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(57) A fiber guide (31) includes a main body (50) and a fiber passage (60). The fiber passage (60) has a first surface (61) disposed mostly in a first region (A1) and a second surface (62) disposed mostly in a second region (A2). The second surface (62) is inclined to be away from the first surface (61) as approaching the outlet (55). The first surface (61) is inclined by 5 degrees or less with respect to the axis (50L), and the second surface (62) is inclined by 5 degrees or more and 30 degrees or less with respect to the axis (50L). In the outlet (55), a first portion (55-1) included in the first region (A1) is smaller than a second portion (55-2) included in the second region (A2).

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a fiber guide, a pneumatic spinning device, and a pneumatic spinning unit.

2. Description of the Related Art

[0002] Conventionally, a technique related to a spinning device that produces a yarn from a sliver (a fiber bundle) is known. A spinning device described in JP 2009-001935 A (Patent Document 1) includes a fiber bundle introducing member, and an introduction passage into which the fiber bundle is introduced is formed to penetrate the fiber bundle introducing member. The introduction passage is configured to be bent around an axis of a needle-shaped guide member and to connect an inlet and an outlet. A fiber bundle guiding surface of the fiber bundle introducing member includes: a first surface extending from the inlet to the outlet; a second surface joined from the first surface to a downstream side in a whirling direction of whirling airflow and also reaching from the inlet side to the outlet; and a third surface joined from the second surface to the downstream side in the whirling direction and also reaching from the inlet side to the outlet.

[0003] A spinning device described in JP 2021-025171 A (Patent Document 2) includes a fiber guiding section, and a twisted passage is formed in a main body of the fiber guiding section. An introduction port has a rectangular shape, and one side closest to an axial center among four sides constituting a contour of the introduction port is a guide edge portion. A fiber bundle is introduced from a portion on one side of the guide edge portion. The twisted passage includes: a first surface formed so as to extend downstream from a portion on one side of the guide edge portion; a second surface formed so as to extend downstream from a portion opposite to the one side of the guide edge portion; and a third surface connecting the first surface and the second surface. The first surface, the second surface, and the third surface are connected to a delivery port.

[0004] Meanwhile, in a fiber guide, reduction of fiber loss is required. In order to reduce the fiber loss, it is effective to increase an amount of tension applied to a fiber bundle or to further enhance convergence of the fiber bundle. For example, by increasing a distance from an axis of the fiber guide to an inlet (by moving a position of the inlet away from the axis), the amount of tension applied can be increased. However, since a space is provided in a passage in order to apply a twist to the fiber bundle, it is difficult to cause the fiber bundle to follow an inner wall surface of the fiber guide, and thus it is difficult to reliably apply tension to the fiber bundle. It is also dif-

ficult to cause the fiber bundle to converge. In conventional fiber guides, it has been difficult to accomplish convergence of the fiber bundle while applying tension to the entire fiber bundle.

BRIEF SUMMARY OF THE INVENTION

[0005] An object of the present invention is to provide a fiber guide capable of accomplishing convergence of a fiber bundle while applying tension to the entire fiber bundle.

[0006] One aspect of the present invention is a fiber guide to be applied to a pneumatic spinning device. The fiber guide includes: a main body having a front end surface and a rear end surface in a direction of an axis; and a fiber passage formed in the main body and connecting an inlet formed on the front end surface and an outlet formed on the rear end surface. The inlet is a long hole extending in a predetermined direction at a position different from the axis. In the main body, when a first region located on one side and a second region located on another side with respect to a virtual plane including the axis and equally dividing the inlet are defined, the fiber passage includes: a first surface disposed mostly in the first region and extending to be inclined from the inlet toward the outlet; and a second surface disposed mostly in the second region and extending to be inclined from the inlet toward the outlet. The second surface is inclined to be away from the first surface as approaching the outlet, the first surface is inclined by 5 degrees or less with respect to the axis, and the second surface is inclined by 5 degrees or more and 30 degrees or less with respect to the axis. In the outlet, an area of a first portion included in the first region is smaller than an area of a second portion included in the second region.

[0007] According to this fiber guide, the fiber bundle is introduced from the inlet on the front end surface. As the fiber bundle travels along the first surface and the second surface of the fiber passage and approaches the outlet, the fiber bundle converges to the vicinity of the second surface. While the first surface is substantially parallel (parallel or at a slight angle) to the axis, the second surface is inclined at a relatively large angle with respect to the axis. At the outlet, the area of the second portion included in the second region is relatively large. These configurations make it possible to accomplish convergence of the fiber bundle while applying tension to the entire fiber bundle. As a result, the fiber loss can be reduced.

[0008] Another aspect of the present invention is a fiber guide to be applied to a pneumatic spinning device. The fiber guide includes: a main body having a front end surface and a rear end surface in a direction of an axis; and a fiber passage formed in the main body and connecting an inlet formed on the front end surface and an outlet formed on the rear end surface. The inlet is a long hole extending in a predetermined direction at a position different from the axis. In the main body, when a first region

located on one side and a second region located on another side with respect to a virtual plane including the axis and equally dividing the inlet are defined, the fiber passage includes: a first surface disposed mostly in the first region and extending from the inlet toward the outlet; and a second surface disposed mostly in the second region and extending from the inlet toward the outlet. The second surface is inclined to be away from the first surface as approaching the outlet. A minimum width portion where a width of the second surface in a predetermined direction is minimum is provided at the outlet.

[0009] According to this fiber guide, the fiber bundle is introduced from the inlet on the front end surface. As the fiber bundle travels along the first surface and the second surface of the fiber passage and approaches the outlet, the fiber bundle converges to the vicinity of the second surface. The second surface is inclined to be away from the first surface as approaching the outlet, and the minimum width portion of the second surface is provided at the outlet. This configuration makes it possible to accomplish convergence of the fiber bundle while applying tension to the entire fiber bundle. As a result, the fiber loss can be reduced.

[0010] At the outlet, a size of the first portion may be 1/2 or less of a size of the second portion. According to this configuration, 2/3 or more of the size of the outlet is formed in the second region where the second surface exists. Therefore, the fiber bundle converges more easily.

[0011] The rear end surface may be flat. According to this configuration, a certain distance can be maintained between a hollow guide shaft body and the fiber guide included in the pneumatic spinning device. That is, the fiber guide and the hollow guide shaft body are not too close to each other. Therefore, for example, even when a foreign substance or the like is mixed, reversal of a rear end of fibers of the fiber bundle is not inhibited, and the rear end of the fibers can be favorably reversed.

[0012] The second surface may be inclined at 10 degrees or more and 25 degrees or less with respect to the first surface. According to this configuration, introduction of the fiber bundle on the first surface and guiding (that is, reversal and convergence) of the fiber bundle to the second surface are favorably performed.

[0013] The fiber passage has a flat third surface formed between the first surface and the second surface. When an end edge constituting a part of the outlet in the first surface is defined as a first end edge, and an end edge constituting a part of the outlet in the third surface is defined as an inclined end edge, in the rear end surface, a virtual extension line of the inclined end edge may form an angle of 100 degrees or more and 130 degrees or less with respect to a virtual extension line of the first end edge. According to this configuration, when the fiber bundle travels from the first surface to the third surface, the fiber bundle can be smoothly moved.

[0014] Between the first end edge and the inclined end edge, a first arc-shaped portion may be provided. Ac-

cording to this configuration, since a portion between the two sides at the outlet is not a pin corner, tension can be applied to the fiber bundle while the fiber bundle converges smoothly.

[0015] The first arc-shaped portion may connect the first end edge and the inclined end edge, and a length of the first arc-shaped portion may be shorter than a length of the first end edge. According to this configuration, application of tension to the fiber bundle and convergence of the fiber bundle are smoothly performed with a suitable balance between the first end edge of the first surface and the first arc-shaped portion.

[0016] When an end edge constituting a part of the outlet in the second surface is defined as a second end edge, a second arc-shaped portion may be provided between the inclined end edge and the second end edge, and a length of the second arc-shaped portion may be shorter than a length of the inclined end edge. According to this configuration, the fiber bundle can be smoothly moved with a suitable balance between the inclined end edge of the third surface and the second arc-shaped portion.

[0017] A distance between the first end edge and a first another virtual plane including the axis and being parallel to the first end edge may be 1 mm or more and 3 mm or less. According to this configuration, it is possible to smoothly move the fiber bundle to the third surface while appropriately applying tension to the fiber bundle.

[0018] Between the first surface and the second surface, a twisted surface having a shape twisted with respect to an extending direction of the axis may be formed, and the first surface and the second surface may be connected by the twisted surface. According to this configuration, since the fiber bundle travels along the twisted surface, the fiber bundle is favorably reversed.

[0019] The minimum width portion having a minimum width of the second surface in a predetermined direction may be provided at the outlet. According to this configuration, the fiber bundle can be converged most in the vicinity of the outlet.

[0020] When an end edge constituting a part of the outlet in the second surface is defined as a second end edge, and a virtual plane including the axis and being parallel to the second end edge is defined as a second another virtual plane, a distance between the second end edge and the second another virtual plane may be 1.5 mm or less. According to this configuration, the fiber can be smoothly introduced into the hollow guide shaft body.

[0021] The second end edge may be located on an opposite side of the inlet with respect to the second another virtual plane. According to this configuration, it is possible to favorably reverse a rear end of fibers of the fiber bundle fed from the fiber guide while appropriately restraining the fiber bundle.

[0022] The main body may have a substantially cylindrical shape, and the axis may be a center line passing through a center of the substantially cylindrical shape. According to this configuration, a position of the axis can

be determined with high accuracy.

[0023] As still another aspect of the present invention, a pneumatic spinning device may be provided including: any of the fiber guides described above; a nozzle block in which a nozzle is formed; and a hollow guide shaft body having a distal end portion arranged in a spinning chamber formed between the fiber guide and the nozzle block. In this pneumatic spinning device, the fiber bundle can converge more reliably with the configuration of the fiber guide.

[0024] As still another aspect of the present invention, a pneumatic spinning unit may be provided including: the pneumatic spinning device described above; a draft device arranged upstream of the pneumatic spinning device and configured to draft a fiber bundle to be supplied to the pneumatic spinning device; and a winding device arranged downstream of the pneumatic spinning device and configured to wind a yarn produced by the pneumatic spinning device. In this pneumatic spinning unit, the fiber bundle can converge more reliably with the configuration of the fiber guide.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025]

FIG. 1 is a front view illustrating a spinning machine according to a first embodiment of the present invention;

FIG. 2 is a side view of a pneumatic spinning unit of the spinning machine illustrated in FIG. 1;

FIG. 3 is a cross-sectional view of a pneumatic spinning device illustrated in FIG. 1;

FIG. 4 is a perspective view of a fiber guide in FIG. 3;

FIG. 5 is a front view of the fiber guide of FIG. 4;

FIG. 6A is a rear view of the fiber guide of FIG. 4;

FIG. 6B is an enlarged view illustrating a periphery of an outlet;

FIG. 7 is a perspective view of the fiber guide taken along line VII-VII of FIG. 6A;

FIG. 8 is a cross-sectional view of the fiber guide taken along line VII-VII of FIG. 6A;

FIG. 9 is a perspective view of the fiber guide taken along line IX-IX of FIG. 6A;

FIG. 10 is a cross-sectional view of the fiber guide taken along line X-X of FIG. 8; and

FIG. 11 is a view illustrating an example of a convergence state of a fiber bundle guided by the fiber guide.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0026] An embodiment of the present invention will be hereinafter described with reference to the drawings. In the description of the drawings, the same reference numerals are given for the same elements, and redundant explanations are omitted.

[0027] As illustrated in FIG. 1, a spinning machine 1 includes a plurality of spinning units (pneumatic spinning units) 2, a yarn joining cart 3, a doffing cart (not illustrated), a first end frame 4, and a second end frame 5. The plurality of the spinning units 2 are arranged in a row. Each of the spinning units 2 is configured to produce a yarn Y and to wind the yarn Y around a package P. After the yarn Y is cut, or is broken for some reason in a spinning unit 2, the yarn joining cart 3 performs the yarn joining operation at such a spinning unit 2. The doffing cart is configured to doff a package P and to supply a new bobbin 20 to a spinning unit 2 after the package P is fully-wound in such a spinning unit 2. The first end frame 4 accommodates, for example, a collecting device configured to collect a fiber waste, a yarn waste, and the like generated in the spinning units 2.

[0028] The second end frame 5 accommodates an air supplying section configured to adjust air pressure of compressed air (air) to be supplied to each section of the spinning machine 1 and to supply the air to each section, a drive motor configured to supply power to each section of the spinning unit 2, and the like. The second end frame 5 is provided with a machine control device 100, a touch panel screen 102, and an input key 104. The machine control device 100 is configured to intensively manage and control each section of the spinning machine 1. The touch panel screen 102 can display information relating to set contents and/or a status, or the like of the spinning units 2. An operator can perform a setting operation of the spinning unit 2 by performing an appropriate operation with a button, the input key 104, or the like displayed on the touch panel screen 102.

[0029] As illustrated in FIGS. 1 and 2, each spinning unit 2 includes a draft device 6, an air-jet spinning device (a pneumatic spinning device) 7, a yarn monitoring device 8, a tension sensor 9, a yarn accumulating device 11, a waxing device 12, and a winding device 13 in this order from upstream in a travelling direction of the yarn Y. A unit controller 10 is provided for every predetermined number of the spinning units 2 and is configured to control operations of the spinning units 2.

[0030] The draft device 6 is configured to draft a fiber bundle (a sliver) S. The draft device 6 includes a pair of back rollers 14, a pair of third rollers 15, a pair of middle rollers 16, and a pair of front rollers 17 in this order from upstream in a travelling direction of the fiber bundle S.

[0031] The pair of back rollers 14 include a back bottom roller 14a on a driving side and a back top roller 14b on a driven side. The back bottom roller 14a and the back top roller 14b are opposed to each other with a travelling path, on which the fiber bundle S travels, interposed in between. The pair of third rollers 15 include a third bottom roller 15a on a driving side and a third top roller 15b on a driven side. The third bottom roller 15a and the third top roller 15b are opposed to each other with the travelling path, on which the fiber bundle S travels, interposed in between. The pair of middle rollers 16 include a middle bottom roller 16a on a driving side and a middle top roller

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

[0032] The back bottom roller 14a, the third bottom roller 15a, the middle bottom roller 16a, and the front bottom roller 17a are rotated by drive motors provided in the spinning unit 2, at mutually different rotational speeds so as to be faster in the downstream side rollers. An apron belt 18a is provided for the middle bottom roller 16a. An apron belt 18b is provided for the middle top roller 16b. The front bottom roller 17a may be driven by a drive motor in the second end frame 5 provided in common for the plurality of spinning units 2.

[0033] The back top roller 14b, the third top roller 15b, the middle top roller 16b, and the front top roller 17b are rotatably supported by a draft cradle (not illustrated). The back top roller 14b, the third top roller 15b, the middle top roller 16b, and the front top roller 17b are respectively brought into contact with the back bottom roller 14a, the third bottom roller 15a, the middle bottom roller 16a, and the front bottom roller 17a at a predetermined pressure, to be driven and rotated.

[0034] The air-jet spinning device 7 produces the yarn Y by twisting a fiber bundle F drafted by the draft device 6, with whirling airflow. Details of the air-jet spinning device 7 will be described later.

[0035] The yarn monitoring device 8 is configured to monitor information on the travelling yarn Y between the air-jet spinning device 7 and the yarn accumulating device 11, and to detect presence or absence of a yarn defect based on the information acquired by the monitoring. When detecting the yarn defect, the yarn monitoring device 8 transmits a yarn defect detection signal to the unit controller 10. The yarn monitoring device 8 detects a thickness abnormality of the yarn Y and/or a foreign substance included in the yarn Y, for example, as the yarn defect. The yarn monitoring device 8 also detects a yarn breakage or the like.

[0036] The tension sensor 9 is configured to measure tension of the travelling yarn Y between the air-jet spinning device 7 and the yarn accumulating device 11, and to transmit a tension measurement signal to the unit controller 10.

[0037] When the unit controller 10 determines a presence of an abnormality based on a detection result of the yarn monitoring device 8 and/or the tension sensor 9, the yarn Y is cut in the spinning unit 2. Specifically, by stopping air supply to the air-jet spinning device 7 to interrupt the production of the yarn Y, the yarn Y is cut. Alternatively, the yarn Y may be cut with a cutter separately provided.

[0038] The waxing device 12 is configured to apply wax

to the yarn Y between the yarn accumulating device 11 and the winding device 13.

[0039] The yarn accumulating device 11 accumulates the yarn Y between the air-jet spinning device 7 and the winding device 13. The yarn accumulating device 11 includes a yarn accumulating roller configured to accumulate the yarn Y by winding the yarn Y around an outer peripheral surface. The yarn accumulating device 11 has a function of stably withdrawing the yarn Y from the air-jet spinning device 7, a function of preventing the yarn Y from slackening by accumulating the yarn Y fed from the air-jet spinning device 7 at the time of the yarn joining operation or the like by the yarn joining cart 3, and a function of preventing variation in the tension of the yarn Y at downstream of the yarn accumulating device 11 from being propagated to the air-jet spinning device 7.

[0040] The winding device 13 is configured to wind the yarn Y around the bobbin 20 to form the package P. The winding device 13 includes a cradle arm 21, a winding drum 22 and a traverse guide 23. The cradle arm 21 is configured to rotatably support the bobbin 20. The cradle arm 21 is swingably supported by a supporting shaft 24 and is configured to bring a surface of the bobbin 20 or a surface of the package P into contact with a surface of the winding drum 22 under appropriate pressure. A drive motor (not illustrated) provided in the second end frame 5 is configured to simultaneously drive the winding drums 22 each provided in the plurality of the spinning units 2. Accordingly, in each spinning unit 2, the bobbin 20 or the package P is rotated in a winding direction. The traverse guide 23 of each spinning unit 2 is provided on a shaft 25 shared by the plurality of the spinning units 2. By the drive motor in the second end frame 5 driving the shaft 25 to reciprocate in a rotational axis direction of the winding drum 22, the traverse guide 23 traverses the yarn Y in a predetermined width with respect to the rotating bobbin 20 or package P.

[0041] After the yarn Y is cut, or is broken for some reason in a spinning unit 2, the yarn joining cart 3 travels to such a spinning unit 2 to perform the yarn joining operation. The yarn joining cart 3 includes a yarn joining device 26, a suction pipe 27 and a suction mouth 28. The suction pipe 27 is swingably supported by a supporting shaft 27a, and is configured to catch the yarn Y from the air-jet spinning device 7 and to guide the caught yarn Y to the yarn joining device 26. The suction mouth 28 is swingably supported by a supporting shaft 27b, and is configured to catch the yarn Y from the winding device 13 and to guide the caught yarn Y to the yarn joining device 26. The yarn joining device 26 joins the guided yarns Y together. The yarn joining device 26 is a splicer using compressed air, a knotter that joins the yarns Y together in a mechanical manner, or the like.

[0042] When the yarn joining cart 3 performs the yarn joining operation, the package P is rotated in an unwinding direction (reversely rotated). At this time, the cradle arm 21 is moved by an air cylinder (not illustrated) such that the package P is located away from the winding drum

22, and the package P is reversely rotated by a reversely-rotating roller (not illustrated) provided in the yarn joining cart 3.

[0043] Next, with reference to FIGS. 3 to 10, the air-jet spinning device 7 will be described in detail. In FIGS. 3 to 10, an xyz orthogonal coordinate system is also illustrated for reference of a position or an arrangement of members or components. The xyz orthogonal coordinate system illustrated in FIG. 3 is illustrated with a nozzle house 30 as a reference instead of a hollow guide shaft body 34.

[0044] As illustrated in FIG. 3, the air-jet spinning device 7 includes the nozzle house 30 and the hollow guide shaft body 34. The nozzle house 30 includes a nozzle holder (a supporting block) 37, a fiber guide 31, a spinning chamber 32, and a nozzle block 38. The hollow guide shaft body 34 includes a yarn passage 35 and a second nozzle 36. An operation of the air-jet spinning device 7 is controlled by the unit controller 10. The second nozzle 36 may not be provided.

[0045] The fiber guide 31 and the nozzle block 38 are fixed to the nozzle holder 37, which is a main body of the nozzle house 30. The fiber guide 31 and the nozzle block 38 are fixed to the nozzle holder 37 by, for example, a nozzle cap 39. In the nozzle house 30, the fiber guide 31 and the nozzle block 38 are configured as separate members, but the fiber guide 31 and the nozzle block 38 may be configured integrally or from one member.

[0046] As illustrated in FIGS. 3 and 4, the fiber guide 31 is a member configured to guide the drafted fiber bundle F toward inside of the air-jet spinning device 7. The fiber guide 31 is applied to the air-jet spinning device 7. The fiber guide 31 includes, for example, a main body 50 having a substantially cylindrical shape, a fiber passage 60 formed in the main body 50, and a needle-shaped member 31b disposed along an axis 50L of the main body 50. The main body 50 has a front end surface 52 and a rear end surface 53 in a direction of the axis 50L, an inlet 54 formed on the front end surface 52, and an outlet 55 formed on the rear end surface 53. The fiber passage 60 is a space connecting the inlet 54 and the outlet 55. The fiber guide 31 guides the fiber bundle F into the spinning chamber 32 by the fiber passage 60 that is connected to the spinning chamber 32. When the needle-shaped member 31b is provided, the fiber bundle F is guided into the spinning chamber 32 through the needle-shaped member 31b.

[0047] In the present specification, the "outlet 55" is a concept including an intersection line between the fiber passage 60 and the rear end surface 53 and a region near the intersection line, that is, a region slightly entering inside the fiber passage 60 from the intersection line. Further, in the present specification, the "inlet 54" is a concept including an intersection line between the fiber passage 60 and the front end surface 52 and a region near the intersection line, that is, a region slightly entering inside the fiber passage 60 from the intersection line. The "intersection line" is a connection line connecting a cer-

tain surface (the front end surface 52 or the rear end surface 53) and a wall surface forming a certain space (the fiber passage 60).

[0048] As illustrated in FIG. 3, the nozzle block 38 includes first nozzles 33. The nozzle block 38 and the rear end surface 53 of the fiber guide 31 form the spinning chamber 32. That is, the spinning chamber 32 is formed inside the air-jet spinning device 7. The first nozzles 33 are arranged around the spinning chamber 32 (a path where the fiber bundle F travels). The air-jet spinning device 7 injects air from the first nozzles 33 into the spinning chamber 32, and applies whirling airflow on the fiber bundle F in the spinning chamber 32. With the whirling airflow, each fiber end of a plurality of fibers that form the fiber bundle F is reversed and whirled.

[0049] A rotation direction of the whirling airflow generated in the spinning chamber 32 by the injection of the air from the first nozzles 33, that is, a nozzle air rotation direction R is, for example, as illustrated in FIG. 6A, a clockwise direction as seen from downstream in the travelling direction of the fiber bundle F (that is, when the rear end surface 53 is seen from a direction of the axis 50L). The nozzle air rotation direction R can be changed by changing a structure of the nozzle block 38 (specifically, a direction of the first nozzles 33).

[0050] The hollow guide shaft body 34 is a cylindrical member, and the yarn passage 35 is formed inside the hollow guide shaft body 34. The hollow guide shaft body 34 guides the produced yarn Y toward outside of the air-jet spinning device 7. A distal end portion of the hollow guide shaft body 34 is arranged in the spinning chamber 32 formed between the fiber guide 31 and the nozzle block 38.

[0051] When performing the yarn discharge spinning for starting the spinning operation, the air-jet spinning device 7 injects air from the second nozzle 36 into the yarn passage 35 to generate whirling airflow in the yarn passage 35. A direction of the whirling airflow generated in the yarn passage 35 is opposite to a direction of whirling airflow inside the spinning chamber 32. This causes the fiber bundle F to be introduced from the draft device 6 to the air-jet spinning device 7, and the production of the yarn Y is started. After the yarn discharge spinning is finished, the injection of air from the second nozzle 36 is stopped.

[0052] The needle-shaped member 31b may be omitted, and a downstream end of the fiber guide 31 may have the function of the needle-shaped member 31b.

[0053] When the yarn Y is connected by piecing, air is injected from the second nozzle 36 to reversely feed the yarn Y from the package P into the air-jet spinning device 7. After reverse travelling of the yarn Y into the air-jet spinning device 7, the injection of air from the second nozzle 36 is stopped. Thereafter, the yarn Y is connected (pieced) by restarting the draft operation by the draft device 6 and the spinning operation by the air-jet spinning device 7.

[0054] Next, with reference to FIGS. 4 to 10, the con-

figuration of the fiber guide 31 will be described in more detail. As illustrated in FIGS. 4, 5, and 6A, in the present embodiment, the front end surface 52 and the rear end surface 53 are, for example, flat surfaces orthogonal to the axis 50L. The inlet 54 is formed in the flat front end surface 52, but no protruding portion is formed on the front end surface 52. The outlet 55 is formed on the flat rear end surface 53, but no protruding portion is formed on the rear end surface 53.

[0055] When the needle-shaped member 31b is provided in the fiber guide 31, the needle-shaped member 31b protrudes from the rear end surface 53. Specifically, the needle-shaped member 31b protrudes from the rear end surface 53 by the needle-shaped member 31b being inserted into and fixed to a hole formed on the rear end surface 53. Alternatively, the needle-shaped member 31b and the fiber guide 31 may be configured integrally (as the same member), and in this case, the protruding portion is formed on the rear end surface 53. Further, a concave and/or a recess may be formed on at least one of the front end surface 52 or the rear end surface 53.

[0056] A shape of the main body 50 can be changed as appropriate, but the main body 50 has a substantially cylindrical shape. On an outer peripheral surface of the main body 50, a groove may be formed in a circumferential direction. The main body 50 has the axis 50L which is a center line.

[0057] As illustrated in FIG. 5, the inlet 54 is a long hole extending in a predetermined direction at a position different from the axis 50L. The inlet 54 is, for example, a rectangular long hole extending long in the x direction. The shape of the inlet 54 may be changed as appropriate. The inlet 54 may have any shape and size as long as it is a long hole extending long in a predetermined direction. The "long hole" means that a length of a maximum width of the hole is longer than a length (a height) in a direction orthogonal to a direction of the maximum width. In a case of the present embodiment, the x direction is the direction of the maximum width (the predetermined direction). The inlet 54 includes, for example, a pair of a lower end edge 54a and an upper end edge 54b that are parallel to one another, and a pair of a side end edge 54c and a side end edge 54d that are parallel to one another. The x direction illustrated in FIG. 5 is parallel to a nip line L (see FIG. 3) where the front top roller 17b and the front bottom roller 17a contact with each other. However, the inlet 54 may extend in a direction inclined with respect to the nip line L.

[0058] As illustrated in FIG. 6A, the outlet 55 includes, for example, a pair of a second end edge 62b (a lower end edge) and an upper end edge 55b that are parallel to one another, and a pair of a side end edge 55c and a side end edge 55d that are parallel to one another.

[0059] As illustrated in FIGS. 4, 5, and 6A, the main body 50 of the fiber guide 31 includes the inlet 54 which is a long and thin long hole formed on the front end surface 52, and the fiber passage 60 having a twisted shape in the main body 50. The fiber passage 60 of the main

body 50 is formed to be uniform in left and right regions and to be shallow when viewed from the front end surface 52 side. Whereas, the fiber passage 60 of the main body 50 is formed to be biased to the right region and to be deep when viewed from the rear end surface 53 side.

[0060] In the fiber guide 31 of the present embodiment, in the main body 50, a virtual plane P1 including the axis 50L and equally dividing the inlet 54 is first defined. Then, in the main body 50, a first region A1 located on one side (a right side illustrated in FIG. 5) of the virtual plane P1 and a second region A2 located on another side (a left side illustrated in FIG. 5) of the virtual plane P1 are defined. When the inlet 54 is formed in a symmetrical shape with the virtual plane P1 as a center on the front end surface 52, the virtual plane P1 equally divides the front end surface 52 and substantially equally divides the main body 50. That is, each of the first region A1 and the second region A2 has a shape obtained by dividing a cylinder in half. However, depending on a position and a shape of the inlet 54, the virtual plane P1 may not equally divide the front end surface 52 or the main body 50.

[0061] The fiber passage 60 has a first surface 61, a second surface 62, and a twisted surface 63. The first surface 61 is disposed mostly in the first region A1, and the first surface 61 extends from the inlet 54 toward the outlet 55. The second surface 62 is disposed mostly in the second region A2, and the second surface 62 extends from the inlet 54 toward the outlet 55. The twisted surface 63 connects the first surface 61 and the second surface 62. The first surface 61 is, for example, a flat surface having a triangular shape or a trapezoidal shape. The first surface 61 extends from the inlet 54 toward the outlet 55. The first surface 61 connects a part of the inlet 54 and a part of the outlet 55. The first surface 61 has a wide width at the inlet 54, but the width of the first surface 61 decreases as approaching the outlet 55.

[0062] The second surface 62 is, for example, an elongated trapezoidal flat surface extending in the direction of the axis 50L. The second surface 62 extends from the inlet 54 toward the outlet 55. The second surface 62 connects another part of the inlet 54 and another part of the outlet 55. The second surface 62 has a predetermined width at the inlet 54, and the width of the second surface 62 decreases as approaching the outlet 55 (see also FIG. 10).

[0063] As illustrated in FIG. 5, the lower end edge 54a includes a first end edge 61a, which is an intersection line between the first surface 61 and the front end surface 52, and a second end edge 62a, which is an intersection line between the second surface 62 and the front end surface 52.

[0064] In the present embodiment, an upstream end portion of the first surface 61 is illustrated to coincide with the lower end edge 54a of the inlet 54, but the upstream end portion of the first surface 61 and the lower end edge 54a of the inlet 54 may be separated from each other by a predetermined length. In the present embodiment, an upstream end portion of the second surface 62 is illus-

trated to coincide with the lower end edge 54a of the inlet 54, but the upstream end portion of the second surface 62 and the lower end edge 54a of the inlet 54 may be separated from each other by a predetermined length.

[0065] As for the shape of the second surface 62, various alternative aspects may be adopted. The second surface 62 may include a curved surface or an uneven surface instead of a flat surface. For example, the second surface 62 may have any one characteristic among: a curved surface having a recess somewhere in the fiber travelling direction; a curved surface having a protrusion somewhere in the fiber travelling direction; a curved surface having a recess somewhere in a direction orthogonal to the fiber travelling direction; and a curved surface having a protrusion somewhere in a direction orthogonal to the fiber travelling direction. The second surface 62 may include a flat surface in a part, and include a curved surface or an uneven surface in another part. A shape of a contour of the second surface 62 is not limited to a case where four sides are linear, and at least one side may be a curve, or a plurality of straight lines may be combined. In any mode, the second surface 62 is provided at a height different from that of the first surface 61 in a height direction (a direction along the virtual plane P1) orthogonal to the direction of the axis 50L, which is the fiber travelling direction. More specifically, the second surface 62 is inclined to be away from the first surface 61 as approaching the outlet 55.

[0066] As for the first surface 61 and the second surface 62, "disposed mostly in the first region or the second region" means that, for example, 80% or more of an area of each surface is disposed in any one of the regions. As for at least one of the first surface 61 or the second surface 62, 90% or more of an area of the at least one of the surfaces may be disposed in any one of the regions. Alternatively, as for at least one of the first surface 61 or the second surface 62, the at least one of the surfaces may be entirely arranged in any one of the regions.

[0067] As illustrated in FIG. 8, the first surface 61 is inclined by 5 degrees or less (preferably 2 degrees or less) with respect to the axis 50L. In FIG. 8, since the inclination angle of the first surface 61 is minute, it is difficult to visually recognize the angle. However, for example, the first surface 61 may be inclined so as to approach the axis 50L as approaching the outlet 55, and the inclination angle may be 5 degrees or less than 5 degrees. In this case, the inclination angle of the first surface 61 is a positive angle, and is +5 degrees or less. Alternatively, for example, the first surface 61 may be inclined to be away from the axis 50L as approaching the outlet 55, and the inclination angle may be 5 degrees or less than 5 degrees. In this case, the inclination angle of the first surface 61 is a negative angle, and is -5 degrees or more and less than 0 degrees. "The first surface is inclined at 5 degrees or less with respect to the axis" described in the claims means that an absolute value of the inclination angle is 5 degrees or less, and includes any of the above inclinations. The inclination angle of the

first surface 61 is an angle appearing in a cross section of FIG. 8. In other words, the inclination angle of the first surface 61 is an angle of an intersection line between the first surface 61 and the virtual plane P1 (or a plane parallel to the virtual plane P1) with respect to the axis 50L.

[0068] The second surface 62 is inclined at 5 degrees or more and 30 degrees or less (preferably 15 degrees or more and 25 degrees or less) with respect to the axis 50L. The second surface 62 is inclined at the above-described positive inclination angle, and thus, is away from the first surface 61 as approaching the outlet 55. When the second surface 62 is a flat surface, the inclination angle of the second surface 62 with respect to the axis 50L is constant (see FIG. 7), and is, for example, 5 degrees or more and 30 degrees or less (see an angle θ_2 illustrated in FIG. 8). When the second surface 62 includes a partially flat surface, an inclination angle of the flat surface may be set as the inclination angle of the second surface 62. Alternatively, an average of inclination angles of each section of the second surface 62 may be set as the inclination angle of the second surface 62.

[0069] Further, from another point of view, the second surface 62 is inclined by, for example, 10 degrees or more and 25 degrees or less with respect to the first surface 61.

[0070] As illustrated in FIGS. 7 and 9, the twisted surface 63 has a shape twisted with respect to an extending direction of the axis 50L. The twisted surface 63 has a configuration in which a curved surface and a flat surface are combined, and these surfaces are twisted with respect to the axis 50L as a whole. A twisting direction from the inlet 54 toward the outlet 55 coincides with the nozzle air rotation direction R. More specifically, as illustrated in FIG. 6B, the twisted surface 63 has a flat third surface 66 formed between the first surface 61 and the second surface 62. Between the third surface 66 and the first surface 61, a curved surface connecting the third surface 66 and the first surface 61 is provided. Between the third surface 66 and the second surface 62, a curved surface connecting the third surface 66 and the second surface 62 is provided.

[0071] Next, with reference to FIGS. 6A to 10, each configuration of the second surface 62 and the outlet 55 will be described in more detail.

[0072] In the fiber guide 31, an area of a first portion 55-1 included in the first region A1 in the outlet 55 is smaller than an area of a second portion 55-2 included in the second region A2 in the outlet 55 (see FIG. 6B). More specifically, at the outlet 55, for example, a size of the area of the first portion 55-1 is 1/2 or less of a size of the area of the second portion 55-2. The size of the area of the first portion 55-1 may be 1/5 or less or 1/10 or less of the size of the area of the second portion 55-2.

[0073] FIG. 7 is a perspective view of the fiber guide 31 taken along line VII-VII of FIG. 6A. FIG. 8 is a cross-sectional view of the fiber guide 31 taken along line VII-VII of FIG. 6A. FIG. 10 is a cross-sectional view of the fiber guide 31 taken along line X-X of FIG. 8. As illustrated in FIG. 10, a width of the second surface 62 in the x di-

rection (a direction in which the inlet 54 extends long) gradually decreases from the inlet 54 toward the outlet 55. A minimum width portion W_{min} in which the width of the second surface 62 in the x direction is minimum is provided at the outlet 55.

[0074] The third surface 66 is provided with an inclined end edge 66b constituting a part of the outlet 55. The first surface 61 is provided with a first end edge 61b constituting a part of the outlet 55. As illustrated in FIG. 6A, on the rear end surface 53, a virtual extension line of the inclined end edge 66b forms an angle of, for example, 100 degrees or more and 130 degrees or less with respect to a virtual extension line of the first end edge 61b (see an angle α illustrated in FIG. 6B). Here, the inclined end edge 66b is an intersection line between the third surface 66 and the rear end surface 53. The first end edge 61b is an intersection line between the first surface 61 and the rear end surface 53.

[0075] Between the first end edge 61b and the inclined end edge 66b, a first arc-shaped portion 67 is provided. The first arc-shaped portion 67 connects the first end edge 61b and the inclined end edge 66b. A length of the first arc-shaped portion 67 is shorter than a length of the first end edge 61b. On the second surface 62, a part of the outlet 55 is constituted by a fourth end edge 69 (the second end edge 62b). Between the inclined end edge 66b and the fourth end edge 69 (the second end edge 62b), a second arc-shaped portion 68 is provided. The second end edge 62b is an intersection line between the second surface 62 and the rear end surface 53. A length of the second arc-shaped portion 68 is shorter than a length of the inclined end edge 66b. The first arc-shaped portion 67 and the second arc-shaped portion 68 are formed in the main body 50 so as to protrude into the fiber passage 60.

[0076] An end edge 63b constitutes a part of the outlet 55, and is an intersection line between the twisted surface 63 and the rear end surface 53. The end edge 63b includes the inclined end edge 66b, the first arc-shaped portion 67 and the second arc-shaped portion 68, and the fourth end edge 69.

[0077] When a virtual plane including the axis 50L and being parallel to the first end edge 61b is defined as another virtual plane P2, a distance between the first end edge 61b and the another virtual plane P2 is, for example, 1 mm or more and 3 mm or less (see a distance D1 illustrated in FIG. 6B). Since the first surface 61 extends substantially parallel or at a slight inclination angle with respect to the axis 50L, the first end edge 61b is located above the axis 50L (on a side of the inlet 54).

[0078] When a virtual plane including the axis 50L and being parallel to the second end edge 62b is defined as another virtual plane P2, a distance between the second end edge 62b and the another virtual plane P2 is 1.5 mm or less (see a distance D2 illustrated in FIG. 6B). The second end edge 62b is located on an opposite side of the inlet 54 with respect to the another virtual plane P2.

[0079] The another virtual plane P2 parallel to the first

end edge 61b and the another virtual plane P2 parallel to the second end edge 62b are common when the first end edge 61b and the second end edge 62b are parallel (both extend in the x direction), but are different virtual planes when the first end edge 61b and the second end edge 62b are not parallel. The "distance" means a shortest distance between a straight line and a plane.

[0080] According to the fiber guide 31, the air-jet spinning device 7, and the spinning unit 2 of the present embodiment, the fiber bundle F is introduced from the inlet 54 of the front end surface 52. As the fiber bundle F travels along the first surface 61 and the second surface 62 of the fiber passage 60 and approaches the outlet 55, the fiber bundle F converges to the vicinity of the second surface 62 (see FIG. 11). While the first surface 61 is substantially parallel (parallel or at a slight angle) to the axis 50L, the second surface 62 is inclined at a relatively large angle with respect to the axis 50L. At the outlet 55, an area of the second portion 55-2 included in the second region A2 is relatively large. These configurations make it possible to accomplish convergence of the fiber bundle F while applying tension to the entire fiber bundle F. As a result, the fiber loss can be reduced.

[0081] According to the fiber guide 31 of the present embodiment, the fiber bundle F is introduced from the inlet 54 of the front end surface 52. As the fiber bundle F travels along the first surface 61 and the second surface 62 of the fiber passage 60 and approaches the outlet 55, the fiber bundle F converges to the vicinity of the second surface 62 (see FIG. 11). The second surface 62 is inclined to be away from the first surface 61 as approaching the outlet 55. The minimum width portion W_{min} of the second surface 62 is provided at the outlet 55. This configuration makes it possible to accomplish convergence of the fiber bundle F while applying tension to the entire fiber bundle F. As a result, the fiber loss can be reduced.

[0082] At the outlet 55, the size of the area of the first portion 55-1 is 1/2 or less of the size of the area of the second portion 55-2. Therefore, since 2/3 or more of the size of the area of the outlet 55 is formed in the second region A2 where the second surface 62 exists, the fiber bundle F converges more easily.

[0083] The rear end surface 53 is flat. Accordingly, a certain distance can be maintained between the hollow guide shaft body 34 and the fiber guide 31 included in the air-jet spinning device 7. That is, the fiber guide 31 and the hollow guide shaft body 34 are not too close to each other. Therefore, for example, even when a foreign substance or the like is mixed, reversal of a rear end of fibers of the fiber bundle F is not inhibited, and the rear end of the fibers can be favorably reversed.

[0084] The second surface 62 is inclined at 10 degrees or more and 25 degrees or less with respect to the first surface 61. As a result, introduction of the fiber bundle F on the first surface 61 and guiding (that is, reversal and convergence) of the fiber bundle F to the second surface 62 are favorably performed.

[0085] When viewed from the rear end surface 53, a

virtual extension line of the inclined end edge 66b of the third surface 66 forms an angle of 100 degrees or more and 130 degrees or less with respect to a virtual extension line of the first end edge 61b. This allows the fiber bundle F to be smoothly moved when the fiber bundle F travels from the first surface 61 to the third surface 66.

[0086] Since the first arc-shaped portion 67 is provided between the first end edge 61b and the inclined end edge 66b, a portion between two sides at the outlet 55 is not a pin corner. Therefore, tension can be applied to the fiber bundle F while the fiber bundle F converges smoothly.

[0087] A length of the first arc-shaped portion 67 is shorter than a length of the first end edge 61b. With a suitable balance between the first end edge 61b of the first surface 61 and the first arc-shaped portion 67, application of tension to the fiber bundle F and convergence of the fiber bundle F are smoothly performed.

[0088] The second arc-shaped portion 68 is provided between the inclined end edge 66b and the second end edge 62b, and a length of the second arc-shaped portion 68 is shorter than a length of the inclined end edge 66b. With a suitable balance between the inclined end edge 66b of the third surface 66 and the second arc-shaped portion 68, the fiber bundle F can be smoothly moved.

[0089] A distance between the first end edge 61b and the another virtual plane P2 is 1 mm or more and 3 mm or less (see the distance D1 illustrated in FIG. 6B). As a result, a height from the axis 50L to the first surface 61 is obtained, and the fiber bundle F can be smoothly moved to the third surface 66 while tension is appropriately applied to the fiber bundle F.

[0090] According to the configuration in which the twisted surface 63 is provided between the first surface 61 and the second surface 62, since the fiber bundle F travels along the twisted surface 63, the fiber bundle F is favorably reversed.

[0091] The minimum width portion Wmin of the second surface 62 is provided at the outlet 55. Therefore, the fiber bundle F can be converged most in the vicinity of the outlet 55.

[0092] A distance between the second end edge 62b and the another virtual plane P2 is 1.5 mm or less (see the distance D2 illustrated in FIG. 6B). As a result, since the fibers travel near the axis 50L, the fibers can be smoothly introduced into the hollow guide shaft body 34.

[0093] The second end edge 62b is located on an opposite side of the inlet 54 with respect to the another virtual plane P2. This makes it possible to favorably reverse the rear end of the fibers of the fiber bundle F fed from the fiber guide 31, while appropriately restraining the fiber bundle F.

[0094] One embodiment of the present invention has been described, but the present invention is not limited to the above-described embodiment. The above-described embodiment and the following alternative embodiments may be appropriately combined.

[0095] The nozzle air rotation direction R in the fiber

guide 31 may be opposite to that in the above-described embodiment. In that case, the arrangement of the first region A1 and the second region A2 can also be reversed from that in the above-described embodiment. That is, when viewed from the front end surface 52 side illustrated in FIG. 5, the first region A1 is located on a left side, and the second region A2 is located on a right side. When viewed from the rear end surface 53 side illustrated in FIG. 6A, the first region A1 is located on a right side, and the second region A2 is located on a left side. The first surface 61 is disposed mostly in the first region A1, and the second surface 62 is disposed mostly in the second region A2.

[0096] In the above-described embodiment, a mode in which the second end edge 62b is located on the opposite side of the inlet 54 with respect to the another virtual plane P2 has been described as an example. However, the second end edge 62b may be located on the same side as the inlet 54 with respect to the another virtual plane P2. In this case, a distance between the second end edge 62b and the another virtual plane P2 may be 1.5 mm or less.

[0097] In the outlet 55, the minimum width portion Wmin at which the width of the second surface 62 in the x direction is minimum may be provided inside the main body 50 (somewhere along the path, at a portion located at the middle of, preferably closer to the outlet 55 by 1/4 of a length of the second surface 62 in the fiber travelling direction), instead of the most downstream end of the outlet 55. In this case, the second end edge 62b wider than the minimum width portion Wmin may extend to the vicinity of the virtual plane P1 or may extend beyond the virtual plane P1. A shape of a lower part of the outlet 55 may be expanded.

[0098] The present invention is not limited to the mode in which the first end edge 61b and the inclined end edge 66b are connected by the first arc-shaped portion 67. The first arc-shaped portion 67 may be omitted, and the first end edge 61b and the inclined end edge 66b may be connected at a predetermined angle.

[0099] The present invention is not limited to the mode in which the inclined end edge 66b and the fourth end edge 69 are connected by the second arc-shaped portion 68. The second arc-shaped portion 68 may be omitted, and the inclined end edge 66b and the fourth end edge 69 may be connected at a predetermined angle.

[0100] At least one of the first surface 61 or the second surface 62 may include an uneven shape (with a concave and/or a recess). In FIGS. 5, 6A, and the like, the inlet 54 and the outlet 55 are illustrated to have a right angle portion at a corner portion. However, at least one of the corner portions of the inlet 54 and the outlet 55 may have an arc shape (a shape protruding in an arc shape toward inside the fiber passage 60).

[0101] In the above-described embodiment, a mode in which the draft device 6 includes the pair of back rollers 14, the pair of third rollers 15, the pair of middle rollers 16, and the pair of front rollers 17 has been described by

way of example. However, one or more pairs of rollers may be provided upstream of the pair of back rollers 14. Further, the pair of front rollers 17 (a pair of rollers arranged at a position closest to the air-jet spinning device 7 in a conveyance path of the fiber bundle F) may be configured as a part of another device. For example, the spinning unit 2 may include a supplying device configured to supply the fiber bundle F drafted by the draft device 6 to the air-jet spinning device 7, and the pair of front rollers 17 may be included in a part of the supplying device. The pair of front rollers 17 may be included in the draft device 6 configured to draft the fiber bundle S or the supply device configured to supply the fiber bundle F to the air-jet spinning device 7, or may be provided alone without being included in other devices.

[0102] In the spinning unit 2, the yarn accumulating device 11 has a function of withdrawing the yarn Y from the air-jet spinning device 7, but the yarn Y may be withdrawn from the air-jet spinning device 7 with a delivery roller and a nip roller. In a case of withdrawing the yarn Y from the air-jet spinning device 7 with the delivery roller and the nip roller, a slack tube using suction airflow or a mechanic compensator, and/or the like may be provided instead of the yarn accumulating device 11 or in addition to the yarn accumulating device 11.

[0103] In the spinning unit 2, instead of the configuration in which two yarn ends are connected by the yarn joining device 26, the yarn Y from the air-jet spinning device 7 and the yarn Y of the package P may be connected (subjected to piecing) by inserting the yarn Y from the package P into the air-jet spinning device 7 and starting a draft operation of the draft device 6 and a spinning operation of the air-jet spinning device 7.

[0104] In the spinning machine 1, each device is arranged such that the yarn Y supplied at an upper side is wound at a lower side in a direction of a machine height. However, each device may be arranged such that the yarn Y supplied at the lower side is wound at the upper side.

[0105] In the spinning machine 1, at least one of the bottom rollers in the draft device 6, and the traverse guide 23 are driven by power from the second end frame 5 (that is, in common with the plurality of spinning units 2). However, each section (for example, a draft device, a spinning device, a winding device, or the like) of the spinning unit 2 may be driven independently for each spinning unit 2.

[0106] In the travelling direction of the yarn Y, the tension sensor 9 may be arranged upstream of the yarn monitoring device 8. The unit controller 10 may be provided for every spinning unit 2. In the spinning unit 2, the waxing device 12, the tension sensor 9, and the yarn monitoring device 8 may be omitted. When the wax is not applied to the yarn Y, the wax alone may be removed from the waxing device 12 without omitting the waxing device 12.

[0107] FIG. 1 illustrates that the spinning machine 1 winds a cheese package P, but the spinning machine 1 can also wind a conical package. In a case of the conical

package, slackening of the yarn Y occurs by traversing of the yarn Y, but the slackening can be absorbed with the yarn accumulating device 11. A material and a shape of each component are not limited to the above-described material and shape, and various materials and shapes can be adopted.

Claims

1. A fiber guide (31) to be applied to a pneumatic spinning device (7), the fiber guide (31) comprising:

a main body (50) having a front end surface (52) and a rear end surface (53) in a direction of an axis (50L); and
a fiber passage (60) formed in the main body (50) and connecting an inlet (54) formed on the front end surface (52) and an outlet (55) formed on the rear end surface (53),
wherein the inlet (54) is a long hole extending in a predetermined direction at a position different from the axis (50L),
in the main body (50), when a first region (A1) located on one side and a second region (A2) located on another side with respect to a virtual plane (P1) including the axis (50L) and equally dividing the inlet (54) are defined,
the fiber passage (60) includes:

a first surface (61) disposed mostly in the first region (A1) and extending to be inclined from the inlet (54) toward the outlet (55); and
a second surface (62) disposed mostly in the second region (A2) and extending to be inclined from the inlet (54) toward the outlet (55),
the second surface (62) is inclined to be away from the first surface (61) as approaching the outlet (55),
the first surface (61) is inclined at 5 degrees or less with respect to the axis (50L),
the second surface (62) is inclined at 5 degrees or more and 30 degrees or less with respect to the axis (50L), and
in the outlet (55), an area of a first portion (55-1) included in the first region (A1) is smaller than an area of a second portion (55-2) included in the second region (A2).

2. A fiber guide (31) to be applied to a pneumatic spinning device (7), the fiber guide (31) comprising:

a main body (50) having a front end surface (52) and a rear end surface (53) in a direction of an axis (50L); and
a fiber passage (60) formed in the main body (50) and connecting an inlet (54) formed on the

front end surface (52) and an outlet (55) formed on the rear end surface (53), wherein the inlet (54) is a long hole extending in a predetermined direction at a position different from the axis (50L), in the main body (50), when a first region (A1) located on one side and a second region (A2) located on another side with respect to a virtual plane (P1) including the axis (50L) and equally dividing the inlet (54) are defined, the fiber passage (60) includes:

a first surface (61) disposed mostly in the first region (A1) and extending from the inlet (54) toward the outlet (55); and
a second surface (62) disposed mostly in the second region (A2) and extending from the inlet (54) toward the outlet (55), the second surface (62) is inclined to be away from the first surface (61) as approaching the outlet (55), and
a minimum width portion (Wmin) where a width of the second surface (62) in a predetermined direction is minimum is provided at the outlet (55).

3. The fiber guide (31) as claimed in claim 1, wherein, at the outlet (55), a size of the first portion (55-1) is 1/2 or less of a size of the second portion (55-2).
4. The fiber guide (31) as claimed in any one of claims 1 to 3, wherein the rear end surface (53) is flat.
5. The fiber guide (31) as claimed in any one of claims 1 to 4, wherein the second surface (62) is inclined at 10 degrees or more and 25 degrees or less with respect to the first surface (61).
6. The fiber guide (31) as claimed in any one of claims 1 to 5, wherein

the fiber passage (60) has a third surface (66) that is flat and is formed between the first surface (61) and the second surface (62), and when an end edge constituting a part of the outlet (55) in the first surface (61) is defined as a first end edge (61b), and an end edge constituting a part of the outlet (55) in the third surface (66) is defined as an inclined end edge (66b), on the rear end surface (53), a virtual extension line of the inclined end edge (66b) forms an angle of 100 degrees or more and 130 degrees or less with respect to a virtual extension line of the first end edge (61b).

7. The fiber guide (31) as claimed in claim 6, wherein, between the first end edge (61b) and the inclined end edge (66b), a first arc shaped portion (67) is

provided.

8. The fiber guide (31) as claimed in claim 7, wherein

the first arc shaped portion (67) connects the first end edge (61b) and the inclined end edge (66b), and
a length of the first arc shaped portion (67) is shorter than a length of the first end edge (61b).

9. The fiber guide (31) as claimed in any one of claims 6 to 8, wherein

when an end edge constituting a part of the outlet (55) in the second surface (62) is defined as a second end edge (62b),
between the inclined end edge (66b) and the second end edge (62b), a second arc-shaped portion (68) is provided, and
a length of the second arc-shaped portion (68) is shorter than a length of the inclined end edge (66b).

10. The fiber guide (31) as claimed in any one of claims 6 to 9, wherein a distance (D1) between the first end edge (61b) and a first another virtual plane (P2) including the axis (50L) and being parallel to the first end edge (61b) is 1 mm or more and 3 mm or less.

11. The fiber guide (31) as claimed in any one of claims 1 to 10, wherein, between the first surface (61) and the second surface (62), a twisted surface (63) having a shape twisted with respect to an extending direction of the axis (50L) is formed, and the first surface (61) and the second surface (62) are connected by the twisted surface (63).

12. The fiber guide (31) as claimed in claim 1, wherein a minimum width portion (Wmin) where a width of the second surface (62) in a predetermined direction is minimum is provided at the outlet (55).

13. The fiber guide (31) as claimed in any one of claims 1 to 12, wherein

when an end edge constituting a part of the outlet (55) in the second surface (62) is defined as a second end edge (62b), and
a virtual plane (P1) including the axis (50L) and being parallel to the second end edge (62b) is defined as a second another virtual plane (P2), a distance between the second end edge (62b) and the second another virtual plane (P2) is 1.5 mm or less.

14. The fiber guide (31) as claimed in claim 13, wherein the second end edge (62b) is located on an opposite side of the inlet (54) with respect to the second an-

other virtual plane (P2).

15. The fiber guide (31) as claimed in any one of claims 1 to 14, wherein

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the main body (50) has a substantially cylindrical shape, and
the axis (50L) is a center line passing through a center of the substantially cylindrical shape.

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16. A pneumatic spinning device (7) comprising:

the fiber guide (31) as claimed in any one of claims 1 to 15;

a nozzle block (38) in which a nozzle (33) is formed; and

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a hollow guide shaft body (34) having a distal end portion arranged in a spinning chamber (32) formed between the fiber guide (31) and the nozzle block (38).

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17. A pneumatic spinning unit (2) comprising:

the pneumatic spinning device (7) as claimed in any one of claims 1 to 16;

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a draft device (6) arranged upstream of the pneumatic spinning device (7) and adapted to draft a fiber bundle (F) to be supplied to the pneumatic spinning device (7); and

a winding device (13) arranged downstream of the pneumatic spinning device (7) and adapted to wind a yarn (Y) produced by the pneumatic spinning device (7).

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FIG. 1

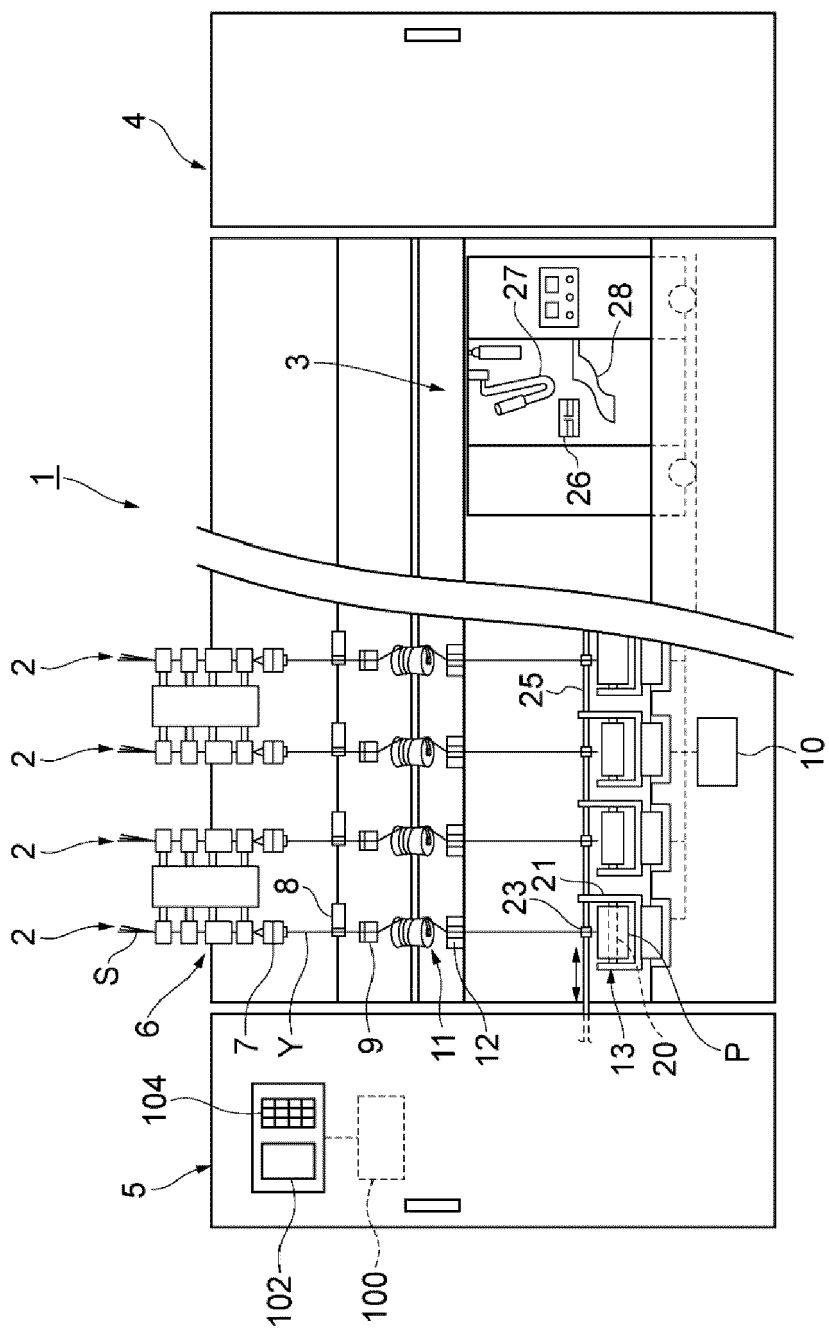


FIG. 2

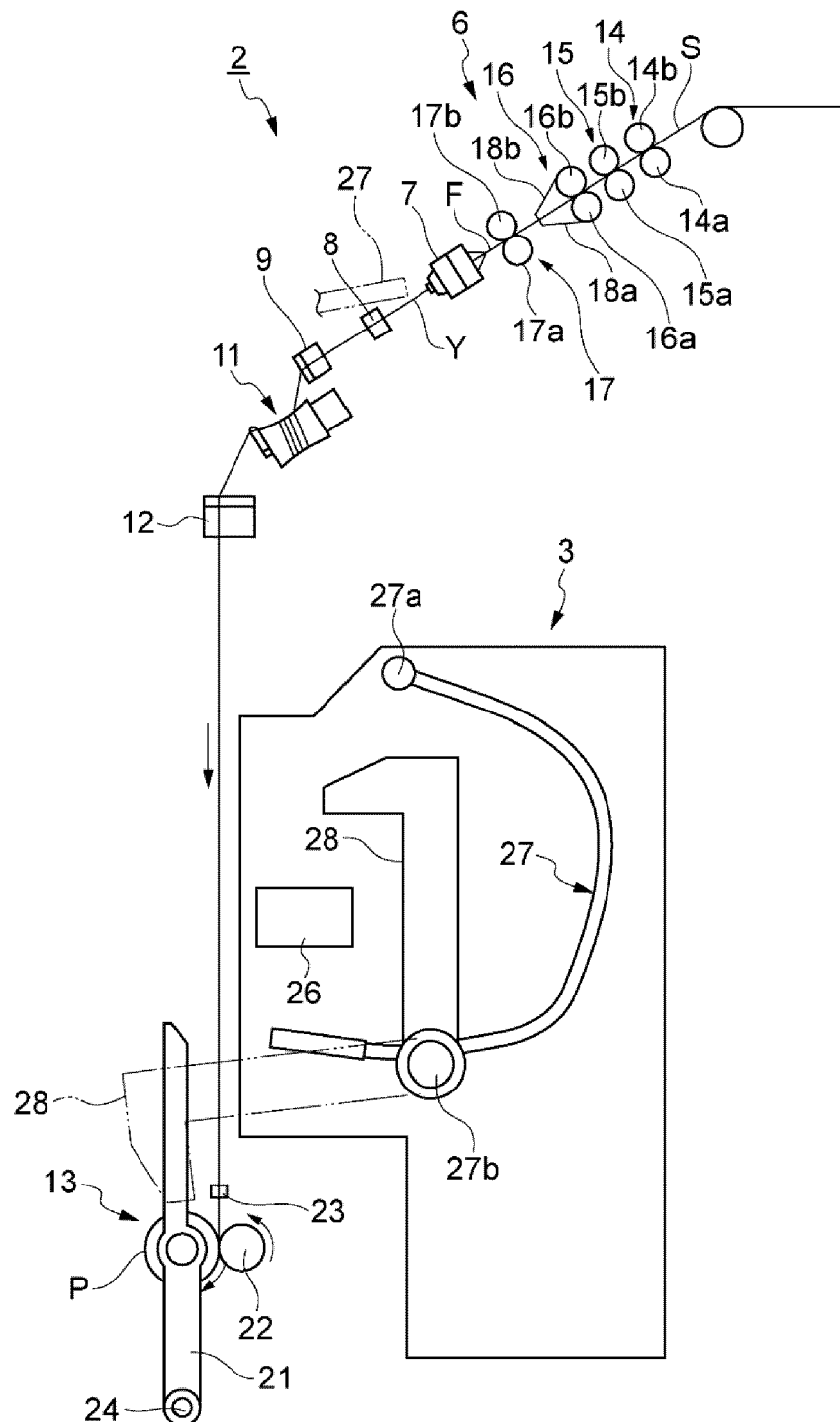


FIG. 3

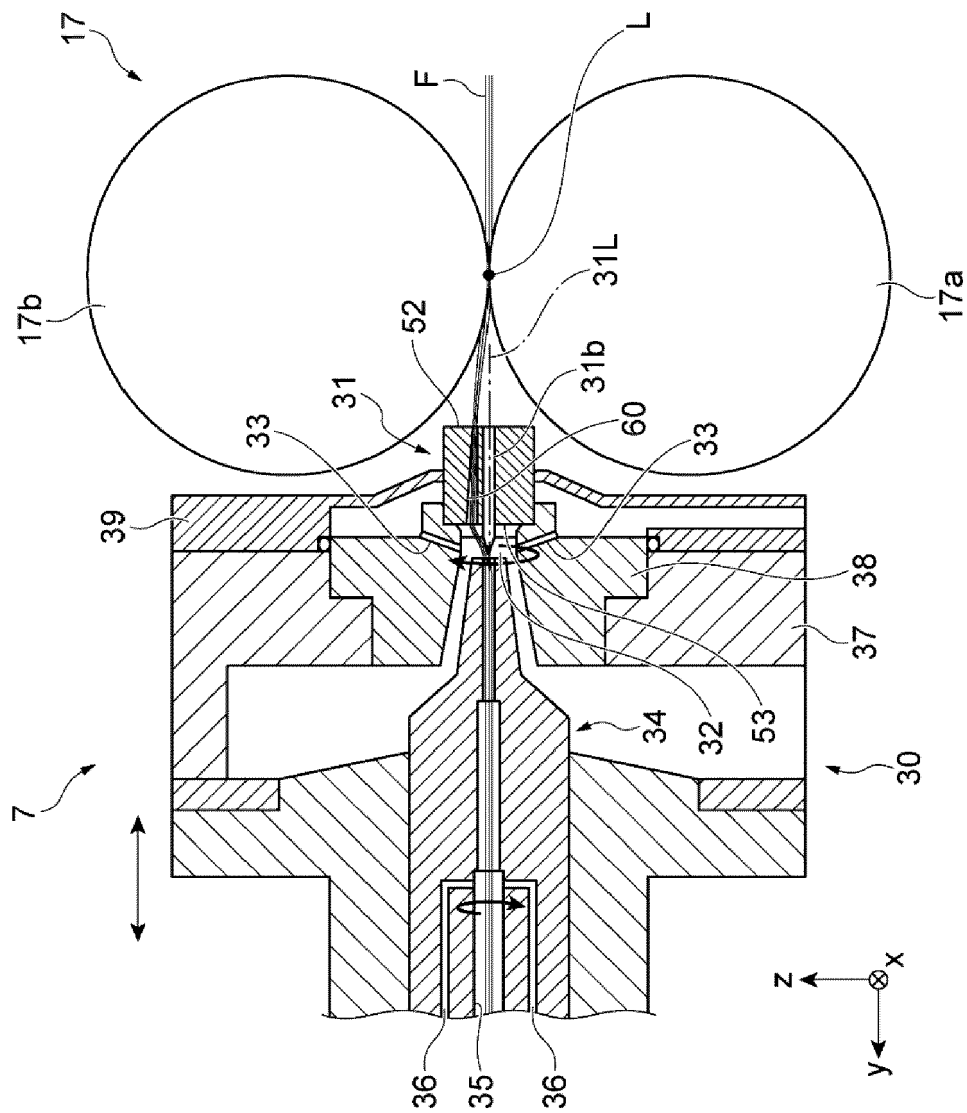


FIG. 4

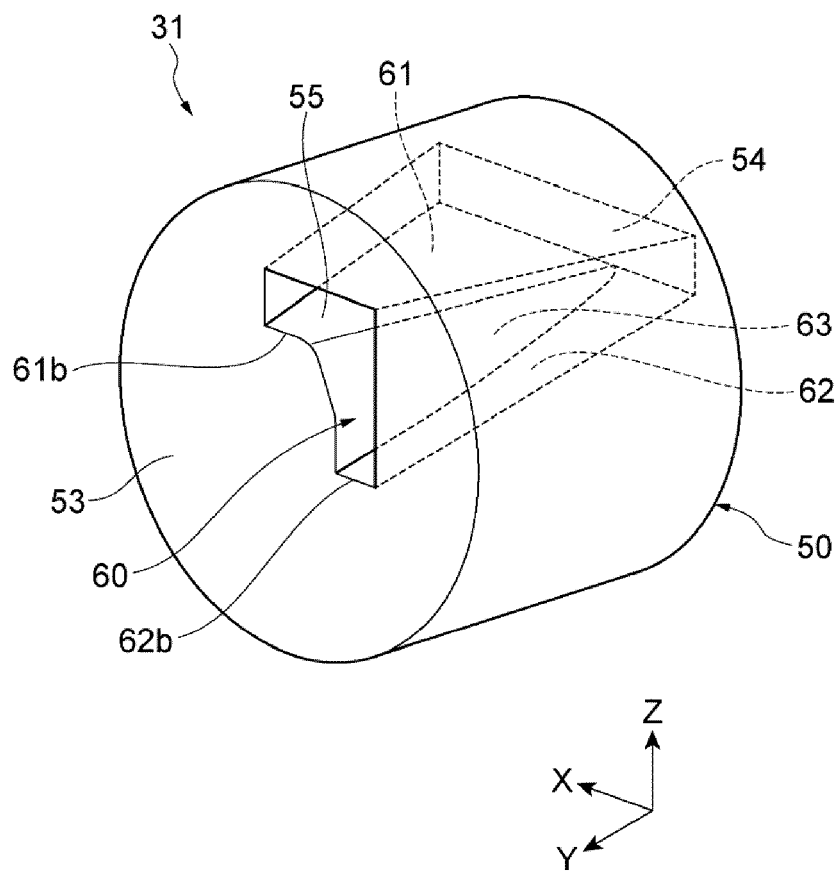


FIG. 5

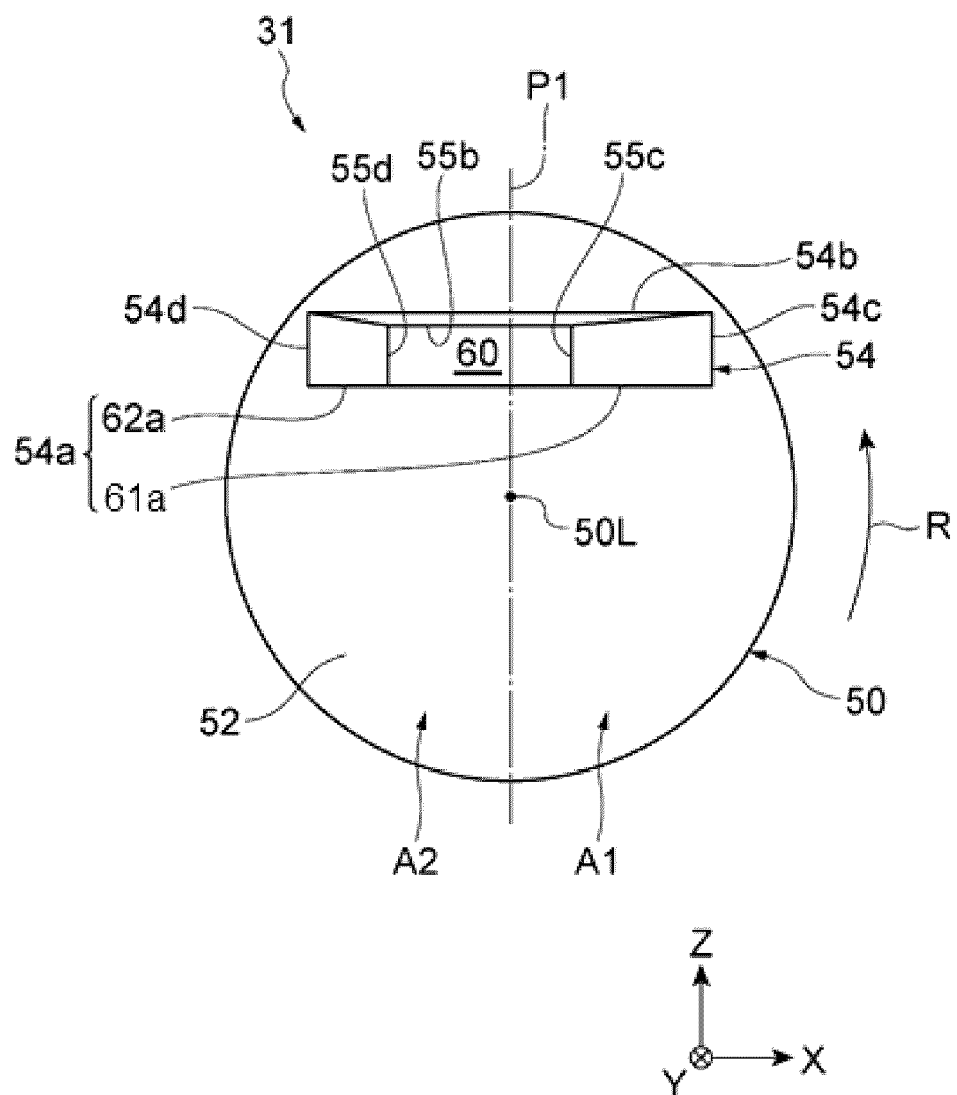


FIG. 6A

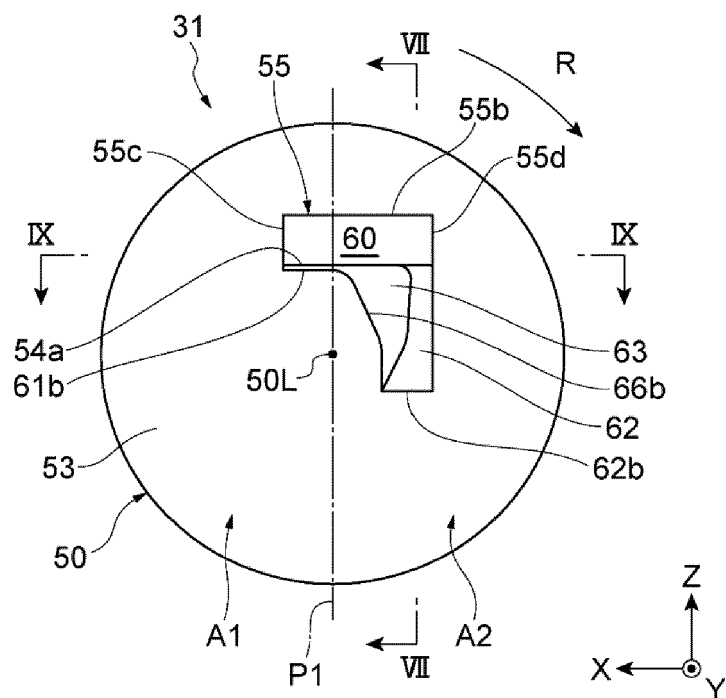


FIG. 6B

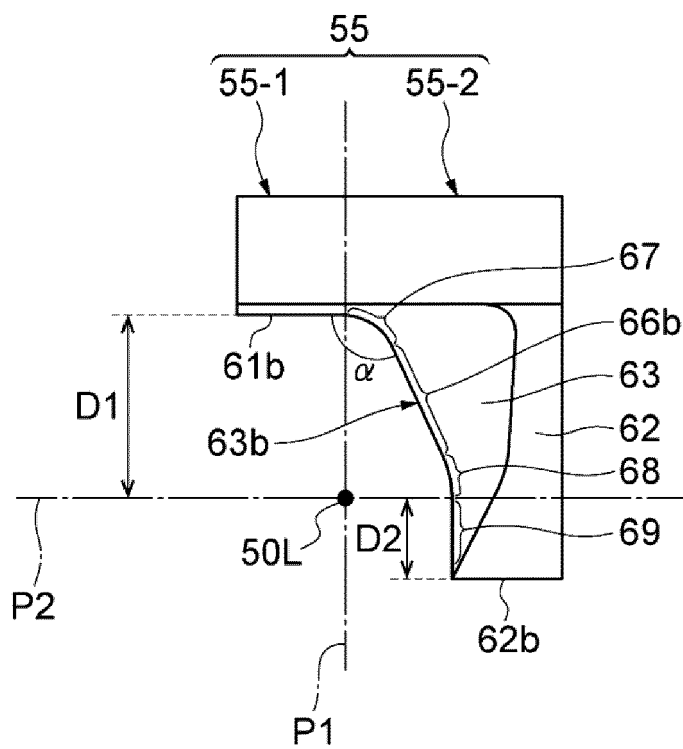


FIG. 7

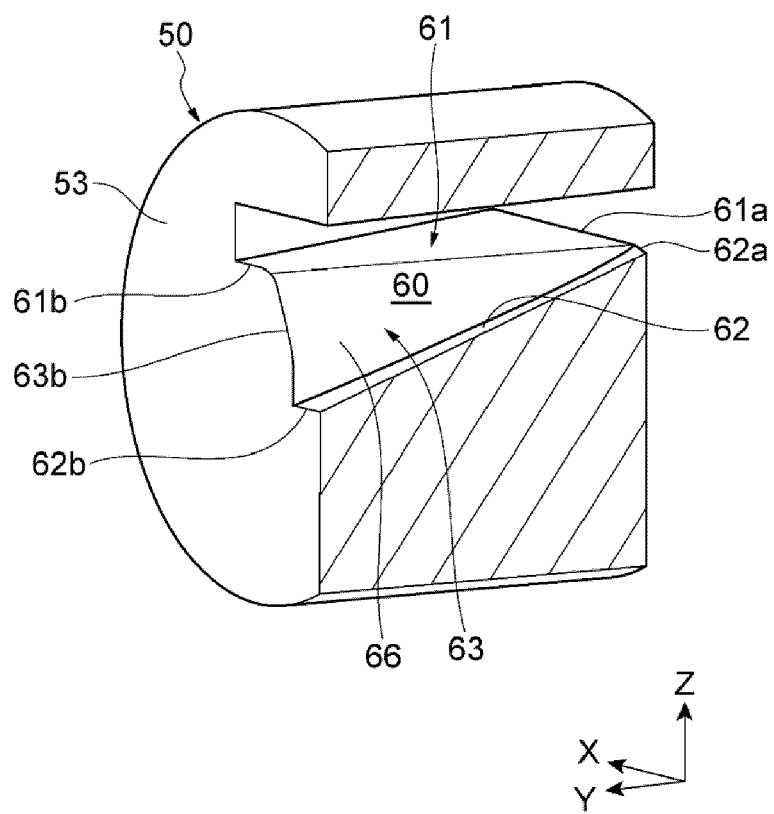


FIG. 8

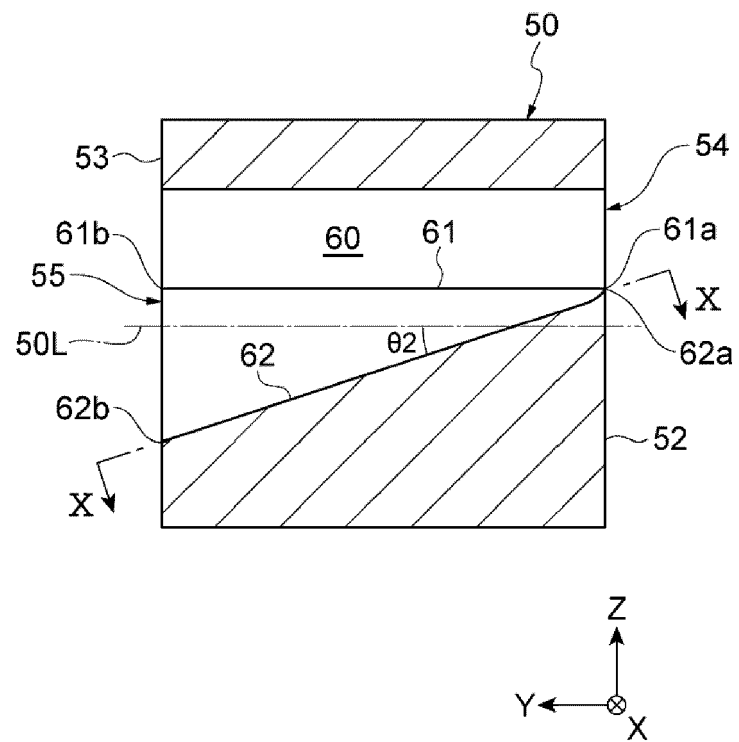


FIG. 9

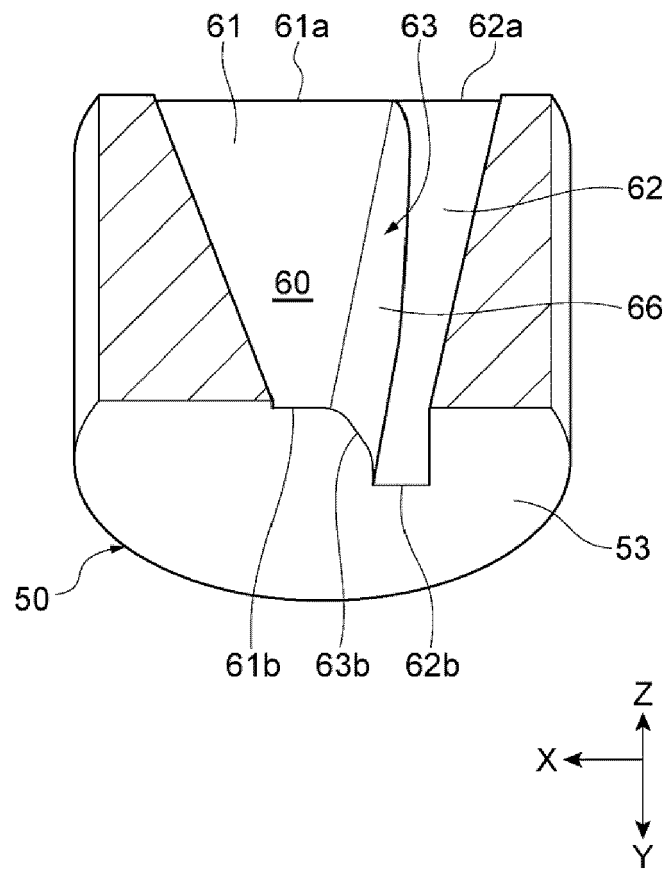


FIG. 10

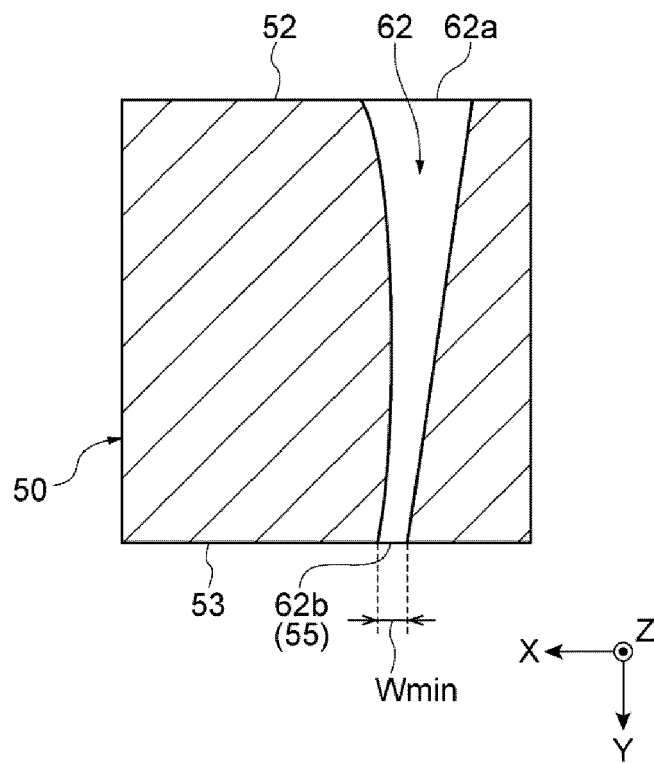
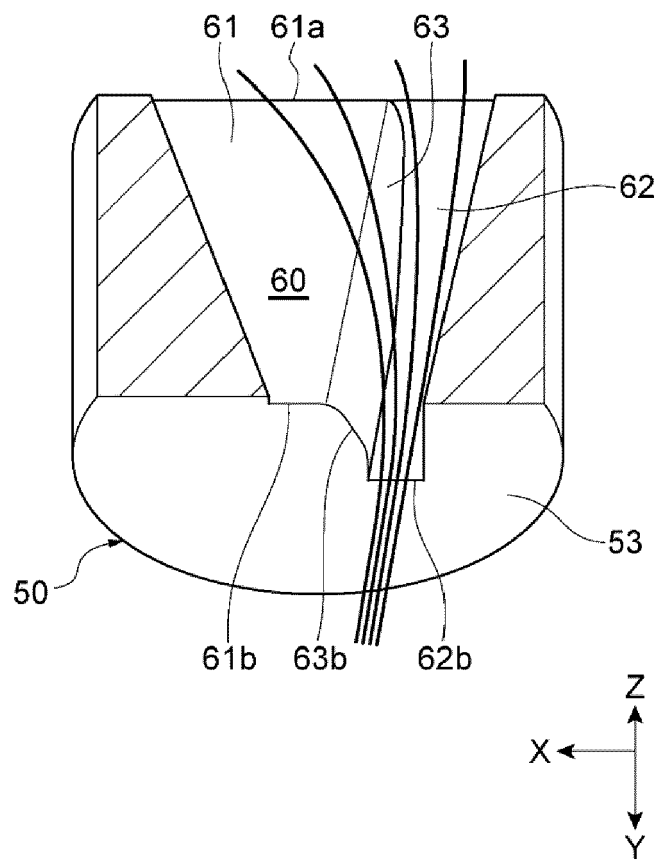


FIG. 11





EUROPEAN SEARCH REPORT

Application Number

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Place of search Munich	Date of completion of the search 6 December 2022	Examiner Humbert, Thomas
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		
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