(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 012 362 A2

# (12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
**27.04.2016 Bulletin 2016/17**

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

(21) Application number: **15183651.7**

(22) Date of filing: **03.09.2015**

(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**
Designated Validation States:
**MA**

(30) Priority: **30.09.2014 JP 2014199701**

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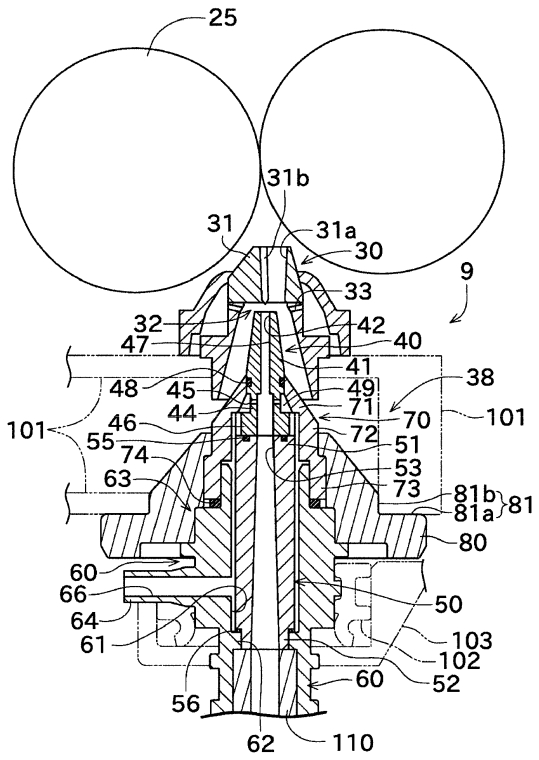
## (54) HOLLOW GUIDE SHAFT, AIR-JET SPINNING DEVICE, AND TEXTILE MACHINERY

(57) A hollow guide shaft (38) includes a first member (40) and a second member (50). In the first member (40) are formed an introducing opening (42) through which a fiber bundle (8) is introduced, a first fiber passageway (47) through which the guided fiber bundle (8) passes, and an assisting nozzle (45) arranged so as to generate inside the first fiber passageway (47) a swirling air current that conveys the fiber bundle (8) downstream during yarn discharge spinning. In the second member (50) is formed a second fiber passageway (53) through which the fiber bundle (8) that has passed through the first fiber passageway (47) passes. The second member (50) is arranged as a separate member from the first member (40).

**FIG.3**

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## Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

**[0001]** The present invention generally relates to a hollow guide shaft used in an air-jet spinning device that forms a spun yarn by twisting a fiber bundle.

2. Description of the Related Art

**[0002]** Air-jet spinning devices that perform yarn discharge spinning are known in the art. Yarn discharge spinning refers to a process performed at the start of spinning whereby a yarn is formed by spinning in a manner that is different from regular spinning. In air-jet spinning devices that perform yarn discharge spinning, a spinning nozzle is arranged in a nozzle block, and an assisting nozzle is arranged in a hollow guide shaft. A swirling air current is generated inside the air-jet spinning device by blowing compressed air from the spinning nozzle and the assisting nozzle.

**[0003]** In the air-jet spinning device, during yarn discharge spinning, the spun yarn is formed by twisting a fiber bundle drafted by a drafting device with the swirling air current generated by the compressed air blown from the spinning nozzle. The fiber bundle is further twisted while being pulled the fiber bundle downstream with the swirling air current generated by the compressed air blown from the assisting nozzle. During regular spinning performed thereafter, the air-jet spinning device forms the spun yarn from the fiber bundle with only the swirling air current from the spinning nozzle.

**[0004]** Japanese Patent Application Laid-open No. 2001-146646 (Patent Document 1) discloses a spinning machine that includes a spinning nozzle and an assisting nozzle. In this spinning machine, an introducing opening through which fibers drafted by a drafting device are introduced, an assisting nozzle, and a yarn outlet through which the formed spun yarn is guided out are all formed in a single member (hollow guide shaft).

**[0005]** Japanese Patent Application Laid-open No. 2001-146647 (Patent Document 2) discloses a spindle (hollow guide shaft) that includes a main part and a tip part. At the tip part of the spindle, plural holes through which fibers can pass are formed side by side in a fiber running direction. When viewed from an axial direction, the holes partially overlap with one another. With this configuration, accumulation of impurities can be prevented and spinning can be performed at high speed.

SUMMARY OF THE INVENTION

**[0006]** In the hollow guide shaft disclosed in Patent Document 1, the introducing opening, the assisting nozzle, and the yarn outlet arranged downstream thereof are all formed on the same member. Hence, the hollow guide shaft disclosed in Patent Document 1 is very long in the axial direction. Although, the hollow guide shaft is generally an elongate member having a horizontal cross-sectional diameter of less than 1 centimeter (cm), high precision is required when forming a fiber passageway (hole) inside the hollow guide shaft. Hence, if the hollow guide shaft is long in the axial direction as disclosed in Patent Document 1, machining to form the fiber passageway may be difficult.

**[0007]** It is mentioned in Patent Document 2 that the tip part and the main part of the hollow guide shaft are separate members. However, there is no mention or suggestion in Patent Document 2 regarding formation of assisting nozzle in the hollow guide shaft.

**[0008]** It is an object of the present invention to provide a hollow guide shaft in which machining for forming a fiber passageway inside the hollow guide shaft can be performed easily.

**[0009]** A hollow guide shaft according to an aspect of the present invention includes an introducing opening through which fibers are introduced; a first fiber passageway that is a through hole formed from the introducing opening along a central axis; and an assisting nozzle that is formed so as to open into the first fiber passageway. A substantially cylindrical part where the introducing opening and the first fiber passageway are formed has a region where an outer peripheral diameter increases as a distance from the introducing opening increases.

**[0010]** A hollow guide shaft according to another aspect of the present invention includes a first member in which are formed an introducing opening through which fibers are introduced, a first fiber passageway that is a through hole formed from the introducing opening along a central axis, and an assisting nozzle that is formed so as to open into the first fiber passageway; a second member in which is formed a second fiber passageway through which the fibers that have passed through the first fiber passageway pass and that is arranged as a separate member from the first member; and a supporting member that supports the second member.

**[0011]** An air-jet spinning device according to still another aspect of the present invention includes the hollow guide shaft; a nozzle block that is arranged to form a spinning chamber between the hollow guide shaft and the nozzle block, and that includes a spinning nozzle arranged to generate inside the spinning chamber a swirling air current that acts on the fibers in the spinning chamber; and a fiber guide that is arranged opposing the hollow guide shaft and that guides the fibers to the first fiber passageway.

**[0012]** A textile machinery according to still another aspect of the present invention includes the air-jet spinning device.

BRIEF DESCRIPTION OF THE DRAWINGS

**[0013]**

FIG. 1 is a front view of an overall structure of a spinning frame according to an embodiment of the present invention.

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

FIG. 3 is a cross-sectional view of an air-jet spinning device.

FIG. 4 is a perspective view of a first member, a second member, and an inner cover part.

## DETAILED DESCRIPTION

**[0014]** Exemplary embodiments of a spinning frame (textile machinery) according to the present invention are explained in detail below with reference to the accompanying drawings. A spinning frame 1 shown in FIG. 1 includes plural spinning units 2 arranged side by side, a yarn joining carrier 3, a motor box 4, and a main control device 90.

**[0015]** The main control device 90 centrally manages all the structural components of the spinning frame 1, and includes a monitor 91 and input keys 92. An operator can appropriately operate the input keys 92 to perform setting operations of a specific spinning unit 2 or all the spinning units 2 and have settings, status, and the like of a specific spinning unit 2 or all the spinning units 2 displayed on the monitor 91.

**[0016]** As shown in FIG. 2, each of the spinning units 2 includes, sequentially arranged from upstream to downstream, a drafting device 7, an air-jet spinning device 9, a yarn pooling device 14, and a winding device 96. The terms "upstream" and "downstream" in the following explanation refer to upstream and downstream, respectively, in a running (transportation) direction of a sliver 6, a fiber bundle 8, and a spun yarn 10 during spinning. Each of the spinning units 2 spins, by using the air-jet spinning device 9, the fiber bundle 8 conveyed from the drafting device 7 and forms the spun yarn 10. The spun yarn 10 is wound into a package 28 by the winding device 96.

**[0017]** The drafting device 7 is arranged near the top end of a housing 5 of the spinning machine 1. The drafting device 7 includes four roller pairs, namely, sequentially from upstream, a back roller pair 21, a third roller pair 22, a middle roller pair 24 with an apron belt 23 stretched over each roller thereof, and a front roller pair 25. The drafting device 7 drafts (stretches a bundle of fibers) the sliver 6 supplied from a not shown sliver case via a sliver guide 20 until the fiber bundle 8 attains a predetermined thickness. The fiber bundle 8 drafted by the drafting device 7 is supplied to the air-jet spinning device 9.

**[0018]** The air-jet spinning device 9 forms the spun yarn 10 by twisting, by the action of a swirling air current, the fiber bundle 8 supplied from the drafting device 7. A structure of the air-jet spinning device 9 is explained in detail later.

**[0019]** A yarn quality measuring device 12 and a spinning sensor 13 are arranged downstream of the air-jet spinning device 9. The spun yarn 10 formed by the air-jet spinning device 9 passes through the yarn quality measuring device 12 and the spinning sensor 13.

**[0020]** The yarn quality measuring device 12 monitors a thickness of the running spun yarn 10 by using a not shown optical sensor. When a yarn defect (a portion of the spun yarn 10 having an abnormal thickness) is detected, the yarn quality measuring device 12 transmits a yarn defect detection signal to a not shown unit controller. The sensor of the yarn quality measuring device 12 is not limited to the optical sensor; it can be, for example, an electrostatic capacitive sensor. Moreover, the yarn quality measuring device 12 can also detect a foreign substance included in the spun yarn 10 as a yarn defect.

**[0021]** The spinning sensor 13 is arranged immediately downstream of the yarn quality measuring device 12. The spinning sensor 13 detects a tension on the spun yarn 10 at a position between the air-jet spinning device 9 and the yarn pooling device 14. The spinning sensor 13 transmits a detection signal corresponding to the detected tension to the unit controller. The unit controller detects an abnormal portion, such as weak yarn, by monitoring the tension detected by the spinning sensor 13.

**[0022]** The yarn pooling device 14 is arranged downstream of the yarn quality measuring device 12 and the spinning sensor 13. As shown in FIG. 2, the yarn pooling device 14 includes a yarn pooling roller 15 and a motor 16 that rotationally drives the yarn pooling roller 15.

**[0023]** The yarn pooling roller 15 temporarily pools the spun yarn 10 by winding a certain amount of the spun yarn 10 on an outer peripheral surface thereof. The spun yarn 10 is pulled from the air-jet spinning device 9 and conveyed downstream at a predetermined speed by causing the yarn pooling roller 15 to rotate at a predetermined rotational speed with the spun yarn 10 wound on the outer peripheral surface thereof. Because the spun yarn 10 can be temporarily pooled on the outer peripheral surface of the yarn pooling roller 15, the yarn pooling device 14 can be made to function as a kind of buffer. The buffering function of the yarn pooling device 14 avoids troubles (for example, slackening of the spun yarn 10) caused by a mismatch in a spinning speed of the air-jet spinning device 9 and a winding speed (the speed of the spun yarn 10 being wound into the package 28) due to some reason.

**[0024]** A yarn guide 17 and the winding device 96 are arranged downstream of the yarn pooling device 14. The winding device 96 includes a cradle arm 97 that rotatably supports a bobbin around which the spun yarn 10 is wound.

**[0025]** The winding device 96 includes a winding drum 98, a traverse guide 99, and a not shown winding drum driving motor. The driving force of the winding drum driving motor is transmitted to the winding drum 98, causing the winding drum 98 to rotate in a state of being in contact with an outer peripheral surface of the bobbin or the package 28. The traverse guide 99 guides the spun yarn 10. The winding device 96 drives the winding drum 98 with the winding drum driving motor while causing the traverse

guide 99 to perform reciprocating movement with a not shown driving member. With these operations, the winding device 96 causes the package 28 that is in contact with the winding drum 98 to rotate, and thus the spun yarn 10 is wound into the package 28.

**[0026]** As shown in FIGS. 1 and 2, the yarn joining carrier 3 includes a yarn joining device 93, a suction pipe 94, and a suction mouth 95. When yarn cut or yarn breakage occurs in a certain spinning unit 2, the yarn joining carrier 3 travels on a not shown rail and moves to that spinning unit 2 and stops. The suction pipe 94 swings upward about a shaft to catch the spun yarn 10 from the air-jet spinning device 9, and then swings downward about the shaft to guide the spun yarn 10 to the yarn joining device 93. The suction mouth 95 swings downward about a shaft to catch the spun yarn 10 from the package 28, and then swings upward about the shaft to guide the spun yarn 10 to the yarn joining device 93. The yarn joining device 93 joins the two guided spun yarns 10 together.

**[0027]** The structure and operation of the air-jet spinning device 9 are explained below with reference to FIGS. 3 and 4.

**[0028]** The air-jet spinning device 9 forms the spun yarn 10 by twisting the fiber bundle 8 supplied from the drafting device 7. As shown in FIG. 3, the air-jet spinning device 9 includes a nozzle block 30 and a hollow guide shaft 38. The nozzle block 30 includes a fiber guide 31, a spinning chamber 32, and one or more spinning nozzles 33. The nozzle block 30 is supported by a nozzle block supporting member 101 attached to the housing 5 of the spinning frame 1.

**[0029]** The fiber guide 31 guides the fiber bundle 8 drafted by the drafting device 7 toward the interior (downstream side) of the air-jet spinning device 9. A guide hole 31a is formed in the fiber guide 31 and a guide needle 31b is arranged in the fiber guide 31. The fiber bundle 8 drafted by the drafting device 7 is guided downstream through the guide hole 31a so as to be wound over the guide needle 31b.

**[0030]** The spinning chamber 32 is formed downstream of the fiber guide 31. The spinning chamber 32 is arranged between the nozzle block 30 and the hollow guide shaft 38. The air-jet spinning device 9 blows compressed air (hereinafter, referred to simply as "air") supplied from a not shown compressed air source through the spinning nozzles 33 into the spinning chamber 32, and thereby generates the swirling air current inside the spinning chamber 32. After being twisted by the swirling air current inside the spinning chamber 32, the fiber bundle 8 is conveyed to the hollow guide shaft 38.

**[0031]** The hollow guide shaft 38 further twists the fiber bundle 8 that has been twisted by the nozzle block 30 and guides it downstream. As shown in FIG. 3, the hollow guide shaft 38 is supported on (fixed to) a hollow guide shaft supporting member 103 via a rubber 102. The hollow guide shaft 38 includes a first member 40, a second member 50, a supporting member 60, an inner cover part 70, and an outer cover part 80. The inner cover part 70 and the outer cover part 80 together may be referred to simply as "cover part".

**[0032]** As shown in FIGS. 3 and 4, the first member 40 includes a tip part 41, a middle part 44, and a base part 46. The first member 40 is a member formed by machining a member of a predetermined shape. That is, the first member 40 is a single member and not a member formed by joining plural members.

**[0033]** The first member 40 according to the present embodiment is made of ceramic that contains alumina in a content ratio of greater than or equal to 50%. The alumina content ratio can be set as desired and can, for example, be greater than or equal to 10%. Because the first member 40 is made from ceramic that contains alumina, wear resistance and toughness can be improved. Although the first member 40 is constantly in contact with the fiber bundle 8 during spinning, the life of the first member 40 can be prolonged by improving the wear resistance of the first member 40.

**[0034]** The first member 40 can be made of stainless steel, instead of ceramic, and a surface thereof can be given a coating of a diamond-like carbon. Because diamond-like carbon has a low coefficient of friction, the friction between the hollow guide shaft 38 and fibers can be reduced. Hence, the life of the first member 40 can be prolonged. Moreover, because a whirling speed of the fiber bundle 8 can be further improved, the spinning speed of the air-jet spinning device 9 can be increased.

**[0035]** The tip part 41 is a substantially cylindrical member that is located at the most upstream side of the first member 40. An introducing opening 42 is formed at the upstream end of the tip part 41. The introducing opening 42 is a part through which the fiber bundle 8 (spun yarn 10) twisted in the spinning chamber 32 is guided. A first fiber passageway 47 is a through hole formed along the central axis of the tip part 41. The fiber bundle 8 guided through the introducing opening 42 is conveyed downstream through the first fiber passageway 47. An O-ring fitting part 43 that is cut out as an annular depression is formed around an outer peripheral surface of the tip part 41. An O-ring (sealing member) 48 can be fitted into the O-ring fitting part 43.

**[0036]** The middle part 44 is a cylindrical part and positioned downstream of the tip part 41. The middle part 44 has a smaller outer diameter than the tip part 41 and the base part 46. One or more assisting nozzles 45 are formed in the middle part 44. Each of the assisting nozzles 45 is a hole formed so as to penetrate in a perpendicular direction to the axial direction of the first member 40 (radial direction). The compressed air is supplied to the assisting nozzles 45 via an air supply passageway 66 (explained in detail later), and by being blown toward the inside (that is, into the first fiber passageway 47) through the assisting nozzles 45, the swirling air current can be generated in the first fiber passageway 47.

**[0037]** During yarn discharge spinning, the swirling air current is generated from the air blown from both the

spinning nozzles 33 and the assisting nozzles 45. Alternatively, the air can be blown only from the assisting nozzles 45. The fiber bundle 8 drafted by the drafting device 7 is loosely twisted by the swirling air current generated in the spinning chamber 32, and is conveyed to the hollow guide shaft 38 in a loosely twisted form. The swirling air current generated inside the first fiber passageway 47 of the hollow guide shaft 38 flows in an opposite direction to the swirling air current generated inside the spinning chamber 32. Hence, the fiber bundle 8 is conveyed downstream while being spun into a bundled fiber form, and is guided out as the spun yarn 10 from the hollow guide shaft 38. During regular spinning that is performed following the yarn discharge spinning, the swirling air current is generated in the spinning chamber 32. That is, the compressed air is blown from the spinning nozzles 33 and not from the assisting nozzles 45. Alternatively, the compressed air can be blown from the assisting nozzles 45 during the regular spinning, in which case, however, a pressure of the compressed air blown from the assisting nozzles 45 during regular spinning can be kept lower than a pressure of the compressed air blown from the assisting nozzles 45 during yarn discharge spinning.

**[0038]** The base part 46 is a cylindrical part and positioned downstream of the middle part 44. An outer diameter of the base part 46 is greater than those of the tip part 41 and the middle part 44. The second member 50 is attached so as to make contact with a downstream end of the base part 46.

**[0039]** As shown in FIGS. 3 and 4, the second member 50 is an elongate, substantially cylindrical member, and includes a main part 51 and a reduced diameter part 52. The second member 50 is made of stainless steel. The second member 50 can be formed from a desired material including, for example, ceramic. Because a long hole in the axial direction needs to be formed with high precision in the second member 50, it is preferable that the material used for the second member 50 is easy to machine.

**[0040]** The second member 50 is a single member and not a member formed by joining plural members. A second fiber passageway 53 is formed inside the main part 51 and the reduced diameter part 52. The second fiber passageway 53 is a passageway through which the fiber bundle 8 that has passed through the first fiber passageway 47 passes. An area of an imaginary surface that is perpendicular to a fiber running direction (flow passage cross-sectional area) of the first fiber passageway 47 is smaller than a flow passage cross-sectional area of the second fiber passageway 53. To explain it in further detail, the flow passage cross-sectional areas of the upstream end and the downstream end, and the average flow passage cross-sectional area are all smaller in the first fiber passageway 47 than those in the second fiber passageway 53. Hence, the air flows from the first fiber passageway 47 to the second fiber passageway 53. The second fiber passageway 53 is formed such that the flow passage cross-sectional area on the downstream side is greater than the flow passage cross-sectional area on the upstream side. Hence, the air flows downstream in the second fiber passageway 53. The air that has flowed through the second fiber passageway 53 is guided out via a yarn guiding-out member 110 that is attached as a separate member further downstream.

**[0041]** An O-ring fitting groove 54 is formed in the upstream end of the main part 51. The O-ring fitting groove 54 is an annular groove. An O-ring 55 is fitted into the O-ring fitting groove 54.

**[0042]** Because an outer diameter of the reduced diameter part 52 is smaller than an outer diameter of the main part 51, a stepped part is formed on the surface near the downstream end of the second member 50. The second member 50 is supported, via an O-ring 56, on the supporting member 60 by the stepped part (specifically, the downstream end of the main part 51).

**[0043]** In the present embodiment, the fiber passageways of the hollow guide shaft 38 are formed by two members (the first member 40 and the second member 50). Hence, a length in the axial direction of each member forming the fiber passageway can be made short. Consequently, the machining for forming the fiber passageways can be performed easily. Moreover, if each member having the fiber passageway formed therein has a short length in the axial direction thereof, there is hardly any force exerted on the members in a bending direction. Hence, damage to the hollow guide shaft 38 can be prevented when separating it from the nozzle block 30 to remove the fibers remaining between the nozzle block 30 and the hollow guide shaft 38.

**[0044]** As shown in FIG. 3, the supporting member 60 supports the first member 40 and the second member 50. The supporting member 60 according to the present embodiment is made of stainless steel; however, it can be made of a desired material. A through hole 61, a second member supporting member 62, a cover mounting member 63, and a compressed air introducing member 64 are formed in the supporting member 60.

**[0045]** The through hole 61 is formed along the fiber running direction in the central part of the supporting member 60. The second member 50 is arranged inside the through hole 61. The second member supporting member 62 is formed near the downstream end of the through hole 61. An inner diameter of the second member supporting member 62 is smaller than that of the through hole 61. The second member 50 is supported on the second member supporting member 62 via the O-ring 56.

**[0046]** Plural steps (cover mounting member 63) are formed on the outer surface of the supporting member 60 by varying the outer diameter thereof. A cover part (the inner cover part 70 and the outer cover part 80) is attached to the cover mounting member 63. The movement of the supporting member 60 is regulated with the cover part. The compressed air introducing member 64 is a tubular part that extends radially from the through hole 61. A tube that connects the compressed air introducing member 64 to a not shown compressed air source

is connected to the compressed air introducing member 64.

**[0047]** The inner cover part 70 is a member that is arranged so as to cover the first member 40, the second member 50, and the supporting member 60. The first member 40 is attached to the inner cover part 70 by inserting and fitting in the first member 40 from the downstream side of the inner cover part 70. As shown in FIGS. 3 and 4, the inner cover part 70 is constituted by a first tube 71, a second tube 72, and a third tube 73. The inner cover part 70 according to the present embodiment is made of resin; however, it can be made of a desired material. Because the inner cover part 70 does not often come into contact with the fiber bundle 8 unlike the first member 40, it is preferable that the inner cover part 70 is made from a material that can be easily machined or is of low cost rather than a wear-resistant material.

**[0048]** The first tube part 71 is a member positioned on the upstream side. The first tube part 71 is formed such that an inner diameter and an outer diameter thereof become smaller toward the upstream side. When the first member 40 is inserted into the first tube part 71, the upstream end of the base part 46 of the first member 40 and an inner surface of the first tube part 71 come into contact with each other. In this manner, the first member 40 can be positioned with the tip part 41 thereof protruding out from the first tube 71 by a predetermined amount. The upstream end of the first tube 71 is attached so as to come into contact with the O-ring 48 fitted in the O-ring fitting part 43.

**[0049]** The second tube 72 is a member that is positioned downstream of the first tube 71 and has an inner diameter and an outer diameter larger than the first tube 71. The third tube 73 is a member that is positioned downstream of the second tube 72 and has an inner diameter and an outer diameter larger than the second tube 72. The outer cover part 80 is attached to the outer side of the second tube 72 and the third tube 73. The third tube 73 is positioned on the outer side of the supporting member 60 (specifically, the cover mounting member 63) and is supported on the cover mounting member 63 via an O-ring 74.

**[0050]** When the compressed air is supplied from the air supply passageway 66, the supplied compressed air passes between the second member 50 and the supporting member 60 and flows upstream of the fiber running direction (upward in FIG. 3). Because the O-ring 56 is fitted between the second member 50 and the supporting member 60, the leakage of the supplied compressed air from between the second member 50 and the supporting member 60 can be prevented. Moreover, because the O-ring 74 is fitted between the supporting member 60 and the inner cover part 70, leakage of the supplied compressed air from between the supporting member 60 and the inner cover part 70 can be prevented. Furthermore, because the O-ring 55 is fitted between the first member 40 and the second member 50, leakage of the supplied air from between the first member 40 and the second member 50 can be prevented. Consequently, a consumption amount of the compressed air can be suppressed, and moreover, yarn discharge spinning can be performed stably. Besides preventing leakage of the compressed air from the air supply passageway 66 to the second fiber passageway 53, the O-rings 55 and 56 also prevent leakage of the compressed air from the second fiber passageway 53 to the air supply passageway 66.

**[0051]** The compressed air passes through slits (notches) 46a (see FIG. 4) formed on an outer peripheral surface of the base part 46 and is supplied to an air storing part 49. In an alternative configuration, instead of slits, a space through which the compressed air can pass can be formed by linear or arc-shaped chamfering. The notches are formed in the axial direction of the base part 46.

**[0052]** The air storing part 49 is a space formed between the first member 40 (middle part 44) and the inner cover part 70 (first tube 71). Because the supplied compressed air passes through the air storing part 49, the air storing part 49 is a part of the air supply passageway 66. Moreover, as explained above, because the O-ring 48 is fitted between the first member 40 and the inner cover part 70, leakage of the supplied compressed air from between the first member 40 and the inner cover part 70 is prevented. The assisting nozzles 45 are arranged so as to be connected to the air storing part 49 (air supply passageway 66). Hence, by supply of the compressed air to the air storing part 49, the compressed air can be supplied from the assisting nozzles 45 to the first fiber passageway 47.

**[0053]** The outer cover part 80 is attached, as explained above, to the supporting member 60 and the inner cover part 70. The outer cover part 80 according to the present embodiment is made of resin; however, it can be made of a desired material. Because the outer cover part 80 does not often come into contact with the fiber bundle 8 unlike the first member 40, it is preferable that the outer cover part 80 is made from a material that can be easily machined or is of low cost rather than a wear-resistant material.

**[0054]** A positioning part 81 is formed in the outer cover part 80. The positioning part 81 is constituted by an annular first contact surface 81a that is formed on an outer peripheral part of the outer cover part 80, perpendicular to the axial direction, and a cylindrical second contact surface 81b that is perpendicular to the first contact surface 81a. The first contact surface 81a and the second contact surface 81b each come into contact with a predetermined part of the nozzle block supporting member 101. With this configuration, the hollow guide shaft 38 can be positioned with respect to the fiber guide 31.

**[0055]** As explained above, the introducing opening 42 that guides the fiber bundle 8, the first fiber passageway 47 that is formed from the introducing opening 42 along the central axis, and the assisting nozzles 45 that open into the first fiber passageway 47 are formed in the hollow

guide shaft 38 according to the present embodiment. The substantially cylindrical part where the introducing opening 42 and the first fiber passageway 47 are formed has a region where an outer peripheral diameter increases as a distance from the introducing opening 42 increases.

**[0056]** In the hollow guide shaft 38, the annularly cut out O-ring fitting part 43 is formed in the substantially cylindrical part. With this configuration, for example, the hollow guide shaft 38 can be fitted in the air-jet spinning device 9 with the O-ring 48 fitted into the O-ring fitting part 43.

**[0057]** The hollow guide shaft 38 includes the tip part 41 in which the introducing opening 42 is formed and the middle part 44 in which the assisting nozzles 45 are formed. The outer diameter of the middle part 44 is smaller than that of the tip part 41.

**[0058]** The hollow guide shaft 38 further includes the base part 46 with the slits 46a formed on the outer peripheral surface thereof. The middle part 44 is located between the tip part 41 and the base part 46.

**[0059]** As explained above, the hollow guide shaft 38 according to the present embodiment includes the first member 40 and the second member 50. In the first member 40 are formed the introducing opening 42 for introducing the fiber bundle 8, the first fiber passageway 47 through which the introduced fiber bundle 8 passes, and the assisting nozzles 45 that are arranged so as to generate inside the first fiber passageway 47 the swirling air current that conveys the fiber bundle 8 downstream during the yarn discharge spinning. In the second member 50 is formed the second fiber passageway 53 through which the fiber bundle 8 that has passed through the first fiber passageway 47 passes. The second member 50 is arranged as a separate member from the first member 40.

**[0060]** With this configuration, by dividing the hollow guide shaft 38 in the axial direction thereof, the machining for forming the fiber passageways can be easily performed and there is hardly any risk of damage to the hollow guide shaft 38 even if a force is exerted in the bending direction while performing maintenance operations or the like. Because the assisting nozzles 45 are formed in the first member 40, the center of the introducing opening 42 and a swirl center of the swirling air current can be precisely aligned with each other. Furthermore, because the assisting nozzles 45 can be arranged near the introducing opening 42, a success rate of yarn discharge spinning can be improved.

**[0061]** In the hollow guide shaft 38 according to the present embodiment, the flow passage cross-sectional area of the first fiber passageway 47 is smaller than the flow passage cross-sectional area of the second fiber passageway 53.

**[0062]** With this configuration, because the air flows smoothly from the first fiber passageway 47 to the second fiber passageway 53, the fiber bundle 8 guided into the hollow guide shaft 38 can be smoothly conveyed downstream.

**[0063]** The hollow guide shaft 38 according to the present embodiment includes the supporting member 60 and the cover part (the inner cover part 70 and the outer cover part 80). The supporting member 60 supports the second member 50. The cover part fixes the second member 50 to the supporting member 60.

**[0064]** With this configuration, the movement of the supporting member 60 that supports the second member 50 can be regulated with the cover part, and thereby the positioning of the second member 50 can be performed.

**[0065]** In the hollow guide shaft 38 according to the present embodiment, the cover part includes the inner cover part 70 and the outer cover part 80. The inner cover part 70 is arranged so as to cover at least some portion of the first member 40, the second member 50, and the supporting member 60. The outer cover part 80 covers the inner cover part 70 and performs the positioning of the first member 40 with respect to the nozzle block 30 in which the spinning nozzles 33 are formed.

**[0066]** By covering the first member 40 and the like with the inner cover part 70 and the outer cover part 80, the first member 40 and the like can be protected. Moreover, by positioning the first member 40 with the outer cover part 80, the first member 40 can be precisely positioned with respect to the nozzle block 30.

**[0067]** In the hollow guide shaft 38 according to the present embodiment, the air supply passageway 66 is formed between the first member 40 and the inner cover part 70, and the air that has passed through the air supply passageway 66 is blown out from the assisting nozzles 45.

**[0068]** Because the space between the members constituting the hollow guide shaft 38 forms the air supply passageway 66, the cost of machining and forming the air supply passageway 66 can be reduced. Moreover, the space for arranging the air supply passageway 66 can be reduced.

**[0069]** In the hollow guide shaft 38 according to the present embodiment, the air storing part 49 that temporarily stores the air to be supplied from the assisting nozzles 45 to the first fiber passageway 47 is arranged between the first member 40 and the inner cover part 70.

**[0070]** With this configuration, because not only the air supply passageway 66 but also the air storing part 49 is formed by utilizing the space between the members constituting the hollow guide shaft 38, the cost can be further reduced. Moreover, the flow of the air blown from the assisting nozzles 45 can be made uniform, and thereby a stabilized yarn discharge spinning can be performed.

**[0071]** Exemplary embodiments of the present invention are explained above. The structure explained above can, however, be modified as follows.

**[0072]** The shapes of the first member 40 and the second member 50 according to the present embodiment can be changed as desired, and can be suitably modified to secure the air supply passageway 66. The first member 40 according to the present embodiment is fixed by fitting it into the first tube 71. In an alternative configuration, the

first tube 71 and the first member 40 can be fixed together by a bonding agent. When a bonding agent is used, leakage of the air can be prevented without having to arrange the O-ring 48 because the bonding agent functions as a sealing member. Furthermore, the first member 40 can be constituted by two component parts. That is, the tip part 41 and the middle part 44 can be formed with one component part and the base part 46 can be formed with a different component part. In this configuration, the material of the tip part 41 and the middle part 44 and the material of the base part 46 can be different.

**[0073]** The guide needle 31b can be omitted, and the downstream end of the fiber guide 31 can serve as the guide needle 31b.

**[0074]** The cover part according to the present embodiment is constituted by the inner cover part 70 and the outer cover part 80. In an alternative configuration, the cover part can be constituted by one member that has the functions of the inner cover part 70 and the outer cover part 80.

**[0075]** Instead of or in addition to the yarn pooling device 14, a delivery roller that is rotationally driven and a nip roller that is pressed against the delivery roller can be arranged downstream of the air-jet spinning device 9, and the spun yarn 10 can be conveyed downstream by being nipped between the delivery roller and the nip roller.

**[0076]** In the present embodiment, the spun yarn 10 formed by the air-jet spinning device 9 is wound into the package 28 by the winding device 96. In an alternative configuration, a knitting machine or the like can be arranged downstream of the air-jet spinning device 9.

**[0077]** A hollow guide shaft according to an aspect of the present invention includes an introducing opening through which fibers are introduced; a first fiber passageway that is a through hole formed from the introducing opening along a central axis; and an assisting nozzle that is formed so as to open into the first fiber passageway. A substantially cylindrical part where the introducing opening and the first fiber passageway are formed has a region where an outer peripheral diameter increases as a distance from the introducing opening increases.

**[0078]** With this configuration, the fiber passageway can be easily machined inside the hollow guide shaft.

**[0079]** In the hollow guide shaft, the substantially cylindrical part has an annularly cut out depression. With this configuration, for example, the hollow guide shaft can be fitted in an air-jet spinning device with a sealing member fitted into the depression.

**[0080]** The hollow guide shaft includes a tip part in which the introducing opening is formed and a middle part in which the assisting nozzle is formed. An outer diameter of the middle part is smaller than an outer diameter of the tip part. With this configuration, for example, when the hollow guide shaft is attached to a cover part, an air storing part can be easily formed between the cover part and the middle part.

**[0081]** The hollow guide shaft further includes a base part with notches formed on an outer peripheral surface thereof. The middle part is located between the tip part and the base part. With this configuration, compressed air supplied to the assisting nozzle can pass through.

**[0082]** A hollow guide shaft according to another aspect of the present invention includes a first member in which are formed an introducing opening through which fibers are introduced, a first fiber passageway that is a through hole formed from the introducing opening along a central axis, and an assisting nozzle that is formed so as to open into the first fiber passageway; a second member in which is formed a second fiber passageway through which the fibers that have passed through the first fiber passageway pass and that is arranged as a separate member from the first member; and a supporting member that supports the second member.

**[0083]** With this configuration, by dividing the hollow guide shaft in an axial direction, a length of each member forming the fiber passageways can be shortened. Hence, machining for forming the fiber passageways can be easily performed.

**[0084]** In the hollow guide shaft, an area of an imaginary surface that is perpendicular to a fiber running direction of the first fiber passageway is smaller than an area of an imaginary surface that is perpendicular to a fiber running direction of the second fiber passageway.

**[0085]** With this configuration, because the air flows smoothly from the first fiber passageway to the second fiber passageway, the fibers guided to the hollow guide shaft can be smoothly conveyed downstream.

**[0086]** The hollow guide shaft further includes a cover part that covers the supporting member so as to regulate the movement of the supporting member.

**[0087]** With this configuration, positioning of the second member can be performed by regulating the movement of the supporting member that supports the second member.

**[0088]** In the hollow guide shaft, the cover part includes an inner cover part that covers at least a portion of the first member, the second member, and the supporting member, and an outer cover part that covers the inner cover part and positions the first member with respect to a nozzle block in which a spinning nozzle is formed.

**[0089]** With this configuration, because the first member and the like are covered with the inner cover part and the outer cover part, the first member and the like can be protected. Moreover, by positioning the first member with the outer cover part, the first member can be precisely positioned with respect to the nozzle block.

**[0090]** In the hollow guide shaft, an air supply passageway is formed between the first member and at least one of the supporting member and the cover part, and the assisting nozzle is connected to the air supply passageway.

**[0091]** With this configuration, because the space between the members constituting the hollow guide shaft forms the air supply passageway, the cost of machining and forming the air supply passageway can be reduced.

**[0092]** The hollow guide shaft further includes, at a po-

sition between the first member and at least one of the supporting member and the cover part, an air storing part that temporarily stores therein air to be supplied from the assisting nozzle to the first fiber passageway.

**[0093]** With this configuration, because not only the air supply passageway but also the air storing part is formed with the space between the members constituting the hollow guide shaft, the cost can be further reduced.

**[0094]** The hollow guide shaft further includes a sealing member at a position between the first member and at least one of the supporting member and the cover part.

**[0095]** With this configuration, because leakage of the compressed air from the air storing part can be prevented, a consumption amount of the compressed air can be suppressed.

**[0096]** In the hollow guide shaft, the sealing member is an O-ring.

**[0097]** With this configuration, leakage of the compressed air can be suppressed by using a member that is readily available.

**[0098]** In the hollow guide shaft, the sealing member is a bonding agent.

**[0099]** With this configuration, because the sealing member also functions as a member that bonds the first member and the cover part together, the number of component parts can be reduced.

**[0100]** In the hollow guide shaft, the first member and the cover part are made of mutually different materials.

**[0101]** With this configuration, because the materials used for the first member and the cover part have different characteristics, by selecting the materials by taking those characteristics into consideration, the costs of the first member and the cover part can be reduced or the performances of the first member and the cover part can be improved.

**[0102]** In the hollow guide shaft, the first member is made of a material containing at least one of ceramic and diamond-like carbon, and the cover part is made of a material containing at least one of stainless steel and resin.

**[0103]** With this configuration, by using a wear-resistant material for the first member that is constantly in contact with the fibers during spinning, the life of the first member can be prolonged. Moreover, by using an inexpensive material for the cover part that does not often come into contact with the fibers, the cost can be reduced without compromising the performance of the hollow guide shaft.

**[0104]** In the hollow guide shaft, a depression or a hole is formed on the cover part. The first member is attached to the cover part by being fitted into the depression or the hole.

**[0105]** With this configuration, the first member can be attached to the cover part merely by fitting the first member into the cover part, and thereby the attaching operation can be simplified.

**[0106]** An air-jet spinning device according to still another aspect of the present invention includes the hollow guide shaft; a nozzle block that is arranged to form a spinning chamber between the hollow guide shaft and the nozzle block, and that includes a spinning nozzle arranged to generate inside the spinning chamber a swirling air current that acts on the fibers in the spinning chamber; and a fiber guide that is arranged opposing the hollow guide shaft and that guides the fibers to the first fiber passageway.

**[0107]** With this configuration, the air-jet spinning device includes the hollow guide shaft having a structure whereby machining for forming the fiber passageway inside the hollow guide shaft can be performed easily.

**[0108]** A textile machinery according to still another aspect of the present invention includes the air-jet spinning device.

**[0109]** With this configuration, the textile machinery includes the hollow guide shaft having a structure whereby machining for forming the fiber passageways inside the hollow guide shaft can be performed easily.

## Claims

**1.** A hollow guide shaft (40) comprising:

an introducing opening (42) through which fibers (8) are introduced;
a first fiber passageway (47) that is a through hole formed from the introducing opening (42) along a central axis; and
an assisting nozzle (45) that is formed so as to open into the first fiber passageway (47),
wherein a substantially cylindrical part (41) where the introducing opening (42) and the first fiber passageway (47) are formed has a region where an outer peripheral diameter increases as a distance from the introducing opening (42) increases.

**2.** The hollow guide shaft (40) as claimed in Claim 1, wherein the substantially cylindrical part (41) has an annularly cut out depression (43).

**3.** The hollow guide shaft (40) as claimed in Claim 1 or Claim 2, further comprising:

a tip part (41) in which the introducing opening (42) is formed; and
a middle part (44) in which the assisting nozzle (45) is formed,
wherein an outer diameter of the middle part (44) is smaller than an outer diameter of the tip part (41).

**4.** The hollow guide shaft (40) as claimed in Claim 3, further comprising:

a base part (46) with a notch (46a) formed on

an outer peripheral surface thereof,
wherein the middle part (44) is located between the tip part (41) and the base part (46).

**5.** A hollow guide shaft (38) comprising:

a first member (40) in which are formed an introducing opening (42) through which fibers (8) are introduced, a first fiber passageway (47) that is a through hole formed from the introducing opening (42) along a central axis, and an assisting nozzle (45) that is formed so as to open into the first fiber passageway (47);
a second member (50) in which is formed a second fiber passageway (53) through which the fibers (8) that have passed through the first fiber passageway (47) pass and that is arranged as a separate member from the first member (40); and
a supporting member (60) that supports the second member (50).

**6.** The hollow guide shaft (38) as claimed in Claim 5, wherein an area of an imaginary surface that is perpendicular to a fiber running direction of the first fiber passageway (47) is smaller than an area of an imaginary surface that is perpendicular to a fiber running direction of the second fiber passageway (53).

**7.** The hollow guide shaft (38) as claimed in Claim 5 or Claim 6, further comprising a cover part (70, 80) adapted to cover the supporting member (60) so as to regulate the movement of the supporting member (60).

**8.** The hollow guide shaft (38) as claimed in Claim 7, wherein the cover part (70, 80) includes:

an inner cover part (70) adapted to cover at least a portion of the first member (40), the second member (50), and the supporting member (60), and
an outer cover part (80) adapted to cover the inner cover part (70) and to position the first member (40) with respect to a nozzle block (30) in which a spinning nozzle (33) is formed.

**9.** The hollow guide shaft (38) as claimed in Claim 7 or Claim 8, wherein an air supply passageway (66) is formed between the first member (40) and at least one of the supporting member (60) and the cover part (70, 80), and
the assisting nozzle (45) is connected to the air supply passageway (66).

**10.** The hollow guide shaft (38) as claimed in Claim 9, further comprising, at a position between the first member (40) and at least one of the supporting member (60) and the cover part (70, 80), an air storing part (49) adapted to temporarily store therein air to be supplied from the assisting nozzle (45) to the first fiber passageway (47).

**11.** The hollow guide shaft (38) as claimed in Claim 10, further comprising a sealing member (48) at a position between the first member (40) and at least one of the supporting member (60) and the cover part (70, 80).

**12.** The hollow guide shaft (38) as claimed in Claim 11, wherein the sealing member (48) is at least one of an O-ring (48) and a bonding agent adapted to bond the first member (40) and the cover part (70) together.

**13.** The hollow guide shaft (38) as claimed in any one of Claims 7 to 12, wherein the first member (40) and the cover part (70, 80) are made of mutually different materials.

**14.** The hollow guide shaft (38) as claimed in Claim 13, wherein
the first member (40) is made of a material containing at least one of ceramic and diamond-like carbon, and the cover part (70, 80) is made of a material containing at least one of stainless steel and resin.

**15.** An air-jet spinning device (9) comprising:

the hollow guide shaft (38) as claimed in any one of Claims 5 to 14;
a nozzle block (30) that is arranged to form a spinning chamber (32) between the hollow guide shaft (38) and the nozzle block (30), and that includes,
a spinning nozzle (33) arranged to generate inside the spinning chamber (32) a swirling air current that acts on the fibers (8) in the spinning chamber (32); and
a fiber guide (31) arranged opposing the hollow guide shaft (38) and adapted to guide the fibers (8) to the first fiber passageway (47).

FIG.1

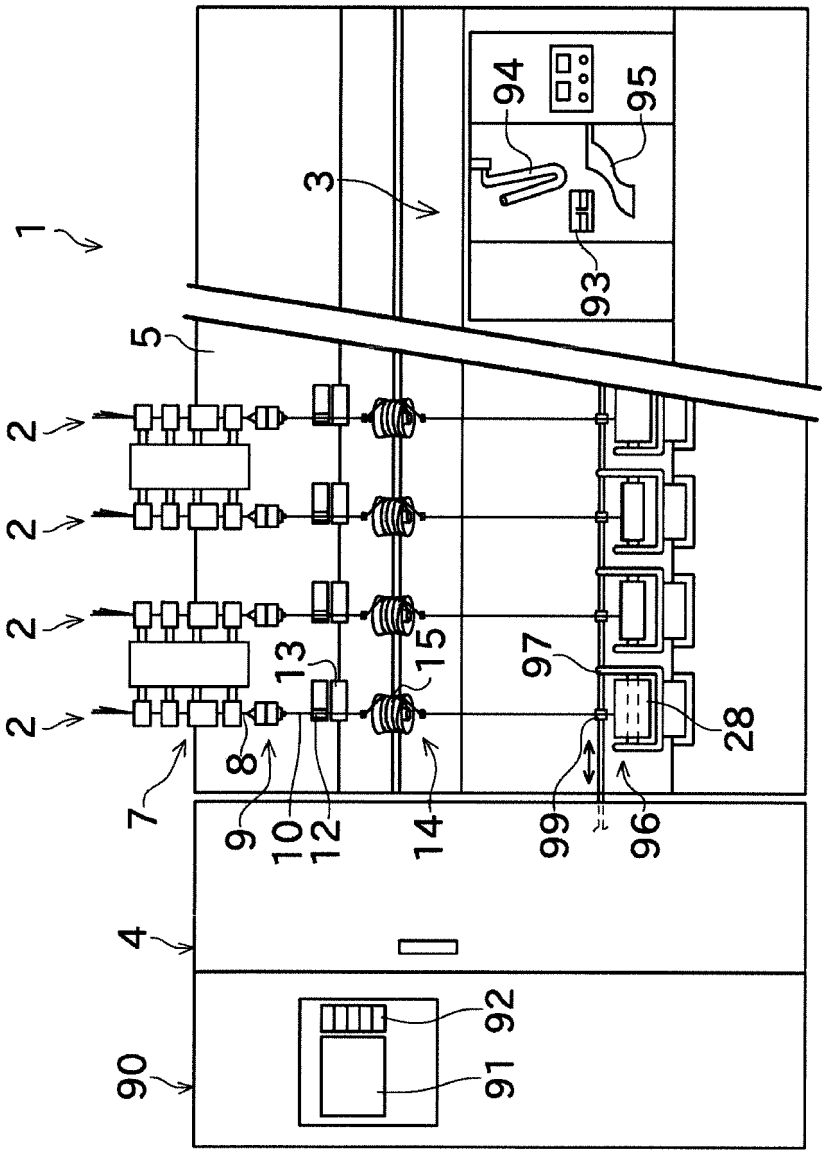

FIG.2

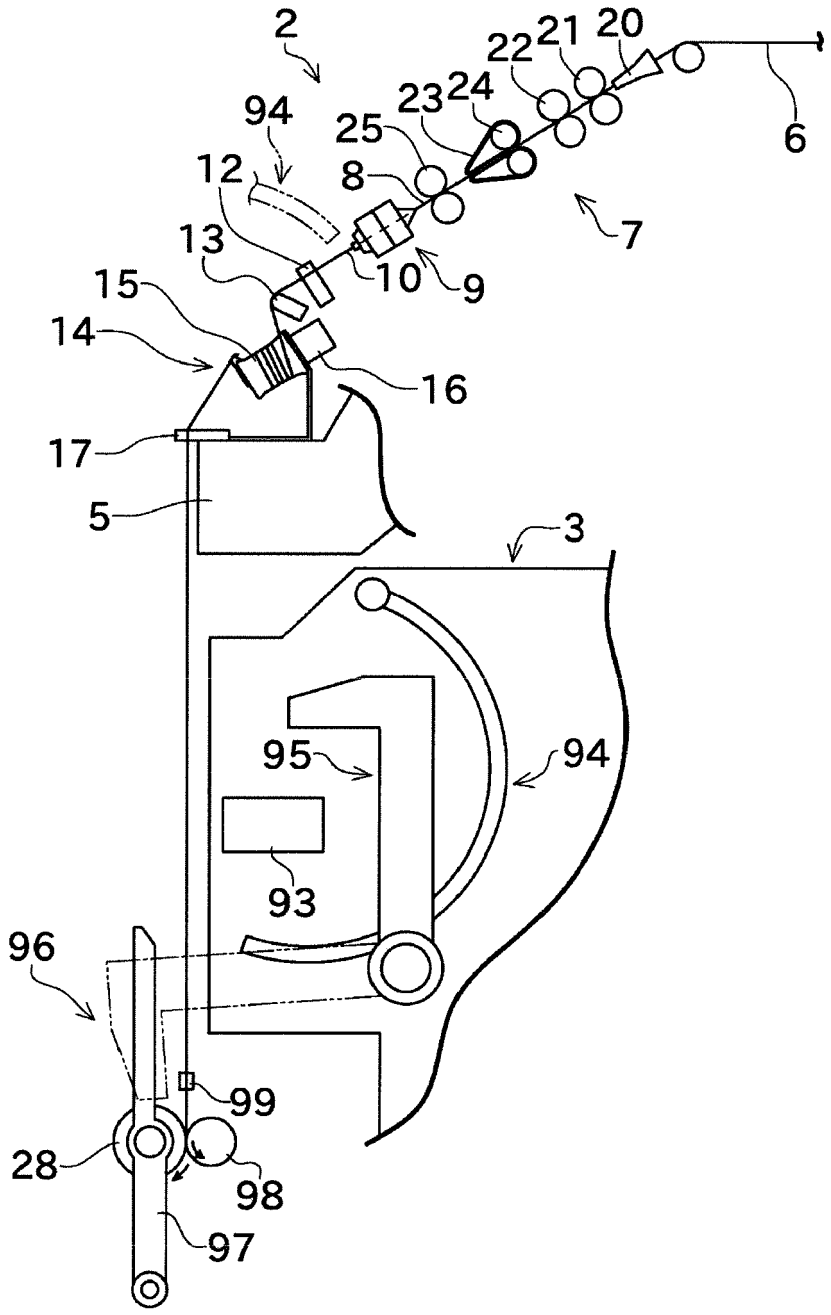
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FIG.3

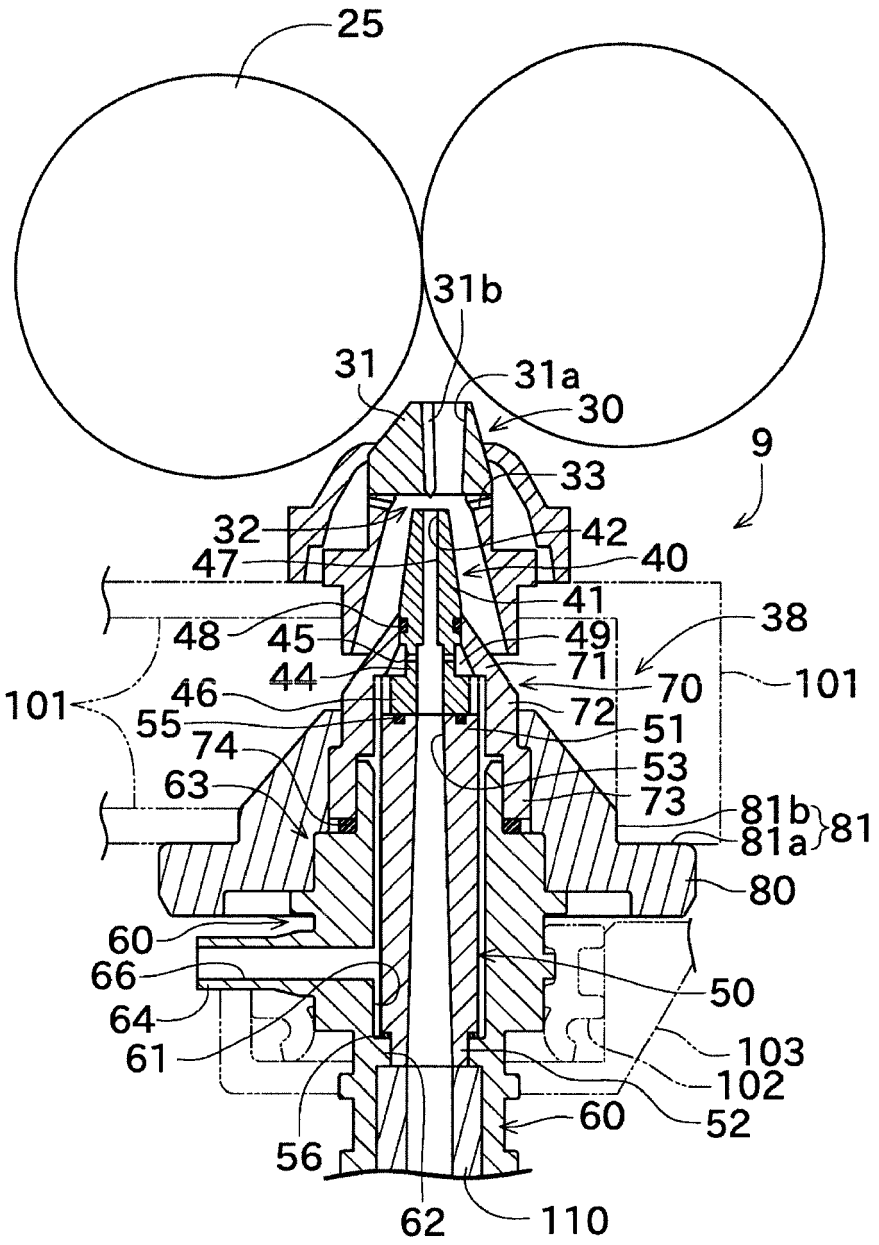
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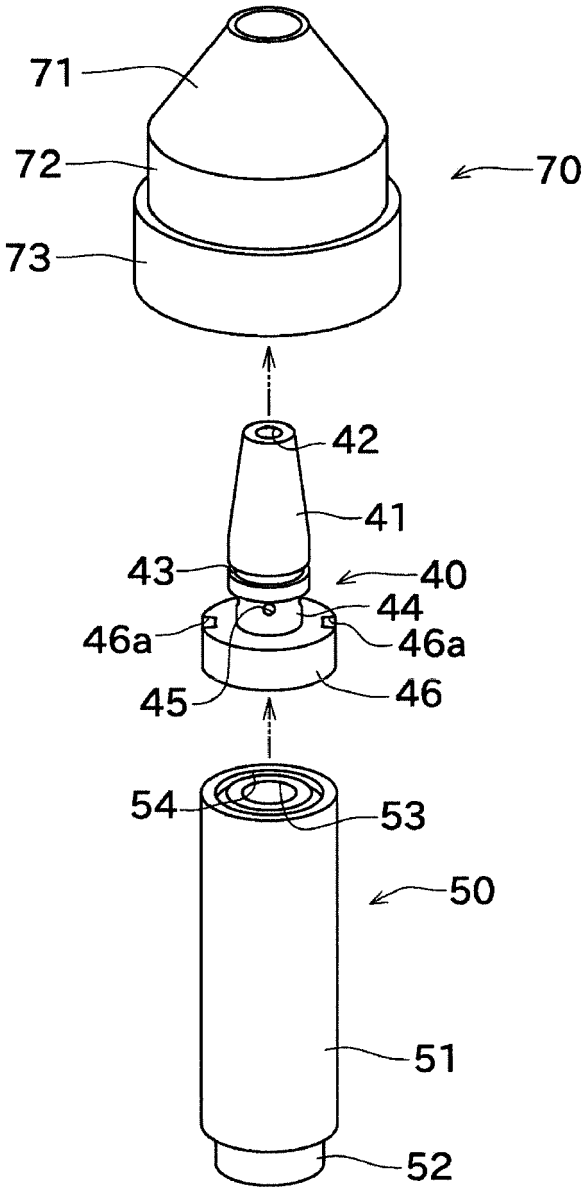
FIG.4



## REFERENCES CITED IN THE DESCRIPTION

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