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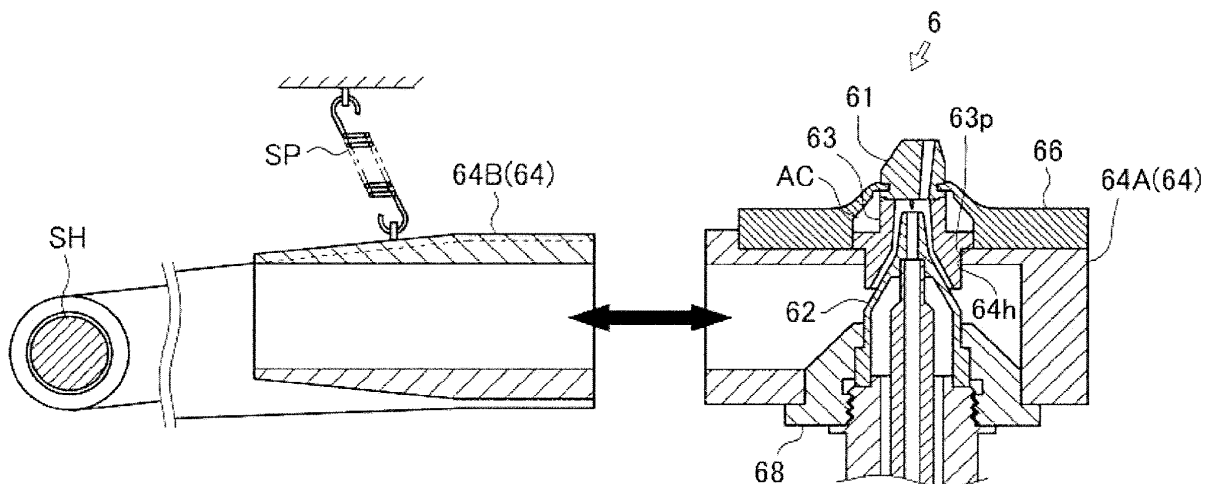
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(54) **Air spinning device and spinning apparatus including the same**

(57) An air spinning device (6) includes a fiber guide (61), a nozzle block (63), a spindle (62), a nozzle holder (64) that holds the nozzle block (63) while being in a state of abutment against the nozzle block (63), and a nozzle

cap (66) that fixes the fiber guide (61) and the nozzle block (63) to the nozzle holder (64). The nozzle cap (66) is attached to the nozzle holder (64) while being in a state of direct abutment against the nozzle holder (64).

**FIG.5**



## Description

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

**[0001]** The present invention relates to an air spinning device and a spinning apparatus including the same.

#### 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 air spinning devices supply 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 application No. 2003-193337 and Japanese unexamined utility model application publication No. H4-131661).

### SUMMARY OF THE INVENTION

**[0003]** It is an object of the present invention to provide an air spinning device in which variations in the shape of a spinning chamber can be reduced by improving a precision of attachment positions of a fiber guide and a nozzle block, and that allows the fiber guide and the nozzle block to be easily replaced, and enables spinning according to fiber characteristics. It is a further object of the present invention to provide a spinning apparatus that includes such an air spinning device.

**[0004]** These objects are achieved an air spinning device according to claim 1, and by a spinning apparatus according to claim 9.

**[0005]** Since air spinning devices cause fibers to swing by utilizing a swirling airflow, the produced spun yarn is likely to be influenced by the shape of a spinning chamber. Accordingly, the air spinning devices have a problem that a twisting firmness of the produced spun yarn varies if the shape of the spinning chamber changes due to shifting of attachment positions of a fiber guide, a nozzle block, etc., that define the spinning chamber. Therefore, there is a need for an air spinning device in which variations in the shape of the spinning chamber can be reduced by improving a precision of the attachment positions of the fiber guide and the nozzle block.

**[0006]** The air spinning devices cause fibers to swing by utilizing a swirling airflow, and hence the spun yarn is likely to be influenced by the fiber characteristics of a fiber bundle. Moreover, in the air spinning devices, twisting firmness of the produced spun yarn varies according to the fiber characteristics, such as an average fiber length. Therefore, there is a need for an air spinning device in which the fiber guide and the nozzle block can be easily replaced which enables spinning to be performed according to the fiber characteristics.

**[0007]** An air spinning device according to an aspect

of the present invention includes a fiber guide that has a fiber introducing passage that communicates with a spinning chamber, and guides a fiber bundle into a spinning chamber; a nozzle block that has an air hole that communicates with the spinning chamber, and guides air into the spinning chamber; a spindle that has a fiber passageway that communicates with the spinning chamber, and guides the fiber bundle twisted in the spinning chamber; a nozzle holder that holds the nozzle block while being in a state of abutment against the nozzle block; and a nozzle cap that immovably fixes the fiber guide and the nozzle block to the nozzle holder, the nozzle cap is adapted to be attached to the nozzle holder while being in a state of direct abutment against the nozzle holder.

**[0008]** An air spinning device according to another aspect of the present invention includes a fiber guide that has a fiber introducing passage that communicates with a spinning chamber, and guides a fiber bundle into a spinning chamber; a nozzle block that has an air hole that communicates with the spinning chamber, and guides air into the spinning chamber; a spindle that has a fiber passageway that communicates with the spinning chamber, and guides the fiber bundle twisted in the spinning chamber; a spindle holder that holds the spindle; and a spindle locking member that locks the spindle into the spindle holder with just one touch.

**[0009]** A spinning apparatus according to still another aspect of the present invention includes an air spinning device according to the above aspect and a winding device that winds a spun yarn spun by the air spinning device into a package.

**[0010]** The above and other objects, features, advantages 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

#### **[0011]**

FIG. 1 is a schematic diagram of a structure of a spinning unit according to an embodiment of the present invention;

FIG. 2 is a schematic diagram of an air spinning device of the spinning unit shown in FIG. 1;

FIG. 3 is a schematic diagram of the air spinning device shown in FIG. 2 that does not include a needle;

FIG. 4 is a schematic diagram of a tension stabilizer of the spinning unit shown in FIG. 1;

FIG. 5 is a schematic diagram showing a method of fixing and detaching a fiber guide, a nozzle block, etc.;

FIG. 6 is a schematic diagram of a structure for supplying pressurized air from an air supply source to a spinning chamber;

FIGS. 7A and 7B are schematic diagrams showing a method of locking a spindle;

FIG. 8 is a schematic diagram showing another method of locking the spindle;

FIGS. 9A and 9B are schematic diagrams of a structure for locking a nozzle holder by using a stopper;

FIG. 10 is a schematic diagram of a structure for changing a locking position of the nozzle holder by switching the stopper;

FIG. 11 is a schematic diagram of a structure for changing the locking position of the nozzle holder by extending or retracting the stopper; and

FIG. 12 is a schematic diagram showing a method of fixing the fiber guide and the nozzle block in a conventional air spinning device.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

**[0012]** Exemplary embodiments of the present invention are described in detail below with reference to the accompanying drawings.

**[0013]** A configuration of a spinning unit 1 according to an embodiment of the present invention is described in detail 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.

**[0014]** 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 (not shown). The sliver F stored in the sliver casing 41 is supplied to the drafting device 5 through the sliver guide.

**[0015]** The drafting device 5 makes the thickness of the sliver F uniform by drafting the sliver F. The drafting device 5 includes four pairs of draft rollers, i.e., 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.

**[0016]** 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.

**[0017]** 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.

**[0018]** 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.

**[0019]** The air spinning device 6 twists the drafted sliver F, thereby producing the spun yarn Y. As shown in FIG. 2, the air spinning device 6 includes a fiber guide 61, a spindle 62, and a nozzle block 63. Moreover, solid arrows shown in FIG. 2 indicate the feed direction of the sliver F and the spun yarn Y. Hollow arrows shown in FIG. 2 indicate an airflow direction of supplied air.

**[0020]** 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.

**[0021]** The spindle 62 is a member that partially defines the spinning chamber SC. The spindle 62 guides the sliver F twisted in the spinning chamber SC, that is, the spun yarn Y, to the yarn-defect detecting device 7. More specifically, the spindle 62 guides the spun yarn Y through a fiber passageway 62s, which communicates with the spinning chamber SC, to the yarn-defect detecting device 7. The yarn-defect detecting device 7 is arranged on a downstream side in a yarn feed direction.

**[0022]** The nozzle block 63 is a member that partially defines the spinning chamber SC. The nozzle block 63 supplies pressurized air generated by an air supply source AB, which is described later, to the spinning chamber SC. More specifically, the nozzle block 63 guides the air through air holes 63a, which communicate with the spinning chamber SC, into the spinning chamber SC. 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. As a result, a swirling airflow is generated inside the spinning chamber SC (see the hollow arrows shown in FIG. 3).

**[0023]** 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 64h in the nozzle block

63 and the fiber guide 61 attached onto the other side of the nozzle block 63.

**[0024]** 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 FIGS. 2 and 3) by the swirling airflow. Furthermore, in the space SC2, the turned-over trailing-end portions of the fibers of the sliver F are swung (see long dashed double-short dashed lines in FIGS. 2 and 3) by the swirling airflow.

**[0025]** In the spinning chamber SC configured in this way, the trailing-end portions of the fibers of the sliver F that runs along the needle 61n are turned over and 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.

**[0026]** As shown in FIG. 3, in an alternative structure, the air spinning device 6 is configured without the needle 61n. In this embodiment, a downstream edge of the fiber guide 61 performs a function of the needle 61n. Even though the air spinning device 6 is configured without the needle 61n, the same object and effect according to the present invention are achieved.

**[0027]** The yarn-defect detecting device 7 detects a defect produced in the spun yarn Y. The yarn-defect detecting device 7 includes a light source (not shown), a light-receiver (not shown), and a casing (not shown).

**[0028]** The light source 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 is arranged so as to illuminate the spun yarn Y with the light emitted from the light source.

**[0029]** The light-receiver is a semiconductor device, or, put another way, a phototransistor, that can control electric current with optical signals. The light-receiver is arranged so as to receive the light emitted from the light source.

**[0030]** The casing is a member that holds the light source and the light-receiver at predetermined positions. A yarn passage, through which the spun yarn Y passes, is defined in the casing. The casing holds the light source and the light-receiver such that the light source and the light-receiver face each other with the spun yarn Y therebetween.

**[0031]** In the yarn-defect detecting device 7 configured in this way, an amount of light received by the light-receiver can be calculated by subtracting light shielded by the spun yarn Y from the light emitted from the light source 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.

**[0032]** 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.

**[0033]** The tension stabilizer 8 maintains proper tension on the spun yarn Y and stabilizes the tension. As shown in FIG. 4, 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.

**[0034]** 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.

**[0035]** 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.

**[0036]** 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. Meanwhile, a permanent magnet (not shown) 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.

**[0037]** 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 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.

**[0038]** As described above, the tension stabilizer 8 is operative to pull out the spun yarn Y from the air spinning device 6. In an alternative structure, the spun yarn Y is pulled out by a delivery roller and a nip roller by arranging them, for example, on a downstream side of the air spinning device 6. In an alternative structure, the tension sta-

bilizer 8 is arranged on the downstream side of the delivery roller and the nip roller to wind and store the spun yarn Y. In an alternative structure, the tension stabilizer 8 is not provided and the spun yarn Y is pulled out by the winding device 9.

**[0039]** 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.

**[0040]** 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.

**[0041]** 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.

**[0042]** 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.

**[0043]** How a fiber guide 161 and a nozzle block 163 are fixed in a conventional air spinning device 106 is explained below with reference to FIG. 12. FIG. 12 is a side view of the conventional air spinning device 106.

**[0044]** The nozzle block 163 is supported by a nozzle holder 164 in a state in which the nozzle block 163 is engaged into a through hole 164h of the nozzle holder 164 and a through hole 165h of a spacer 165. More specifically, the nozzle block 163 is engaged into the through hole 164h of the nozzle holder 164 and the through hole 165h of the spacer 165, and supported by the nozzle holder 164 in a state in which a locking surface 163p of the nozzle block 163 abuts against the spacer 165.

**[0045]** The fiber guide 161 is fitted with an upper end surface (an upstream side end surface in a fiber-bundle running direction) of the nozzle block 163. More specifically, the fiber guide 161 is supported with a lower end portion (a downstream end surface in the fiber-bundle running direction) thereof fitted with a recess provided on the upper end surface of the nozzle block 163.

**[0046]** The fiber guide 161 and the nozzle block 163 that are fitted with each other are immovably fixed to the

nozzle holder 164 via the spacer 165 by a nozzle cap 166. More specifically, the fiber guide 161 and the nozzle block 163 are immovably fixed to the spacer 165 and the nozzle holder 164 by the nozzle cap 166 with pawls thereof grasping the fiber guide 161.

**[0047]** Thus, in the conventional air spinning device 106, the fiber guide 161 and the nozzle block 163 are fixed onto the spacer 165 first, and then the spacer 165 is fixed to the nozzle holder 164. This is because in the spinning unit 1, the air spinning device 106 and the pair of front rollers 54 are very close to each other so that it is difficult for an operator to directly fix the fiber guide 161 and the nozzle block 163 to the nozzle holder 164. Furthermore, as disclosed in Japanese unexamined utility model application publication No. H4-131661, generally, a common nozzle holder is provided for two adjacent air spinning devices 106 and it is necessary to use the spacer 165 for attaching the fiber guide 161 and the nozzle block 163 to the air spinning device 106.

**[0048]** Problems encountered in the conventional method of fixing the fiber guide 161 and the nozzle block 163 are explained below.

**[0049]** In the conventional air spinning device 106 in which the spacer 165 is provided between the locking surface 163p of the nozzle block 163 and the nozzle holder 164, it is possible to change the attachment positions of the fiber guide 161 and the nozzle block 163 by replacing the spacer 165 with an appropriate spacer. However, if a tolerance of the spacer 165 is added to tolerances of the fiber guide 161, the nozzle block 163, and the nozzle cap 166, a precision of the attachment positions of the fiber guide 161 and the nozzle block 163 is likely to reduce.

**[0050]** If a distance D between the fiber guide 161 and a spindle 162 is shorter than a predetermined value, trailing-end portions of the synthetic fibers forming the sliver F are hard to be turned over. As a result, the spun yarn Y that is loosely twisted is produced. More specifically, if the distance D between the fiber guide 161 and the spindle 162 is short, only a small number of the trailing-end portions of the synthetic fibers forming the sliver F are moved by and along the swirling airflow. This makes it difficult to turn over a sufficient number of the trailing-end portions. Accordingly, the number of the synthetic fibers forming the sliver F that are swung and sufficiently wound around the central fibers is reduced. As a result, a loosely twisted spun yarn (loose yarn) Y is produced.

**[0051]** If the distance D between the fiber guide 161 and the spindle 162 is equal to the predetermined value, trailing-end portions of the fibers forming the sliver F can be easily turned over. Consequently, the spun yarn Y that is firmly twisted is produced. More specifically, if the distance D between the fiber guide 161 and the spindle 162 is equal to the predetermined value, the trailing-end portions of the fibers forming the sliver F are moved by and along the swirling airflow easily, and therefore the trailing-end portions of the fibers are easily turned over. Accordingly, the fibers that are moved by and along the

swirling airflow can be sufficiently wound around central fibers. Consequently, a firmly-twisted spun yarn (firm yarn) Y is produced.

**[0052]** However, if the distance D between the fiber guide 161 and the spindle 162 is too long, both ends of the synthetic fibers forming the sliver F are swung in the spinning chamber SC without being restricted by either of the fiber guide 161 and the spindle 162. Accordingly, the synthetic fibers are discharged to the outside of the air spinning device 106 more frequently. As a result, fiber loss increases, which is disadvantageous. Furthermore, as the distance D increases, the volumetric capacity of the spinning chamber SC increases, and hence the amount of air that needs to be used in producing the swirling airflow also increases. Accordingly, the need for increasing the size of the air supply source arises. This requires upsizing of the spinning unit, which is also disadvantageous.

**[0053]** As described above, the spun yarn Y produced by the air spinning device 106 is likely to be influenced by the shape of the spinning chamber SC because the air spinning device 106 causes the fibers to swing by utilizing the swirling airflow. If the shape of the spinning chamber SC changes due to shifting of the attachment positions of the fiber guide 161, the nozzle block 163, etc., that define the spinning chamber SC, the twisting firmness of the produced spun yarn Y is likely to vary. Furthermore, the fiber loss is also likely to increase. Therefore, there is a need of an air spinning device in which variations in the shape of the spinning chamber SC can be reduced by improving the precision of the attachment positions of the fiber guide and the nozzle block.

**[0054]** How the fiber guide 61 and the nozzle block 63 are fixed in the air spinning device 6 according to an embodiment of the present invention is explained below with reference to FIG. 5. FIG. 5 is a side view of the air spinning device 6 according to the embodiment of the present invention.

**[0055]** The nozzle block 63 is supported in a state in which the nozzle block 63 is engaged into the through hole 64h of a nozzle holder 64. More specifically, the nozzle block 63 is engaged into the through hole 64h of the nozzle holder 64, and supported in a state in which a locking surface 63p of the nozzle block 63 abuts against the nozzle holder 64.

**[0056]** The fiber guide 61 is fitted with an upper end surface (an upstream side end surface in the fiber-bundle running direction) of the nozzle block 63. More specifically, the fiber guide 61 is supported with a lower end portion (a downstream side end surface in the fiber-bundle running direction) thereof fitted with the recess provided on the upper end surface of the nozzle block 63.

**[0057]** The fiber guide 61 and the nozzle block 63 are fitted with each other and fixed to the nozzle holder 64 by a nozzle cap 66. More specifically, the fiber guide 61 and the nozzle block 63 are directly fixed to the nozzle holder 64 by the nozzle cap 66 with pawls thereof grasp-

ing the fiber guide 61.

**[0058]** This structure enables improvement in a precision of an attachment position of the nozzle block 63; because, the nozzle block 63 is fixed by the nozzle cap 66 with the locking surface 63p of the nozzle block 63 abutting against the nozzle holder 64 and the nozzle cap 66 directly abutting against the nozzle holder 64. A precision of an attachment position of the fiber guide 61 that is fixed in a state of being fitted into the nozzle block 63 also improves. Thus, the quality of the spun yarn Y can be improved by reducing the variations in the shape of the spinning chamber SC. Furthermore, because the fiber guide 61 and the nozzle block 63 can be fixed with a simple structure, cost reduction can also be realized.

**[0059]** In the structure disclosed in Japanese unexamined utility model application publication No. H4-131661 in which one positioning plate is provided for two adjacent air spinning devices 106, there are restrictions due to the positioning plate. That is, it is difficult to position the air spinning device 106 relative to a drafting device freely for each spinning unit. However, according to the configuration of the present embodiment, by immovably fixing the fiber guide 61 and the nozzle block 63 to the nozzle holder 64, the air spinning device 6 can be positioned relative to the drafting device 5 freely for each spinning unit 1.

**[0060]** As explained above, the air spinning device 6 causes the fibers to swing by utilizing the swirling airflow, and therefore, the spun yarn Y produced by the air spinning device 6 is likely to be influenced by the fiber characteristics. Accordingly, the twisting firmness of the produced spun yarn Y may vary according to the fiber characteristics, such as, an average fiber length. Therefore, there is a need for an air spinning device that allows the fiber guide and the nozzle block to be easily replaced, and enables spinning according to the fiber characteristics.

**[0061]** A structure that enables easy replacement of the fiber guide 61 and the nozzle block 63 is explained below with reference to FIG. 5.

**[0062]** The nozzle holder 64 of the air spinning device 6 includes a first nozzle holder member 64A and a second nozzle holder member 64B. A solid arrow shown in FIG. 5 indicates directions of attachment and detachment of the first nozzle holder member 64A.

**[0063]** The fiber guide 61 and the nozzle block 63 are immovably fixed to the first nozzle holder member 64A by the nozzle cap 66. The spindle 62 inserted into the through hole 64h of the nozzle block 63 is locked by abutment of a spindle cap 68 that is described later against the first nozzle holder member 64A. The second nozzle holder member 64B is rotatably coupled to a shaft SH (supporting member) of the spinning unit 1.

**[0064]** The first nozzle holder member 64A is detachably attached to one end of the second nozzle holder member 64B. More specifically, the first nozzle holder member 64A can be attached to or detached from the second nozzle holder member 64B by tightening or re-

moving two bolts BT (see FIG. 6).

**[0065]** With this structure, the first nozzle holder member 64A to which the fiber guide 61 and the nozzle block 63 are immovably fixed is rendered detachable. Therefore, the fiber guide 61 and the nozzle block 63 can be easily replaced. Consequently, the air spinning device 6 can perform spinning according to the fiber characteristics and the quality of the spun yarn Y can be improved.

**[0066]** A structure for supplying the pressurized air generated by the air supply source AB to the spinning chamber SC is explained below with reference to FIG. 6. FIG. 6 is a top view of the air spinning device 6 according to the embodiment of the present invention.

**[0067]** An air-guiding passage 64p that guides the air pressure-fed from the air supply source AB to the spinning chamber SC includes a first air-guiding passage 64Ap provided in the first nozzle holder member 64A and a second air-guiding passage 64Bp provided in the second nozzle holder member 64B. Hollow arrows shown in FIG. 6 indicate a direction of flow of air and a solid arrow shown in FIG. 6 indicates the directions of attachment and detachment of the first nozzle holder member 64A.

**[0068]** The first air-guiding passage 64Ap communicates with an air chamber AC (see FIG. 5) via a coupling member 64Ac attached to one end of the first nozzle holder member 64A. The air guided to the air chamber AC is supplied to the spinning chamber SC through the air holes 63a of the nozzle block 63. The second air-guiding passage 64Bp communicates with a boss hole member 64Bh provided at one end of the second nozzle holder member 64B via a coupling member 64Bc attached to a side edge of the second nozzle holder member 64B.

**[0069]** When the first nozzle holder member 64A is attached to the second nozzle holder member 64B, the first air-guiding passage 64Ap communicates with the second air-guiding passage 64Bp. More specifically, when the first nozzle holder member 64A is attached to the second nozzle holder member 64B, the coupling member 64Ac of the first nozzle holder member 64A is inserted into the boss hole member 64Bh of the second nozzle holder member 64B; therefore, the first air-guiding passage 64Ap communicates with the second air-guiding passage 64Bp.

**[0070]** In this structure, the first nozzle holder member 64A can be detached without having to remove a pipe AH that extends from the air supply source AB. Therefore, the fiber guide 61 and the nozzle block 63 can be easily replaced. Consequently, the air spinning device 6 can perform spinning according to the fiber characteristics and the quality of the spun yarn Y can be improved. Because the pipe AH extending from the air supply source AB does not need to be removed, mixing of contaminants into the air-guiding passage 64p (64Ap and 64Bp) can be prevented and the quality of the spun yarn Y can be improved.

**[0071]** A method of locking the spindle 62 is explained below with reference to FIGS. 7A and 7B. FIG. 7A is a magnified side view of the spindle 62 of the air spinning

device 6 according to the embodiment of the present invention. FIG. 7B is a cross-sectional view of the spindle 62 taken along a line X-X shown in FIG. 7A.

**[0072]** The spindle 62 is supported by a spindle holder 67 with a projection thereof engaged into the spindle 62. More specifically, the spindle 62 is supported by the spindle holder 67 such that the projection provided on an upper end surface (the upstream end surface in the fiber-bundle running direction) of the spindle holder 67 is engaged into a lower end (the downstream end surface in the fiber-bundle running direction) of the spindle 62.

**[0073]** The spindle 62 is locked in the spindle holder 67 by the spindle cap 68 that functions as a spindle locking member. More specifically, the spindle 62 is locked in the spindle holder 67 by the spindle cap 68 with pawls thereof grasping a locking surface 62p of the spindle 62. In the present embodiment, a female screw part is provided in the spindle cap 68 and the spindle cap 68 is threaded onto a male screw part of the spindle holder 67.

**[0074]** With this structure, because the spindle 62 can be locked in the spindle holder 67 with just one touch merely by threading in the spindle cap 68, the spindle 62 can be easily replaced. Consequently, the air spinning device 6 can perform spinning according to the fiber characteristics and the quality of the spun yarn Y can be improved. The spindle 62 can be locked in the spindle holder 67 with a simple structure; therefore, cost reduction can be realized.

**[0075]** In the method of locking the spindle 62 of the air spinning device 6, a projection 67u provided on the spindle holder 67 meshes with a recess 68u provided in the spindle cap 68 when the spindle cap 68 is threaded onto the spindle holder 67. In an alternative structure, the projection 67u is provided on the spindle cap 68 instead of on the spindle holder 67 and the recess 68u is provided in the spindle holder 67 instead of in the spindle cap 68.

**[0076]** With this structure, if the spindle cap 68 is threaded until the projection 67u meshes with the recess 68u, a tightening torque reaches a predetermined value. Therefore, the spindle 62 can be easily locked and easily replaced. Consequently, the air spinning device 6 can perform spinning according to the fiber characteristics and the quality of the spun yarn Y can be improved.

**[0077]** The spindle cap 68 is made of resin; therefore, the spindle cap 68 deforms while being threaded in and the projection 67u meshes with the recess 68u. Therefore, the spindle 62 can be locked in the spindle holder 67 with just one touch without having to use a tool. Consequently, a time required for the operator to replace the spindle 62 is reduced and an operation efficiency of the spinning unit 1 is improved.

**[0078]** In the conventional air spinning device 106, for example, as disclosed in Japanese Patent Application Laid-open No. H7-126924, the spindle 162 is locked to a spindle holder 167 using bolts. The conventional air spinning device 106 is arranged very close to the drafting device, and there is a lack of adequate working space

for carrying out replacement of the spindle 162. Thus, it is difficult to perform operations using tools, and locking the spindle 162 in the spindle holder 167 with the bolts. However, in a method in which the spindle 62 is locked in the spindle holder 67 with just one touch by threading in the spindle cap 68 as in the present embodiment, no operations necessitate a use of a tool. Therefore, the spindle 62 can be locked even if there is a narrow working space.

**[0079]** In the method of locking the spindle 162 using the bolts in the conventional air spinning device 106, the operator may drop the bolts by mistake. However, in the method in which the spindle 62 is locked in the spindle holder 67 by threading in the spindle cap 68 as in the present embodiment, the number of components required for locking the spindle 62 in the spindle holder 67 is less, and as a result, the spindle 62 can be easily locked.

**[0080]** As shown in FIG. 8, in an alternative structure, the spindle 62 is locked using a hook member Ho without using the spindle cap 68. The hook member Ho that is a spindle locking member enables the spindle 62 to be easily locked, and easily replaced. Thus, the air spinning device 6 can perform spinning according to the fiber characteristics and the quality of the spun yarn Y can be improved. Because the spindle 62 can be locked with a simple structure, cost reduction can also be realized.

**[0081]** A structure for locking the nozzle holder 64 by a stopper 64s is explained below with reference to FIGS. 9A and 9B. FIG. 9A is a side view of the air spinning device 6 according to the embodiment of the present invention and FIG. 9B is a front view of the air spinning device 6 from a direction of an arrow Y shown in FIG. 9A.

**[0082]** As shown in FIG. 9A, the second nozzle holder member 64B of the nozzle holder 64 is rotatably coupled to the shaft SH (supporting member) of the spinning unit 1. The shaft SH supports the nozzle holder 64 so as to be movable towards or away from the wall surface W that is arranged facing the nozzle holder 64.

**[0083]** An urging member SP that urges the nozzle holder 64 towards the wall surface W is attached to the second nozzle holder member 64B of the nozzle holder 64. An urging force acts on the nozzle holder 64 such that the nozzle holder 64 moves towards the wall surface W that is arranged facing the nozzle holder 64. A solid arrow shown in FIG. 9A indicates a direction of the urging force that acts on the nozzle holder 64.

**[0084]** As shown in FIG. 9B, the stopper 64s is provided on the first nozzle holder member 64A of the nozzle holder 64. The stopper 64s is provided so as to be protruding towards the wall surface W direction from an upper surface of the first nozzle holder member 64A. Thus, the stopper 64s abuts against the wall surface W, thereby locking the nozzle holder 64.

**[0085]** With this structure, because the nozzle holder 64 on which the urging force acts is locked by the stopper 64s, a play of the nozzle holder 64 is suppressed and a precision of a positioning of the nozzle holder 64 im-

proves. A precision of positions of the fiber guide 61 and the nozzle block 63 immovably fixed to the nozzle holder 64 relative to the spindle 62 also improves. Consequently, variations in the shape of the spinning chamber SC can be reduced and the quality of the spun yarn Y can be improved.

**[0086]** As shown in FIG. 10, a dial 64D that includes a plurality of the stoppers 64s having different shapes in a peripheral direction may be provided on the nozzle holder 64 and the stopper 64s that abuts against the wall surface W can be switched. More specifically, the stoppers 64s having different shapes are formed such that a protrusion length of each of the stoppers 64s from a surface of the nozzle holder 64 is different. When spinning the sliver F having a longer fiber length, the dial 64D is switched such that the nozzle holder 64 is locked by the stopper 64s having a long protrusion length. When spinning the sliver F having a shorter fiber length, the dial 64D is switched such that the nozzle holder 64 is locked by the stopper 64s having a short protrusion length.

**[0087]** Because the nozzle holder 64 includes the stoppers 64s of different shapes, the locking position of the nozzle holder 64 can be changed by switching to any of the stoppers 64s. Consequently, the air spinning device 6 can perform spinning according to the fiber characteristics and the quality of the spun yarn Y can be improved.

**[0088]** As shown in FIG. 11, a structure can be provided in which the locking position of the nozzle holder 64 can be changed by extending or retracting the stopper 64s (see an arrow in FIG. 11). Consequently, the air spinning device 6 can perform spinning according to the fiber characteristics and the quality of the spun yarn Y can be improved.

**[0089]** In the spinning apparatus that includes the air spinning device 6 described above, the package P can be produced with high quality spun yarn Y and cost reduction can be realized.

**[0090]** In the spinning apparatus that includes a plurality of the spinning units 1, the spun yarn Y produced in each spinning unit 1 is required to be of the same quality. Thus, by producing the spun yarn Y by using the air spinning device 6 according to the present embodiment, variation in the quality of the spun yarn Y among the spinning units 1 can be reduced.

**[0091]** In the spinning unit 1 according to the present embodiment, the sliver F is fed from an upward direction to a downward direction. However, the present invention is not to be thus limited. For example, cans in which the sliver F is stored can be arranged in a lower portion of a machine base and the winding device 9 can be arranged in an upper portion of the machine base.

**[0092]** An air spinning device according to a first aspect of the present invention includes a fiber guide, a nozzle block, a spindle, a nozzle holder, and a nozzle cap. The nozzle holder holds the nozzle block while being in a state of abutment against the nozzle block. The nozzle cap fixes the fiber guide and the nozzle block to the nozzle holder, and is attached to the nozzle holder while being



in a state of direct abutment against the nozzle holder.

**[0093]** In an air spinning device according to a second aspect of the present invention, the nozzle holder includes a first nozzle holder member and a second nozzle holder member. The first nozzle holder member holds the nozzle block and has the nozzle cap attached thereon. The second nozzle holder member supports the first nozzle holder member. The first nozzle holder member is detachably attached to the second nozzle holder member.

**[0094]** In an air spinning device according to a third aspect of the present invention, the first nozzle holder member includes a first air-guiding passage that guides the air into the spinning chamber. The second nozzle holder member includes a second air-guiding passage that guides the air that is pressure-fed from an air supply source. The first air-guiding passage and the second air-guiding passage communicate with each other when the first nozzle holder member is attached to the second nozzle holder member.

**[0095]** An air spinning device according to a fourth aspect of the present invention includes a fiber guide, a nozzle block, a spindle, a spindle holder, and a spindle locking member. The spindle holder holds the spindle. The spindle locking member locks the spindle into the spindle holder with just one touch.

**[0096]** In an air spinning device according to a fifth aspect of the present invention, the spindle locking member is threaded with respect to the spindle holder while being in a state of abutment against the spindle.

**[0097]** In an air spinning device according to a sixth aspect of the present invention, the spindle holder has a recess or a projection. The spindle locking member has a projection or a recess. The spindle holder is held in the spindle locking member by a meshing of the recess/projection of the spindle holder with the projection/recess of the spindle locking member.

**[0098]** In an air spinning device according to a seventh aspect of the present invention, the air spinning device includes a supporting member, a stopper, and an urging member. The supporting member supports the nozzle holder so as to enable the nozzle holder to move towards or away from a wall surface facing the nozzle holder. The stopper that positions the nozzle holder by abutting against the wall surface is provided on the nozzle holder. The urging member urges the nozzle holder towards the wall surface.

**[0099]** In an air spinning device according to an eighth aspect of the present invention, a plurality of the stoppers of different shapes is provided on the nozzle holder, and a switching structure is provided that enable switching of the stopper that abuts against the wall surface.

**[0100]** A spinning apparatus according to a ninth aspect of the present invention includes an air spinning device according to any one of the first to the eight aspects of the present invention, and a winding device that winds a spun yarn spun by the air spinning device into a package.

**[0101]** According to the first aspect of the present invention, a nozzle cap, which is attached to a nozzle holder while being in a state of direct abutment against the nozzle holder, fixes a nozzle block while the nozzle block is in a state of abutment against the nozzle holder. Therefore, there is improved precision of an attachment position of the nozzle block. Consequently, a precision of an attachment position of a fiber guide, which is also fixed in a state of being fitted into the nozzle block, also improves. Thus, variations in a shape of a spinning chamber can be reduced and a quality of spun yarns can be improved. Furthermore, the fiber guide and the nozzle block are fixed to the nozzle holder with a simple structure. Consequently, cost reduction is realized.

**[0102]** According to the second aspect of the present invention, a first nozzle holder member, to which the fiber guide and the nozzle block are fitted, is detachable, enabling the fiber guide and the nozzle block to be easily replaced. Therefore, spinning can be performed according to fiber characteristics, and thereby the quality of the spun yarns can be improved.

**[0103]** According to the third aspect of the present invention, the first nozzle holder member can be detached without having to remove a pipe extending from an air supply source. Consequently, the fiber guide and the nozzle block can be easily replaced. Therefore, spinning can be performed according to the fiber characteristics, and thereby the quality of the spun yarns can be improved. Furthermore, because the pipe extending from the air supply source needs not be removed, contaminants can be prevented from entering an air guiding passage, and therefore, the quality of the spun yarns can be improved.

**[0104]** According to the fourth aspect of the present invention, a spindle is locked in a spindle holder with a simple structure. Consequently, cost reduction is realized.

**[0105]** According to the fifth aspect of the present invention, because the spindle can be locked in the spindle holder merely by threading a spindle locking member, the spindle can be easily replaced. Therefore, spinning can be performed according to the fiber characteristics, and thereby the quality of the spun yarns can be improved.

**[0106]** According to the sixth aspect of the present invention, a predetermined clamping torque is reached by threading in the spindle locking member until a projection and a recess mesh. Consequently, the spindle can be easily locked and easily replaced. Therefore, spinning can be performed according to the fiber characteristics, and thereby the quality of the spun yarns can be improved.

**[0107]** According to the seventh aspect of the present invention, because the nozzle holder, which is subjected to an urging force, is locked with a stopper, a play of the nozzle holder can be suppressed and a precision of a positioning of the nozzle holder is improved. Consequently, a precision of positions of the fiber guide and

the nozzle block, which are fixed to the nozzle holder, relative to the spindle also improves. Therefore, variations in the shape of the spinning chamber can be reduced and the quality of the spun yarns can be improved.

**[0108]** According to the eighth aspect of the present invention, because a plurality of the stoppers of different shapes are provided, a locking position of the nozzle holder can be changed by switching to any of the stoppers. Thus, spinning can be performed according to the fiber characteristics, and thereby the quality of the spun yarns can be improved.

**[0109]** According to the ninth aspect of the present invention, packages of high quality spun yarns are produced, and cost reduction is realized.

**[0110]** 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 comprising:

a fiber guide (61) that has a fiber introducing passage (61g) that communicates with a spinning chamber (SC), the fiber guide (61) being adapted to guide a fiber bundle (F) into the spinning chamber (SC);

a nozzle block (63) that has an air hole (63a) that communicates with the spinning chamber (SC), the nozzle block (63) being adapted to guide air into the spinning chamber (SC);

a spindle (62) that has a fiber passageway (62s) that communicates with the spinning chamber (SC), the spindle (62) being adapted to guide the fiber bundle (F) twisted in the spinning chamber (SC);

a nozzle holder (64) that is adapted to hold the nozzle block (63) while being in a state of abutment against the nozzle block (63); and

a nozzle cap (66) that is adapted to fix the fiber guide (61) and the nozzle block (63) to the nozzle holder (64), the nozzle cap (66) being adapted to be attached to the nozzle holder (64) while being in a state of direct abutment against the nozzle holder (64).

### 2. The air spinning device according to Claim 1, wherein the nozzle holder (64) includes

a first nozzle holder member (64A) that is adapted to hold the nozzle block (63) and to which the nozzle cap (66) is attachable, and

a second nozzle holder member (64B) that is adapted to support the first nozzle holder member (64A),

the first nozzle holder member (64A) being detachably attachable to the second nozzle holder member (64B).

3. The air spinning device according to Claim 2, wherein the first nozzle holder member (64A) includes a first air-guiding passage (64Ap) that is adapted to guide the air into the spinning chamber (SC), the second nozzle holder member (64B) includes a second air-guiding passage (64Bp) that is adapted to guide the air that is pressure-fed from an air supply source (AB), and the first air-guiding passage (64Ap) and the second air-guiding passage (64Bp) communicate with each other when the first nozzle holder member (64A) is attached to the second nozzle holder member (64B).

4. The air spinning device according any one of Claims 1 to 3, further comprising:

a spindle holder (67) that is adapted to hold the spindle (62); and

a spindle locking member (68) that is adapted to lock the spindle (62) into the spindle holder (67) without a tool.

5. The air spinning device according to Claim 4, wherein the spindle locking member (68) is threaded with respect to the spindle holder (67) while being in a state of abutment against the spindle (62).

6. The air spinning device according to Claim 5, wherein the spindle holder (67) has any one of a recess and a projection, the spindle locking member (68) has a projection when the spindle holder (67) has the recess and has a recess when the spindle holder (67) has a projection, and the spindle (62) is coupled to the spindle holder (67) by a meshing of the recess/projection of the spindle holder (67) with the projection/recess of the spindle locking member (68).

7. The air spinning device according to any one of Claims 1 to 6, further comprising:

a supporting member (SH) that is adapted to support the nozzle holder (64) so as to enable the nozzle holder (64) to move towards or away from a wall surface (W) facing the nozzle holder (64);

a stopper (64s) that is provided on the nozzle holder (64) and that is adapted to position the nozzle holder (64) by abutting against the wall surface (W); and

an urging member (SP) that is adapted to urge

the nozzle holder (64) towards the wall surface (W).

8. The air spinning device according to Claim 7, further comprising:

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a plurality of the stoppers (64s) of different shapes that is provided on the nozzle holder (64); and

a switching structure that is adapted to enable switching of the stopper (64s) that abuts against the wall surface (W).

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9. A spinning apparatus comprising:

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an air spinning device (6) according to any one of Claims 1 to 8; and

a winding device (9) that is adapted to wind a spun yarn (Y) spun by the air spinning device (6) into a package (P).

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FIG.1

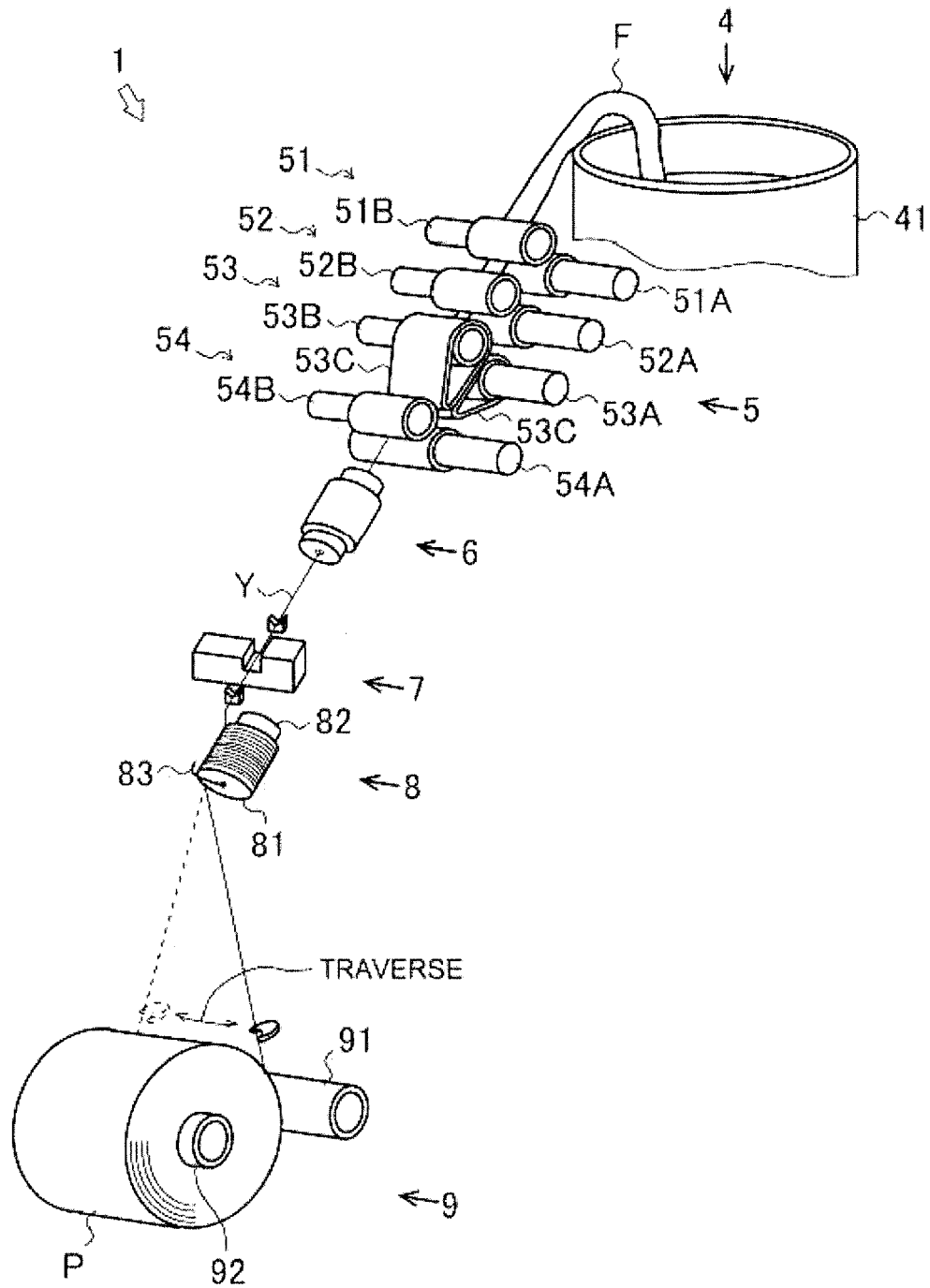


FIG.2

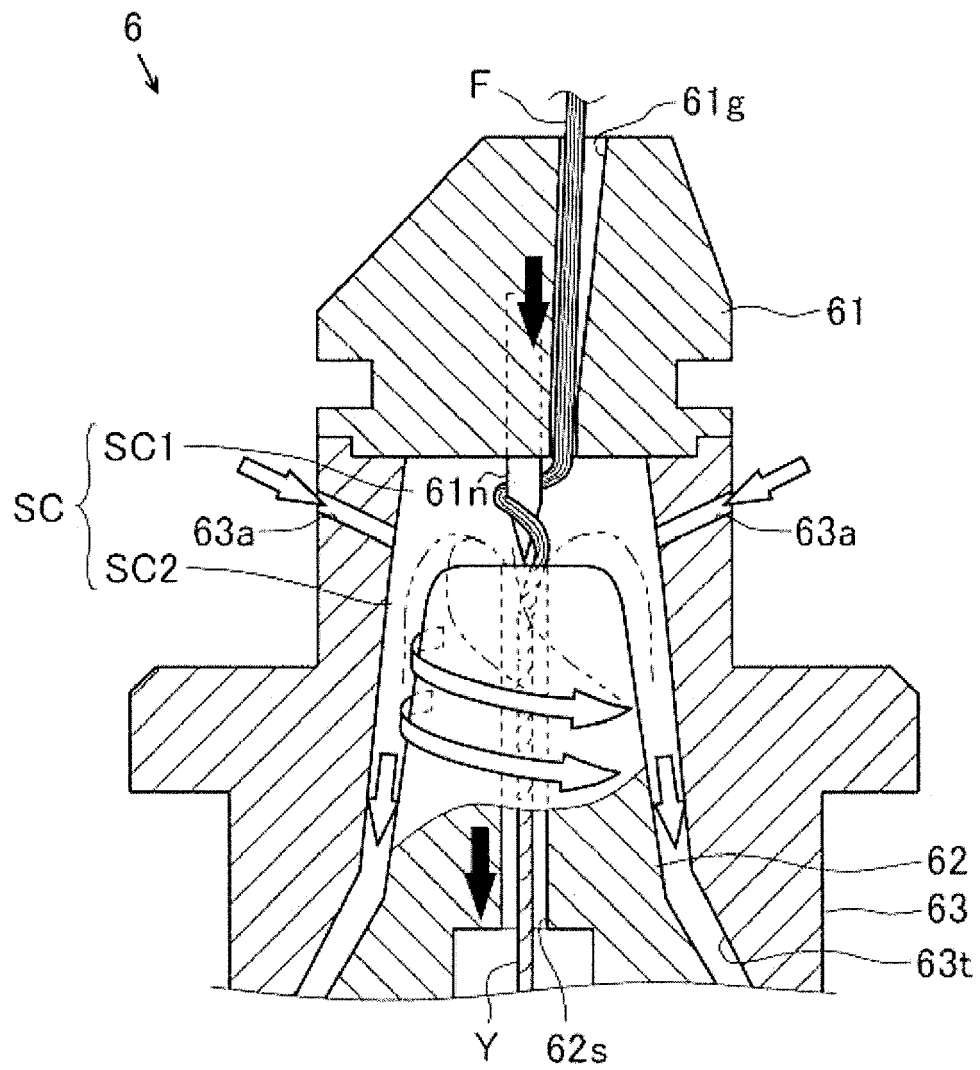


FIG.3

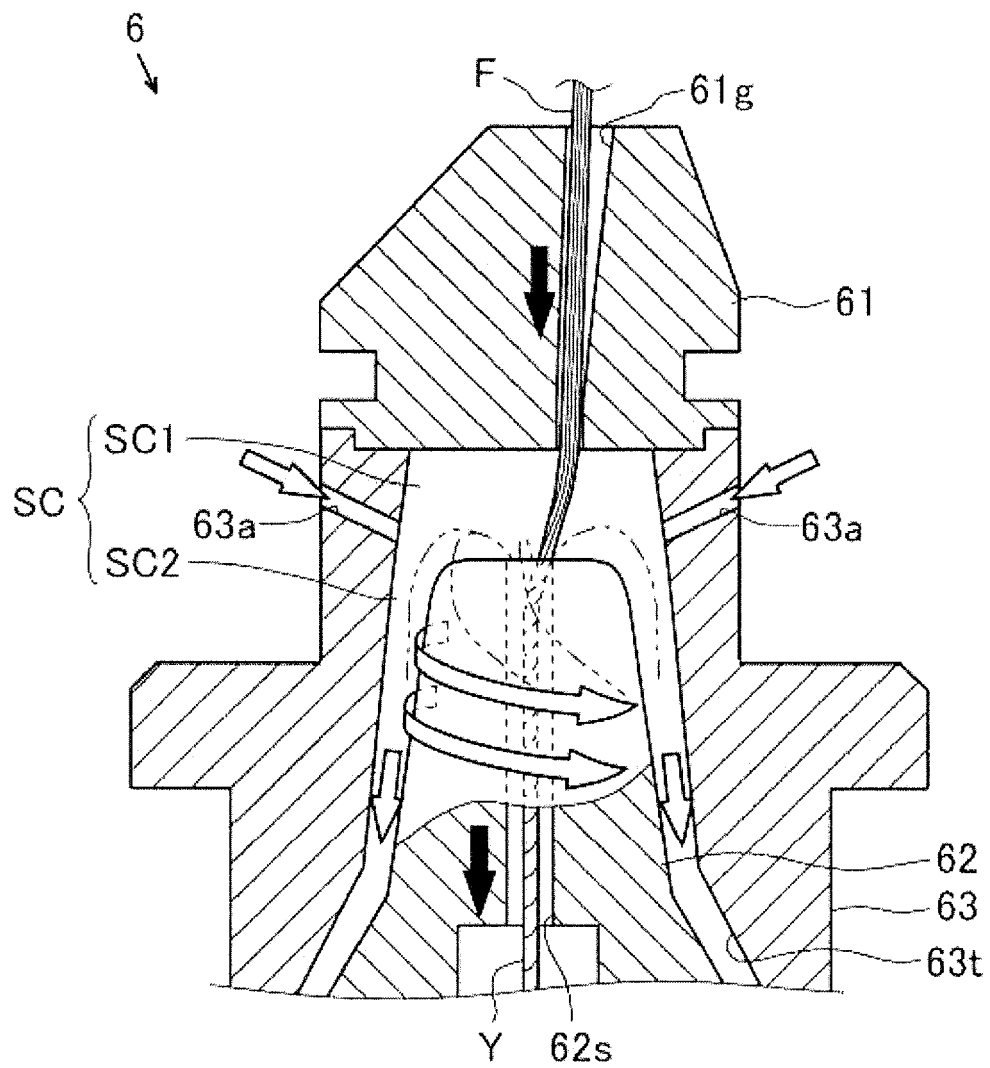


FIG.4

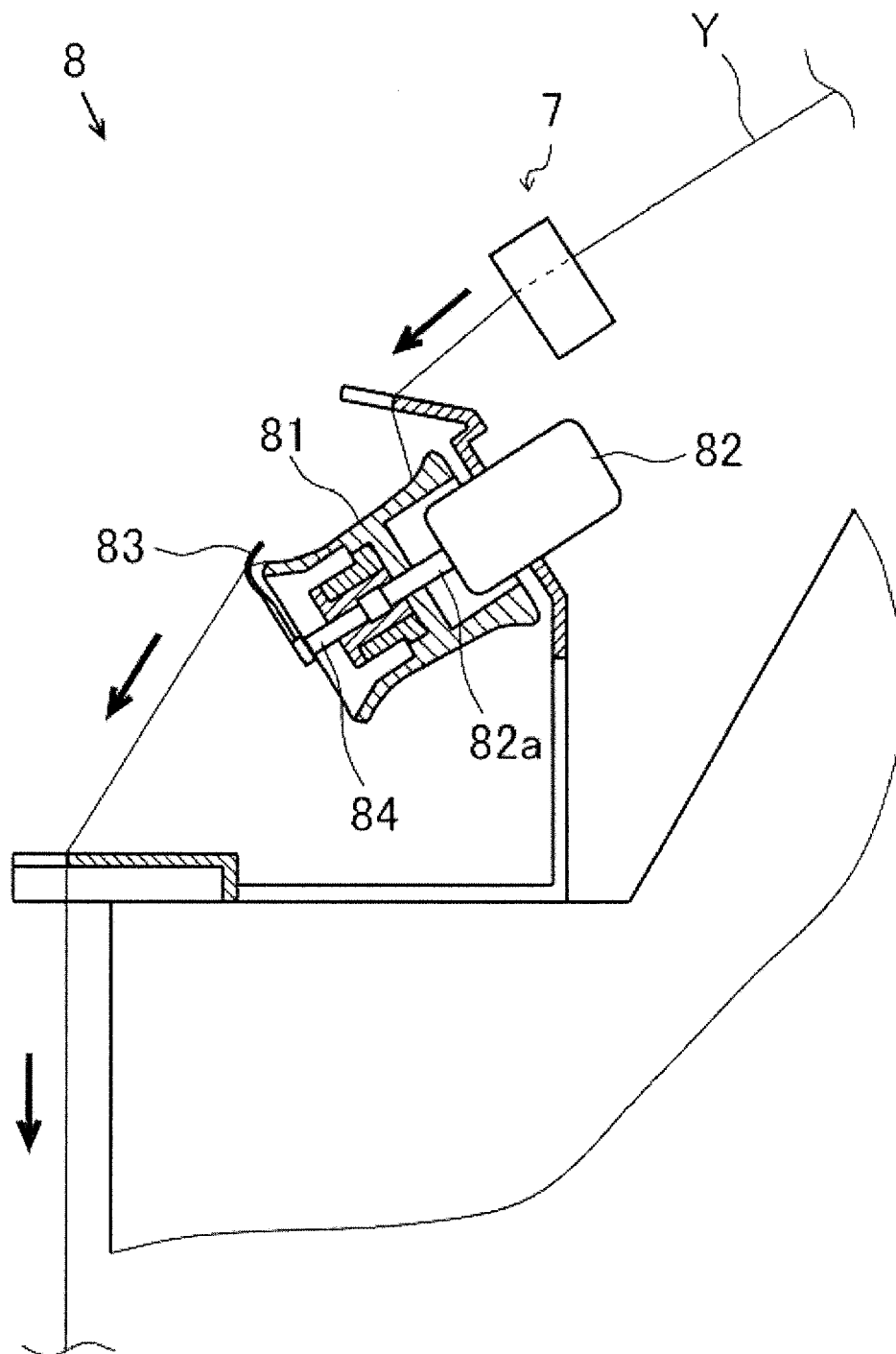


FIG.5

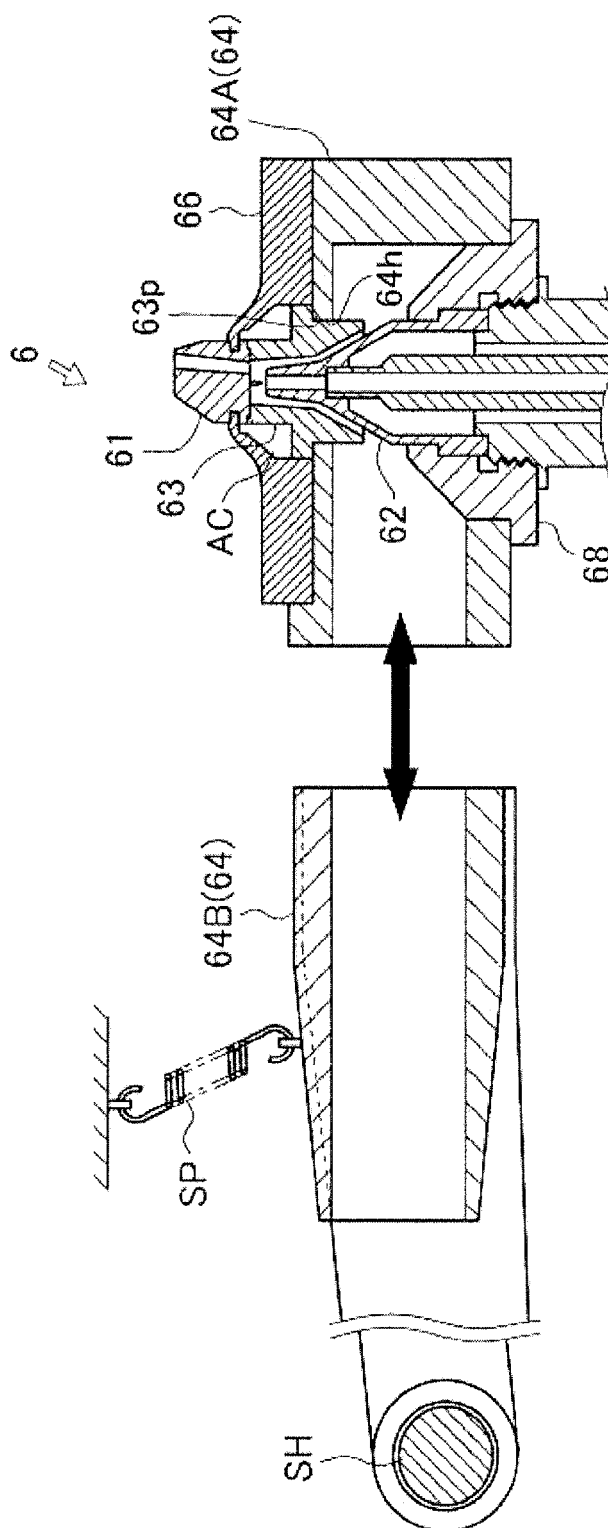




FIG.6

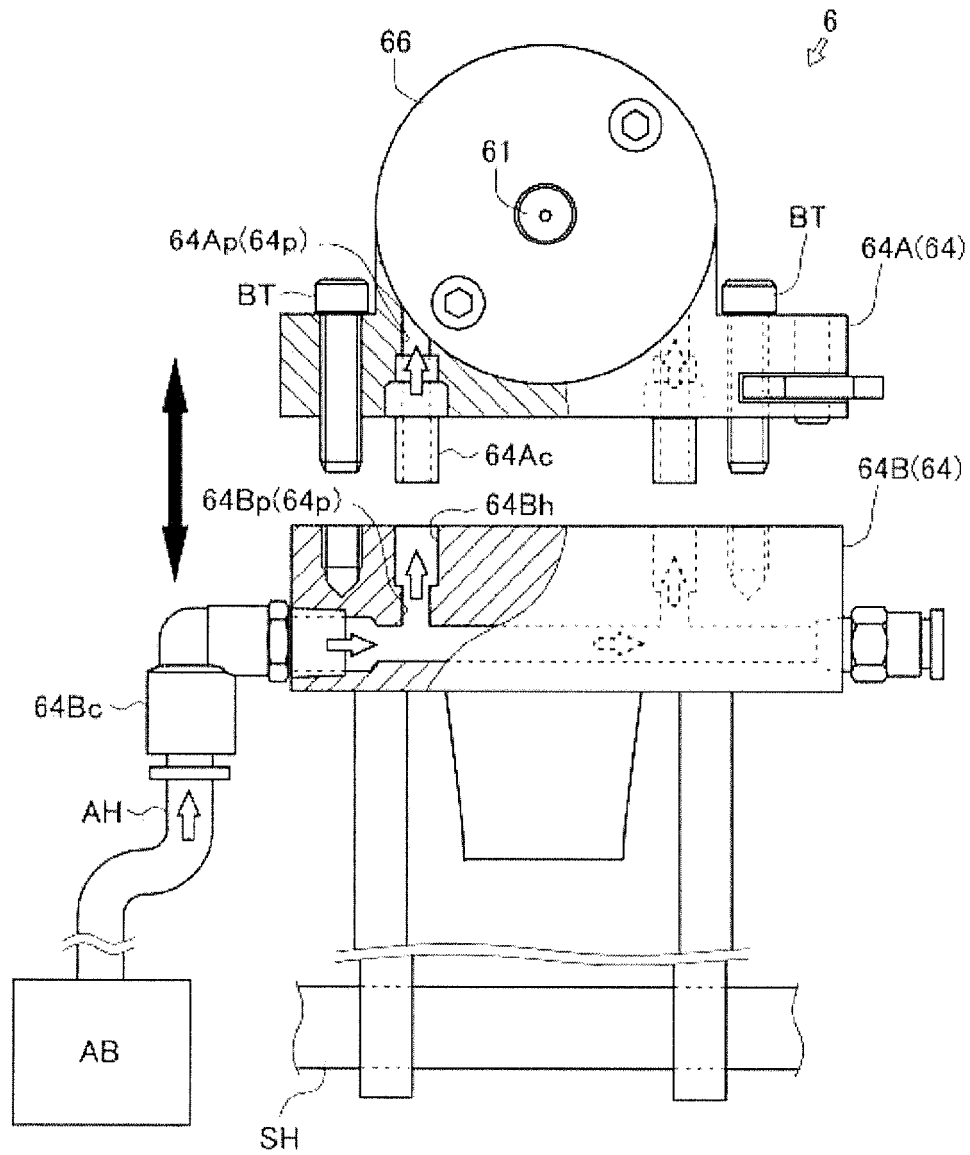


FIG. 7B

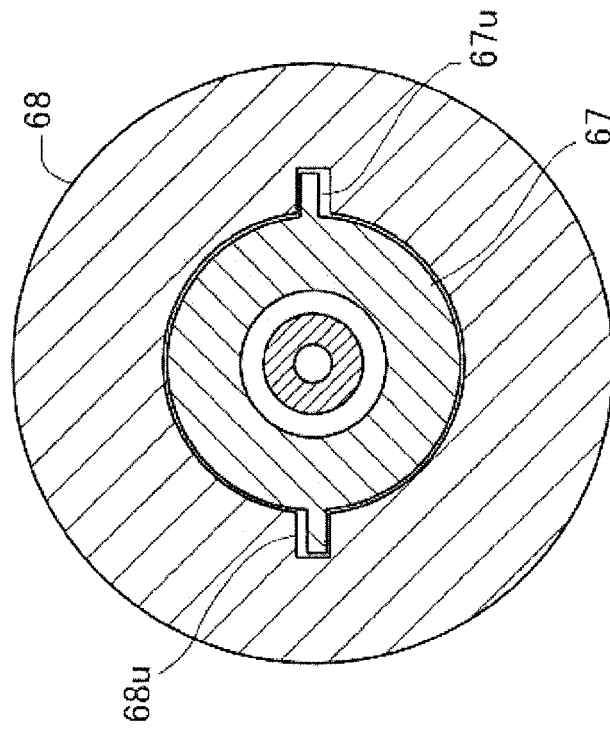


FIG. 7A

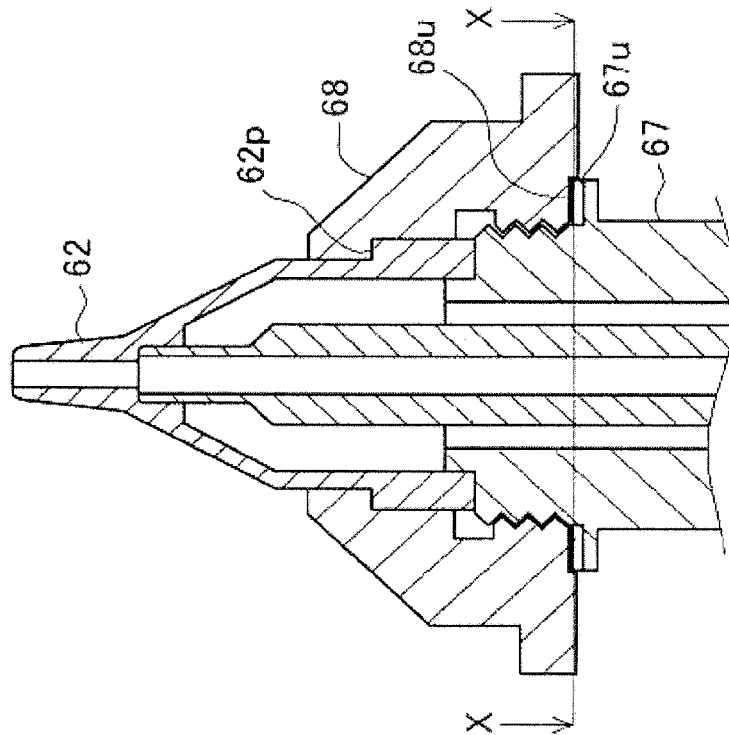


FIG.8

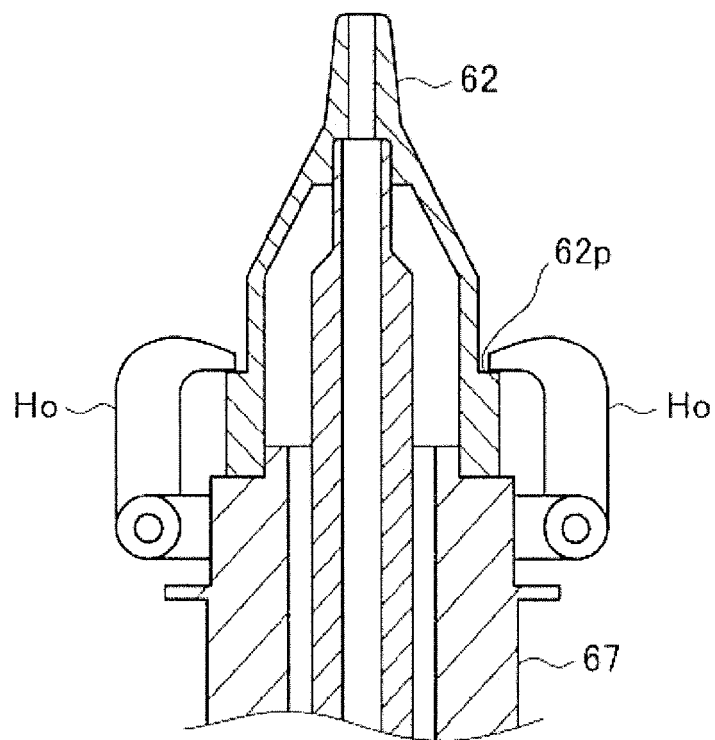


FIG.9A

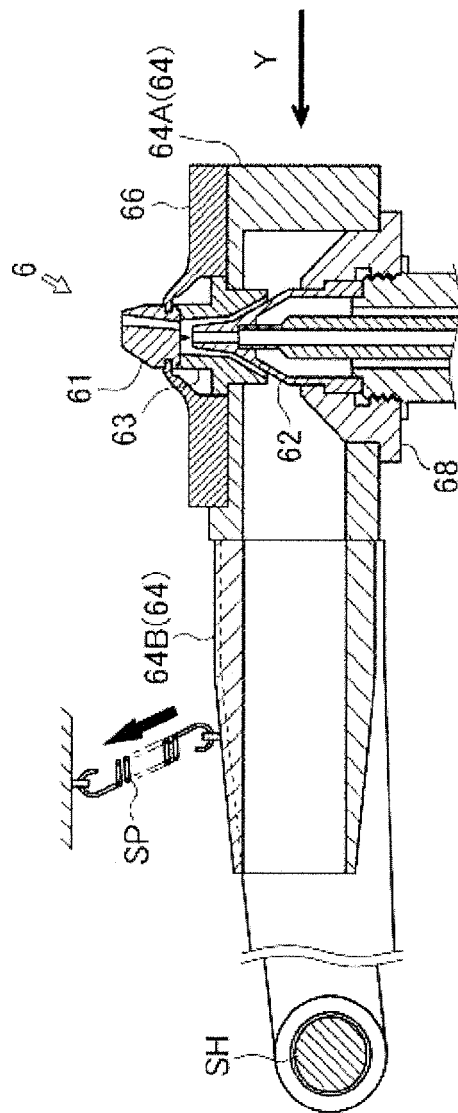


FIG.9B

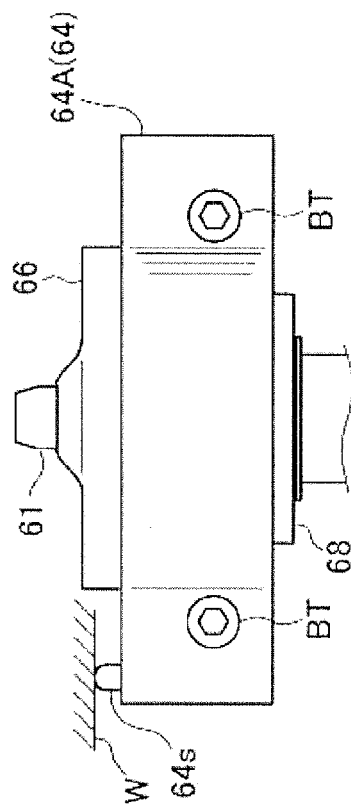


FIG.10

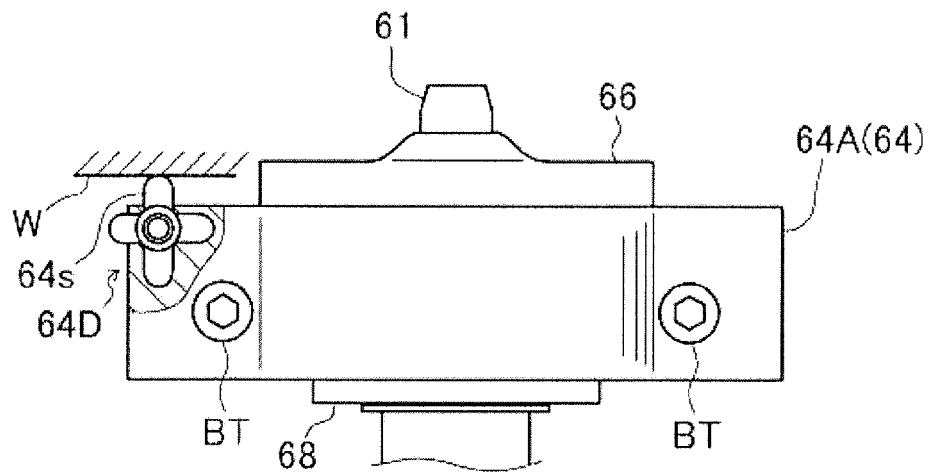


FIG.11

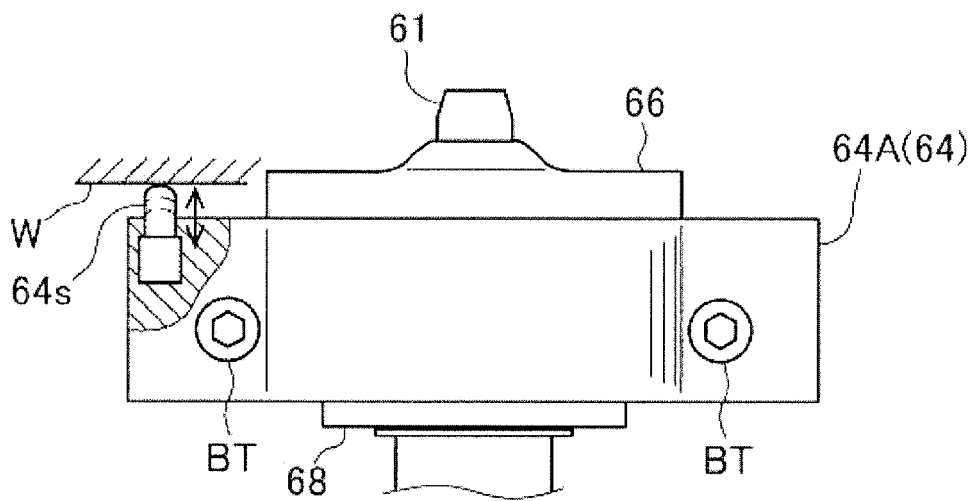
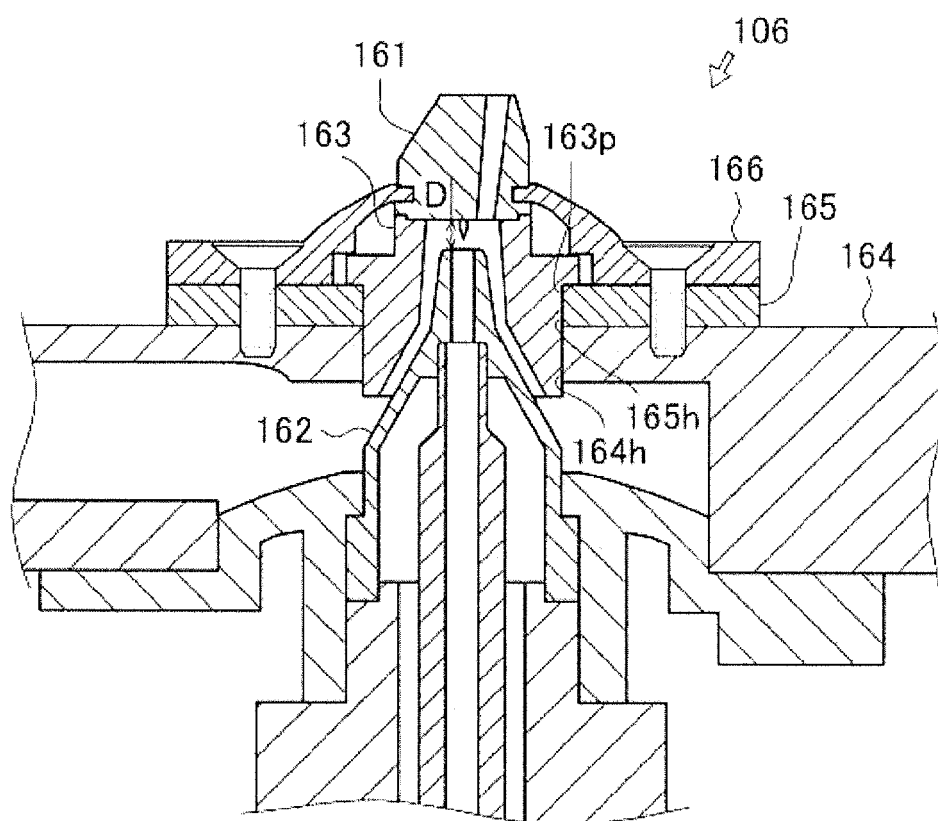


FIG.12



**REFERENCES CITED IN THE DESCRIPTION**

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- JP H4131661 B [0002] [0047] [0059]
- JP H7126924 B [0078]