0098] The features of the first inner wall surface 141a and the third inner wall surface 141c will be described in more detail below with reference to FIGS. 5 and 6. FIG. 6 shows the first passage portion 141 of the fiber guide 101 obtained by cutting the fiber guide 101 at the plane SP1 shown in FIG. 5 by a chain line, and this cross section (first cross section) is viewed in the direction of the bold arrow in FIG. 5. The plane SP1 is defined to be parallel to the axis line AL of the fiber guide 101 and parallel to the longitudinal direction of the upstream opening 111a.

[0099] As shown in FIG. 5, a contour of the upstream opening 111a and the plane SP1 has two intersection points, and a contour of the downstream opening 111b and the plane SP1 has two intersection points. The cross-sectional contour of the distorted passage 111 obtained by cutting the distorted passage 111 by the plane SP1 has two lines corresponding to the first inner wall surface 141a and the third inner wall surface 141c, and the four intersection points are located at the ends of any of the lines. In the following description, the upstream intersection point on the first inner wall surface 141a side may be referred to as first upstream end point AU1 and the downstream intersection point on the first inner wall surface 141a side may be referred to as first downstream end point AD1. The upstream intersection point on the third inner wall surface 141c side may be referred to as second upstream end point AU2, and the downstream intersection point on the third inner wall surface 141c side may be referred to as second downstream end point AD2.

[0100] The first upstream end point AU1 and the first downstream end point AD1 are located on one side of the distorted passage 111, and the second upstream end point AU2 and the second downstream end point AD2 are located on the other side of the distorted passage 111. The distance between the first upstream end point AU1 and the second upstream end point AU2 is longer than the distance between the first downstream end point AD1 and the second downstream end point AD2.

[0101] A line (intersection line) at the intersection of the first inner wall surface 141a and the plane SP1 may hereinafter be referred to as first inner wall line WL1. As shown in FIG. 6, the first inner wall line WL1 is a portion of the contour of the first cross section obtained by cutting the distorted passage 111, and corresponds to the first inner wall surface 141a. In this embodiment, the first inner wall line WL1 appears as a straight line connecting the first upstream end point AU1 and the first downstream end point AD1. Therefore, if a virtual straight line connecting the first upstream end point AU1 and the first downstream end point AD1 is defined as a first virtual straight line VL1, the first inner wall line WL1 and the first virtual straight line VL1 coincide.

[0102] As shown in FIG. 6, the first virtual straight line VL1 connecting the first upstream end point AU1 and the first downstream end point AD1 is inclined at an inclination angle of 25° or more and 70° or less (preferably 30° or more and 50° or less) with respect to the axis line AL of the fiber guide 101. Hereinafter, the angle at which the first virtual straight line VL1 is inclined with respect to the axis line AL may be referred to as first inclination angle $\theta 1$. In this embodiment, the first inclination angle $\theta 1$ is about 35°.

[0103] A line (intersection line) of the intersection of the third inner wall surface 141c and the plane SP1 may hereinafter be referred to as second inner wall line WL2. As shown in FIG. 6, the second inner wall line WL2 is a portion of the contour of the first cross section obtained by cutting the distorted passage 111, and corresponds to the third inner wall surface 141c. In this embodiment, the second inner wall line WL2 appears as a straight line connecting the second upstream end point AU2 and the second downstream end point AD2. Therefore, if a virtual straight line connecting the second upstream end point AU2 and the second downstream end point AD2 is defined as a second virtual straight line VL2, the second inner wall line WL2 and the second virtual straight line VL2 coincide.

[0104] As shown in FIG. 6, the second virtual straight line VL2 connecting the second upstream end point AU2 and the second downstream end point AD2 is inclined at an inclination angle of 0° or more and less than 25° with respect to the axis line AL of the fiber guide 101. Hereinafter, an angle at which the second virtual straight line VL2 is inclined with respect to the axis line AL may be referred to as second inclination angle θ2. The second inclination angle θ2 may be 0°. That is, the second virtual straight line VL2 may be parallel to the axis line AL. In this embodiment, the second inclination angle θ2 is about 16°.

[0105] In the first cross section, the first virtual straight line VL1 and the second virtual straight line VL2 (in other words, the first inner wall line WL1 and the second inner wall line WL2) are inclined to be away from the periphery of the body part 115 as they approach the downstream end surface 115b.

[0106] In air spinning, it is desired to reduce fiber loss which is the loss of fibers from the fiber bundle 34 in the spinning chamber 113, in order to reduce material costs and the like. The distance L0 shown in FIG. 3 is the distance from the upstream end surface 102a of the spindle 102 to the nip point NP1 of the front roller pair 47. Shortening the distance L0 is effective for reducing fiber loss because the fibers are less likely to travel freely. By setting the first inclination angle θ1 and the second inclination angle θ2 as described above, even if the length L1 of the fiber guide 101 is shortened, the fiber bundle 34 can be converged well as the fiber bundle 34 is passed through the distorted passage 111.

[0107] In the fiber guide 101 of this embodiment, the axial length of the distorted passage 111 substantially corresponds to the axial length L1 of the fiber guide 101. Here, consider a transverse section of the distorted passage 111 obtained by cutting the distorted passage 111 by a plane SP3 perpendicular to the axial direction of the fiber guide 101 at the position where this length L1 is bisected into two equal parts. The plane SP3 is shown in FIG. 4.

[0108] This transverse section has a curved portion 146 as shown in FIG. 8. The curved portion 146 connects the fourth inner wall surface 141d and an intermediate inner wall surface 142a, which is the inner wall of the second passage portion 142. In the transverse section, the curved portion 146 is formed as an arcuate protrusion. The intermediate inner wall surface 142a will be described later. The distorted passage 111 located in the vicinity of the transverse section has a first portion P1 with a smaller dimension D1 perpendicular to the first cross section and a second portion P2 with a larger dimension D2 perpendicular to the first cross section, with the curved portion 146 as a boundary. The position of the second portion P2 corresponds to the position of a recess 143 described later.

[0109] The curved portion 146 is formed in a substantially arcuate shape. One end of the curved portion 146 is smoothly connected to the fourth inner wall surface 141d. The curved portion 146 is curved to be away from the second inner wall surface 141b as it departs from the point of connection with the fourth inner wall surface 141d. The other end of the curved portion 146 smoothly connects to the intermediate inner wall surface 142a.

[0110] In this embodiment, the two virtual straight lines about the first cross section are a first virtual straight line VL1 near the first portion P1 and a second virtual straight line VL2 near the second portion P2. A first inclination angle θ1, which is an inclination angle of the first virtual straight line VL1, is between 25° or more and 70° or less. A second inclination angle θ2, which is an inclination angle of the second virtual straight line VL2, is 0° or more and less than 25°.

[0111] The second inner wall surface 141b is connected to each of the first inner wall surface 141a and the third inner wall surface 141c, as shown in FIG. 5. When viewed from the upstream side along the axis line AL, the second inner wall surface 141b is located on one side of the upstream opening 111a in the transverse direction. Specifically, when viewed from the upstream side along the axis line AL, the second inner wall surface 141b is located on the side far from the axis line AL in the transverse direction of the upstream opening 111a.

[0112] The fourth inner wall surface 141d is located opposite to the second inner wall surface 141b. When viewed from the upstream side along the axis line AL, the fourth inner wall surface 141d is located closer to the axis line AL in the transverse direction of the upstream opening 111a. The fourth inner wall surface 141d constitutes a planar inner wall surface in the distorted passage 111 that is located opposite the direction in which the upstream opening 111a is offset with respect to the axis line AL (the direction indicated by arrow OD1).

[0113] As shown in FIG. 4, etc., an inclined recess 143 is formed on the fourth inner wall surface 141d at the end of the side close to the third inner wall surface 141c. The recess 143 forms an opening at the first passage portion 141 in the distorted passage 111. The recess 143 is also connected to the second downstream opening portion described above that the downstream opening 111b has. The recess 143 is formed so that a distance from the first passage portion 141 increases as it approaches the downstream end surface 115b.

[0114] The second passage portion 142 corresponds to the inner space of the recess 143. The second passage portion 142 is formed to extend in a direction away from the first passage portion 141 (in a direction substantially approaching the axis line AL of the fiber guide 101) as it approaches the downstream side of the distorted passage 111.

[0115] As shown in FIG. 5, the second passage portion 142 has a first extension portion 144 and a second extension portion 145. The first extension portion 144 is formed to extend in a direction to be away from the first passage portion 141. When viewed from the upstream side along the axis line AL, the first extension portion 144 extends in a direction opposite to the arrow OD1 described above, and passing near the axis line AL. The second extension portion 145 is connected to the first extension portion 144 and extends shortly in a direction different from the first extension portion 144. The second extension portion 145 is located close to the axis line AL. When viewed from the upstream side along the axis line AL, the first extension portion 144 and the second extension portion 145 are connected substantially perpendicularly, resulting in the second passage portion 142 being formed in a substantial L-shape.

[0116] The second extension portion 145 is located opposite to the first passage portion 141 with the axis line AL therebetween. When viewed from the upstream side along the axis line AL, the direction in which the second extension portion 145 extends is substantially parallel to the longitudinal direction of the upstream opening 111a.

[0117] The inner wall surface constituting the second passage portion 142 includes at least the intermediate inner wall surface 142a shown in FIG. 5. In the distorted passage 111, the intermediate inner wall surface 142a constitutes a planar inner wall surface that is located opposite the direction in which the upstream opening 111a is offset with respect to the axis line AL (in the direction indicated by arrow OD1).

[0118] The second passage portion 142 will now be described in further detail with reference to FIG. 7. FIG. 7 shows the first passage portion 141 and the second passage portion 142 of the fiber guide 101 cut at the plane SP2 indicated by the chain line in FIG. 5, and this cross section (second cross section) is viewed in the direction of the bold arrow in FIG. 5. The plane SP2 is defined to be parallel to the axis line AL of the fiber guide 101 and perpendicular to the longitudinal direction of the upstream opening 111a.

[0119] As shown in FIG. 7, the second passage portion 142 is formed so that the distance L2 to the downstream opening 11 1b in the direction of the axis line AL of the fiber guide 101 becomes shorter as it is located away from the first passage portion 141. That is, a guide surface 142c, which is an inner wall surface constituting the second passage portion 142, is formed inclined with respect to the axis line AL of the fiber guide 101.

[0120] A contour of the upstream opening 111a and the plane SP2 has two intersection points, and a contour of the downstream opening 111b and the plane SP2 has two intersection points. The cross-sectional contour of the distorted passage 111 obtained by cutting the distorted passage 111 by the plane SP2 has two lines corresponding to the second inner wall surface 141b and the guide surface 142c, and the four intersection points are located at the ends of any of the lines. In the following description, the upstream intersection point on the second inner wall surface 141b side may be referred to as third upstream end point BU3 and the downstream intersection point on the second inner wall surface 141b side may be referred to as third downstream end point BD3. The intersection point on the upstream side of the guide surface 142c may be referred to as fourth upstream end point BU4, and the intersection point on the downstream side of the guide surface 142c may be referred to as fourth downstream end point BD4.

[0121] The third upstream end point BU3 and the third downstream end point BD3 are located on one side of the distorted passage 111, and the fourth upstream end point BU4 and the fourth downstream end point BD4 are located on the other side of the distorted passage 111. The distance between the third upstream end point BU3 and the fourth upstream end point BU4 is shorter than the distance between the third downstream end point BD3 and the fourth downstream end point BD4.

[0122] A line (intersection line) at the intersection of the second inner wall surface 141b and the plane SP2 may hereinafter be referred to as third inner wall line WL3. The third inner wall line WL3 is a portion of the contour of the second cross section obtained by cutting the distorted passage 111, and corresponds to the second inner wall surface 141b. In this embodiment, the third inner wall line WL3 appears as a straight line connecting the third upstream end point BU3 and the third downstream end point BD3. Therefore, if a virtual straight line connecting the third upstream end point BU3 and the third downstream end point BD3 is defined as a third virtual straight line VL3, the third inner wall line WL3 and the third virtual straight line VL3 coincide.

[0123] As shown in FIG. 7, the third virtual straight line VL3 connecting the third upstream end point BU3 and the third downstream end point BD3 is inclined at an inclination angle of, for example, 0° or more and 10° or less with respect to the axis line AL of the fiber guide 101. Hereinafter, the angle at which the third virtual line VL3 is inclined with respect to the axis line AL may be referred to as third inclination angle $\theta 3$. The third inclination angle $\theta 3$ may be 0°. That is, the third virtual line VL3 may be parallel to the axis line AL.

[0124] A line (intersection line) of the intersection of the guide surface 142c and the plane SP2 may hereinafter be referred to as fourth inner wall line WL4. The fourth inner wall line WL4 is a portion of the contour of the second cross section obtained by cutting the distorted passage 111, and corresponds to the guide surface 142c. In this embodiment, the fourth inner wall line WL4 appears to have a curved portion. Therefore, if a virtual straight line connecting the fourth upstream end point BU4 and the fourth downstream end point BD4 is defined as a fourth virtual straight line VL4, the fourth inner wall line WL4 and the fourth virtual straight line VL4 do not coincide.

[0125] As shown in FIG. 7, the fourth virtual straight line VL4 connecting the fourth upstream end point BU4 and the fourth downstream end point BD4 is inclined at an inclination angle of 35° or more and 85° or less, preferably 40° or more and 70° or less with respect to the axis line AL of the fiber guide 101. Hereinafter, an angle at which the fourth virtual straight line VL4 is inclined with respect to the axis line AL may be referred to as fourth inclination angle $\theta 4$. In this embodiment, the fourth inclination angle $\theta 4$ is about 45°.

[0126] In the second cross section, the third virtual straight line VL3 and the fourth virtual straight line VL4 (in other words, the third inner wall line WL3 and fourth inner wall line WL4) are inclined in the direction opposite to the arrow OD1 described above as they approach the downstream end surface 115b.

[0127] By setting the fourth inclination angle θ4 to be 35° or more and 85° or less, it is possible to realize a configuration in which the inner wall surface of the distorted passage 111 is less likely to inhibit the inversion of fibers in the spinning chamber 113. As a result, the physical properties of the spun yarn 30 generated by the air spinning device 23 can be improved. In addition, because the volume of the distorted passage 111 can be increased, the action of sucking air from the upstream opening 111a can be improved. Thus, smooth air spinning can be achieved.

[0128] In the body part 115 of the fiber guide 101, as shown in FIG. 4, etc., a first chamfer portion 114 and a second chamfer portion 116 are formed between the upstream end surface 115a and the outer circumference of the fiber guide 101. The second chamfer portion 116 is located opposite to the first chamfer portion 114 across the axis line AL. Each of the first chamfer portion 114 and the second chamfer portion 116 is formed in an inclined planar shape.

[0129] When viewed from the upstream side along the axis line AL, the first chamfer portion 114 is located on one side and the second chamfer portion 116 is located on the other side in the transverse direction of the upstream opening 111a, as shown in FIG. 5.

[0130] The first chamfer portion 114 is inclined at an inclination angle of 50° or more and 70° or less with respect to the axis line AL of the fiber guide 101, as shown by the angle θA in FIG. 7. The second chamfer portion 116 is inclined at an inclination angle of 20° or more and 30° or less with respect to the axis line AL of the fiber guide 101, as shown by the angle θB in FIG. 7. In this embodiment, the angle θA is about 55° and the angle θB is about 25°.

[0131] The first chamfer portion 114 and the second chamfer portion 116 allow the fiber guide 101 to be positioned close to the front roller pair 47 of the draft device 21. In addition, in this embodiment, the first chamfer portion 114 and the second chamfer portion 116 are asymmetrically inclined. Therefore, as shown in FIG. 3, the upstream opening 111a, which is offset with respect to the axis line AL, can be easily positioned in accordance with the fiber bundle passage passing through the front roller pair 47.

[0132] As described above, the distorted passage 111 is formed in the fiber guide 101 of this embodiment. The first cross section of the fiber guide 101 obtained by cutting the distorted passage 111 along the plane SP1 parallel to the axial direction includes the first inner wall line WL1 and the second inner wall line WL2, as shown in FIG. 6. The first inner wall line WL1 corresponds to the first inner wall surface 141a on one side of the distorted passage 111. The second inner wall line WL2 corresponds to the third inner wall surface 141c opposite to the first inner wall surface 141a. The distance between the first upstream end point AU1, corresponding to the upstream end of the distorted passage 111, on the first inner wall line WL1 and the second upstream end point AU2, corresponding to the upstream end of the distorted passage 111, on the second inner wall line WL2 is longer than the distance between the first downstream end point AD1, corresponding to the downstream end of the distorted passage 111, on the first inner wall line WL1 and the second downstream end point AD2, corresponding to the downstream end of the distorted passage 111, on the second inner wall line WL2. The first virtual straight line VL1 connecting the first upstream end point AU1 and the first downstream end point AD1 is inclined at the inclination angle of 25° or more and 70° or less with respect to the axial direction of the fiber guide 101 (25°≤θ1≤70°).

[0133] Accordingly, the distorted passage 111 can be configured to guide the fiber bundle 34 downstream while suitably converging the fiber bundle 34.

[0134] In the fiber guide 101 of this embodiment, the first virtual straight line VL1 is inclined at the inclination angle of 30° or more and 50° or less with respect to the axial direction of the fiber guide 101 (30°≤θ1≤50°).

[0135] Accordingly, the distorted passage 111 can be configured to guide the fiber bundle 34 downstream while converging the fiber bundle 34 more suitably.

[0136] In the fiber guide 101 of this embodiment, the first inner wall line WL1 is formed as a straight line connecting the first upstream end point AU1 and the first downstream end point AD1. The second inner wall line WL2 is formed as a straight line connecting the second upstream end point AU2 and the second downstream end point AD2.

[0137] Accordingly, the fiber bundle 34 can be smoothly guided downstream.

[0138] In the fiber guide 101 of this embodiment, the angle formed by the first virtual straight line VL1 and the axial direction of the fiber guide 101 and the angle formed by the second virtual straight line VL2 and the axial direction of the fiber guide 101 are different (θ1 ≠ θ2).

[0139] Accordingly, flexibility in the shape of a path through which the fiber bundle 34 passes can be increased.

[0140] In the fiber guide 101 of this embodiment, the first virtual straight line VL1 is inclined at the inclination angle of 25° or more and 70° or less with respect to the axial direction of the fiber guide 101 (25° ≤ θ1 ≤ 70°). The second virtual straight line VL2 is inclined at the inclination angle of less than 25° with respect to the axial direction of the fiber guide 101 (θ2 < 25°).

[0141] Accordingly, the fiber bundle 34 can be guided downstream while being suitably converged.

[0142] In the fiber guide 101 of this embodiment, the transverse section of the distorted passage 111 obtained by cutting the distorted passage 111 along the plane SP3 perpendicular to the axial direction of the fiber guide 101 at the position bisecting the axial length L1 of the distorted passage 111 has the curved portion 146 as shown in FIG. 8. The distorted passage 111 located near the transverse section has the first portion P1 with a smaller dimension D1 perpendicular to the first cross section and the second portion P2 with a larger dimension D2 perpendicular to the first cross section, with the curved portion 146 as a boundary. The first virtual straight line VL1 which is inclined at an inclination angle of 25° or more and 70° or less, is closer to the first portion P1 than the second virtual straight line VL2 which is inclined at an inclination angle less than 25°.

[0143] Accordingly, the fiber bundle 34 can be transferred from the first portion P1 to the second portion P2 through the curved portion 146 and can also be guided downstream while being suitably converged.

[0144] The distorted passage 111 is formed in the fiber guide 101 of this embodiment. In the fiber guide 101, the second cross section of the distorted passage 111 obtained by cutting the distorted passage 111 along the plane SP2 parallel to the axial direction includes the third inner wall line WL3 and the fourth inner wall line WL4, as shown in FIG. 7. The third inner wall line WL3 corresponds to the second inner wall surface 141b on one side of the distorted passage 111. The fourth inner wall line WL4 corresponds to the guide surface 142c on the opposite side of the second inner wall surface 141b. The distance between the third upstream end point BU3, corresponding to the upstream end of the distorted passage 111, on the third inner wall line WL3 and the fourth upstream end point BU4, corresponding to the upstream end of the distorted passage 111, on the fourth inner wall line WL4 is shorter than the distance between the third downstream end point BD3, corresponding to the downstream end of the distorted passage 111, on the third inner wall line WL3 and the fourth downstream end point BD4, corresponding to the upstream end of the distorted passage 111, on the fourth inner wall line WL4. The fourth virtual straight line VL4 connecting the fourth upstream end point BU4 and the fourth downstream end point BD4 is inclined at the inclination angle of 35° or more and 85° or less with respect to the axial direction of the fiber guide 101 ($35° \leq \theta 4 \leq 85°$).

[0145] Accordingly, a configuration can be accomplished in which the inner wall surface of the distorted passage 111 is less likely to inhibit the inversion of the fibers that are to be inverted by air spinning performed downstream of the distorted passage 111.

[0146] In the fiber guide 101 of this embodiment, the fourth virtual straight line VL4 is inclined at an inclination angle of 40° or more and 70° or less with respect to the axial direction of the fiber guide 101 ($40° \leq \theta 4 \leq 70°$).

[0147] Accordingly, a configuration can be accomplished in which the inner wall surface of the distorted passage 111 is less likely to inhibit the inversion of the fibers that are to be inverted by air spinning performed downstream of the distorted passage 111.

[0148] In the fiber guide 101 of this embodiment, the upstream opening 111a located at the upstream end of the distorted passage 111 is offset to one side with respect to the axis line AL of the fiber guide 101. A portion of the inner wall surface of the distorted passage 111 that is located opposite the direction in which the upstream opening 111a is offset with respect to the axis line AL (the direction indicated by arrow OD1) includes two planes, that is, the fourth inner wall surface 141d and the intermediate inner wall surface 142a.

[0149] Accordingly, the fiber bundle 34 can be properly guided downstream by the inner wall surface.

[0150] The fiber guide 101 of this embodiment has the upstream end surface 115a and the downstream end surface 115b. The upstream end surface 115a has the upstream opening 111a located at the upstream end of the distorted passage 111. The downstream end surface 115b has the downstream opening 111b located at the downstream end of the distorted passage 111. The length L1 between the upstream end surface 115a and the downstream end surface 115b is 1 mm or more and 5 mm or less ($1 \text{ mm} \leq L1 \leq 5 \text{ mm}$).

[0151] Accordingly, the fiber guide 101 can be made small.

[0152] The fiber guide 101 of this embodiment has a first chamfer portion 114. The first chamfer portion 114 is formed between the upstream end surface 115a and the side face. The inclination angle of the first chamfer portion 114 with respect to the axial direction of the fiber guide 101 is 50° or more and 70° or less ($50° \leq \theta A \leq 70°$).

[0153] Accordingly, the fiber guide 101 can be positioned close to the front roller pair 47 of the draft device 21.

[0154] The air spinning device 23 of this embodiment has the fiber guide 101 and the spindle 102. The spindle 102 guides the spun yarn 30 twisted by the air ejected from the spinning nozzle 131 downstream.

[0155] As a result, the fiber bundle 34 is guided downstream while being suitably converged in the distorted passage 111, and spinning is performed by the swirling air flow on the fiber bundle 34 which has been guided, thus generating the spun yarn 30 of good physical properties. In addition, fiber loss, which is dropping out of the fibers without being spun in the air spinning process, can be reduced.

[0156] The air spinning machine 1 of this embodiment includes the air spinning device 23, the yarn storage roller 53, and the winding device 27. The yarn storage roller 53 draws out the spun yarn 30 spun by the air spinning device 23. The winding device 27 winds the spun yarn 30 drawn out by the yarn storage roller 53.

[0157] Accordingly, the air spinning machine 1 can be realized in which the spun yarn 30 of good physical properties can be wound and in which fiber loss is few.

[0158] While some preferred embodiments of the present invention have been described above, the foregoing configurations may be modified, for example, as follows. The modification can be singly made or any combination of several modifications can be made.

[0159] The shape of the first inner wall line WL1 is arbitrary and can be formed, for example, as at least one straight, polygonal or curved line. The same applies to the shape of the second inner wall line WL2, the third inner wall line WL3 and the fourth inner wall line WL4.

[0160] In the configuration of FIG. 6 or FIG. 9, the distorted passage 111 can also be formed so that $\theta 1 = \theta 2$. Both the first inclination angle $\theta 1$ and the second inclination angle $\Theta 2$ may be 25° or more and 70° or less, and both the first inclination angle $\theta 1$ and the second inclination angle $\Theta 2$ may be 30° or more and 50° or less.

[0161] In the configuration of FIG. 6 or FIG. 9, the distorted passage 111 may be configured so that $\theta 1 < 25°$ and $25° \leq \Theta 2 \leq 70°$.

[0162] Both the third inclination angle $\theta 3$ and the fourth inclination angle $\theta 4$ may be 35° or more and 85° or less, and both the third inclination angle $\theta 3$ and the fourth inclination angle $\theta 4$ may be 40° or more and 70° or less.

[0163] The needle member 104 can be omitted. In this case, the through hole 112 is not formed in the fiber guide 101.

[0164] The shape of the distorted passage 111, including the shape of the upstream opening 111a, the downstream opening 111b, the curved portion 146, and the recess 143, can be modified as appropriate.

[0165] If the length in the direction of the axis line AL of the portion between the upstream opening 111a and the downstream opening 111b of the distorted passage 111 that actually makes contact with and guides the fiber bundle 34 is 1 mm or more and 5 mm or less, the length in the axial AL direction of the fiber guide 101 may be more than 5 mm.

[0166] As shown in FIG. 9, the downstream side of the first passage portion 141 (or the entire distorted passage 111) may have a vertical portion 111c that extends straight when viewed in a direction perpendicular to the axis line AL of the fiber guide 101. In this case, the length L3 of this vertical portion 111c is preferably less than 50% of the total length L4 of the distorted passage 111 in the direction along the axial line AL.

[0167] As shown in the example of FIG. 10, the second extension portion 145 may be omitted in the second passage portion 142.

[0168] As shown in the example in FIG. 11, the second passage portion 142 (in other words, the recess 143) may be omitted in the distorted passage 111. In this case, among the plane of the inner wall surface of the distorted passage 111, only the fourth inner wall surface 141d is located opposite the direction indicated by the arrow OD1.

[0169] The shape of the fiber guide 101 is arbitrary and can be formed, for example, as a block. The inclination angles of the first chamfer portion 114 and the second chamfer portion 116 can be modified as appropriate. At least any of the first chamfer portion 114 and the second chamfer portion 116 can be omitted.

[0170] The fiber guide 101 and the nozzle block 103 can be configured as one member. In this case, the fiber guide 101 is integrally formed with the spinning nozzle 131 and the spinning chamber 113. This configuration can reduce the number of parts.

[0171] A device including a delivery roller and a driven roller may be provided in the spinning unit 7 instead of or in addition to the yarn storage roller 53. By rotating and driving the delivery roller while the spun yarn 30 is nipped between the delivery roller and the driven roller, the spun yarn 30 can be drawn out downstream from the air spinning device 23.

[0172] The air spinning device 23 may be configured to perform two types of spinning, the normal spinning and piecing, instead of the normal spinning and the yarn-discharge spinning. The piecing is a yarn joining method that does not use either a splicer device or a knotter as in the above embodiment, and is a method of yarn joining by making the spun yarn 30 to travel backward from the package 73 to the air spinning device 23 or the front roller pair 47, and in this state, restarting the draft operation by the draft device 21 and the spinning operation by the air spinning device 23 so that the yarn is joined. In this case, air may be injected from auxiliary nozzles to introduce the spun yarn 30 from the package 73 into the air spinning device 23.

[0173] Instead of the configuration that the air spinning machine 1 has a yarn joining cart 9, each of the spinning units 7 may have at least some of the devices related to yarn joining.

Claims

1. A fiber guide (101) in which a fiber passage (111) is formed therein, wherein

   a first cross section of the fiber guide (101) obtained by cutting the fiber passage (111) along a plane (SP1) parallel to an axial direction of the fiber guide (101) includes a first inner wall line (WL1) corresponding to an inner wall surface (141a) on one side of the fiber passage (111), and a second inner wall line (WL2) corresponding to an inner wall surface (141c) opposite to the inner wall surface (141a),

   a distance between a first upstream end point (AU1), corresponding to an upstream end of the fiber passage (111), on the first inner wall line (WL1) and a second upstream end point (AU2), corresponding to an upstream end of the fiber passage (111), on the second inner wall line (WL2) is longer than a distance between a first downstream end point (AD1), corresponding to a downstream end of the fiber passage (111), on the first inner wall line (WL1) and a second downstream end point (AD2), corresponding to a downstream end of the fiber passage (111), on the second inner wall line (WL2), and

   at least one of a first virtual straight line (VL1) connecting the first upstream end point (AU1) and the first downstream end point (AD1) and a second virtual straight line (VL2) connecting the second upstream end point (AU2) and the second downstream end point (AD2) is inclined at an inclination angle of 25° or more and 70° or less with respect to the axial direction of the fiber guide (101).

2. The fiber guide (101) according to claim 1, wherein at least one of the first virtual straight line (VL1) and the second virtual straight line (VL2) is inclined at the inclination angle of 30° or more and 50° or less with respect to the axial direction of the fiber guide (101).

3. The fiber guide (101) according to claim 1 or 2, wherein

the first inner wall line (WL1) is formed as a straight line connecting the first upstream end point (AU1) and the first downstream end point (AD1), and
the second inner wall line (WL2) is formed as a straight line connecting the second upstream end point (AU2) and the second downstream end point (AD2).

4. The fiber guide (101) according to one of the preceding claims, wherein
an angle (θ1) formed by the first virtual straight line (VL1) and the axial direction of the fiber guide (101) and an angle (θ2) formed by the second virtual straight line (VL2) and the axial direction of the fiber guide (101) are different.

5. The fiber guide (101) according to one of the preceding claims, wherein

the first virtual straight line (VL1) is inclined at an inclination angle (θ1) of 25° or more and 70° or less with respect to the axial direction of the fiber guide (101), and
the second virtual straight line (VL2) is parallel to or inclined at an inclination angle (θ2) of less than 25° with respect to the axial direction of the fiber guide (101).

6. The fiber guide (101) according to claim 5, wherein

a transverse section of the fiber passage (111) obtained by cutting the fiber passage (111) along a plane (SP3) perpendicular to the axial direction of the fiber guide (101) at a position bisecting an axial length of the fiber passage (111) has a curved portion (146),
the fiber passage (111) located in the vicinity of the transverse section has a first portion (P1) with a smaller dimension (D1) perpendicular to the first cross section and a second portion (P2) with a larger dimension (D2) perpendicular to the first cross section, with the curved portion (146) as a boundary, and
the first virtual straight line (VL1) is closer to the first portion (P1) than the second virtual straight line (VL2).

7. A fiber guide (101) having a fiber passage (111) formed therein, wherein

a second cross section of the fiber guide (101) obtained by cutting the fiber passage (111) along a plane (SP2) parallel to an axial direction of the fiber guide (101) includes a third inner wall line (WL3) corresponding to an inner wall surface (141b) on one side of the fiber passage (111), and a fourth inner wall line (WL4) corresponding to an inner wall surface (142c) opposite to the inner wall surface (141b),
a distance between a third upstream end point (BU3), corresponding to an upstream end of the fiber passage (111), on the third inner wall line (WL3) and a fourth upstream end point (BU4), corresponding to an upstream end of the fiber passage (111), on the fourth inner wall line (WL4) is shorter than a distance between a third downstream end point (BD3), corresponding to a downstream end of the fiber passage (111), on the third inner wall line (WL3) and a fourth downstream end point (BD4), corresponding to a downstream end of the fiber passage (111), on the fourth inner wall line (WL4), and
at least one of a third virtual straight line (VL3) connecting the third upstream end point (BU3) and the third downstream end point (BD3) and a fourth virtual straight line (VL4) connecting the fourth upstream end point (BU4) and the fourth downstream end point (BD4) is inclined at an inclination angle of 35° or more and 85° or less with respect to the axial direction of the fiber guide (101).

8. The fiber guide (101) according to claim 7, wherein at least one of the third virtual straight line (VL3) and the fourth virtual straight line (VL4) is inclined at the inclination angle of 40° or more and 70° or less with respect to the axial direction of the fiber guide (101).

9. The fiber guide (101) according to claim 7 or 8, wherein

an upstream opening (111a) located at the upstream end of the fiber passage (111) is offset to one side with respect to an axis (AL) of the fiber guide (101), and
a portion of the inner wall surface of the fiber passage (111) that is located opposite a direction in which the upstream opening (111a) is offset with respect to the axis (AL) of the fiber guide

(101) includes one or more planes (141d, 142a).

10. The fiber guide (101) according to any one of claims 1 to 9, including:

an upstream end surface (115a) in which an upstream opening (111a) located at the upstream end of the fiber passage (111) is formed; and
a downstream end surface (115b) in which a downstream opening (111b) located at the downstream end of the fiber passage (111) is formed, wherein
a length (L1) between the upstream end surface (115a) and the downstream end surface (115b) is 1 mm or more and 5 mm or less.

11. The fiber guide (101) according to any one of claims 1 to 10, wherein:

a spinning nozzle (131) that is arranged to inject air that passes through the spinning nozzle (131); and
a swirling chamber (113) in which a swirling air flow formed by the air injected from the spinning nozzle (131) is arranged to act on fibers
are integrally formed.

12. The fiber guide (101) according to any one of claims 1 to 11, including

a chamfer portion (114) formed between an upstream end surface (115a) and a side surface, wherein an upstream opening (111a) located at the upstream end of the fiber passage (111) is formed in the upstream end surface (115a), wherein
an inclination angle (θA) of the chamfer portion (114) with respect to the axial direction of the fiber guide (101) is 50° or more and 70° or less.

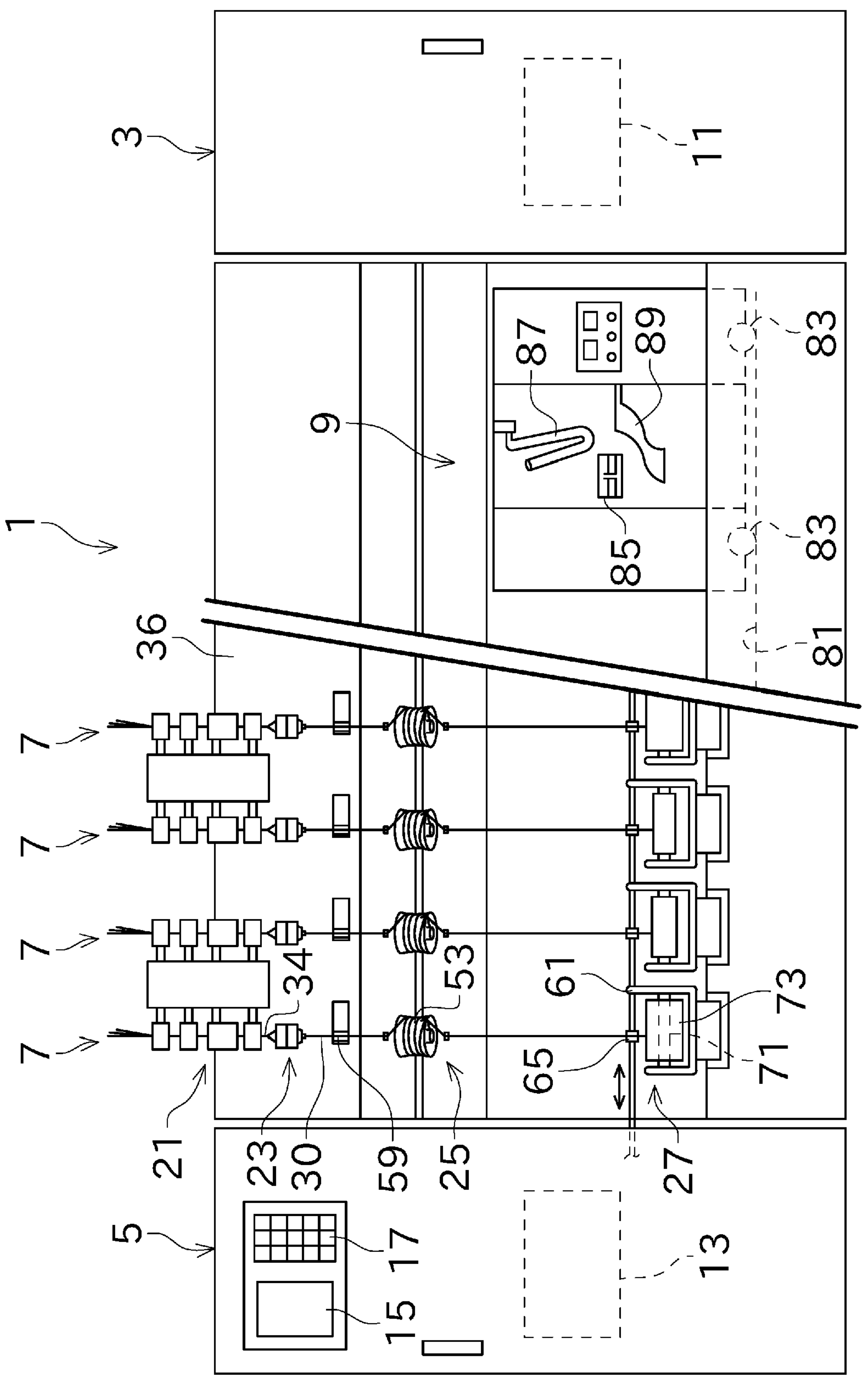
13. An air spinning device (23) comprising:

the fiber guide (101) according to any one of claims 1 to 12; and
a hollow guide shaft body (102) that is arranged to guide fibers twisted by air injected from a spinning nozzle (131) so that the fibers are guided downstream.

14. The air spinning machine (1) comprising:

the air spinning device (23) according to claim 13;
a drawing device (53) for drawing out a yarn (30) spun by the air spinning device (23); and
a winding device (27) for winding the yarn (30) drawn out by the drawing device (53).

FIG. 1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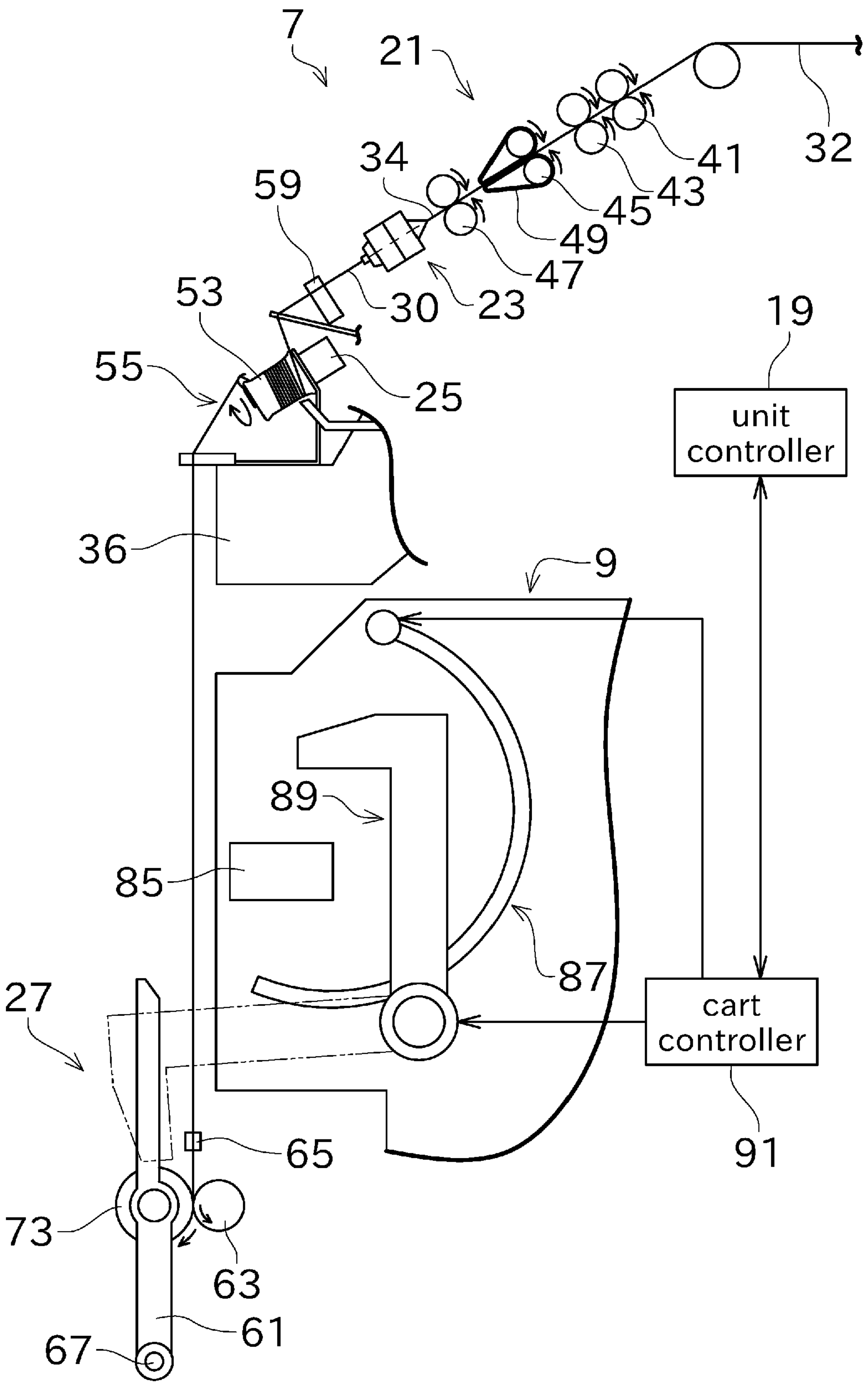
87
89

FIG. 2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21
32
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34
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23
30
53
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unit controller
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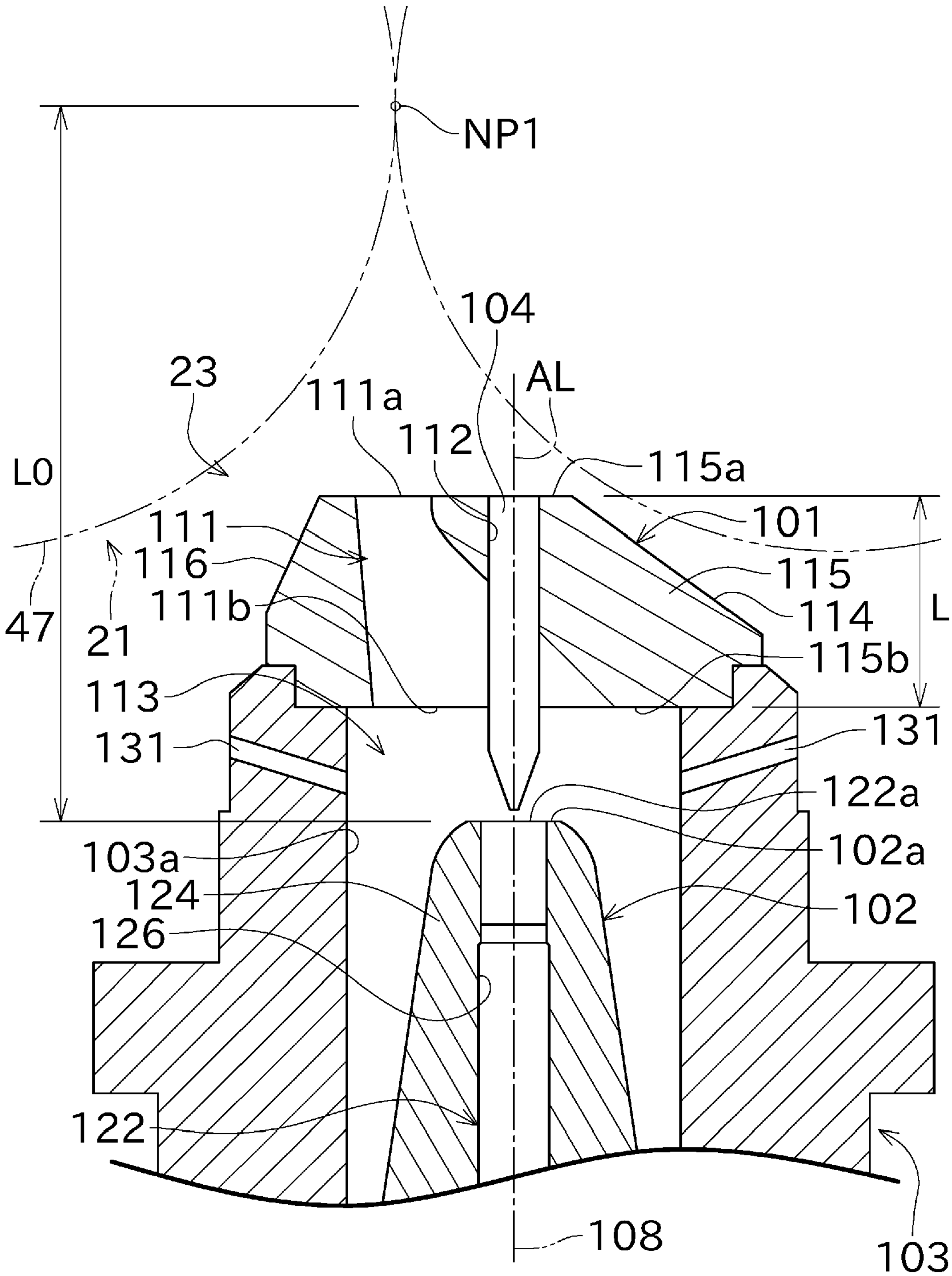
89
85
87
27
cart controller
65
91
73
63
61
67

FIG. 3


NP1
104
AL
23
111a
112
115a
L0
101
111
116
115
111b
114
L1
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21
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131
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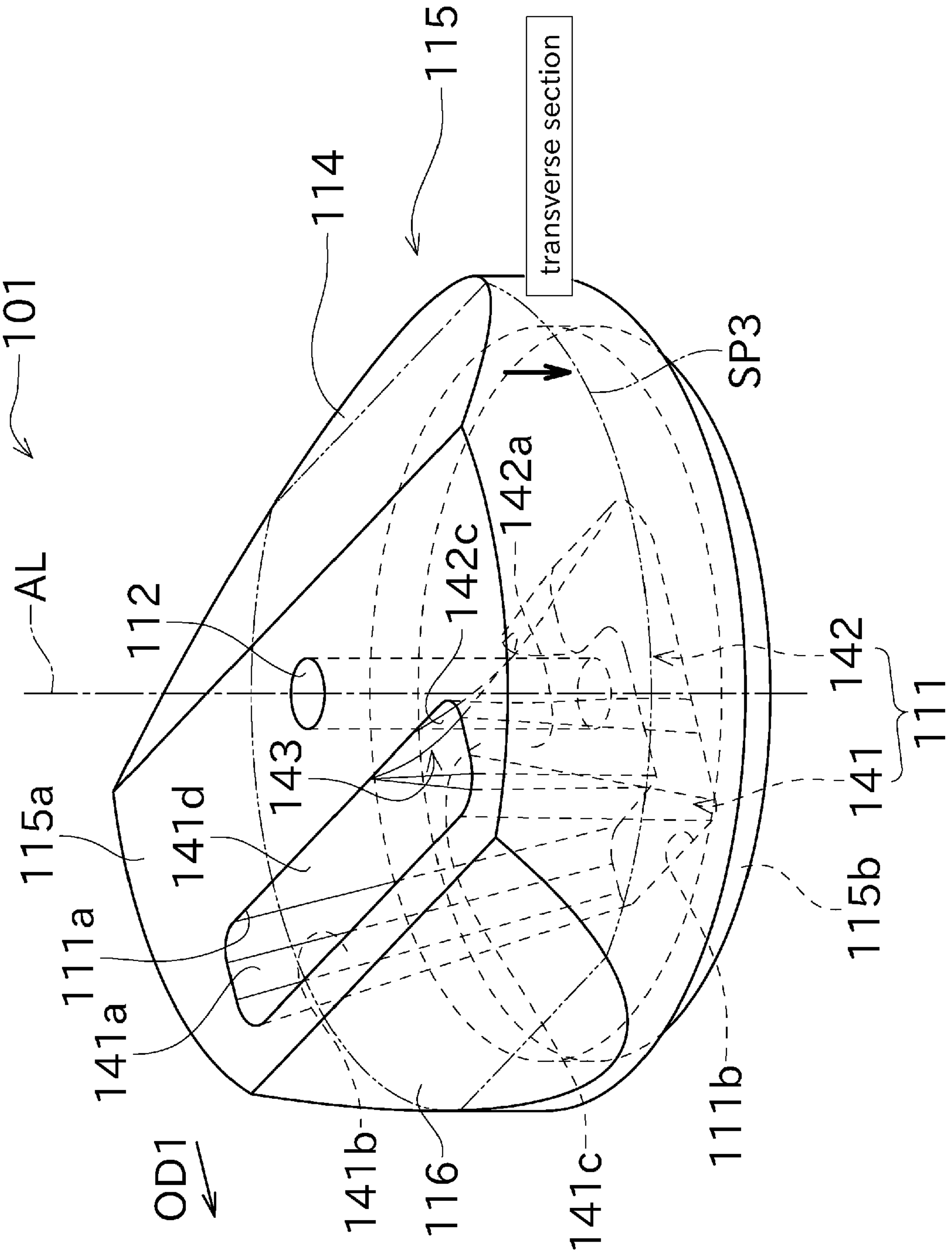
102a
103a
124
102
126
122
108
103

FIG. 4


101
114
115
transverse section
SP3
AL
112
142c
142a
143
115a
141d
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142
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111
115b
111b
OD1
141b
116
141c

FIG. 5

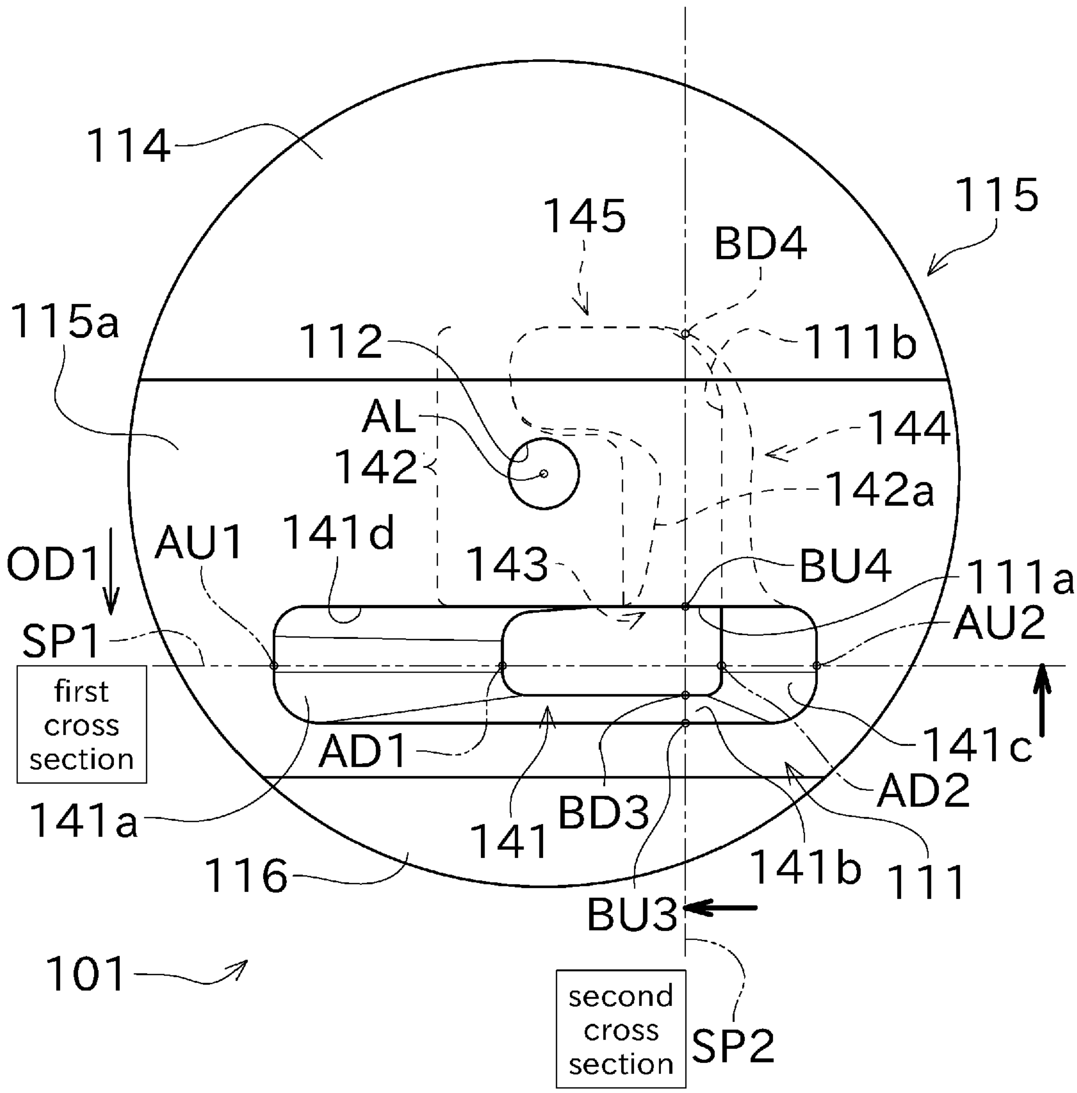

114
145
115
BD4
115a
112
111b
AL
144
142
142a
OD1
AU1
141d
143
BU4
111a
AU2
SP1
first cross section
141c
AD1
AD2
141a
141
BD3
141b
111
116
BU3
101
second cross section
SP2

FIG. 6

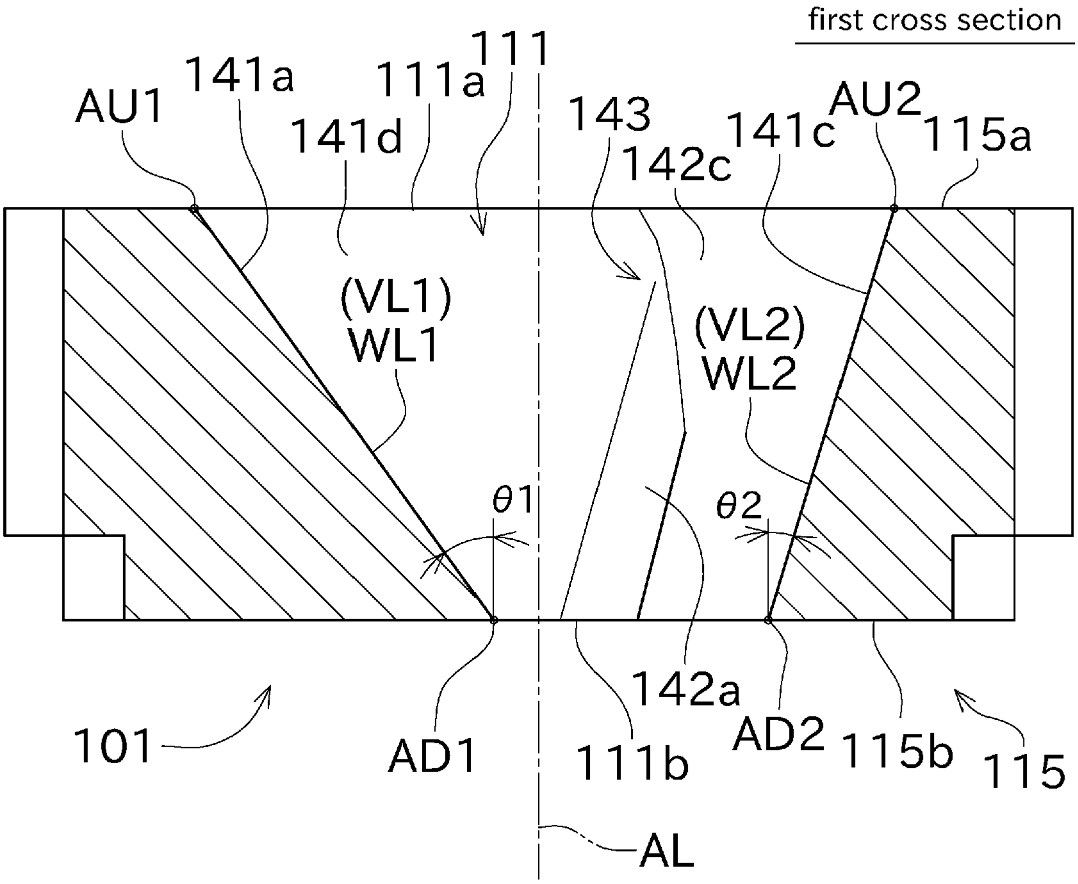

first cross section
AU1
141a
111a
111
141d
143
142c
141c
AU2
115a
(VL1)
WL1
(VL2)
WL2
θ1
θ2
101
AD1
142a
111b
AD2
115b
115
AL

FIG. 7

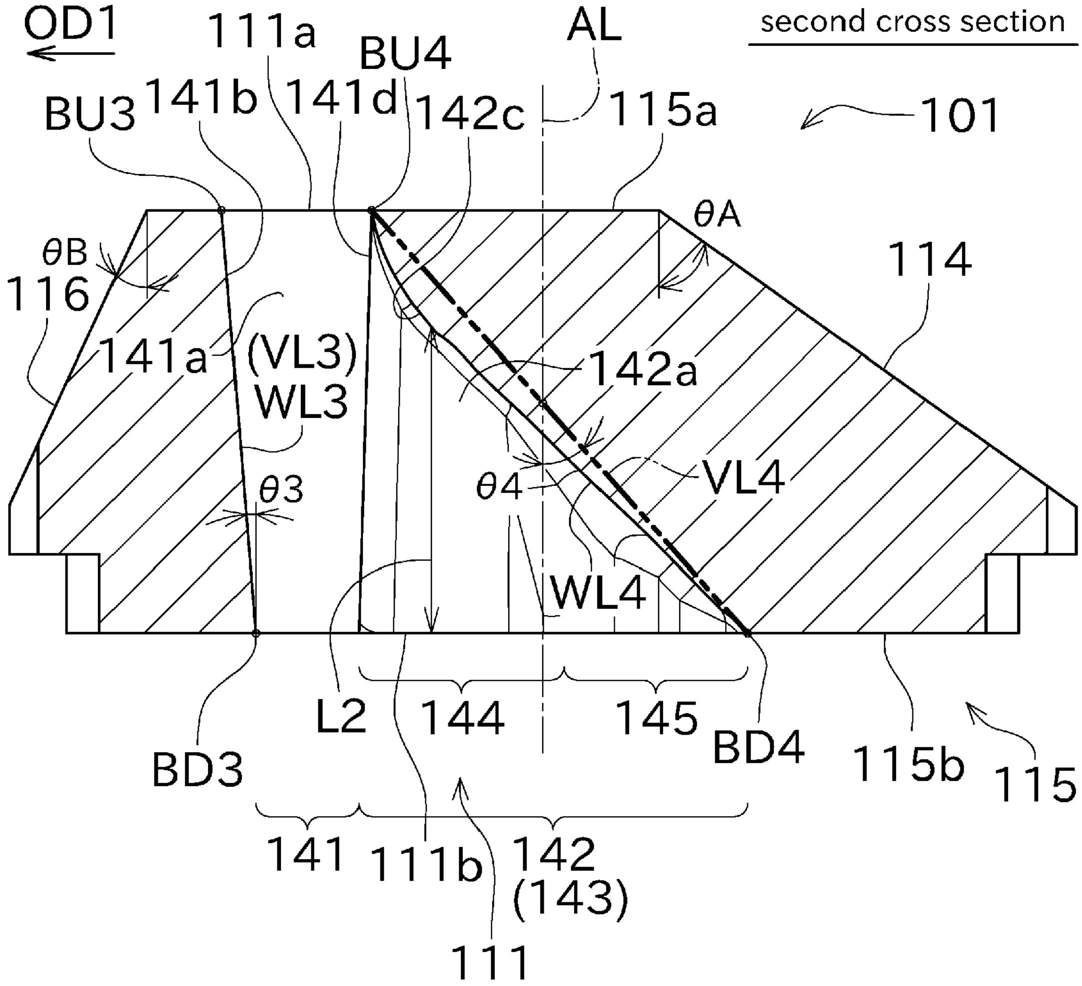

OD1
111a
BU4
AL
second cross section
BU3
141b
141d
142c
115a
101
θA
θB
114
116
141a
(VL3)
WL3
142a
θ3
θ4
VL4
WL4
L2
144
145
BD4
115b
115
BD3
141
111b
142
(143)
111

FIG. 8

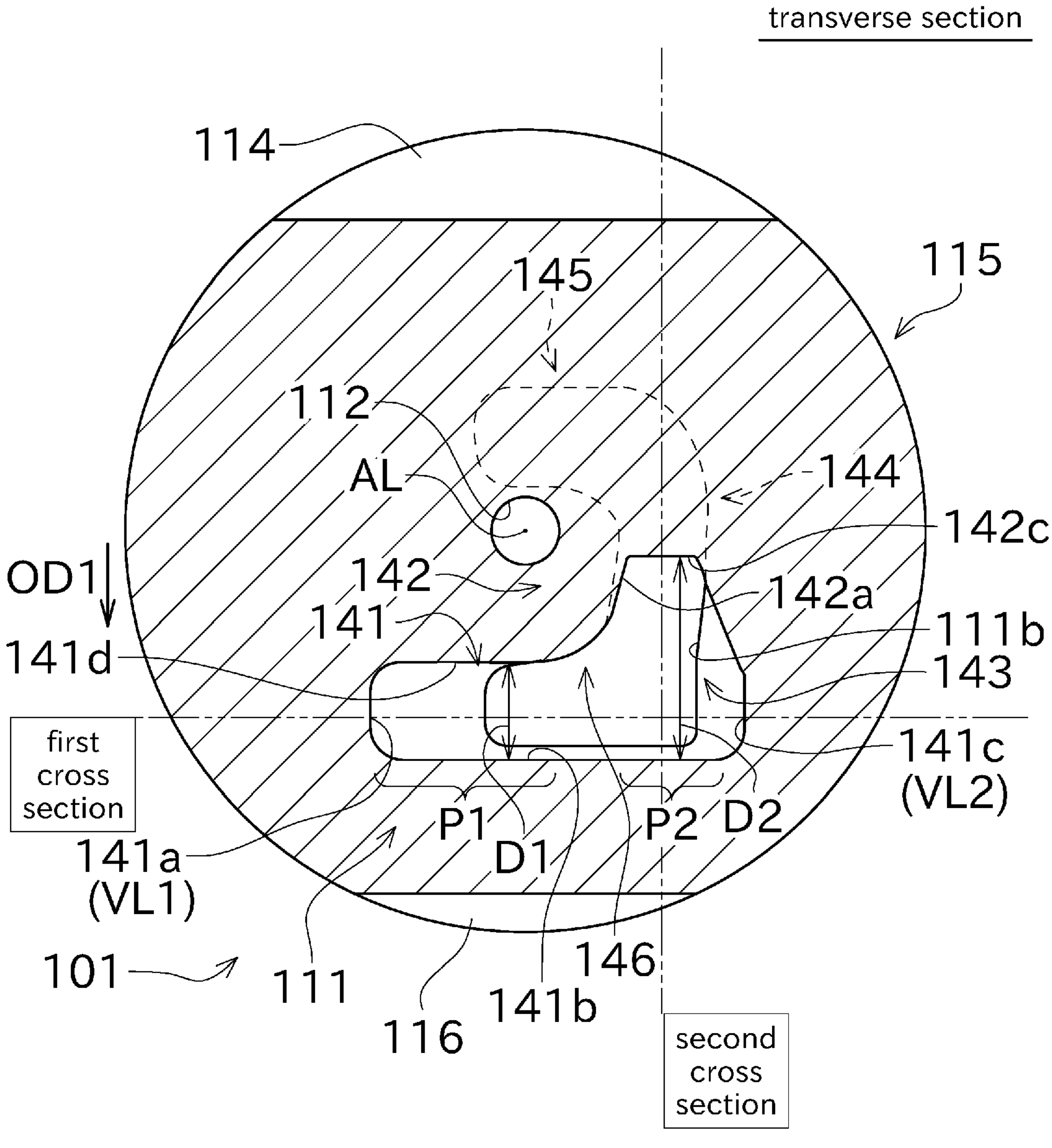

transverse section
114
115
145
112
AL
144
142c
OD1
142
142a
141
111b
141d
143
first cross section
141c (VL2)
P1
P2
D2
D1
141a (VL1)
101
111
146
116
141b
second cross section

FIG. 9

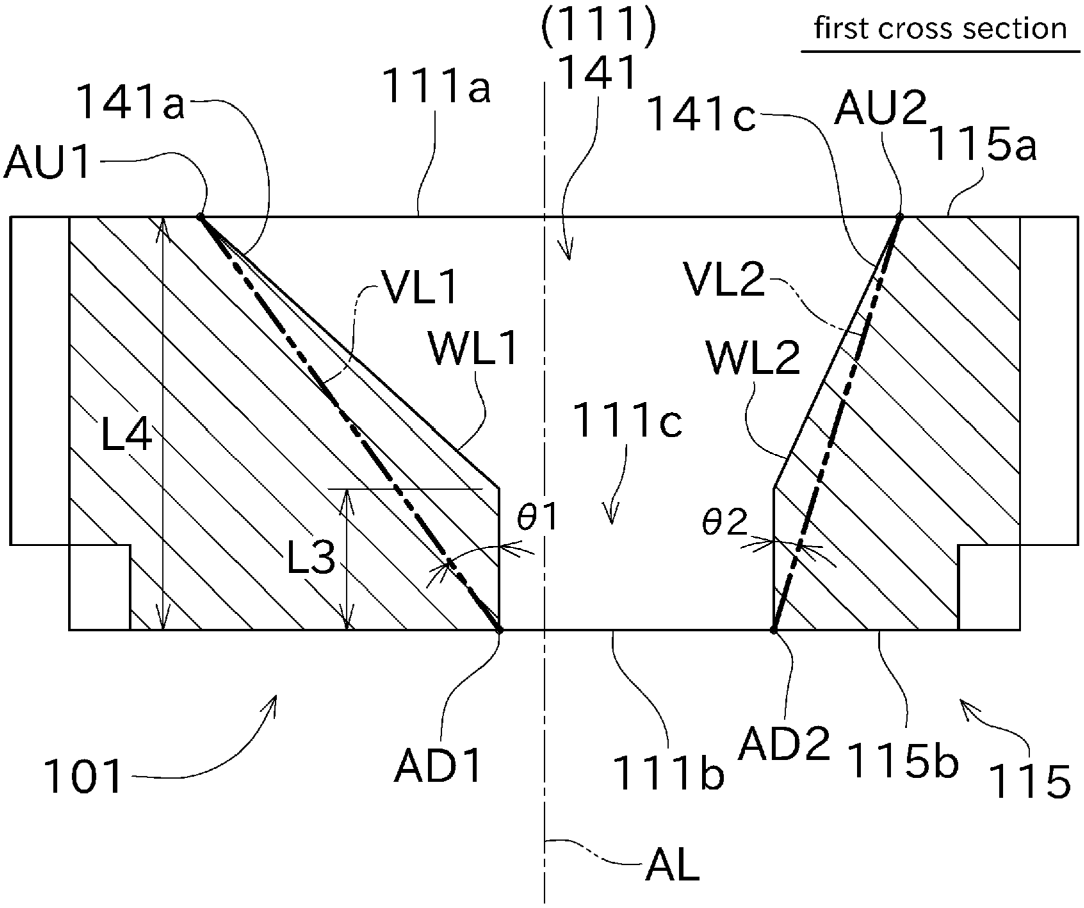
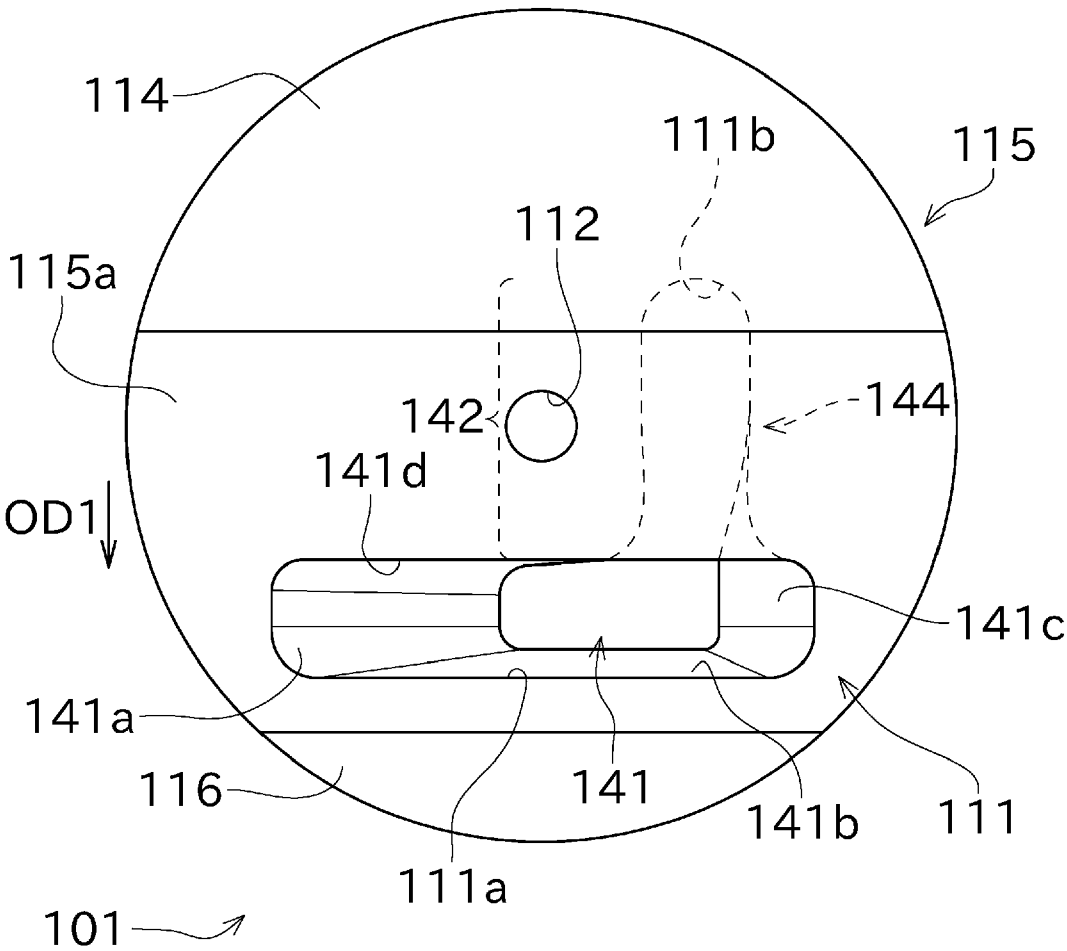

(111)
141
first cross section
141a
111a
141c
AU2
115a
AU1
VL1
WL1
VL2
WL2
111c
L4
L3
θ1
θ2
101
AD1
111b
AD2
115b
115
AL

FIG. 10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141b
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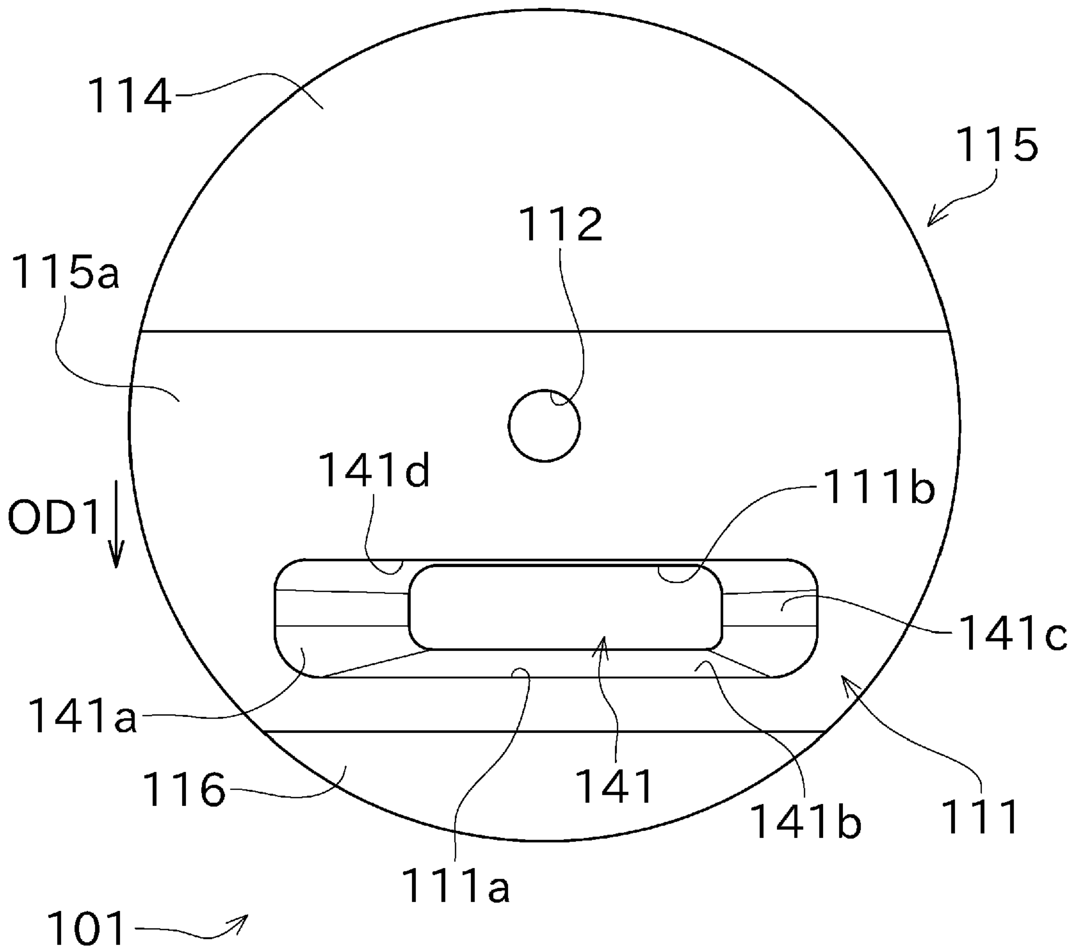
111a
101

FIG. 11


114
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111
111a
101

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EUROPEAN SEARCH REPORT

Application Number
EP 23 19 5092

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 2 009 151 A1 (MURATA MACHINERY LTD [JP]) 31 December 2008 (2008-12-31) * the whole document * * paragraph [0037] * * figures 1,2,3,4(1) * -----	1,7	INV. D01H1/115
A,D	JP 2021 042508 A (MURATA MACHINERY LTD) 18 March 2021 (2021-03-18) * abstract; figures 1,5 * -----	1-14	

TECHNICAL FIELDS SEARCHED (IPC)

D01H

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	1 February 2024	Humbert, Thomas

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EP 23 19 5092

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01-02-2024

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 2009151 A1	31-12-2008	EP 2009151 A1	31-12-2008
		JP 5162975 B2	13-03-2013
		JP 2009001935 A	08-01-2009
JP 2021042508 A	18-03-2021	CN 112501727 A	16-03-2021
		EP 3792381 A1	17-03-2021
		JP 2021042508 A	18-03-2021

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Patent documents cited in the description

- JP 2021042508 A **[0002]**