



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
16.05.2012 Bulletin 2012/20

(51) Int Cl.:
D01H 4/02 (2006.01) D01H 1/115 (2006.01)

(21) Application number: **11187855.9**

(22) Date of filing: **04.11.2011**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(72) Inventor: **Morita, Akihiro**
Kyoto-shi, Kyoto 612-8686 (JP)

(74) Representative: **Zimmermann, Tankred Klaus**
Patentanwälte Schoppe, Zimmermann, Stöckeler, Zinkler & Partner
Postfach 246
82043 Pullach (DE)

(30) Priority: **10.11.2010 JP 2010252278**

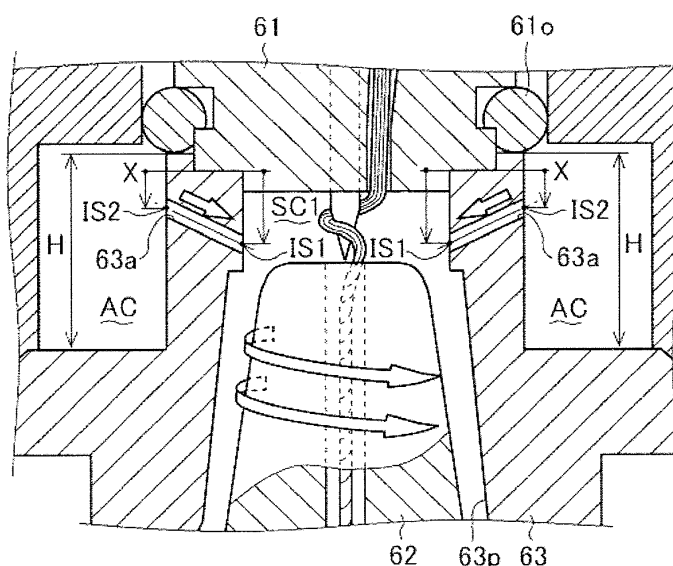
(71) Applicant: **Murata Machinery, Ltd.**
Minami-ku
Kyoto-shi
Kyoto 601-8326 (JP)

(54) **Air spinning device, spinning unit, and spinning method using the air spinning device**

(57) An air spinning device (6) includes a nozzle block (63) that includes a through hole (63p) that partially defines a spinning chamber (SC), and an air hole (63a) that is communicable with the spinning chamber (SC); a fiber guide (61) in which a fiber introducing passage (61g) that is communicable with the spinning chamber (SC) is defined; and a spindle (62) in which a fiber passageway (62s) that is communicable with the spinning chamber

(SC) is defined. The air spinning device (6) spins a spun yarn (Y) from a fiber bundle (F) by supplying air from the air hole (63a) into the spinning chamber (SC). The air hole (63a) is located such that a point of intersection (IS1) between a central axis of the air hole (63a) and a wall surface of the through hole (63p) is in a range of greater than or equal to 3 mm to less than or equal to 10 mm from a contact surface between the nozzle block (63) and the fiber guide (61).

FIG. 10



Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention generally relates to an air spinning device, and in particular relates to an air spinning device capable of easily performing spinning of a yarn according to fiber characteristics. Furthermore, the present invention relates to a spinning unit that includes the air spinning device, and a spinning method performed using the air spinning device.

2. Description of the Related Art

[0002] Air spinning devices that produce a spun yarn by twisting a fiber bundle by utilizing a swirling airflow are known in the art. Such an air spinning device supplies air into a spinning chamber to generate a swirling airflow that causes fibers, which form a fiber bundle, to swing, thereby producing a spun yarn (see, for example, Japanese published unexamined applications 2003-193337 and H6-41822).

SUMMARY OF THE INVENTION

[0003] It is an object of the present invention to provide an air spinning device in which a capacity of a spinning chamber can be easily adjusted according to fiber characteristics when using fiber bundles of different fiber characteristics for producing spun yarns to enable easy spinning according to the fiber characteristics. It is a further object of the present invention to provide a spinning unit, which includes the air spinning device, and a spinning method performed by using the air spinning device.

[0004] According to one aspect of the present invention, an air spinning device that spins a spun yarn from a fiber bundle by supplying air from an air hole into a spinning chamber includes a nozzle block that includes a through hole that partially defines the spinning chamber, and the air hole that is communicable with the spinning chamber; a fiber guide in which a fiber introducing passage that is communicable with the spinning chamber is defined; and a spindle in which a fiber passageway that is communicable with the spinning chamber is defined. The air hole is positioned such that a point of intersection of a central axis of the air hole and a wall surface of the through hole falls in a range of greater than or equal to 3 mm to less than or equal to 10 mm from a contact surface at which a downstream end surface of the fiber guide in a yarn feeding direction is received by an upstream end surface of the nozzle block in the yarn feeding direction.

[0005] According to another aspect of the present invention, an air spinning device that spins a spun yarn from a fiber bundle by supplying air from an air hole into a spinning chamber includes a nozzle block that includes

a through hole that partially defines the spinning chamber, and the air hole that is communicable with the spinning chamber; a fiber guide in which a fiber introducing passage that is communicable with the spinning chamber is defined; and a spindle in which a fiber passageway that is communicable with the spinning chamber is defined. The fiber guide has either a projection that is engagable with the through hole, and a capacity of the spinning chamber is adjustable by replacing the fiber guide with another fiber guide having a projection of a different length, or a recess that is communicable to the through hole, and a capacity of the spinning chamber is adjustable by replacing the fiber guide with another fiber guide having a recess of a different depth.

[0006] According to still another aspect of the present invention, a spinning unit includes the air spinning device according to any one of the above aspects; an air storage chamber that stores therein air to be supplied to the spinning chamber via the air hole; and a winding device that winds a spun yarn produced by spinning the spun yarn from a fiber bundle by supplying the air from the air storage chamber, and forms a package.

[0007] According to still another aspect of the present invention, a spinning method for performing spinning of a spun yarn from a fiber bundle by supplying air from an air hole into a spinning chamber is executed by using an air spinning device. The air spinning device includes a nozzle block that includes a through hole that partially defines the spinning chamber, and the air hole that is communicable with the spinning chamber; a fiber guide in which a fiber introducing passage that is communicable with the spinning chamber is defined, the fiber guide having a projection that is engagable with the through hole or a recess that is communicable to the through hole; and a spindle in which a fiber passageway that is communicable with the spinning chamber is defined. The spinning method includes adjusting a capacity of the spinning chamber by replacing the fiber guide with another fiber guide having a projection of a different length or by replacing the fiber guide with another fiber guide having a recess of a different depth.

[0008] Conventional air spinning devices cause fibers to swing by utilizing a swirling airflow, and therefore the produced spun yarn is likely to be influenced by the fiber characteristics. Accordingly, conventional air spinning devices have a problem that a twisting firmness of a produced spun yarn varies depending on the fiber characteristics, such as a fiber length and fiber stiffness. Embodiments of the invention provide for a process of adjustment of a capacity of the spinning chamber according to the fiber characteristics when using fiber bundles of different fiber characteristics for producing spun yarns. Embodiments of the invention provide for an air spinning device in which the capacity of the spinning chamber can be easily adjusted according to the fiber characteristics when using fiber bundles of different fiber characteristics for producing spun yarns.

[0009] The above and other objects, features, advan-

tages and technical and industrial significance of this invention will be better understood by reading the following detailed description of presently preferred embodiments of the invention, when considered in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010]

FIG. 1 is a schematic diagram of an overall configuration of a spinning unit according to an embodiment of the present invention;
 FIG. 2 is a schematic diagram of a drafting device of the spinning unit shown in FIG. 1;
 FIG. 3 is a schematic diagram of a conventional air spinning device of the spinning unit shown in FIG. 1;
 FIG. 4 is a schematic diagram of a yarn-defect detecting device of the spinning unit shown in FIG. 1;
 FIG. 5 is a schematic diagram of a tension stabilizer of the spinning unit shown in FIG. 1;
 FIG. 6 is a schematic diagram of an air spinning device according to a first embodiment of the present invention;
 FIG. 7 is a schematic diagram of the air spinning device shown in FIG. 6 that does not include a needle;
 FIG. 8 is a schematic diagram of an air spinning device according to a second embodiment of the present invention;
 FIG. 9 is a schematic diagram of the air spinning device shown in FIG. 8 that does not include the needle; and
 FIG. 10 is a schematic diagram showing positions of air holes in a nozzle block.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0011] Exemplary embodiments of the present invention are described in detail below with reference to the accompanying drawings.

[0012] An overall configuration of a spinning unit 1 according to an embodiment of the present invention is described below with reference to FIG. 1. The spinning unit 1 is a spinning apparatus that produces a spun yarn Y from a fiber bundle (hereinafter, "sliver") F and produces a package P. The spinning unit 1 includes a sliver supplying unit 4, a drafting device 5, an air spinning device 6, a yarn-defect detecting device 7, a tension stabilizer 8, and a winding device 9 that are arranged in this order along a feed direction of the sliver F and the spun yarn Y.

[0013] The sliver supplying unit 4 supplies the sliver F, from which the spun yarn Y is to be produced, to the drafting device 5. The sliver supplying unit 4 includes a sliver casing 41 and a sliver guide 42 (see FIG. 2). The sliver F stored in the sliver casing 41 is supplied to the drafting device 5 through the sliver guide 42.

[0014] The drafting device 5 makes the thickness of the sliver F uniform by drafting the sliver F. As shown in FIG. 2, the drafting device 5 includes four pairs of draft rollers, or, more specifically, a pair of back rollers 51, a pair of third rollers 52, a pair of middle rollers 53, and a pair of front rollers 54 arranged in this order along the feed direction of the sliver F. Note that arrows shown in FIG. 2 indicate the feed direction of the sliver F.

[0015] Of the four pairs of draft rollers, the draft rollers 51 include a bottom roller 51A and a top roller 51B, the draft rollers 52 include a bottom roller 52A and a top roller 52B, the draft rollers 53 include a bottom roller 53A and a top roller 53B, and the draft rollers 54 include a bottom roller 54A and a top roller 54B. An apron band 53C is arranged around the bottom roller 53A and another apron band 53C is arranged around the top roller 53B of the pair of middle rollers 53. The apron bands 53C are made of material such as leather or synthetic rubber.

[0016] The bottom rollers 51A, 52A, 53A, and 54A are rotated in the same direction by a driving device (not shown). The top rollers 51B, 52B, 53B, and 54B are rotated in the same direction by rotations of the bottom rollers 51A, 52A, 53A, and 54A. The pairs of draft rollers 51, 52, 53, and 54 are configured to be in order of an increasing rotation speed along the feed direction of the sliver F.

[0017] In the drafting device 5 configured in this way, a feeding speed of the sliver F pinched between the pairs of draft rollers 51, 52, 53, and 54 increases each time the sliver F passes between one of the pairs of draft rollers 51, 52, 53, and 54, to thus be drafted between adjacent pairs of the draft rollers. The drafting device 5 can make the thickness of the sliver F uniform by drafting the sliver F in this way.

[0018] The air spinning device 6 twists the drafted sliver F, thereby producing the spun yarn Y. As shown in FIG. 3, the air spinning device 6 includes a fiber guide 61, a spindle 62, and a nozzle block 63. Solid arrows shown in FIG. 3 indicate the feed direction of the sliver F and the spun yarn Y. Hollow arrows shown in FIG. 3 indicate an airflow direction of supplied air. The air spinning device 6 shown in FIG. 3 represents a conventional air spinning device, and not air spinning devices 6A and 6B according to embodiments of the present invention.

[0019] The fiber guide 61 is a member that partially defines a spinning chamber SC. The sliver F drafted by the drafting device 5 passes through the fiber guide 61 to the spinning chamber SC. More specifically, the sliver F passes through a fiber introducing passage 61g, which communicates with the spinning chamber SC, of the fiber guide 61 to the spinning chamber SC. A needle 61n serving as a guide of the sliver F by causing the sliver F to run therealong is provided in the fiber guide 61 in a manner to project into the spinning chamber SC.

[0020] The spindle 62 is a member that partially defines the spinning chamber SC. The spun yarn Y twisted in the spinning chamber SC is fed through a fiber passageway 62s, which communicates with the spinning

chamber SC, of the spindle 62 to a downstream side in the yarn feed direction of the air spinning device 6.

[0021] The nozzle block 63 is a member that partially defines the spinning chamber SC. A plurality of air holes 63a communicating with the spinning chamber SC is defined in the nozzle block 63. Air delivered by application of pressure from an air pressure conveying device (not shown) is supplied to the spinning chamber SC through the air holes 63a. The air holes 63a defined in the nozzle block 63 communicate with the spinning chamber SC such that air jetted through the air holes 63a flows in the same direction around a central axis of the spinning chamber SC. Thus, the air spinning device 6 is capable of generating a swirling airflow inside the spinning chamber SC (see the hollow arrows shown in FIG. 3).

[0022] The spinning chamber SC is described in more detail below. The spinning chamber SC is a space surrounded by the fiber guide 61, the spindle 62, and the nozzle block 63. More specifically, the spinning chamber SC is a space surrounded by the substantially conical spindle 62 that is inserted from one side relative to a substantially conical through hole 63p in the nozzle block 63 and the fiber guide 61 attached onto the other side of the nozzle block 63. The shape of the through hole 63p is not limited to such a substantially conical shape as illustrated in FIG. 3, and can be a substantially columnar shape or the like. The shape of the through hole 63p is not limited to a specific shape and can be of any shape so long as a swirling airflow is favorably generated in the spinning chamber SC.

[0023] The spinning chamber SC is divided into a space SC1 provided between the fiber guide 61 and the spindle 62 and a space SC2 provided between the spindle 62 and the nozzle block 63. In the space SC1, trailing-end portions of fibers that form the sliver F are turned over (see long dashed double-short dashed lines in FIG. 3) by the swirling airflow. In the space SC2, the turned-over trailing-end portions of the fibers of the sliver F are made to swing (see long dashed double-short dashed lines in FIG. 3) by the swirling airflow.

[0024] In the spinning chamber SC configured in this way, the trailing-end portions of the fibers of the sliver F that runs through the fiber passageway 62s along the needle 61n are turned over and swung. Accordingly, the fibers turned over and swinging are wound around central fibers one after another. The air spinning device 6 is capable of twisting the sliver F by utilizing a swirling airflow in this way, thereby producing the spun yarn Y.

[0025] The yarn-defect detecting device 7 detects a defect in the spun yarn Y. As shown in FIG. 4, the yarn-defect detecting device 7 includes a light source 71, a light-receiver 72, and a casing 73. Arrows shown in FIG. 4 indicate the direction of light emitted from the light source 71.

[0026] The light source 71 is a semiconductor device, or, put another way, a light-emitting diode, that emits light in response to application of forward voltage thereto. The light source 71 is arranged so as to illuminate the spun

yarn Y with the light emitted from the light source 71.

[0027] The light-receiver 72 is a semiconductor device, or, put another way, a phototransistor, that can control electric current with optical signals. The light-receiver 72 is arranged so as to receive the light emitted from the light source 71.

[0028] The casing 73 is a member that holds the light source 71 and the light-receiver 72 at predetermined positions. A yarn passage 73a, through which the spun yarn Y passes, is defined in the casing 73. The casing 73 holds the light source 71 and the light-receiver 72 such that the light source 71 and the light-receiver 72 face each other with the spun yarn Y therebetween.

[0029] In the yarn-defect detecting device 7 configured in this way, an amount of light received by the light-receiver 72 can be calculated by subtracting light shielded by the spun yarn Y from the light emitted from the light source 71 to illuminate the spun yarn Y. The yarn-defect detecting device 7 is capable of measuring the amount of received light according to yarn thickness and therefore can detect a defect in the spun yarn Y.

[0030] Defects that can be detected by the yarn-defect detecting device 7 include anomalies, for example, that a portion of the spun yarn Y is too thick or too thin, and a foreign matter, such as a polypropylene foreign matter, interposed into the spun yarn Y. The yarn-defect detecting device 7 can adopt an electrical capacitance sensor in lieu of the optical sensor described above.

[0031] The tension stabilizer 8 maintains proper tension on the spun yarn Y and stabilizes the tension. As shown in FIG. 5, the tension stabilizer 8 includes a roller 81, a power output section 82, and an unwinding member 83. Note that arrows shown in FIG. 6 indicate the feed direction of the spun yarn Y.

[0032] The roller 81 is a substantially cylindrical rotary member used in pulling out the spun yarn Y from the air spinning device 6 and winding the spun yarn Y around itself. The roller 81 is arranged on a rotary shaft 82a of the power output section 82 and rotated by the power output section 82. The spun yarn Y pulled out from the air spinning device 6 is wound around an outer peripheral surface of the roller 81.

[0033] As the power output section 82, an electric motor that is driven on electric power supplied thereto is used. The power output section 82 rotates the roller 81 while maintaining the rotation speed of the roller 81 at a predetermined value. This makes it possible to wind the spun yarn Y around the roller 81 at a constant winding speed.

[0034] The unwinding member 83 is a threading member that rotates in combination with or separately from the roller 81 to thereby assist unwinding of the spun yarn Y. The unwinding member 83 is provided on its one end to a rotary shaft 84 of the roller 81. A portion on the other end of the unwinding member 83 is curved toward the outer peripheral surface of the roller 81. By hooking the spun yarn Y on the curved portion, the unwinding member 83 unwinds the spun yarn Y from the roller 81. A perma-

nent magnet that exerts a resisting force against rotation of the unwinding member 83 is provided at a basal portion of the rotary shaft 84, to which the unwinding member 83 is attached.

[0035] The unwinding member 83 configured in this way rotates in combination with the roller 81 when a tension placed on the spun yarn Y is relatively weak and overcome by the resisting force. In contrast, the unwinding member 83 rotates separately from the roller 81 when the tension placed on the spun yarn Y is relatively strong to overcome the resisting force. The tension stabilizer 8 can thus cause the unwinding member 83 to rotate in combination with or separately from the roller 81 depending on the tension placed on the spun yarn Y, thereby adjusting an unwinding speed of the spun yarn Y. The tension stabilizer 8 maintains a proper tension on the spun yarn Y and stabilizes the tension in this way.

[0036] Also when the spun yarn Y that is cut is to be spliced by a splicer (not shown), the tension stabilizer 8 can wind the spun yarn Y around the outer peripheral surface of the roller 81 to store the spun yarn Y. The tension stabilizer 8 can therefore take up a slack in the spun yarn Y.

[0037] The winding device 9 winds the spun yarn Y to thereby form a substantially cylindrical (cheese-shaped) package P. The winding device 9 includes a driving roller 91 and a cradle (not shown). The cradle rotatably supports a bobbin 92.

[0038] The driving roller 91 is a rotary member that rotates to cause the bobbin 92 and the package P to be rotated by rotation of the driving roller 91. The driving roller 91 adjusts its rotation speed according to change in the outer diameter of the package P, thereby maintaining the circumferential velocity of the package P constant. This makes it possible to wind the spun yarn Y on the bobbin 92 at a constant winding speed.

[0039] The bobbin 92 is a substantially cylindrical rotary member around which the spun yarn Y is wound. The bobbin 92 is rotated by the rotation of the driving roller 91 that rotates in contact with the outer peripheral surface of any one of the bobbin 92 and the package P. In the winding device 9, a traversing device (not shown) causes the spun yarn Y to be traversed to prevent unbalanced winding of the spun yarn Y on the package P.

[0040] In the winding device 9 configured in this way, the spun yarn Y introduced to the bobbin 92 is wound, without being unbalanced, on the outer peripheral surface of the bobbin 92. The winding device 9 can form the substantially cylindrical (cheese-shaped) package P in this way. The package P to be formed by the winding device 9 is not limited to the substantially cylindrical (cheese-shaped) package P shown in FIG. 1. The winding device 9 can also form the package P having a substantially conical shape.

[0041] The drawback of the conventional air spinning device 6 included in the spinning unit 1 is explained below.

[0042] As described above, the air spinning device 6

produces the spun yarn Y by twisting the sliver F by utilizing the swirling airflow. More specifically, in the space SC1 of the spinning chamber SC, the trailing-end portions of the fibers that form the sliver F are turned over (see the long dashed double-short dashed line in FIG. 3) by the swirling airflow. In the space S2 of the spinning chamber SC, the trailing-end portions of the fibers that form the sliver F are swung (see the long dashed double-short dashed line in FIG. 3) by the swirling airflow.

[0043] Assuming that the fibers to be spun are relatively stiff polyester fibers having a relatively long fiber length, if a capacity of the spinning chamber SC is small in relation to the fiber length of the polyester fibers, the trailing-end portions of the polyester fibers are hard to be turned over. As a result, the spun yarn Y that is loosely twisted is produced. More specifically, if the capacity of the spinning chamber SC is small, that is, if a height h of the space SC1 is less than a predetermined value, it is hard for the trailing-end portions of the polyester fibers to be turned over and be moved by and along the swirling airflow. Accordingly, the number of the polyester fibers that are swung in the space SC2 is reduced. The polyester fibers that are insufficiently swung are introduced into the fiber passageway 62s. As a result, a loosely twisted spun yarn (loose yarn) Y is produced.

[0044] In contrast, if the capacity of the spinning chamber SC is large in relation to the fiber length of the polyester fibers, the trailing-end portions of the polyester fibers are sufficiently turned over. As a result, the spun yarn Y that is firmly twisted is produced. More specifically, if the capacity of the spinning chamber SC is large, that is, if the height h of the space SC1 is greater than a predetermined value, the trailing-end portions of the polyester fibers are easily moved by and along the swirling airflow, and turned over. Accordingly, the polyester fibers in a state where the trailing-end portions of the polyester fibers are sufficiently wound around central fibers are introduced into the fiber passageway 62s. As a result, a firmly twisted spun yarn (firm yarn) Y is produced.

[0045] However, if the height h of the space SC1 is far greater than the predetermined value, both ends of the polyester fibers are swung in the spinning chamber SC without being restricted by either of the fiber guide 61 and the spindle 62. Accordingly, the ends of the polyester fibers escape to the outside of the air spinning device 6 more frequently. As a result, fiber loss increases, which is disadvantageous. Even if no fiber loss occurs, the fibers are loosely wound around the central fibers. As a result, a loosely twisted spun yarn Y is produced. Furthermore, the higher the capacity of the spinning chamber SC is, the more the amount of air that needs to be used in producing the swirling airflow in the spinning chamber SC becomes. Accordingly, the need for increasing the size of the air pressure conveying device arises. This requires upsizing of the spinning unit 1, which is also disadvantageous.

[0046] Now, assuming that the fibers to be spun are relatively supple cotton fibers having a relatively short

fiber length, if the capacity of the spinning chamber SC is small in relation to the fiber length of the cotton fibers, the trailing-end portions of the cotton fibers are hard to be turned over. As a result, the spun yarn Y that is loosely twisted is produced. More specifically, if the capacity of the spinning chamber SC is small, that is, if the height h of the space SC1 is less than a predetermined value, it is hard for the trailing-end portions of the cotton fibers to be turned over and be moved by and along the swirling airflow. Accordingly, the number of the cotton fibers that are swung in the space SC2 is reduced. The cotton fibers that are insufficiently swung are introduced into the fiber passageway 62s. As a result, a loosely twisted spun yarn (loose yarn) Y is produced.

[0047] In contrast, if the capacity of the spinning chamber SC is large in relation to the fiber length of the cotton fibers, the trailing-end portions of the cotton fibers are sufficiently turned over. As a result, the spun yarn Y that is firmly twisted is produced. More specifically, if the capacity of the spinning chamber SC is large, that is, if the height h of the space SC1 is greater than a predetermined value, the trailing-end portions of the cotton fibers are easily moved by and along the swirling airflow, and turned over. Accordingly, the cotton fibers in a state where the trailing-end portions of the cotton fibers are sufficiently wound around the central fibers are introduced into the fiber passageway 62s. As a result, a firmly twisted spun yarn (firm yarn) Y is produced.

[0048] However, if the height h of the space SC1 is far greater than the predetermined value, both the ends of the cotton fibers are swung in the spinning chamber SC without being restricted by either of the fiber guide 61 and the spindle 62. Accordingly, the ends of the cotton fibers are discharged to the outside of the air spinning device 6 more frequently. As a result, fiber loss increases, which is disadvantageous. Even if no fiber loss occurs, the fibers are loosely wound around the central fibers. As a result, a loosely twisted spun yarn Y is produced. Furthermore, the higher the capacity of the spinning chamber SC is, the more the amount of air that needs to be used in producing the swirling airflow in the spinning chamber SC also becomes. Accordingly, the need for increasing the size of the air pressure conveying device arises. This requires upsizing of the spinning unit 1, which is also disadvantageous.

[0049] As described above, the spun yarn Y produced by the air spinning device 6 is influenced by fiber characteristics because the air spinning device 6 causes the fibers to swing by utilizing the swirling airflow. That is, the air spinning device 6 is disadvantageous in that a twisting firmness of the produced spun yarn Y varies according to the fiber characteristics, such as a fiber length and fiber stiffness.

[0050] Due to this, it is necessary to change the fiber guide 61 and the nozzle block 63 in the conventional air spinning device 6 depending on the fiber characteristics, resulting in increased person hours when producing the spun yarns Y from the slivers F of different fiber charac-

teristics.

[0051] The air spinning device 6A according to a first embodiment of the present invention that provides a solution to the problem described above is explained next.

[0052] The air spinning device 6A produces the spun yarn Y by twisting a drafted sliver F. As shown in FIG. 6, the air spinning device 6A mainly includes the fiber guide 61, the spindle 62, and the nozzle block 63. Solid arrows shown in FIG. 6 indicate the feed direction of the sliver F and the spun yarn Y. Hollow arrows shown in FIG. 6 indicate an airflow direction of supplied air.

[0053] As shown in FIG. 6, the air spinning device 6A according to the present embodiment has a configuration that is substantially similar to that of the conventional air spinning device 6 (see FIG. 3). However, the air spinning device 6A differs from the air spinning device 6 in that the fiber guide 61 has a projection 61b that engages into the through hole 63p of the nozzle block 63.

[0054] Like the conventional air spinning device 6, the air spinning device 6A produces the spun yarn Y by twisting the sliver F by utilizing the swirling airflow. In the space SC1 of the spinning chamber SC, the trailing-end portions of the fibers that form the sliver F are turned over (see long dashed double-short dashed lines in FIG. 6) by the swirling airflow. In the space SC2 of the spinning chamber SC, the trailing-end portions of the fibers that form the sliver F are swung (see the long dashed double-short dashed lines in FIG. 6) by the swirling airflow.

[0055] Assuming that the fibers to be spun are relatively stiff polyester fibers having a relatively long fiber length, if the height h of the space SC1 is less than the predetermined value, the trailing-end portions of the polyester fibers are introduced into the fiber passageway 62s before being sufficiently swung, resulting in the production of the spun yarn Y that is loosely twisted (loose yarn). However, in the air spinning device 6A according to the present embodiment, the height h of the space SC1 can be adjusted to an optimum value by replacing the fiber guide 61 with another fiber guide 61 having the projection 61b of shorter length L.

[0056] As explained above, if the height h of the space SC1 is far greater than the predetermined value, the polyester fibers in a state where some of the polyester fibers are loosely wound around the central fibers are introduced into the fiber passageway 62s. As a result, the spun yarn Y that is loosely twisted (loose yarn) is produced. However, in the air spinning device 6A according to the present embodiment, the height h of the space SC1 can be adjusted to the optimum value by replacing the fiber guide 61 with another fiber guide 61 having the projection 61b of longer length L.

[0057] Now, assuming that the fibers to be spun are relatively supple cotton fibers having a relatively short fiber length, if the height h of the space SC1 is less than the predetermined value, the trailing-end portions of the cotton fibers are introduced into the fiber passageway 62s before being sufficiently swung, resulting in the production of the spun yarn Y that is loosely twisted (loose

yarn). However, in the air spinning device 6A according to the present embodiment, the height h of the space SC1 can be adjusted to an optimum value by replacing the fiber guide 61 with another fiber guide 61 having the projection 61b of shorter length L.

[0058] As explained above, if the height h of the space SC1 is far greater than the predetermined value, the cotton fibers in a state where some of the cotton fibers are loosely wound around the central fibers are introduced into the fiber passageway 62s. As a result, the spun yarn Y that is loosely twisted (loose yarn) is produced. However, in the air spinning device 6A according to the present embodiment, the height h of the space SC1 can be adjusted to the optimum value by replacing the fiber guide 61 with another fiber guide 61 having the projection 61b of longer length L.

[0059] By configuring in this way, in the air spinning device 6A according to the present embodiment, the height h of the space SC1 can be easily changed by merely replacing the fiber guide 61. That is, in the air spinning device 6A, by merely replacing the fiber guide 61, the capacity of the spinning chamber SC can be easily adjusted according to the fiber characteristics. Thus, the air spinning device 6A is capable of performing spinning according to the fiber characteristics.

[0060] Furthermore, even if the air spinning device 6A is configured without the needle 61n in the fiber guide 61 as shown in FIG. 7, the same object and effects according to the present invention can be achieved. The scope of the present invention also encompasses such a modification. In the air spinning device 6A configured in this manner, the sliver F is caught at a downstream end portion of the fiber guide 61 and introduced into the fiber passageway 62s of the spindle 62.

[0061] The air spinning device 6B according to a second embodiment of the present invention that provides a solution to the problem described above is explained next.

[0062] The air spinning device 6B produces the spun yarn Y by twisting the drafted sliver F. As shown in FIG. 8, the air spinning device 6B mainly includes the fiber guide 61, the spindle 62, and the nozzle block 63. Solid arrows shown in FIG. 8 indicate the feed direction of the sliver F and the spun yarn Y. Hollow arrows shown in FIG. 8 indicate an airflow direction of supplied air.

[0063] As shown in FIG. 8, the air spinning device 6B according to the present embodiment has a configuration that is substantially similar to that of the conventional air spinning device 6 (see FIG. 3). However, the air spinning device 6B differs from the air spinning device 6 in that the fiber guide 61 has a recess 61c that communicates with the through hole 63p of the nozzle block 63.

[0064] Like the conventional air spinning device 6, the air spinning device 6B produces the spun yarn Y by twisting the sliver F by utilizing the swirling airflow. The trailing-end portions of the fibers that form the sliver F are turned over (see long dashed double-short dashed lines in FIG. 8) in the space SC1 of the spinning chamber SC by the

swirling airflow. The trailing-end portions of the fibers that form the sliver F are swung (see the long dashed double-short dashed lines in FIG. 8) in the space SC2 of the spinning chamber SC by the swirling airflow.

[0065] Assuming that the fibers to be spun are relatively stiff polyester fibers having a relatively long fiber length, if the height h of the space SC1 is less than the predetermined value, the trailing-end portions of the polyester fibers are introduced into the fiber passageway 62s before being sufficiently swung, resulting in the production of the spun yarn Y that is loosely twisted (loose yarn). However, in the air spinning device 6B according to the present embodiment, the height h of the space SC1 can be adjusted to an optimum value by replacing the fiber guide 61 with another fiber guide 61 having the recess 61c of deeper depth D.

[0066] As explained above, if the height h of the space SC1 is far greater than the predetermined value, the polyester fibers in a state where some of the polyester fibers are loosely wound around the central fibers are introduced into the fiber passageway 62s. As a result, the spun yarn Y that is loosely twisted (loose yarn) is produced. However, in the air spinning device 6B according to the present embodiment, the height h of the space SC1 can be adjusted to the optimum value by replacing the fiber guide 61 with another fiber guide 61 having the recess 61c of shallower depth D.

[0067] Now, assuming that the fibers to be spun are relatively supple cotton fibers having a relatively short fiber length, if the height h of the space SC1 is less than the predetermined value, the trailing-end portions of the cotton fibers are introduced into the fiber passageway 62s before being sufficiently swung, resulting in the production of the spun yarn Y that is loosely twisted (loose yarn). However, in the air spinning device 6B according to the present embodiment, the height h of the space SC1 can be adjusted to an optimum value by replacing the fiber guide 61 with another fiber guide 61 having the recess 61c of deeper depth D.

[0068] As explained above, if the height h of the space SC1 is far greater than the predetermined value, the cotton fibers in a state where some of the cotton fibers are loosely wound around the central fibers are introduced into the fiber passageway 62s. As a result, the spun yarn Y that is loosely twisted (loose yarn) is produced. However, in the air spinning device 6B according to the present embodiment, the height h of the space SC1 can be adjusted to the optimum value by replacing the fiber guide 61 with another fiber guide 61 having the recess 61c of deeper depth D.

[0069] By configuring in this way, in the air spinning device 6B according to the present embodiment, the height h of the space SC1 can be easily changed by merely replacing the fiber guide 61. That is, in the air spinning device 6B, by merely replacing the fiber guide 61, the capacity of the spinning chamber SC can be easily adjusted according to the fiber characteristics. Thus, the air spinning device 6B is capable of performing spinning

according to the fiber characteristics.

[0070] Furthermore, even if the air spinning device 6B is configured without the needle 61n in the fiber guide 61 as shown in FIG. 9, the same object and effects according to the present invention are achieved. The scope of the present invention also encompasses such a modification. In the air spinning device 6B configured in this manner, the sliver F is caught at a downstream end portion of the fiber guide 61 and introduced into the fiber passageway 62s of the spindle 62.

[0071] Positions of the air holes 63a provided in the nozzle block 63 are explained next.

[0072] FIG. 10 is an enlarged view of a region of the spinning chamber SC. Hollow arrows shown in FIG. 10 indicate the airflow direction of the supplied air.

[0073] Each of the air holes 63a of the nozzle block 63 runs obliquely connecting an upper part (upstream portion) of an air storage chamber AC to a bottom (downstream portion) of the space SC1 of the spinning chamber SC. The air stored in the air storage chamber AC is supplied to the spinning chamber SC through each of the air holes 63a.

[0074] In the air spinning devices 6A and 6B, a point of intersection IS1 between a central axis of the air hole 63a and a wall surface of the through hole 63p is located in a range of greater than or equal to 3 mm to less than or equal to 10 mm from a contact surface X between the nozzle block 63 and the fiber guide 61.

[0075] By ensuring that the measurement from the point of intersection IS1 to the contact surface X is greater than or equal to 3 mm to less than or equal to 10 mm, it can be ensured that the air holes 63a will produce a swirling airflow in the spinning chamber SC. If the measurement from the point of intersection IS1 to the contact surface X is less than 3 mm, the air holes 63a will be perpendicular to or substantially perpendicular to the spinning chamber SC. In this case, because no swirling airflow is produced in the spinning chamber SC, the fibers cannot be turned over or swung. If the measurement from the point of intersection IS1 to the contact surface X exceeds 10 mm, the capacity of the spinning chamber SC is increased, resulting in an upsized air spinning device 6 and increased consumption of air. Because of the increased capacity of the spinning chamber SC, the fibers cannot be swung at a high speed, leading to loosely twisted spun yarn Y. Therefore, it is essential that the point of intersection IS1 between the central axis of the air hole 63a and the wall surface of the through hole 63p be located in the range of greater than or equal to 3 mm to less than or equal to 10 mm from the contact surface X between the nozzle block 63 and the fiber guide 61.

[0076] By configuring in this way, the produced spun yarn Y will not be influenced by the fiber characteristics even if the spun yarn Y is produced from slivers F of different fiber characteristics, and the twisting firmness of the produced spun yarns Y can be stabilized. Furthermore, by replacing the fiber guide 61 according to the fiber characteristics, a quality of the spun yarn Y can be

easily optimized. That is, by ensuring that the measurement from the intersection point IS1 to the contact surface X is between greater than or equal to 3 mm and less than or equal to 10 mm, the length L of the projection 61b of the fiber guide 61 can be easily changed. Thus, the air spinning devices 6A and 6B are capable of performing spinning according to the fiber characteristics.

[0077] In the air spinning devices 6A and 6B, a point of intersection IS2 between the central axis of the air hole 63a and an external wall surface of the nozzle block 63 is located at a position that is away from the contact surface X between the nozzle block 63 and the fiber guide 61 by greater than or equal to 1 mm. The value of greater than or equal to 1 mm has been determined based on a result of tests carried out using stability of the twisting firmness of the produced spun yarn Y as a parameter. More specifically, the value of greater than or equal to 1 mm enables the air to be evenly supplied from the air storage chamber AC to the spinning chamber SC via the air holes 63a, and causes a stabilized swirling airflow to be produced.

[0078] The reason why a stabilized swirling airflow is produced if an inlet part of the air hole 63a is located at a position that is away from the vicinity of the upper (upstream end) wall surface of the air storage chamber AC is because there is no blockage of the air flowing into each of the air holes 63a. The air hole 63a is provided at a position that is located away by greater than or equal to 1 mm from the contact surface X between the nozzle block 63 and the fiber guide 61 inevitably leads to an increase in a height H of a neck part of the nozzle block 63. Consequently, there is an increase in the capacity of the air storage chamber AC and a good flow of air into each of the air holes 63a.

[0079] By configuring in this way, air is evenly supplied into the spinning chamber SC through the air holes 63a, and the twisting firmness of the produced spun yarn Y can be stabilized. Furthermore, by replacing the fiber guide 61 according to the fiber characteristics, a quality of the spun yarn Y can be easily optimized. Thus, the air spinning devices 6A and 6B are capable of performing spinning according to the fiber characteristics.

[0080] Moreover, the position of the air hole 63a at a position that is located away from the contact surface X between the nozzle block 63 and the fiber guide 61 makes it hard for any contaminant adhering to the contact surface X to enter the air hole 63a. For example, chippings from an O ring 61o that is mounted on an outer periphery of the fiber guide 61 will not easily get into the air hole 63a. Consequently, contaminants are prevented from mixing with the produced spun yarn Y.

[0081] If contaminants enter the spinning chamber SC from the air storage chamber AC, the contaminated portion of the spun yarn Y needs to be removed by the spinning unit 1. This would necessitate stopping the winding operation of the spun yarn Y performed by the winding device 9 for cutting and splicing the spun yarn Y, leading to a reduction in a production efficiency of the spun yarn

Y. However, in the air spinning device 6, mixing of the contaminant with the spun yarn Y is prevented and therefore no reduction in the production efficiency of the spun yarn Y occurs.

[0082] The spinning unit 1 that includes the air spinning device 6A or 6B is capable of performing spinning according to the fiber characteristics. Consequently, the production efficiency of the spun yarn Y can be improved.

[0083] In the spinning unit 1 described above, the spun yarn Y spun by the air spinning device 6A or 6B is drawn out and temporarily stored by the tension stabilizer 8. However, the configuration of the spinning unit 1 is not limited to such a configuration. For example, a configuration is allowable in which a delivery roller and a nip roller are arranged downstream of the air spinning device 6A or 6B, and the delivery roller and the nip roller draw out the spun yarn Y from the air spinning device 6A or 6B. Moreover, a configuration is allowable in which the tension stabilizer 8 is arranged downstream relative to the delivery roller and the nip roller, and the spun yarn Y drawn out from the air spinning device 6A or 6B by the delivery roller and the nip roller is temporarily stored by the tension stabilizer 8. Alternatively, a configuration in which the tension stabilizer 8 is omitted and the winding device 9 directly winds the spun yarn Y can be employed.

[0084] The present invention yields the following effects.

[0085] According to an aspect of the present invention, the produced spun yarn Y is not influenced by fiber characteristics even if a spun yarn is produced from fiber bundles having different fiber characteristics, and a twisting firmness of the produced spun yarn is stabilized.

[0086] According to another aspect of the present invention, a capacity of a spinning chamber can be easily adjusted by merely replacing a fiber guide according to the fiber characteristics. Thus, spinning according to the fiber characteristics is easily performed.

[0087] According to still another aspect of the present invention, the capacity of the spinning chamber can be easily adjusted by merely replacing the fiber guide depending on the fiber characteristics. Thus, spinning according to the fiber characteristics is easily performed.

[0088] According to still another aspect of the present invention, because air can be evenly supplied from air holes to the spinning chamber, the twisting firmness of the produced spun yarn is stabilized. Thus, spinning according to the fiber characteristics is easily performed. Furthermore, because the air hole is defined at a position that is located away from a contact surface of a nozzle block and the fiber guide, any contaminants adhering to the contact surface do not easily enter the air hole, and as a result, mixing of the contaminants with the produced spun yarn is prevented.

[0089] According to still another aspect of the present invention, in a spinning unit, spinning according to the fiber characteristics is easily performed by the air spinning device and the spun yarn can be wound on a package by a winding device. Thus, a production efficiency

of the package is improved.

[0090] According to still another aspect of the present invention, the capacity of the spinning chamber can be easily adjusted by merely replacing the fiber guide according to the fiber characteristics. Thus, spinning according to the fiber characteristics is easily performed.

[0091] According to still another aspect of the present invention, the capacity of the spinning chamber can be easily adjusted by merely replacing the fiber guide according to the fiber characteristics. Thus, spinning according to the fiber characteristics is easily performed.

[0092] According to a first aspect of the present invention, an air spinning device spins a spun yarn from a fiber bundle. The air spinning device includes a nozzle block that includes a through hole that partially defines a spinning chamber and an air hole that communicates with the spinning chamber; a fiber guide in which a fiber introducing passage that is communicable with the spinning chamber is defined; and a spindle in which a fiber passageway that is communicable with the spinning chamber is defined. The air hole is located such that a point of intersection of a central axis of the air hole and a wall surface of the through hole is in a range of greater than or equal to 3 millimeter (mm) to less than or equal to 10 mm from a contact surface between the nozzle block and the fiber guide.

[0093] According to a second aspect of the present invention, an air spinning device spins a spun yarn from a fiber bundle. The air spinning device includes a nozzle block that includes a through hole that partially defines a spinning chamber and an air hole that communicates with the spinning chamber; a fiber guide in which a fiber introducing passage that is communicable with the spinning chamber is defined; and a spindle in which a fiber passageway that is communicable with the spinning chamber is defined. The fiber guide has a projection that is engagable with the through hole of the nozzle block. In the air spinning device, a capacity of the spinning chamber is adjustable by replacing the fiber guide with another fiber guide having a projection of a different length.

[0094] According to a third aspect of the present invention, an air spinning device spins a spun yarn from a fiber bundle. The air spinning device includes a nozzle block that includes a through hole that partially defines a spinning chamber and an air hole that communicates with the spinning chamber; a fiber guide in which a fiber introducing passage that is communicable with the spinning chamber is defined; and a spindle in which a fiber passageway that is communicable with the spinning chamber is defined. The fiber guide has a recess that is communicable with the through hole of the nozzle block. In the air spinning device, a capacity of the spinning chamber is adjustable by replacing the fiber guide with another fiber guide having a recess of a different depth.

[0095] According to a fourth aspect of the present invention, in the air spinning device according to any of the above aspects of the present invention, the air hole is

located such that the point of intersection of the central axis of the air hole and an outer wall surface of the nozzle block is located away by greater than or equal to 1 mm from the contact surface between the nozzle block and the fiber guide.

[0096] According to a fifth aspect of the present invention, a spinning unit includes the air spinning device according to any of the above aspects of the present invention. In addition, the spinning unit includes an air storage chamber and a winding device. The air storage chamber stores therein air to be supplied to the spinning chamber via the air hole. The winding device winds the spun yarn produced by spinning using the air spinning device, and forms a package.

[0097] According to a sixth aspect of the present invention, an air spinning device that spins the spun yarn from the fiber bundle is prepared to execute a spinning method. The air spinning device includes a nozzle block that includes a through hole that partially defines a spinning chamber and an air hole that communicates with the spinning chamber; a fiber guide in which a fiber introducing passage that is communicable with the spinning chamber is defined; and a spindle in which a fiber passageway that is communicable with the spinning chamber is defined. The fiber guide has a projection that is engagable with the through hole of the nozzle block. The spinning method includes adjusting a capacity of the spinning chamber by replacing the fiber guide with another fiber guide having a projection of a different length.

[0098] According to a seventh aspect of the present invention, an air spinning device that spins the spun yarn from the fiber bundle is prepared to execute a spinning method. The air spinning device includes a nozzle block that includes a through hole that partially defines a spinning chamber and an air hole that communicates with the spinning chamber; a fiber guide in which a fiber introducing passage that is communicable with the spinning chamber is defined; and a spindle in which a fiber passageway that is communicable with the spinning chamber is defined. The fiber guide has a recess that is communicable with the through hole of the nozzle block. The spinning method includes changing a capacity of the spinning chamber by replacing the fiber guide with another fiber guide having a recess of a different depth.

[0099] Although the invention has been described with respect to specific embodiments for a complete and clear disclosure, the appended claims are not to be thus limited but are to be construed as embodying all modifications and alternative constructions that may occur to one skilled in the art that fairly fall within the basic teaching herein set forth.

Claims

1. An air spinning device (6) that spins a spun yarn (Y) from a fiber bundle (F) by supplying air from an air hole (63a) into a spinning chamber (SC), the air spin-

ning device (6) comprising:

a nozzle block (63) that includes a through hole (63p) that partially defines the spinning chamber (SC), and the air hole (63a) that is communicable with the spinning chamber (SC);
a fiber guide (61) in which a fiber introducing passage (61g) that is communicable with the spinning chamber (SC) is defined; and
a spindle (62) in which a fiber passageway (62s) that is communicable with the spinning chamber (SC) is defined, wherein
the air hole (63a) is positioned such that a point of intersection (IS1) of a central axis of the air hole (63a) and a wall surface of the through hole (63p) falls in a range of greater than or equal to 3 mm to less than or equal to 10 mm from a contact surface (X) at which a downstream end surface of the fiber guide in a yarn feeding direction is received by an upstream end surface of the nozzle block (63) in the yarn feeding direction.

2. An air spinning device (6) that spins a spun yarn (Y) from a fiber bundle (F) by supplying air from an air hole (63a) into a spinning chamber (SC), the air spinning device (6) comprising:

a nozzle block (63) that includes a through hole (63p) that partially defines the spinning chamber (SC), and the air hole (63a) that is communicable with the spinning chamber (SC);
a fiber guide (61) in which a fiber introducing passage (61g) that is communicable with the spinning chamber (SC) is defined; and
a spindle (62) in which a fiber passageway (62s) that is communicable with the spinning chamber (SC) is defined,

wherein

a) the fiber guide (61) has a projection (61b) that is engagable with the through hole (63p), and a capacity of the spinning chamber (SC) is adjustable by replacing the fiber guide (61) with another fiber guide (61) having a projection (61b) of a different length, or
b) the fiber guide (61) has a recess (61c) that is communicable to the through hole (63p), and a capacity of the spinning chamber (SC) is adjustable by replacing the fiber guide (61) with another fiber guide (61) having a recess (61c) of a different depth.

3. The air spinning device (6) according to any one of Claims 1 or 2, wherein the air hole (63a) is located such that the point of intersection (IS1) of the central axis of the air hole (63a) and an outer wall surface

of the nozzle block (63) is located away by greater than or equal to 1 mm from the contact surface between the nozzle block (63) and the fiber guide (61).

4. A spinning unit (1) comprising:
 - an air spinning device (6) according to any one of Claims 1 to 3;
 - an air storage chamber (AC) adapted to store therein air to be supplied to the spinning chamber (SC) via the air hole (63a); and
 - a winding device (9) adapted to wind a spun yarn (Y) produced by spinning the spun yarn (Y) from a fiber bundle (F) by supplying the air from the air storage chamber (AC), and forms a package.

5. A spinning method for performing spinning of a spun yarn (Y) from a fiber bundle (F) by supplying air from an air hole (63a) into a spinning chamber (SC) using an air spinning device (6), wherein
 - the air spinning device (6) includes
 - a nozzle block (63) that includes a through hole (63p) that partially defines the spinning chamber (SC), and the air hole (63a) that is communicable with the spinning chamber (SC);
 - a fiber guide (61) in which a fiber introducing passage (61g) that is communicable with the spinning chamber (SC) is defined, the fiber guide (61) having a projection (61b) that is engagable with the through hole (63p) or a recess (61c) that is communicable to the through hole (63p); and
 - a spindle (62) in which a fiber passageway (62s) that is communicable with the spinning chamber (SC) is defined, wherein
 - a) the spinning method includes adjusting a capacity of the spinning chamber (SC) by replacing the fiber guide (61) with another fiber guide (61) having a projection (61b) of a different length, or
 - b) the spinning method includes adjusting a capacity of the spinning chamber (SC) by replacing the fiber guide (61) with another fiber guide (61) having a recess (61c) of a different depth.

FIG.1

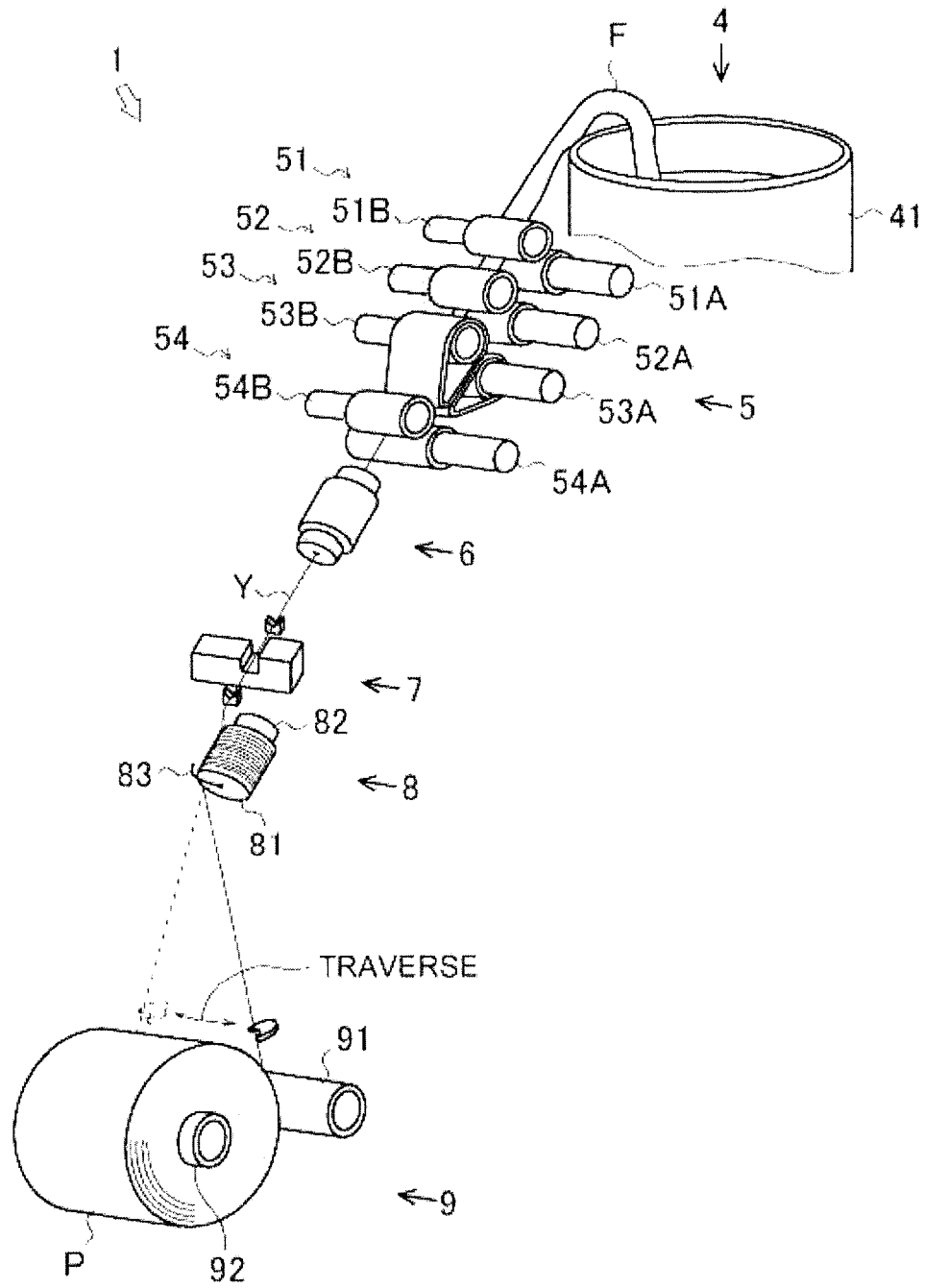


FIG.2

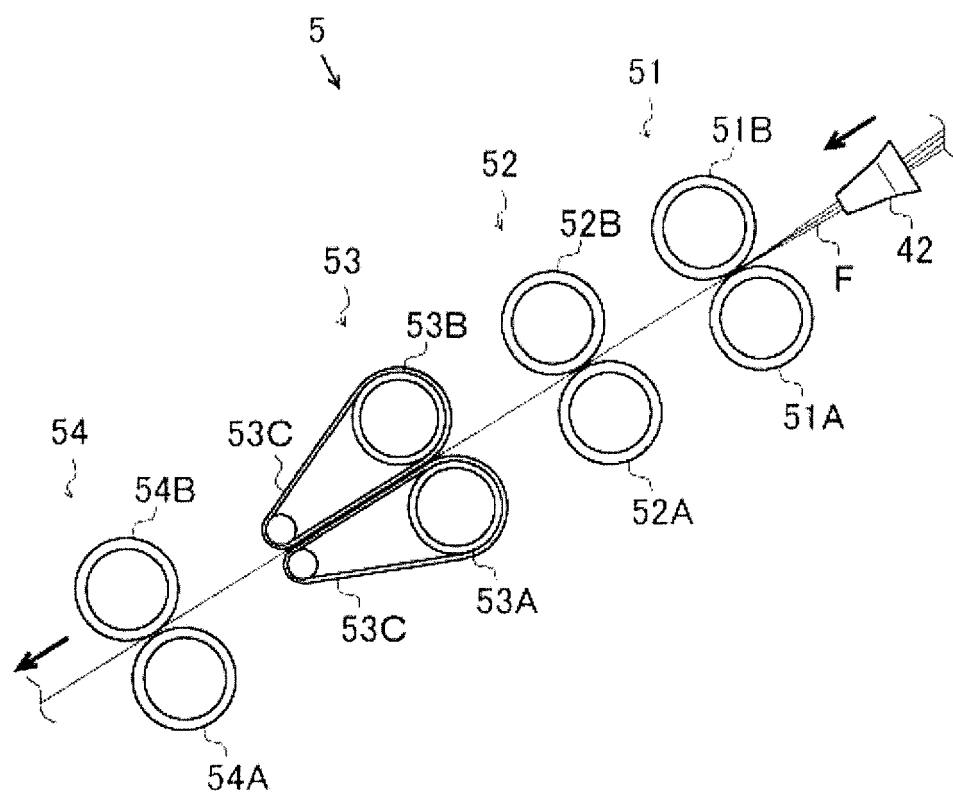


FIG.3

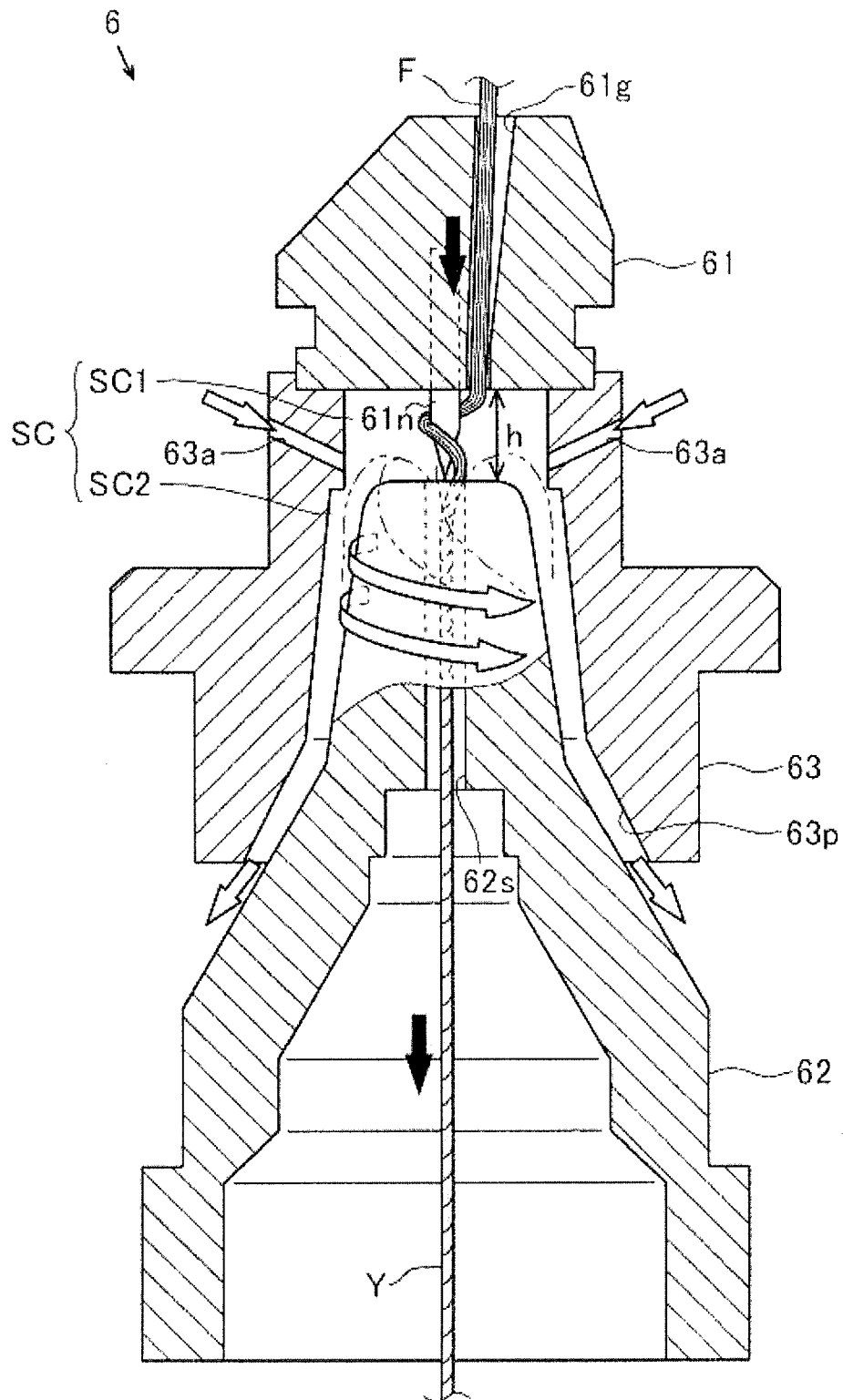


FIG.4

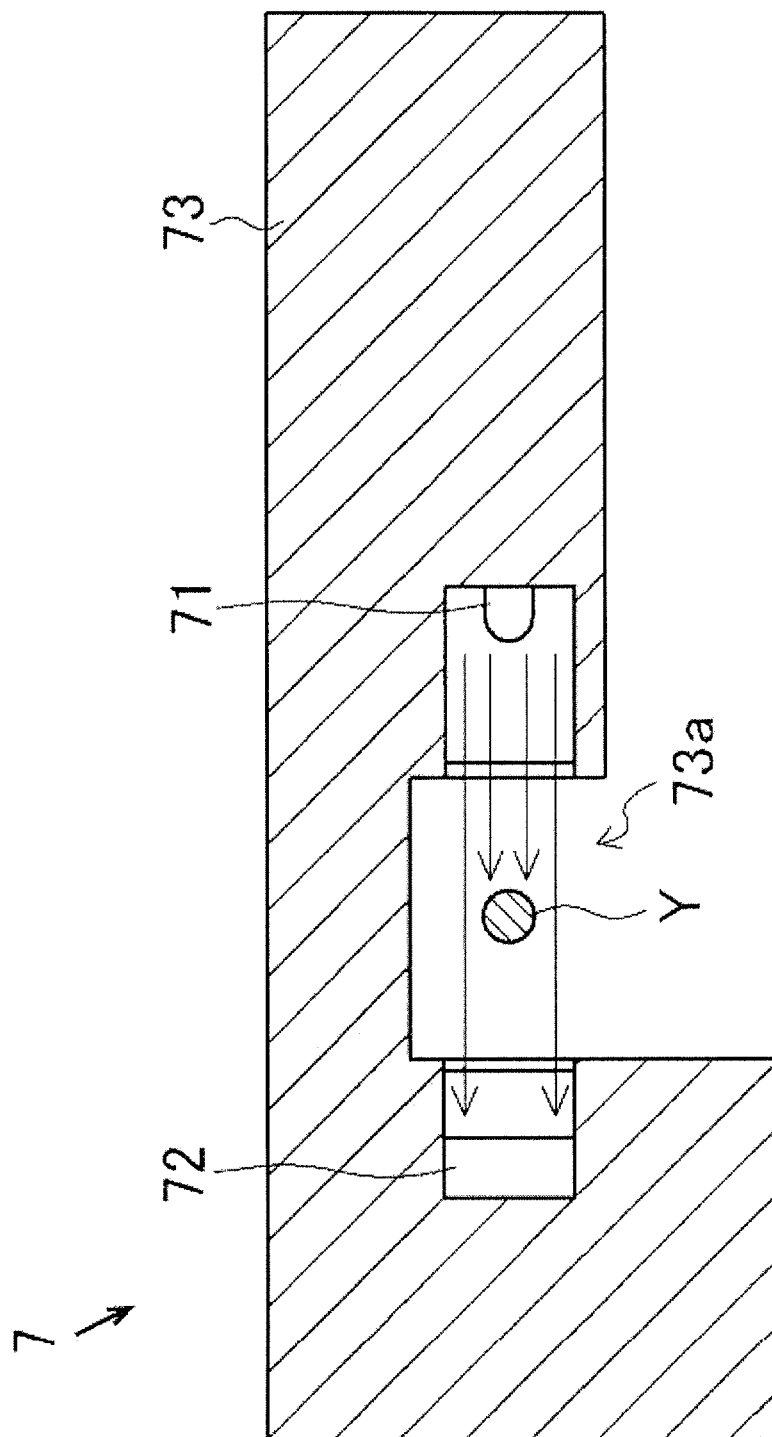


FIG.5

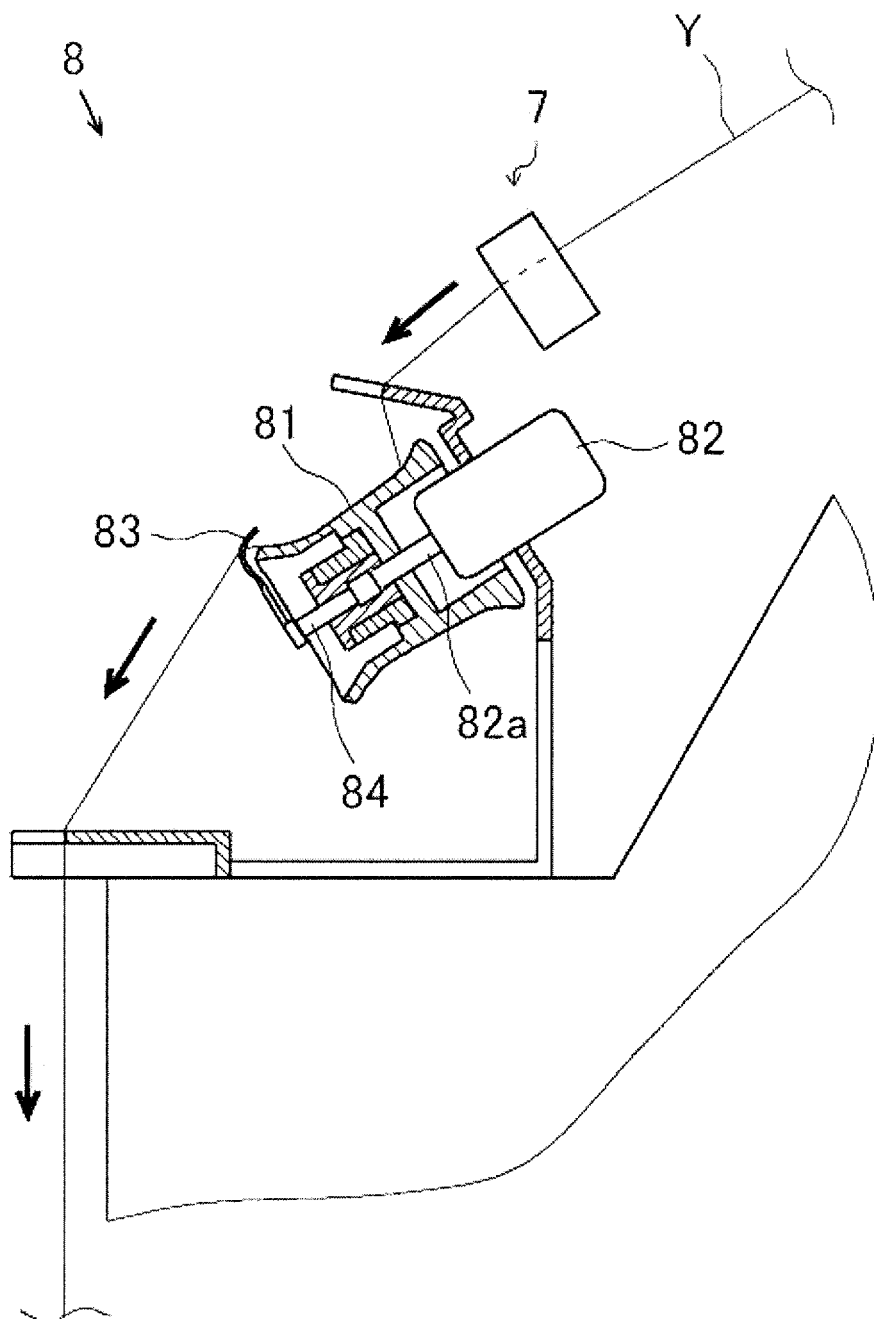


FIG.6

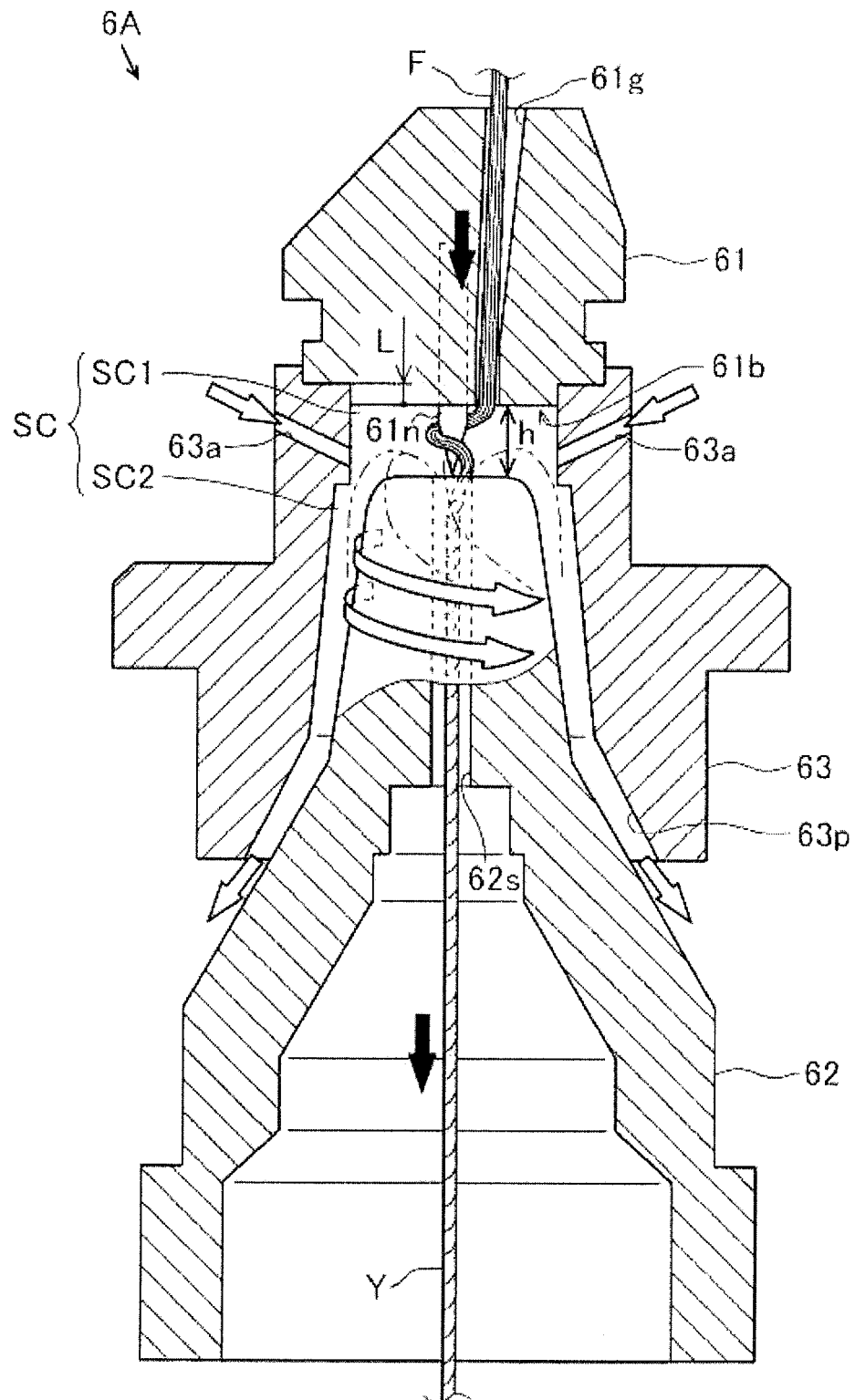


FIG.7

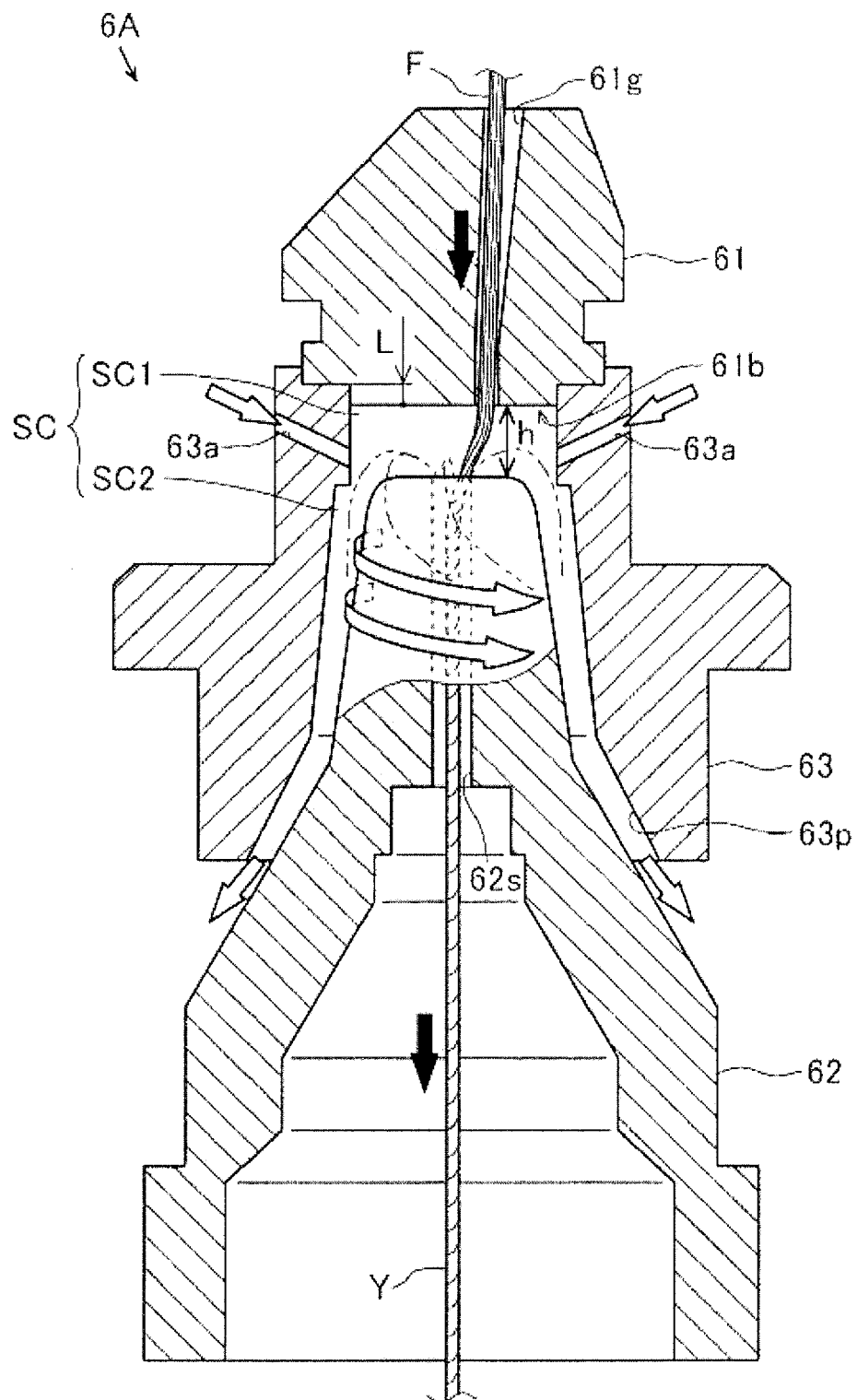


FIG.8

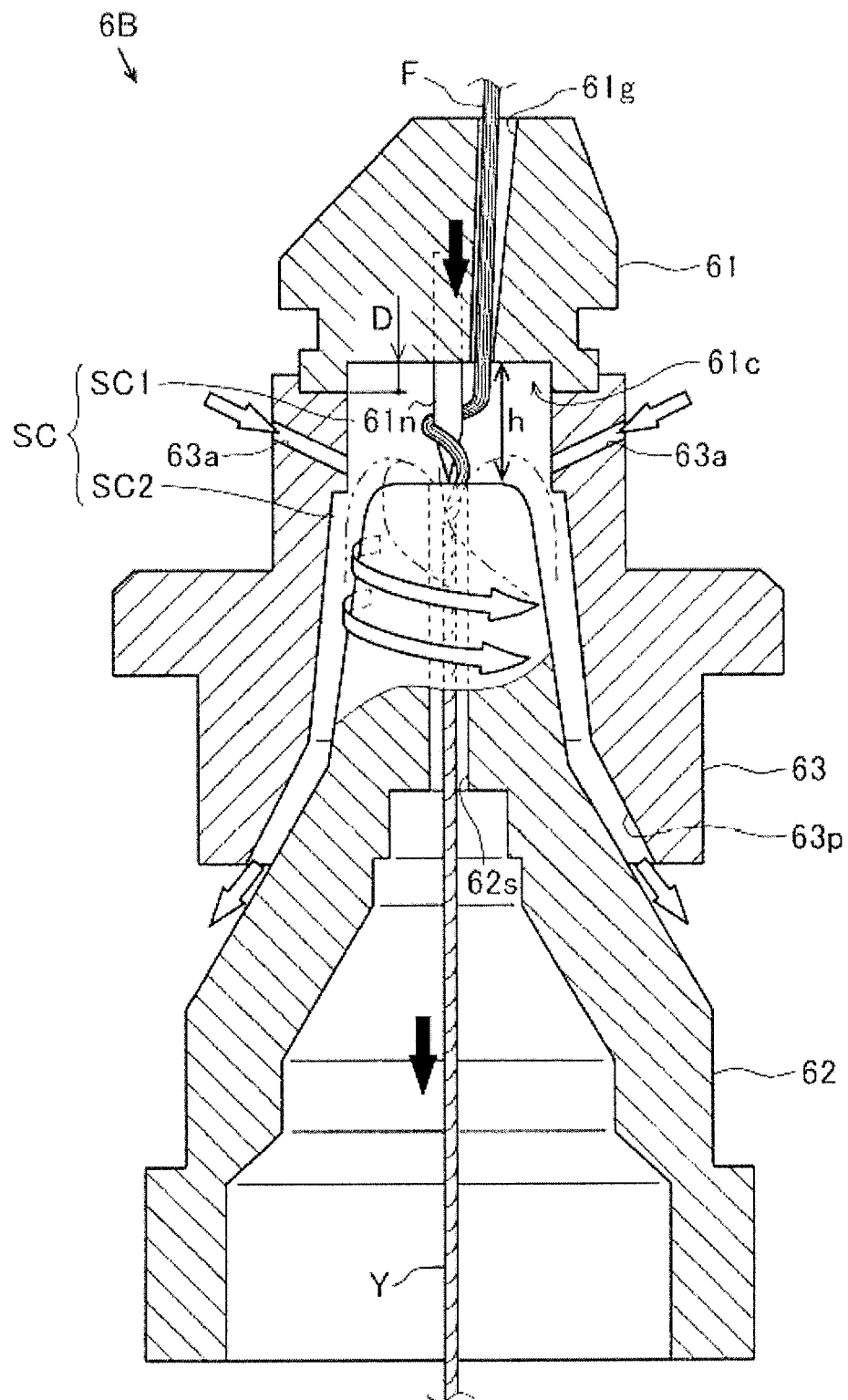


FIG.9

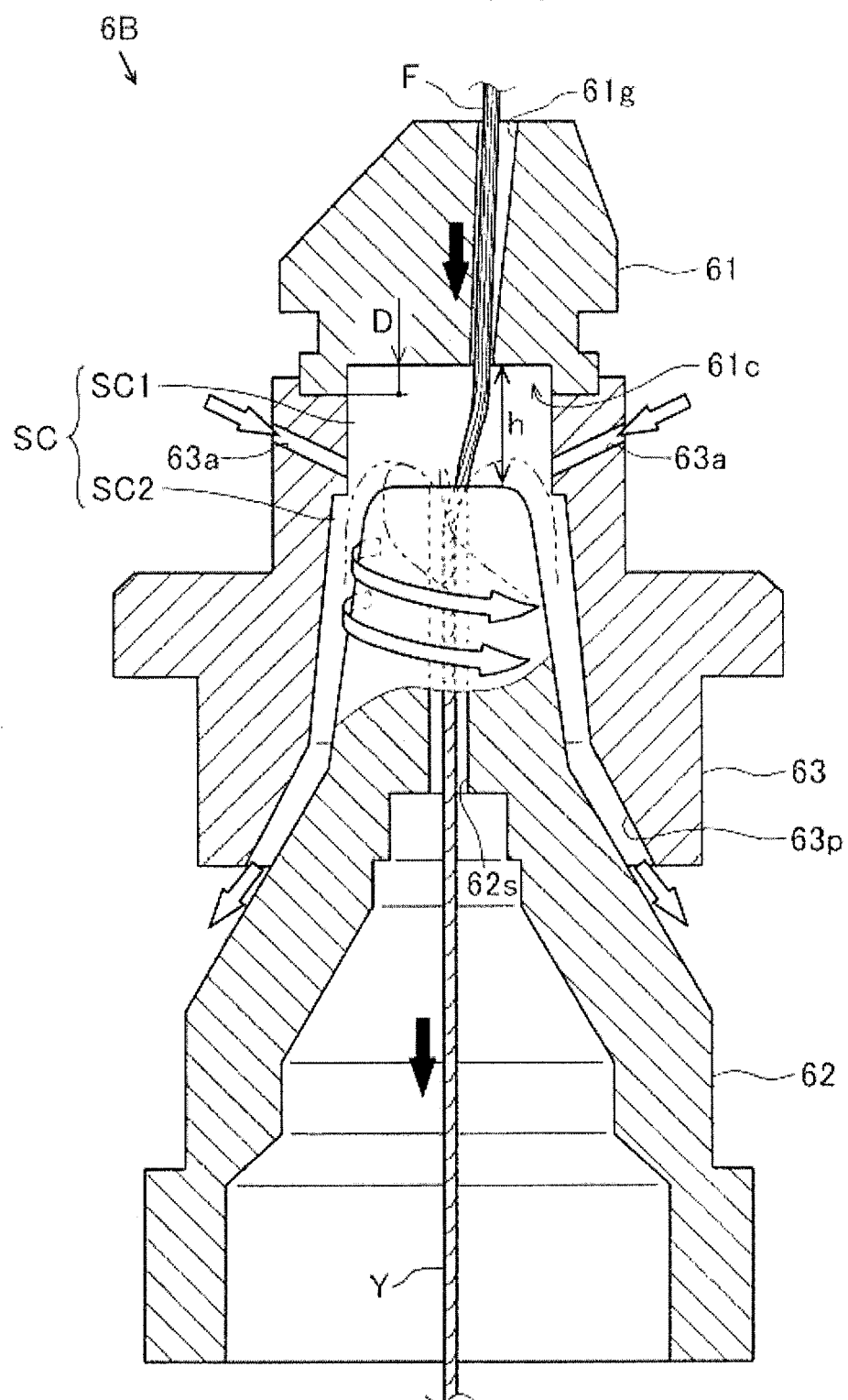
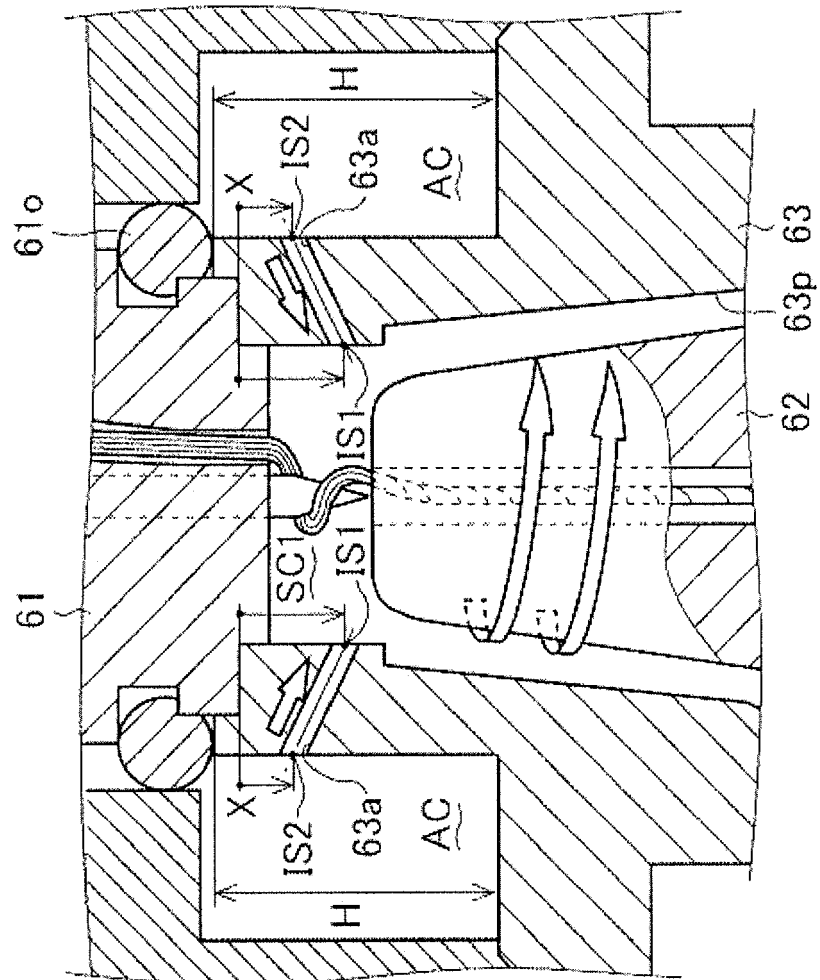


FIG. 10



REFERENCES CITED IN THE DESCRIPTION

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