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(54) **Hollow guide shaft body, air-jet spinning device, and yarn winding machine including the same**

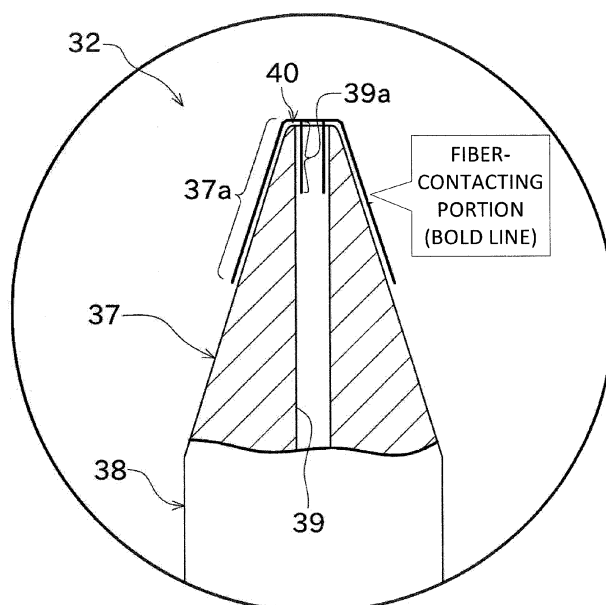
(57) A hollow guide shaft body around which fibres whirl by an action of a whirling airflow in an air-jet spinning device (5) and in which a fibre passage (39) is formed where the fibres pass after being twisted by the whirling airflow. The hollow guide shaft body (32) includes a base member (50) having electrical conductivity, preferable stainless steel, and an external layer (51) provided on a surface of the base member (50), and being harder than the base member (50). Preferably the external layer (51)

is a diamond-like carbon (DLC) coating .

The use of a conductive base member in combination with a abrasion resistant external coating provides a hollow guide shaft with a smaller diameter and being wear resistant compared to a hollow guide shaft consisting of sintered ceramics.

Moreover, an air-jet spinning device (5) and a yarn winding machine comprising such a hollow guide shaft body is disclosed.

FIG. 5



Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention mainly relates to a configuration of a hollow guide shaft body provided in an air-jet spinning device.

2. Description of the Related Art

[0002] There is known an air-jet spinning device adapted to add twists to a fiber bundle and to generate a spun yarn by applying a whirling airflow to the fiber bundle.

[0003] The air-jet spinning device includes a spindle (or a hollow guide shaft body). The spindle has a cylindrical or conical shape around which a predetermined space (a whirling chamber) is formed. In the air-jet spinning device, fibers are swung around the spindle in the whirling chamber by an action of the whirling airflow. Accordingly, the twists are added to the fibers, and the spun yarn is generated.

[0004] Since the fibers are swung around the spindle, friction is generated between a surface of the spindle and the fibers. Thus, abrasion resistance is required for the spindle of the air-jet spinning device. In textile industry, fine ceramics is typically employed as a member for which the abrasion resistance is required. The spindle made of the fine ceramics thus has been employed in a conventional air-jet spinning device. The air-jet spinning device provided with the spindle made of the fine ceramics is described in Japanese Unexamined Patent Application Publication No. 10-317231, for example.

SUMMARY OF THE INVENTION

[0005] Even higher spinning speed has been desired in recent years. Whirling speed of the fibers in the whirling chamber is required to be accelerated to increase the spinning speed in the air-jet spinning device. Therefore, consideration may be made to reduce a whirling radius of the fibers to enhance the whirling speed of the fibers by decreasing a radius of the spindle (making the spindle thinner).

[0006] However, since the spindle provided in the conventional air-jet spinning device is made of ceramics (sintering structure), toughness of the spindle is low and the spindle is fragile. Thus, if the conventional spindle made of the ceramics is made thinner, breakage such as a cracking and/or a chipping may frequently occur. When the spindle is damaged, replacement is required and results in cost increase. Since making the conventional spindle even thinner is difficult, demand for the higher spinning speed has not been met sufficiently.

[0007] Since friction is generated between the fibers and the spindle, static electricity occurs. However, since the ceramics is typically insulator, the ceramics is likely

to be electrically charged being unable to release electrical charge. Wastes such as fiber wastes are likely to attach to the surface of the charged spindle, which may cause an adverse effect on quality of the spun yarn to be generated. Thus, the spindle is required to be frequently cleaned in the conventional air-jet spinning device, and the cleaning task causes production efficiency to decrease.

[0008] An object of the present invention is to provide a spindle that is less likely to be cracked, and to which the wastes such as the fiber wastes are less likely to attach.

[0009] According to an aspect of the present invention, the following configuration of a hollow guide shaft body is provided, around which fibers whirl by an action of a whirling airflow in an air-jet spinning device and in which a fiber passage is formed where the fibers pass after being twisted by the whirling airflow. The hollow guide shaft body includes a base member having electrical conductivity, an upper layer provided at least on a portion of a surface of the base member and being harder than the base member.

[0010] By making the base member electrically conductive, the hollow guide shaft body (spindle) is less likely to be electrically charged. Since wastes are less likely to attach to the hollow guide shaft body, quality of the spun yarn to be generated by the air-jet spinning device is enhanced, and time and labor to clean the hollow guide shaft body can be reduced. Abrasion resistance of the hollow guide shaft body can be improved by the upper layer provided on the surface of the base member. Since the abrasion resistance is not required for the base member itself, a material having relatively high toughness can be employed for the base member. Accordingly, since breakage such as a cracking and/or a chipping of the hollow guide shaft body becomes less likely to occur, flexibility of a shape of the hollow guide shaft body is increased. Since the hollow guide shaft body can be formed thinner (a diameter can be formed shorter) than before, for example, spinning speed of the air-jet spinning device can be enhanced by improving whirling speed of the fibers.

[0011] In the hollow guide shaft body, the upper layer is preferably a diamond-like carbon coating.

[0012] Accordingly, the upper layer having sufficient hardness can be formed. Since the diamond-like carbon coating has a low friction coefficient, friction that occurs between the hollow guide shaft body and the fibers can be reduced. Since the whirling speed of the fibers thus can be more improved, the spinning speed of the air-jet spinning device can be more enhanced.

[0013] In the hollow guide shaft body, the upper layer preferably has electrical conductivity.

[0014] Since the upper layer has electrical conductivity, the hollow guide shaft body becomes even less likely to be electrically charged, and the wastes become even less likely to attach to the hollow guide shaft body.

[0015] In the hollow guide shaft body, the upper layer

is provided on an inlet portion of the fiber passage and at least on a portion of an inner surface of the fiber passage.

[0016] Since the fibers whirled in the air-jet spinning device make contact with the above-described positions of the hollow guide shaft body, by providing the upper layer on such positions, the abrasion resistance of the hollow guide shaft body can be improved.

[0017] In the hollow guide shaft body, the base member is preferably formed from at least one of iron, conductive ceramics, refractory metal and stainless steel.

[0018] By forming the base member of the hollow guide shaft body from a material having electrical conductivity, static electricity occurred by the friction between the hollow guide shaft body and the fibers can be reliably released.

[0019] In the hollow guide shaft body, an intermediate layer adapted to adhere the upper layer and the base member is preferably provided between the upper layer and the base member.

[0020] Accordingly, since the upper layer becomes less likely to be peeled off from the base member, durability of the hollow guide shaft body is improved.

[0021] In the hollow guide shaft body, the upper layer is preferably black.

[0022] By making the surface of the hollow guide shaft body black, the wastes such as fiber wastes attached to the surface can be easily recognized visually. Accordingly, the hollow guide shaft body can be easily cleaned at the time of maintenance or the like.

[0023] According to another aspect of the present invention, an air-jet spinning device includes the hollow guide shaft body, a whirling chamber forming member in which a whirling chamber is formed in which the fibers are whirled, and a fiber guiding section adapted to guide the fibers to the whirling chamber.

[0024] The air-jet spinning device can improve the spinning speed than before by employing the above-described hollow guide shaft body.

[0025] According to yet another aspect of the present invention, a yarn winding machine includes the above-described air-jet spinning device and a winding section adapted to wind the spun yarn spun by the air-jet spinning device and to form a package.

[0026] The yarn winding machine can improve a speed of generating the package than before by employing the above-described air-jet spinning device.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027]

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

FIG. 2 is a side sectional view illustrating a spinning unit.

FIG. 3 is a vertical sectional view illustrating an air-

jet spinning device.

FIG. 4 is a vertical sectional view illustrating the air-jet spinning device adding twists to a fiber bundle.

FIG. 5 is a vertical sectional view illustrating a fiber-contacting portion.

FIG. 6 is a view schematically illustrating a configuration of a hollow guide shaft body.

FIG. 7A is a view illustrating a conventional hollow guide shaft body.

FIG. 7B is a view illustrating the hollow guide shaft body according to the embodiment of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0028] Next, a spinning machine (yarn winding machine) relating to one embodiment of the present invention will be described with reference to the drawings. A spinning machine 1 as a yarn winding machine illustrated in FIG. 1 mainly includes a plurality of spinning units 2 arranged next to each other, and a yarn joining cart 3.

[0029] As illustrated in FIG. 2, each spinning unit 2 includes a draft device 4, an air-jet spinning device 5, a yarn monitoring device 6, a yarn accumulating device 7, and a winding section 8 in this order from upstream towards downstream. "Upstream" and "downstream" in the present specification respectively indicate upstream and downstream in a travelling direction of a fiber bundle and a spun yarn at the time of spinning.

[0030] The draft device 4 drafts a sliver (a material of a fiber bundle) 9 into a fiber bundle 10. The draft device 4 includes a plurality of draft rollers 11, 12, 13 and 14, and a plurality of opposing rollers arranged facing each draft roller. The plurality of draft rollers 11, 12, 13 and 14 are respectively rotated at a predetermined rotation speed. By sandwiching and transporting the sliver 9 supplied from a sliver case (not illustrated) between the rotating draft rollers 11, 12, 13 and 14 and the opposing rollers facing thereto, the draft device 4 drafts the sliver 9 into the fiber bundle 10. The fiber bundle 10 drafted in the draft device 4 is supplied to the air-jet spinning device 5.

[0031] The air-jet spinning device 5 adds twists to the fiber bundle 10 and generates the spun yarn 15 by generating a whirling airflow in its interior and applying the whirling airflow to the fiber bundle 10. The configuration of the air-jet spinning device 5 will be described in detail later.

[0032] The spun yarn 15 generated by the air-jet spinning device 5 passes through the yarn monitoring device 6. The yarn monitoring device 6 monitors a state of the travelling spun yarn 15, and detects a yarn portion with abnormal quality in the spun yarn 15 (a yarn defect). The yarn monitoring device 6 includes a cutter 16 adapted to cut the spun yarn 15 when the yarn defect is detected.

[0033] The spun yarn 15 that has passed through the yarn monitoring device 6 is wound around a bobbin 17

by the winding section 8. The winding section 8 includes a cradle arm 19, a winding drum 20 and a traverse device 21.

[0034] The cradle arm 19 rotatably supports the bobbin 17 around which the spun yarn 15 is wound. The winding drum 20 rotates the bobbin 17 by being rotated in contact with an outer peripheral surface of the bobbin 17. The traverse device 21 includes a traverse guide 22 adapted to be driven from side to side (in a direction of a winding width of the bobbin 17) while being engaged with the spun yarn 15. The spun yarn 15 to be wound around the bobbin 17 is traversed by the traverse device 21.

[0035] By the spinning unit 2 configured as described above, the spun yarn 15 can be generated from the sliver 9 and wound around the bobbin 17. The bobbin 17 around which the spun yarn 15 is wound is referred to as a "package".

[0036] In the spinning machine 1 of the present embodiment, the yarn accumulating device 7 is arranged between the yarn monitoring device 6 and the winding section 8. As illustrated in FIG. 2, the yarn accumulating device 7 includes a yarn accumulating roller 23 and an electric motor 25 adapted to rotate the yarn accumulating roller 23.

[0037] The yarn accumulating roller 23 can temporarily accumulate a predetermined amount of the spun yarn 15 by winding the spun yarn 15 around an outer peripheral surface thereof. Since the yarn accumulating device 7 temporarily accumulates the spun yarn 15 in this manner, the yarn accumulating device 7 functions as a kind of a buffer. Accordingly, a fault (a slackening of the spun yarn 15, for example) in which a spinning speed in the air-jet spinning device 5 and a winding speed in the winding section 8 do not correspond to each other for some reason can be resolved.

[0038] Each spinning unit 2 includes a unit control section 26. The unit control section 26 is adapted to appropriately control each configuration provided in the spinning unit 2.

[0039] As illustrated in FIG. 1 and FIG. 2, the yarn joining cart 3 includes a yarn joining device 27 and suction devices (a suction pipe 28 and a suction mouth 29). The yarn joining cart 3 can travel along a direction in which the spinning units 2 are arranged next to each other (a left-right direction of FIG. 1). In a certain spinning unit 2, when the spun yarn 15 between the air-jet spinning device 5 and the winding section 8 is cut for some reason, the yarn joining cart 3 travels to a front of the relevant spinning unit 2 and joins the spun yarn 15 that has been cut (yarn joining).

[0040] The yarn joining device 27 is adapted to join yarn ends. Although a configuration of the yarn joining device 27 is not limited particularly, an air splicer, for example, that twists the yarn ends together by a whirling airflow may be employed. The suction pipe 28 sucks and catches a yarn end fed from the air-jet spinning device 5, and guides the yarn end to the yarn joining device 27. The suction mouth 29 sucks and catches a yarn end from

a package 18 supported by the winding section 8, and guides the yarn end to the yarn joining device 27.

[0041] Next, the configuration of the air-jet spinning device 5 will be described in detail with reference to FIG. 3. FIG. 3 is a schematic vertical sectional view of the air-jet spinning device 5 when cut by a plane passing through an axis line of a hollow guide shaft body 32.

[0042] As illustrated in FIG. 3, the air-jet spinning device 5 includes a fiber guiding block (fiber guiding section) 30, a nozzle block 31, the hollow guide shaft body 32 and a casing 33. The casing 33 is formed of an upstream casing 33a and a downstream casing 33b.

[0043] The fiber guiding block 30 is provided with a fiber introducing hole 34 adapted to introduce the fiber bundle 10 drafted in the draft device 4. The fiber guiding block 30 holds a needle (the fiber guiding section) 44 arranged on a passage of the fiber bundle 10. The fiber guiding block 30 is held by the upstream casing 33a.

[0044] The hollow guide shaft body 32 includes a tapered portion 37 of which diameter increases towards downstream, and a columnar portion 38 of which diameter is substantially constant. The columnar portion 38 is connected to a large-diameter end of the tapered portion 37 such that axis lines of the columnar portion 38 and the tapered portion 37 correspond to each other. A fiber passage 39 is formed in axial centers of the columnar portion 38 and the tapered portion 37. Accordingly, the hollow guide shaft body 32 is hollow.

[0045] The tapered portion 37 of the hollow guide shaft body 32 is arranged such that a small-diameter end thereof faces upstream. The columnar portion 38 of the hollow guide shaft body 32 is held by the downstream casing 33b.

[0046] An inlet of the fiber passage 39 is opened at an upstream end portion (a small-diameter end portion of the tapered portion 37) of the hollow guide shaft body 32. The upstream end portion of the hollow guide shaft body 32 is referred to as an inlet portion 40 of the fiber passage 39. As illustrated in FIG. 3, the inlet portion 40 is arranged facing a tip of the needle 44. In the configuration as described above, the fiber bundle 10 that has been introduced into the fiber introducing hole 34 is introduced into the fiber passage 39 from the inlet portion 40 while being guided by the fiber guiding block 30 (the needle 44) (see FIG. 4). A downstream end portion of the fiber passage 39 is an outlet hole that is not illustrated.

[0047] The nozzle block 31 is provided with a whirling chamber 41 and a tapered chamber 42. Therefore, the nozzle block 31 may be referred to as a whirling chamber forming member. The whirling chamber 41 is formed as a substantially cylindrical space and is continuous with the fiber introducing hole 34. The tapered chamber 42 is formed as a tapered space widening towards downstream. The tapered chamber 42 is positioned downstream of the whirling chamber 41 being connected thereto. The nozzle block 31 is held by the upstream casing 33a.

[0048] The casing 33 is configured in an openable and

closable manner. In a state in which the casing 33 is closed (a state in which the upstream casing 33a and the downstream casing 33b are close to each other, illustrated in FIG. 3), the tapered portion 37 of the hollow guide shaft body 32 is arranged such that a part of the tapered portion 37 is inserted inside of the whirling chamber 41 and the tapered chamber 42. The hollow guide shaft body 32 is arranged such that its axis line corresponds to axis lines of the whirling chamber 41 and the tapered chamber 42. In a state in which the casing 33 is closed, a predetermined space (the whirling chamber 41 and tapered chamber 42) is formed between an outer peripheral surface of the hollow guide shaft body 32 and an inner surface of the nozzle block 31. When the spun yarn 15 is generated by the air-jet spinning device 5, the casing 33 is closed in this manner.

[0049] By bringing the casing 33 into an opened state (a state in which the upstream casing 33a and the downstream casing 33b are separated from each other, not illustrated), the nozzle block 31 and the fiber guiding block 30 can be separated from the hollow guide shaft body 32. Accordingly, the hollow guide shaft body 32 can be exposed outside. For example, when wastes such as fiber wastes attach to the hollow guide shaft body 32, the casing 33 can be opened to expose the hollow guide shaft body 32 as described above and cleaning can be performed on the hollow guide shaft body 32.

[0050] An air supply chamber 35 is formed around the nozzle block 31. A compressed air supply pipe 36 connected to a compressed air source that is not illustrated is connected to the upstream casing 33a. Accordingly, compressed air can be supplied from the compressed air source to the air supply chamber 35.

[0051] The nozzle block 31 is provided with one or more air-jet nozzles 43 that is continuous with the whirling chamber 41 and the air supply chamber 35. The air-jet nozzle 43 is formed such that its longitudinal direction faces a substantially tangential direction of the whirling chamber 41 when seen in a plan view. The compressed air supplied to the air supply chamber 35 is jetted into the inside of the whirling chamber 41 via the air-jet nozzle 43. Accordingly, the whirling airflow occurs that flows whirling in one direction around the axis line of the hollow guide shaft body 32.

[0052] As illustrated in FIG. 3, the air-jet nozzle 43 is formed such that its longitudinal direction is slightly inclined to downstream. Accordingly, the compressed air jetted from the air-jet nozzle 43 can be flown towards downstream.

[0053] In the configuration described above, the compressed air jetted from the air-jet nozzle 43 flows towards downstream while whirling around the hollow guide shaft body 32 in the whirling chamber 41. In this manner, a spiral whirling airflow that flows towards downstream can be generated in the whirling chamber 41.

[0054] Next, in the air-jet spinning device 5 of the present embodiment, how the twists are added to the fiber bundle 10, and the spun yarn 15 is generated will

be described with reference to FIG. 4. In FIG. 4, the flow of the air in the air-jet spinning device 5 is indicated by a bold line arrow.

[0055] The fiber bundle 10 consists of a plurality of fibers. While a downstream end portion of each fiber that constitutes the fiber bundle 10 is twisted into the fiber bundle 10 to which the twists are being added, an upstream end portion thereof is a free end. The free end of each fiber introduced from the fiber introducing hole 34 to an interior of the air-jet spinning device 5 is flown to downstream by the airflow generated by the jetted air from the air-jet nozzle 43. Since the upstream end portion (the free end) of the fibers is flown to downstream, an orientation of the upstream end portion is "reversed" and faces downstream (a lower side of FIG. 4). The fibers in this state are referred to as reversal fibers 10b.

[0056] A part of fibers included in the fiber bundle 10 become connected between the fiber introducing hole 34 and the fiber passage 39. The fibers in this state are referred to as core fibers 10a.

[0057] The free end of the reversal fibers 10b is affected by the whirling airflow spirally flowing around the hollow guide shaft body 32 in the whirling chamber 41. Accordingly, as illustrated in FIG. 4, the reversal fibers 10b whirl around the tapered portion 37 along a surface of the tapered portion 37 of the hollow guide shaft body 32. The reversal fibers 10b are thus orderly wound around the core fibers 10a.

[0058] The core fibers 10a are twisted by being accompanied by the whirling reversal fibers 10b. Since the reversal fibers 10b are wound around the core fibers 10a, and the twists are further added to the core fibers 10a, the reversal fibers 10b are twisted into the core fibers 10a and the spun yarn 15 is generated.

[0059] Although the twists of the core fibers 10a are likely to propagate to upstream (towards a front roller 14), the propagation is prevented by the needle 44. The needle 44 includes a function to prevent the propagation of the twists.

[0060] Since the spun yarn 15 generated in the air-jet spinning device 5 is to be wound by the winding section 8, transporting force towards downstream is applied to the relevant spun yarn 15. Accordingly, the spun yarn 15 and the core fibers 10a are entirely transported towards downstream. The reversal fibers 10b wound around the core fibers 10a are drawn into the fiber passage 39 from the inlet portion 40 of the fiber passage 39 by being accompanied by the core fibers 10a transported towards downstream.

[0061] As described above, since the reversal fibers 10b are swung around the tapered portion 37 of the hollow guide shaft body 32, friction occurs between an outer peripheral surface of the tapered portion 37 and the reversal fibers 10b. However, the friction does not occur on the entire outer peripheral surface of the tapered portion 37, and the friction mainly occurs in a portion that is close to the inlet portion 40 on the outer peripheral surface of the tapered portion 37 (a portion indicated by 37a

in FIG. 5).

[0062] As described above, since the reversal fibers 10b are drawn into the fiber passage 39 from the inlet portion 40 (the upstream end portion of the hollow guide shaft body 32), strong friction occurs on an end surface of the inlet portion 40, and in a portion that is close to the inlet portion 40 on an inner surface of the fiber passage 39 (a portion indicated by 39a in FIG. 5).

[0063] Therefore, especially the portions 37a, 40 and 39a in which friction occurs with fibers on the surface of the hollow guide shaft body 32 are collectively referred to as a "fiber-contacting portion" (a portion indicated by a bold line in FIG. 5).

[0064] Next, a characteristic configuration of the present embodiment will be described.

[0065] The hollow guide shaft body 32 of the present embodiment includes a base member 50 made of stainless steel in which a thin coating (an upper layer 51) is formed on a surface thereof. In the present embodiment, an intermediate layer 52 is formed between the base member 50 and the upper layer 51. The configuration of the hollow guide shaft body 32 of the present embodiment is schematically illustrated in FIG. 6.

[0066] In the hollow guide shaft body 32 of the present embodiment, the upper layer 51 is a coating by a DLC (Diamond Like Carbon) coating. Since the upper layer 51 (DLC coating) is considerably thin, a large part of the hollow guide shaft body 32 consists of the base member 50 made of the stainless steel. Since the stainless steel has favorable electrical conductivity, the hollow guide shaft body 32 of the present embodiment has favorable electrical conductivity. Therefore, the hollow guide shaft body 32 of the present embodiment can easily release the static electricity occurred by the friction with the fibers.

[0067] The downstream casing 33b holding the hollow guide shaft body 32 is made of a material having favorable electrical conductivity (specifically, metal) to release the static electricity of the hollow guide shaft body 32. Furthermore, the downstream casing 33b is electrically connected to a metallic frame of the spinning unit 2. The metallic frame is grounded.

[0068] According to the configuration described above, since the hollow guide shaft body 32 becomes less likely to be electrically charged, the wastes such as the fiber wastes are less likely to attach to the surface of the hollow guide shaft body 32. Accordingly, since the surface of the hollow guide shaft body 32 can always be maintained clean, the quality of the spun yarn 15 to be generated by the air-jet spinning device 5 can be enhanced. Since time and labor for maintenance such as cleaning of the surface of the hollow guide shaft body 32 can be reduced, productivity of the spinning unit 2 can be enhanced.

[0069] Since the large part of the hollow guide shaft body 32 consists of the base member 50 made of stainless steel, toughness is substantially improved in comparison with the conventional hollow guide shaft body made of the ceramics (sintering structure). Accordingly, since the breakage such as the cracking and/or the chip-

ping of the hollow guide shaft body 32 is less likely to occur, the flexibility of the shape of the hollow guide shaft body 32 can be increased.

[0070] For example, in the conventional hollow guide shaft body 132 illustrated in FIG. 7A, when the diameter of the tapered portion 37 is reduced, a thickness in a direction orthogonal to an axial direction of the hollow guide shaft body 32 becomes thin. Since the conventional hollow guide shaft body 132 has been made of the ceramics, the breakage such as the cracking and/or the chipping is likely to occur when the thickness becomes thin. It was thus difficult to decrease the diameter of the conventional hollow guide shaft body 132. In this respect, since the hollow guide shaft body 32 of the present embodiment has adequate toughness, the breakage such as the cracking and/or the chipping is less likely to occur even when the thickness becomes thin by making the diameter of the tapered portion 37 smaller (the tapered portion 37 thinner) than before. In this manner, the diameter of the tapered portion 37 of the hollow guide shaft body 32 of the present embodiment can be made smaller (the tapered portion 37 can be made thinner) than before. Since whirling radius of the fibers can be reduced, the spinning speed of the air-jet spinning device 5 can be improved.

[0071] In the hollow guide shaft body 32 of the present embodiment, the upper layer 51 consisting of the DLC coating is formed on the surface of the base member 50 made of the stainless steel. As publicly known, the hardness of the DLC coating is considerably higher in comparison with the stainless steel. Therefore, by forming the upper layer 51 (the DLC coating) on the surface of the base member 50, the abrasion resistance of the hollow guide shaft body 32 can be considerably improved.

[0072] From a perspective of improving the abrasion resistance of the hollow guide shaft body 32, the upper layer 51 is preferably formed at least on a portion with which the fibers are in contact (the fiber-contacting portion illustrated in FIG. 5). In the hollow guide shaft body 32 of the present embodiment, the upper layer 51 is formed on the entire outer peripheral surface of the base member 50 (peripheral surfaces of the tapered portion 37 and the columnar portion 38), an end surface of the inlet portion 40, and a portion that is close to the inlet portion 40 of an inner wall surface of the fiber passage 39 (a portion illustrated by 39a in FIG. 5). The upper layer 51 may be entirely formed on the inner surface of the fiber passage 39.

[0073] Since the DLC coating has amorphous nature, the DLC coating is superior in smoothness and has low frictional properties. Thus, the friction between the hollow guide shaft body 32 and the reversal fibers 10b can be reduced. Therefore, the reversal fibers 10b can be smoothly whirled around the hollow guide shaft body 32 enabling the whirling speed of the reversal fibers 10b to be enhanced. According to the hollow guide shaft body 32 of the present embodiment, the spinning speed of the air-jet spinning device 5 can be further improved.

[0074] As described above, according to the configuration of the present embodiment, the hollow guide shaft body 32 having the abrasion resistance and the toughness has low frictional properties and has the electrical conductivity. Accordingly, in comparison with the conventional hollow guide shaft body made of the ceramics, the spinning speed can be enhanced by improving the whirling speed of the fibers.

[0075] The conventional hollow guide shaft body made of fine ceramics is white or nearly white. Therefore, there has been a problem in which even when the wastes such as the fiber wastes (typically white) attach to the hollow guide shaft body, the wastes are difficult to be found.

[0076] Since the DLC coating is typically black, the surface of the hollow guide shaft body 32 of the present embodiment to which the DLC coating is applied is black. Thus, when the wastes such as the fiber wastes attach to the hollow guide shaft body 32 of the present embodiment, the wastes can be easily found. As a result, a necessity of the maintenance such as cleaning of the hollow guide shaft body 32 can be appropriately determined. Therefore, since an unnecessary maintenance is not performed, the productivity of the spinning unit 2 can be improved.

[0077] As a method of forming the above-described DLC coating, a publicly-known appropriate method may be employed. However, the DLC coating, according to the method of forming, may have electrical conductivity or may not. From a perspective of preventing the hollow guide shaft body 32 from being electrically charged, in addition to the base member 50, the upper layer 51 also preferably has electrical conductivity. Therefore, the upper layer 51 of the hollow guide shaft body 32 of the present embodiment is the DLC coating having the electrical conductivity. Accordingly, since the hollow guide shaft body 32 becomes even less likely to be electrically charged, the wastes are efficiently prevented from attaching to the surface of the hollow guide shaft body 32.

[0078] Next, the intermediate layer 52 will be described.

[0079] Since a toughness of the stainless steel and a toughness of the DLC coating differ considerably, an adhesion between the stainless steel and the DLC coating is low. Thus, if the DLC coating is directly formed on the surface of the base member 50, the DLC coating may be peeled off from the base member 50. In the present embodiment, the intermediate layer 52 is provided between the base member 50 and the upper layer 51 to improve the adhesion between the base member 50 and the upper layer 51.

[0080] The intermediate layer 52 is merely required to have hardness intermediate between hardness of the upper layer 51 and hardness of the base member 50. Furthermore, the intermediate layer 52 is preferably configured in a multilayered manner such that hardness thereof gradually becomes higher from the base member 50 to the upper layer 51. In the present embodiment, the intermediate layer 52 consists of a heat treatment layer 53,

a nitriding treatment layer 54 and a plating layer 55 in this order from the base member 50.

[0081] The heat treatment layer 53 is a portion in which the hardness of the surface of the base member 50 is improved by adding heat treatment such as quenching and tempering to the base member 50 made of stainless steel.

[0082] The nitriding treatment layer 54 is a portion in which publicly-known nitriding treatment is performed on the surface of the base member 50 after the heat treatment is applied thereto. Accordingly, the hardness of the surface of the base member 50 can be further improved. If a chemical compound layer is formed on the surface of the base member 50 by the nitriding treatment, the chemical compound layer may be peeled off from the surface of the base member 50. Therefore, a nitriding method for forming only a diffusion layer without forming the chemical compound layer (a radical nitriding method, for example) is preferably employed.

[0083] The plating layer 55 is a portion in which a hard plating coating using tungsten and/or chromium and the like is formed on the surface of the base member 50 after the nitriding treatment is applied thereto.

[0084] The intermediate layer 52 is formed as described above to improve the adhesion between the base member 50 and the upper layer 51, which can prevent the upper layer 51 (the DLC coating) from being peeled off from the base member 50. Since the intermediate layer 52 has electrical conductivity, the intermediate layer 52 can release static electricity from the upper layer 51 to the base member 50 that occurred by friction between the upper layer 51 and the reversal fibers 10b.

[0085] As described above, the fibers whirl around the hollow guide shaft body 32 of the present embodiment by the action of the whirling airflow in the air-jet spinning device 5. The fiber passage 39 is formed in the hollow guide shaft body 32. The fibers to which the twists have been added by the whirling airflow pass through the fiber passage 39. The hollow guide shaft body 32 includes the base member 50 having electrical conductivity, and the upper layer 51 provided on the surface of the base member 50 and being harder than the base member 50.

[0086] By making the base member 50 electrically conductive, the hollow guide shaft body 32 becomes less likely to be electrically charged. Accordingly, since the wastes become less likely to attach to the hollow guide shaft body 32, the quality of the spun yarn 15 to be generated by the air-jet spinning device 5 is improved, and the time and labor to clean the hollow guide shaft body 32 can be reduced. Abrasion resistance of the hollow guide shaft body 32 can be improved by the upper layer 51 provided on the surface of the base member 50. Since the abrasion resistance is not required for the base member 50 itself, a material of relatively high toughness can be employed for the base member 50. Accordingly, since the breakage such as the cracking and/or the chipping of the hollow guide shaft body 32 become less likely to occur, the flexibility of the shape of the hollow guide shaft

body 32 is increased. Since the hollow guide shaft body 32 can be formed thinner (the diameter can be formed smaller) than before, for example, the spinning speed of the air-jet spinning device 5 can be enhanced by improving the whirling speed of the fibers.

[0087] In the hollow guide shaft body 32 of the present embodiment, the upper layer 51 is a diamond-like carbon coating.

[0088] Accordingly, the upper layer 51 having sufficient hardness can be formed. Since the diamond-like carbon coating has a low friction coefficient, the friction that occurs between the hollow guide shaft body 32 and the fibers can be reduced. Since the whirling speed of the fibers thus can be more improved, the spinning speed of the air-jet spinning device 5 can be more enhanced.

[0089] In the hollow guide shaft body 32 of the present embodiment, the upper layer 51 is the DLC coating having the electrical conductivity.

[0090] Since the upper layer 51 has the electrical conductivity, the hollow guide shaft body 32 becomes even less likely to be electrically charged, and the wastes become even less likely to attach to the hollow guide shaft body 32.

[0091] In the hollow guide shaft body 32 of the present embodiment, the upper layer 51 is provided on the inlet portion 40 of the fiber passage 39, and at least on a portion 39a of the inner surface of the fiber passage 39, that is close to the inlet portion 40.

[0092] Since the fibers whirled in the air-jet spinning device 5 make contact with the above-described positions of the hollow guide shaft body 32, by providing the upper layer 51 on such positions, the abrasion resistance of the hollow guide shaft body 32 can be improved.

[0093] In the hollow guide shaft body 32 of the present embodiment, the base member 50 is formed of the stainless steel.

[0094] By forming the base member 50 of the hollow guide shaft body 32 from the material having the electrical conductivity, the static electricity that occurs by the friction between the hollow guide shaft body 32 and the fibers can be reliably released.

[0095] In the hollow guide shaft body 32 of the present embodiment, the intermediate layer 52 adapted to adhere the upper layer 51 and the base member 50, is provided between the upper layer 51 and the base member 50.

[0096] Accordingly, since the upper layer 51 becomes less likely to be peeled off from the base member 50, durability of the hollow guide shaft body 32 is improved.

[0097] In the hollow guide shaft body 32 of the present embodiment, the upper layer 51 is black.

[0098] By making the surface of the hollow guide shaft body 32 black, the wastes such as fiber wastes attached to the surface can be easily recognized visually. Accordingly, the hollow guide shaft body 32 can be easily cleaned at the time of the maintenance or the like.

[0099] The air-jet spinning device 5 of the present embodiment includes the hollow guide shaft body 32, the

nozzle block 31 in which the whirling chamber 41 is formed in which the fibers are whirled, and the needle 44 adapted to guide the fibers to the whirling chamber 41.

[0100] The air-jet spinning device 5 can improve the spinning speed than before by employing the above-described hollow guide shaft body 32.

[0101] The spinning machine 1 of the present embodiment includes the above-described air-jet spinning device 5 and the winding section 8 adapted to wind the spun yarn 15 spun by the air-jet spinning device 5 and to form the package 18.

[0102] The spinning machine 1 can improve the speed of generating the package 18 than before by employing the above-described air-jet spinning device 5.

[0103] Although a preferable embodiment of the present invention is described above, the configurations described above may be changed as follows, for example.

[0104] A material of the base member is not limited to the stainless steel, and may be a material having favorable electrical conductivity is sufficient. As such a material, there may be iron, conductive ceramics, refractory metal (tungsten carbide and the like), or the like. However, in terms of having corrosion resistance as well as adequate toughness, the base member 50 is preferably made of the stainless steel as the above-described embodiment.

[0105] In the above-described embodiment, the upper layer 51 (the DLC coating) is formed on the entire outer peripheral surface of the base member 50. Accordingly, the abrasion resistance of the entire hollow guide shaft body 32 can be improved. However, from a perspective of preventing abrasion of the base member 50 caused by contact with the fibers, the upper layer 51 is not necessarily provided on the entire outer peripheral surface of the base member 50, but the upper layer 51 is sufficient to be formed at least on the portions of the base member 50 with which the fibers make contact (the fiber-contacting portions 37a, 40 and 39a illustrated in FIG. 5). Since the DLC coating is typically expensive, by forming the upper layer 51 only on the above-described fiber-contacting portions, production cost of the hollow guide shaft body 32 can be reduced.

[0106] Since the intermediate layer 52 is adapted to improve the adhesion between the base member 50 and the upper layer 51, the intermediate layer 52 may be omitted when the adhesion between the base member 50 and the upper surface 51 is sufficient.

[0107] The upper layer 51 is not limited to the DLC coating, and may be a layer being harder than the base member 50. For example, any one of the intermediate layer 52 (the plating layer 55, the nitriding treatment layer 54 and the heat treatment layer 53) is harder than the base member 50 (the stainless steel). Therefore, when the DLC coating illustrated in FIG. 6 is omitted, for example, the plating layer 55 can be recognized as an "upper layer".

[0108] In the same manner, when the DLC coating and

the plating layer 55 illustrated in FIG. 6 are omitted, the nitriding treatment layer 54 can be recognized as an "upper layer". Since the nitriding treatment layer 54 is inferior to the DLC coating in terms of hardness, the abrasion resistance may be not sufficient. Therefore, when the upper layer is the nitriding treatment layer 54, the hollow guide shaft body 32 may be abraded by the friction with the fibers. However, when the upper layer is the nitriding treatment layer 54, since the expensive DLC coating is omitted, the hollow guide shaft body 32 can be advantageously configured in a low-cost manner. Therefore, even if the abraded hollow guide shaft body 32 is replaced with a new hollow guide shaft body 32, a burden in terms of cost is light.

[0109] The needle 44 may be omitted. In this case, the fiber bundle 10 is introduced into the whirling chamber 41 while being guided by the inner wall surface of the fiber introducing hole 34 formed in the fiber guiding block 30. In this case, the fiber guiding block 30 itself can be recognized as a "fiber guiding section".

Claims

1. A hollow guide shaft body adapted to let fibers whirl around it by an action of a whirling airflow in an air-jet spinning device (5) and in which a fiber passage (39) is formed, wherein the fiber passage (39) is adapted to let pas the fibers after being twisted by the whirling airflow, the hollow guide shaft body comprising:
 - a base member (50) having electrical conductivity, and
 - an upper layer (51) provided at least on a portion of a surface of the base member (50), and being harder than the base member (50).
2. The hollow guide shaft body according to claim 1, wherein the upper layer (51) is a diamond-like carbon coating.
3. The hollow guide shaft body according to claim 1 or claim 2, wherein the upper layer (51) has electrical conductivity.
4. The hollow guide shaft body according to any one of claim 1 through claim 3, wherein the upper layer (51) is provided on an inlet portion (40) of the fiber passage (39) and at least on a portion of an inner surface of the fiber passage (39).
5. The hollow guide shaft body according to any one of claim 1 through claim 4, wherein the base member (50) is formed from at least one of iron, conductive ceramics, refractory metal, and stainless steel.
6. The hollow guide shaft body according to any one

of claim 1 through claim 5, wherein an intermediate layer (52) is provided between the upper layer (51) and the base member (50) and is adapted to adhere the upper layer (51) and the base member (50).

7. The hollow guide shaft body according to any one of claim 1 through claim 6, wherein the upper layer (51) is black.

8. An air-jet spinning device (5) comprising:

the hollow guide shaft body (32) according to any one of claim 1 through claim 7,
a whirling chamber forming member (31) in which a whirling chamber (41) is formed in which the fibers are whirled, and
a fiber guiding section (30, 44) adapted to guide the fibers to the whirling chamber (41).

9. A yarn winding machine comprising:

the air-jet spinning device (5) according to claim 8, and
a winding section (8) adapted to wind a spun yarn (15) spun by the air-jet spinning device (5) and to form a package (18).

FIG. 1

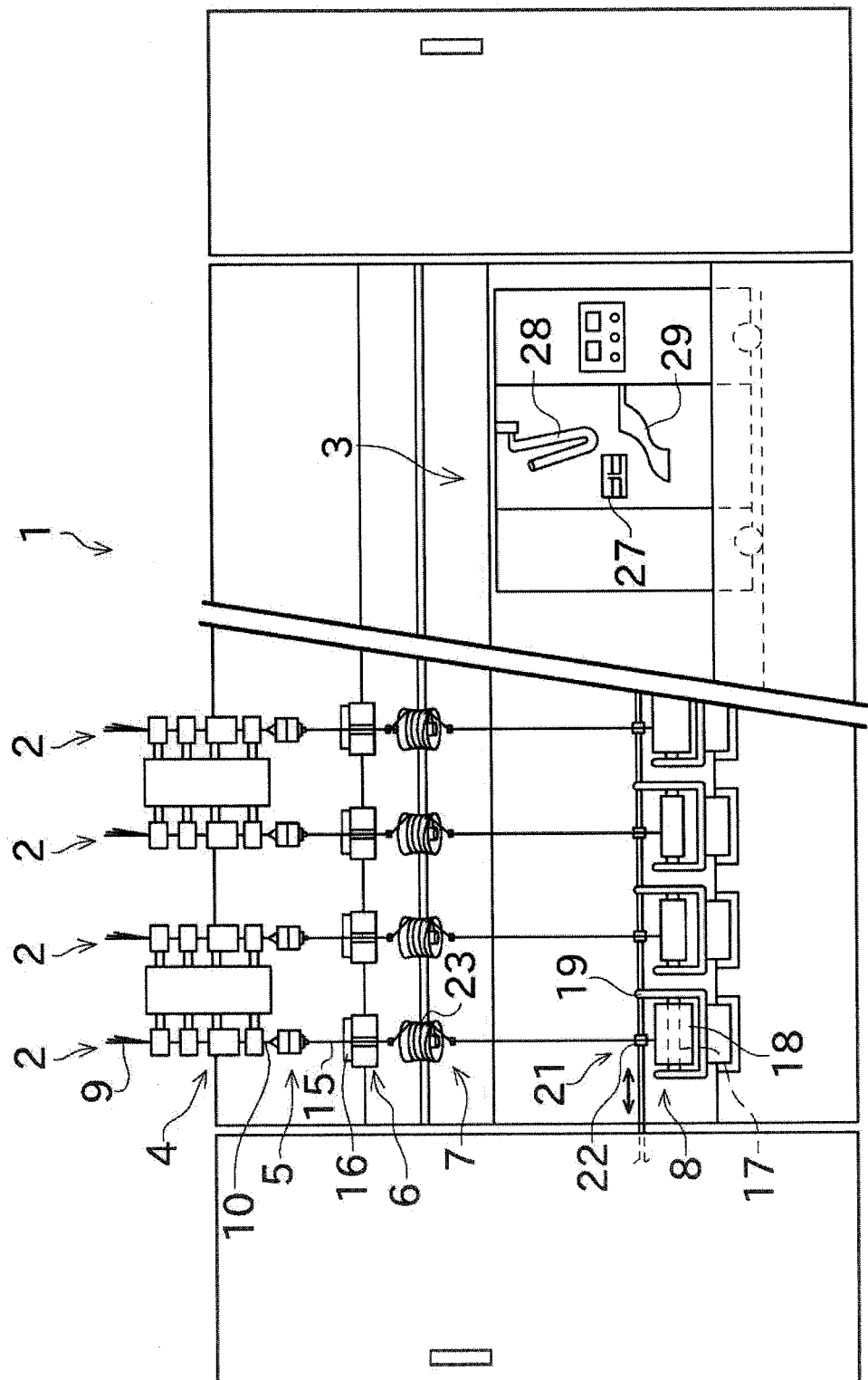


FIG. 2

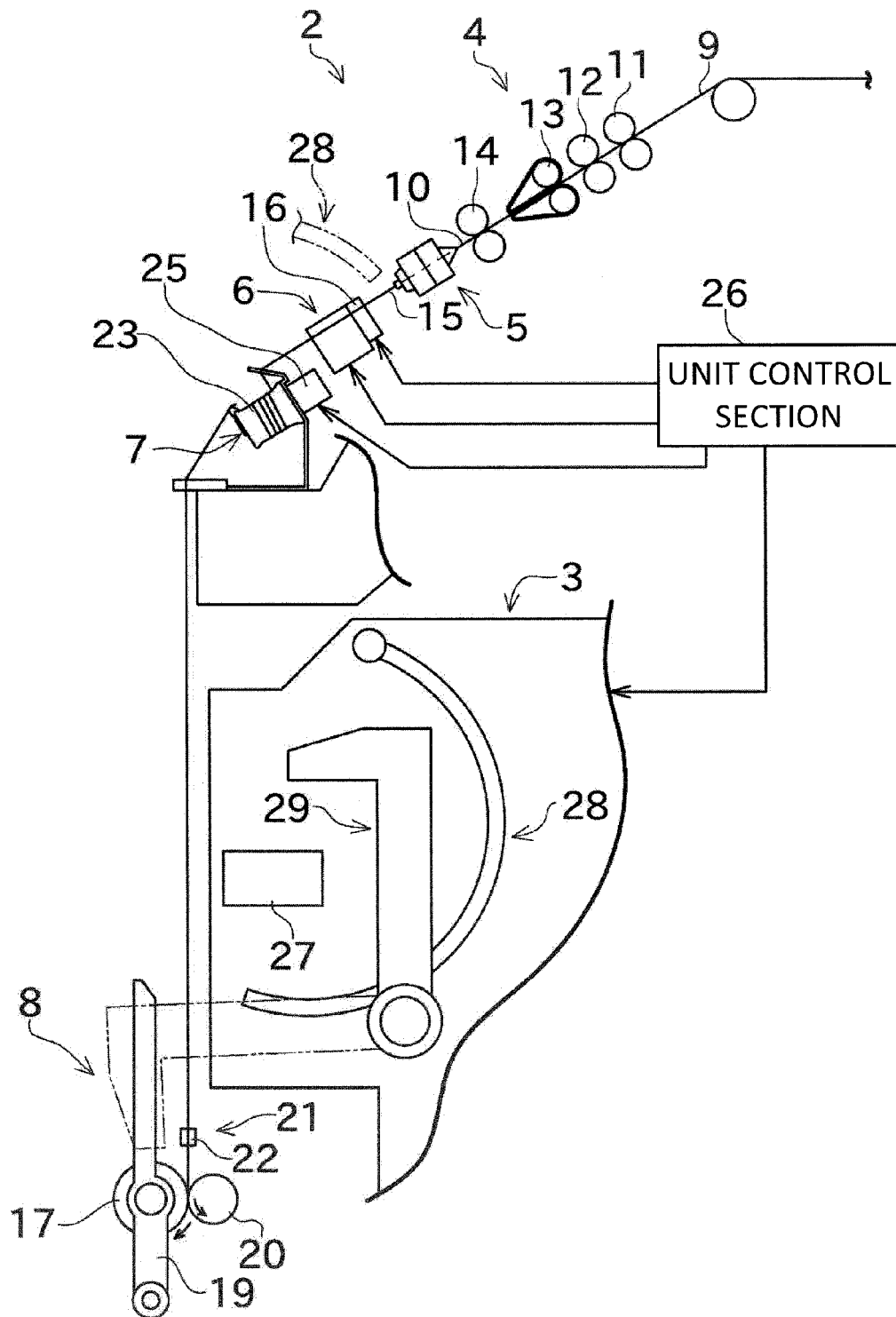


FIG. 3

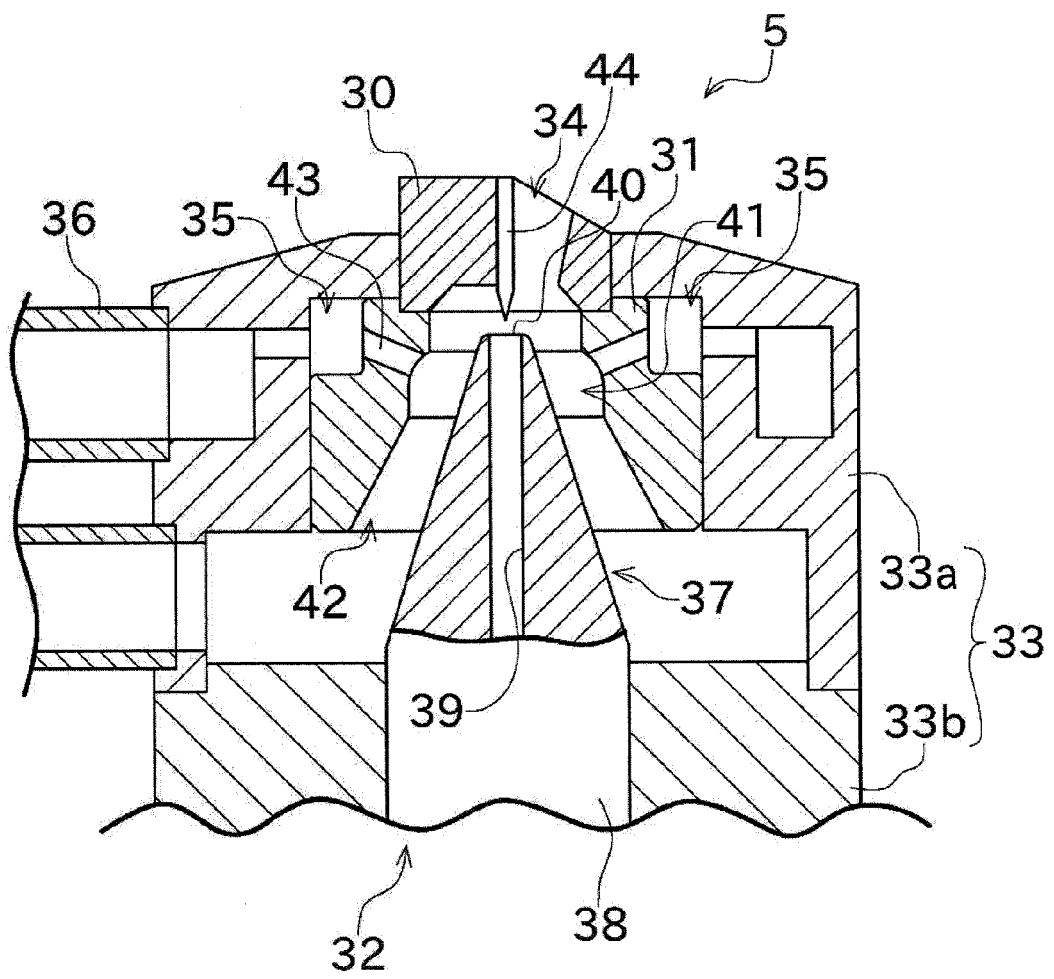


FIG. 4

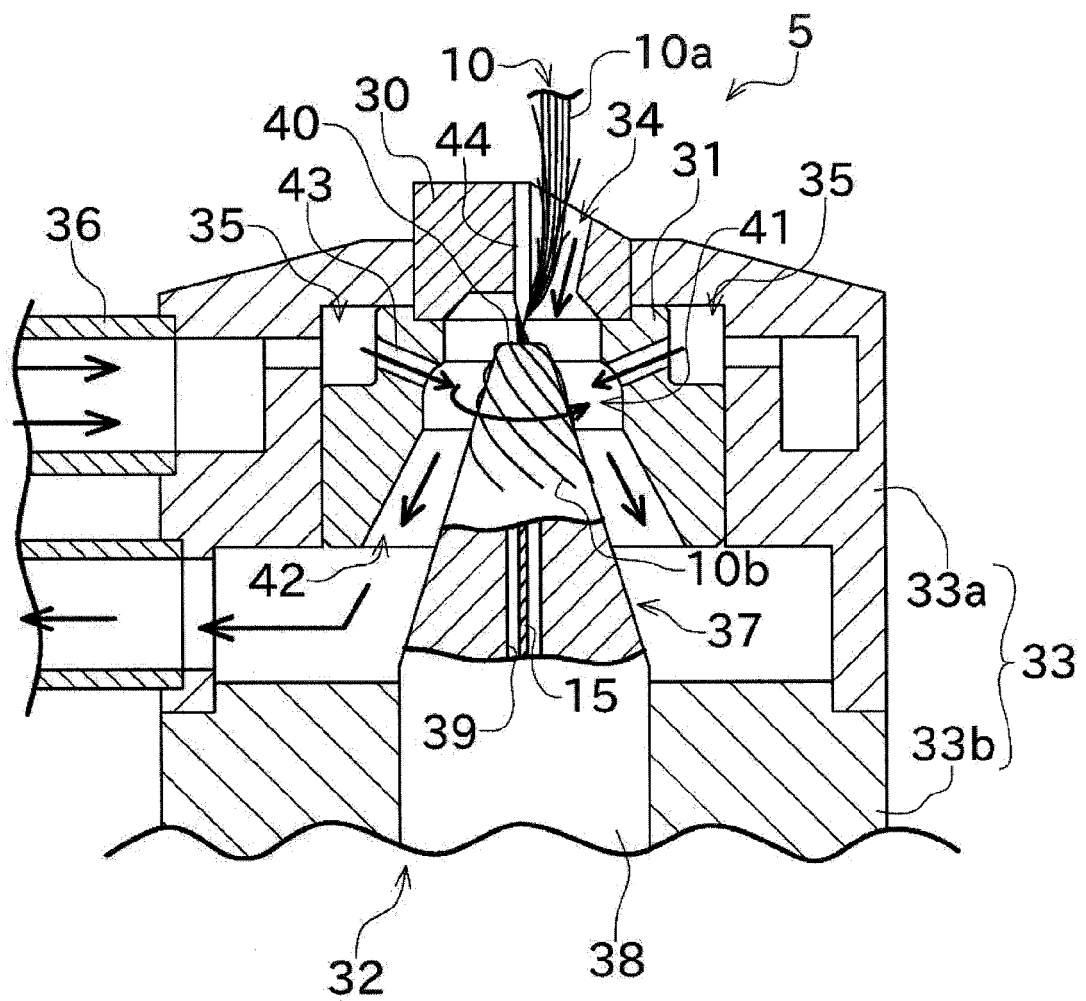


FIG. 5

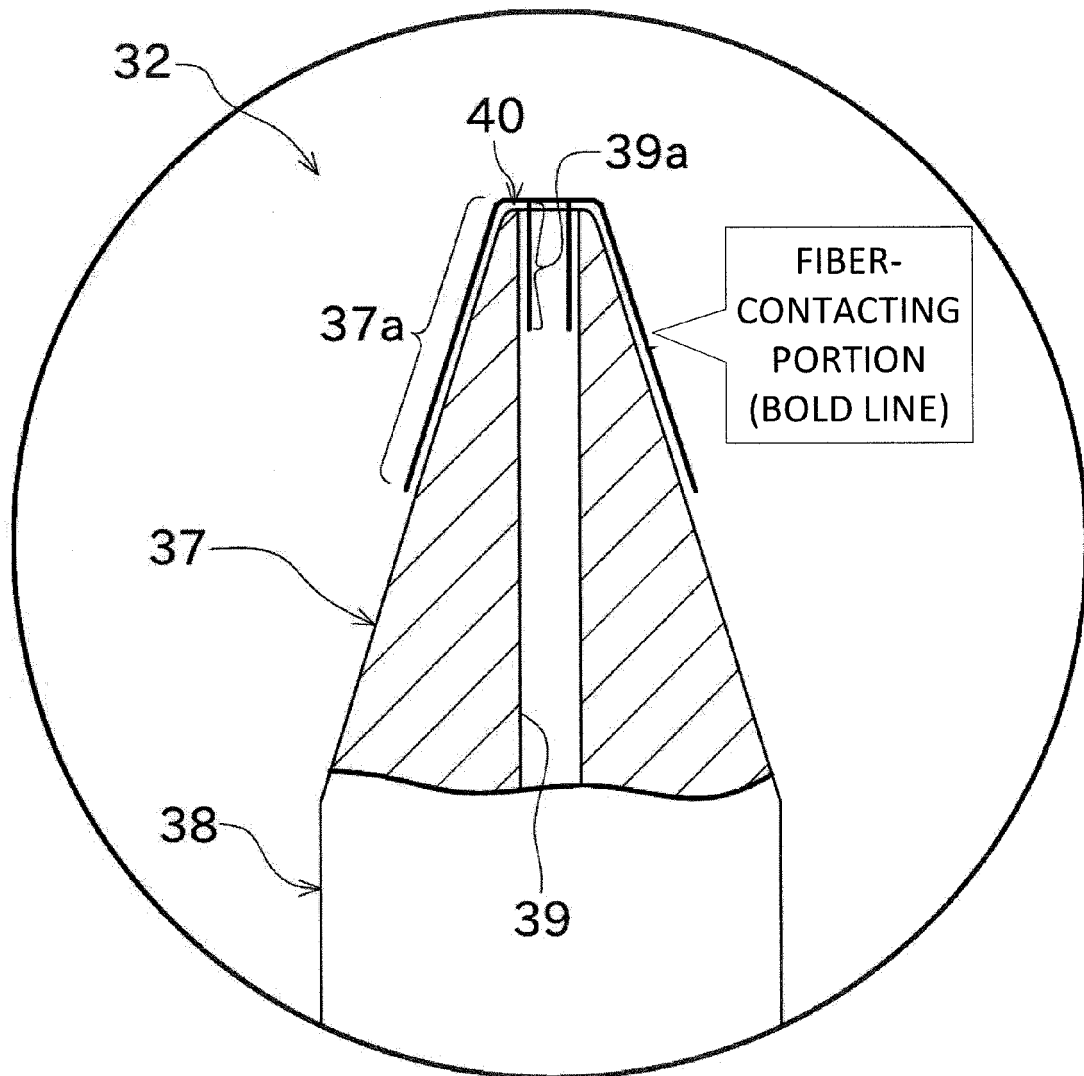


FIG. 6

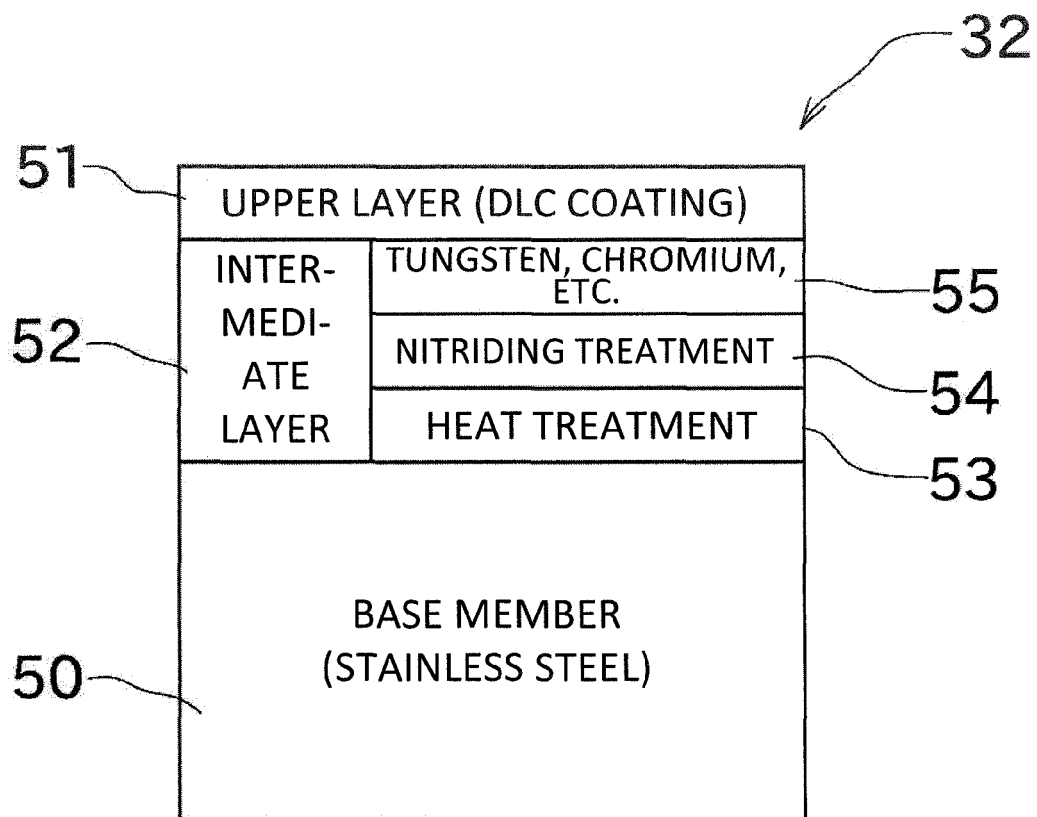


FIG. 7A

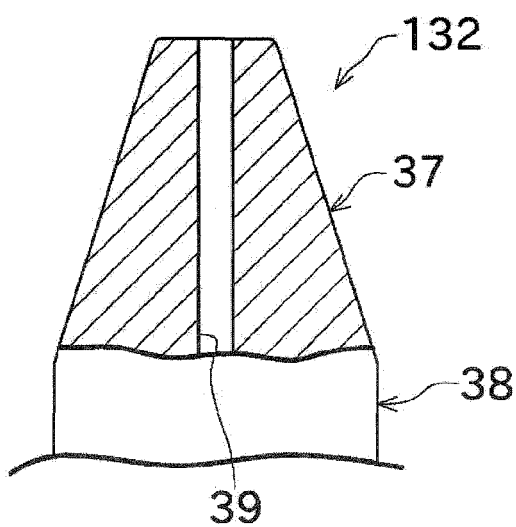
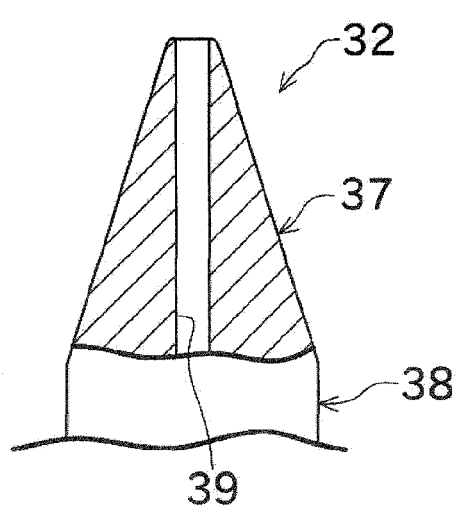


FIG. 7B





EUROPEAN SEARCH REPORT

Application Number
EP 13 17 0142

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