



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
22.04.2020 Bulletin 2020/17

(51) Int Cl.:
D03D 47/30 (2006.01)

(21) Application number: **19199242.9**

(22) Date of filing: **24.09.2019**

(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:
KH MA MD TN

(71) Applicant: **Tsudakoma Kogyo Kabushiki Kaisha**
Kanazawa-shi, Ishikawa-ken 921-8650 (JP)

(72) Inventors:
• **YONEJIMA, Yoshiyuki**
ISHIKAWA-KEN, 921-8650 (JP)
• **KOBORI, Yuichiro**
ISHIKAWA-KEN, 921-8650 (JP)

(30) Priority: **16.10.2018 JP 2018195242**
02.04.2019 JP 2019070571

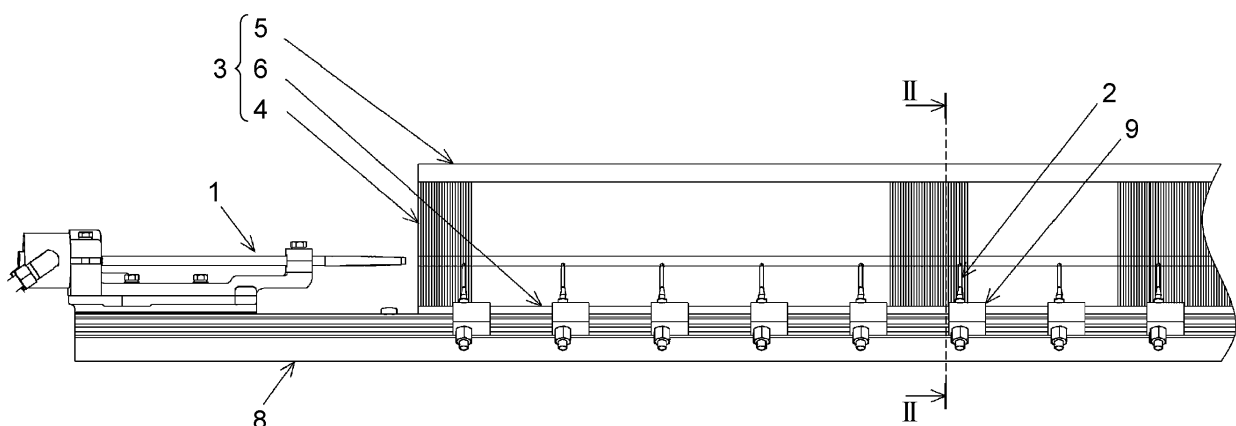
(74) Representative: **Eisenführ Speiser**
Patentanwälte Rechtsanwälte PartGmbB
Postfach 31 02 60
80102 München (DE)

(54) **SUB-NOZZLE FOR AIR JET LOOM**

(57) A sub-nozzle (2) for an air jet loom includes: a cylindrical portion (11) opening at one end thereof; and a flat portion (12) close to another end of the cylindrical portion and having an ejection hole (10). The flat portion has a hollow tube shape as a result of front and rear wall portions (18) and (17) facing each other being connected to each other by a side wall portion (19) and includes a distal end portion closed by the side wall portion. The

front wall portion of the flat portion includes a distal end-side flat surface portion (21) close to the distal end portion at an outer surface (16) of the front wall portion and inclining to approach the rear wall portion toward the distal end portion. The ejection hole is formed across the distal end-side flat surface portion and the side wall portion.

FIG. 1



Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a sub-nozzle for an air jet loom, the sub-nozzle including: a cylindrical portion that is open at one end thereof and to be connected to a compressed-air supply source; and a flat portion formed close to another end of the cylindrical portion and having an ejection hole, the flat portion being formed in a hollow tube shape as a result of a front wall portion and a rear wall portion facing each other being connected to each other by a side wall portion, the flat portion including a distal end portion closed by the side wall portion.

2. Description of the Related Art

[0002] An example of such a sub-nozzle for an air jet loom is disclosed in Japanese Unexamined Patent Application Publication No. 8-60492. The sub-nozzle for the air jet loom disclosed in Japanese Unexamined Patent Application Publication No. 8-60492 has a configuration in which, for the purpose of improving a weft conveying force, an ejection hole is formed such that the position of the center of the ejection hole is a position deviated from the center axis of the sub-nozzle. Specifically, the sub-nozzle for the air jet loom disclosed in Japanese Unexamined Patent Application Publication No. 8-60492 has a configuration in which the position of the center of the ejection hole is closer than the center axis of the sub-nozzle to a reed so that a distance between a weft that travels in a weft guide groove of the reed and the ejection hole is a shorter distance than that in a sub-nozzle having an existing general configuration.

SUMMARY OF THE INVENTION

[0003] Meanwhile, in the sub-nozzle having the existing general configuration (hereinafter referred to as "general configuration"), there is an issue that reducing air consumption while obtaining a desired weft conveying force is limited.

[0004] Specifically, in the general configuration, the wall thickness of a section at which the ejection hole is formed is considerably thin, and the wall thickness is 0.5 mm or less in general. Consequently, in the general configuration, the axial-direction length of the ejection hole is short, and a ratio of the axial-direction length to the diameter of the ejection hole is considerably small. Accordingly, in the general configuration, a degree of diffusion of a flow of air jetted from the ejection hole is high, and the weft conveying force with respect to a pressure (hereinafter, referred to as "supply pressure") of compressed air to be supplied is small.

[0005] Accordingly, when the general configuration is employed, it is required to increase supply pressure to

obtain a desired weft conveying force, and as a result, the air consumption increases; in other words, there is an issue of air consumption unavoidably increasing (being unable to be reduced) to obtain a desired weft conveying force.

[0006] Such an issue is similarly generated even in a configuration (hereinafter referred to as "existing configuration"), such as that disclosed in Japanese Unexamined Patent Application Publication No. 8-60492, in which the position of the center of the ejection hole is deviated from the center axis of the sub-nozzle because the existing configuration is identical to the general configuration in terms of the wall thickness of a section at which the ejection hole is formed being considerably thin.

[0007] Accordingly, it is an object of the present invention to provide a sub-nozzle for an air jet loom configured to obtain a larger weft conveying force compared to the general configuration or the existing configuration, although with the same supply pressure, to thereby enable air consumption to be reduced as much as possible.

[0008] The present invention is based on a sub-nozzle for an air jet loom, the sub-nozzle including: a cylindrical portion that is open at one end thereof and to be connected to a compressed-air supply source; and a flat portion formed close to another end of the cylindrical portion and having an ejection hole, the flat portion being formed in a hollow tube shape as a result of a front wall portion and a rear wall portion facing each other being connected to each other by a side wall portion, the flat portion including a distal end portion closed by the side wall portion. Based on the above, to achieve the aforementioned object, in the sub-nozzle for the air jet loom, on which the present invention is based, the front wall portion of the flat portion is formed to include a distal end-side flat surface portion formed close to the distal end portion at an outer surface of the front wall portion, the distal end-side flat surface portion inclining so as to approach the rear wall portion toward the distal end portion, and the ejection hole is formed across the distal end-side flat surface portion and the side wall portion.

[0009] Note that the 'distal end-side flat surface portion' mentioned in the present invention is a flat surface section formed close to the distal end portion at the outer surface of the front wall portion. The flat surface section is however not limited to a section simply formed to be a flat surface and may be a section formed to be a curved surface. The flat surface section is a section formed to be a substantially flat surface in which the radius of curvature of the curved surface is sufficiently large compared to that of the other sections (the side wall portion and the like) of the flat portion. The substantially flat surface is the 'distal end-side flat surface portion'. The range of the 'distal end-side flat surface portion' is defined by using flatness in general geometrical tolerance. Specifically, the range of the 'distal end-side flat surface portion' is a range fits in a space between two flat surfaces that are parallel to each other with a space of 0.02 mm therebetween, which is a range in which the tolerance level

of so-called flatness is H.

[0010] The 'ejection hole' mentioned in the present invention is not limited to an ejection hole formed by a single hole and includes an ejection hole constituted by a group of a plurality of holes formed at a region at which the ejection hole should be formed. In this case, the position at which the ejection hole is formed is the region at which the plurality of holes are formed, and the position of the center of the region is the position of the center of the ejection hole.

[0011] In the sub-nozzle for the air jet loom of the present invention, the ejection hole may be formed such that a position of a center thereof is a position closer than a center axis of the sub-nozzle to a reed when the front wall portion is viewed from a front and such that, of a distance from an inner edge, which is a section of an inner surface positioned inside an outer edge of the side wall portion, a distance from a closest section of the inner edge is 0.25 mm or less.

[0012] In addition, in the sub-nozzle for the air jet loom of the present invention, the ejection hole may be formed such that the inner circumferential surface thereof includes a tapered portion, which is a section formed to gradually increase a hole diameter toward the inner surface.

[0013] In addition, in the sub-nozzle for the air jet loom of the present invention, a ratio of an area of a section of the ejection hole opening at the side wall portion relative to a whole area of an opening portion, which is a section of the ejection hole opening at a surface of the sub-nozzle may be 3% to 20%.

[0014] According to the sub-nozzle for the air jet loom of the present invention, due to the ejection hole being formed across the distal end-side flat surface portion and the side wall portion, the weft conveying force with respect to the same supply pressure is improved compared to the general configuration and the existing configuration.

[0015] Specifically, as described above, the side wall portion of the sub-nozzle is a section connecting the front wall portion and the rear wall portion to each other, and therefore, the wall thickness direction of the distal end-side flat surface portion at the front wall portion differs from the wall thickness direction of the section of the side wall portion in continuous with the distal end-side flat surface portion. Moreover, the ejection hole of the sub-nozzle is formed based on (such that the axial direction and the wall thickness direction coincide or substantially coincide with each other) the wall thickness direction of the section of the front wall portion at which the distal end-side flat surface portion is formed. Consequently, the axis of the thus formed ejection hole forms a larger angle with respect to the wall thickness direction of the aforementioned section of the side wall portion than an angle formed with respect to the wall thickness direction of the aforementioned section of the front wall portion. Thus, when such an ejection hole is formed across the distal end-side flat surface portion and the side wall portion,

the ejection hole is in a state of being formed with a large angle formed with respect to the side wall portion as described above.

[0016] Consequently, the axial-direction length of the section of the ejection hole opening at the distal end-side flat surface portion is substantially identical to the wall thickness of the sub-nozzle (the aforementioned section of the front wall portion), as in the case with the existing configuration; however, the axial-direction length of the section opening at the side wall portion is longer than the wall thickness of the sub-nozzle (the aforementioned section of the side wall portion). Consequently, according to such an ejection hole, the dimensions of a portion of the ejection hole in the axial direction is increased compared to the general configuration and the existing configuration, which increases converging of a flow of air jetted from the ejection hole and improves the weft conveying force with respect to the same supply pressure. As a result of this, it becomes possible to obtain a desired weft conveying force with the supply pressure set to a lower pressure, which enables air consumption to be reduced as much as possible.

[0017] In addition, in the sub-nozzle for the air jet loom of the present invention, as a result of the ejection hole being formed at a position at which the aforementioned distance is 0.25 mm or less, the section of the ejection hole opening at the side wall portion is increased, and, in the ejection hole, the section whose axial-direction length is longer than the wall thickness of the sub-nozzle is increased. Consequently, the aforementioned effect of improving the weft conveying force is achieved by a higher degree, and it is possible to reduce air consumption more effectively.

[0018] In addition, as a result of the ejection hole being formed to include the aforementioned tapered portion, when a flow of air passes the aforementioned tapered portion, at which the diameter is gradually reduced toward the outer surface, the flow velocity of the flow of air is increased. Consequently, the flow velocity at the position of a weft travelling in the weft guide groove of the reed is also increased. Thus, compared to a configuration in which the ejection hole does not include the aforementioned tapered portion, the weft conveying force with respect to the same supply pressure is improved, and it is possible to reduce air consumption.

[0019] In addition, as a result of the ejection hole being formed such that the ratio of the area of the section opening at the side wall portion is 3% to 20%, the ratio of the section of the ejection hole opening at the side wall portion is a predetermined ratio regardless of the size of the hole diameter of the ejection. Consequently, obtaining the aforementioned effect of reducing air consumption is achieved constantly by a desired degree regardless of the configuration of the sub-nozzle.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020]

Fig. 1 is a front view of an air jet loom to which the present invention is applied;
 Fig. 2 is a view of the air jet loom as viewed in the direction of the arrow II of Fig. 1;
 Fig. 3 is a front view of a sub-nozzle in the air jet loom of the present invention;
 Fig. 4 is a side view of Fig. 3;
 Fig. 5 is an enlarged view of the portion V of Fig. 3;
 Fig. 6 is a sectional view taken along line VI-VI of Fig. 5;
 Figs. 7A and 7B are graphs each showing, regarding the sub-nozzle for the air jet loom of the present invention, a relation between the wind velocity of compressed air jetted from the sub-nozzle and a shortest distance C, where the hole diameter of an outer opening portion of an ejection hole is 1.6 mm in Fig. 7A and the hole diameter thereof is 1.7 mm in Fig. 7B;
 Fig. 8 is a graph showing, regarding the sub-nozzle for the air jet loom of the present invention, a relation between the wind velocity of compressed air jetted from the sub-nozzle and the area ratio of the ejection hole; and
 Fig. 9 is a partial sectional view illustrating another embodiment of the sub-nozzle in the air jet loom of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0021] As illustrated in Fig. 1 and Fig. 2, an air jet loom to which a sub-nozzle of the present invention is applied includes a main-nozzle 1 for weft insertion and a plurality of sub-nozzles 2 arranged along a weft travelling passage to assist travelling of a weft delivered out from the main-nozzle 1. The air jet loom includes a reed 3 that performs beating of an inserted weft with respect to a loom front of a woven fabric.

[0022] The reed 3 is a so-called modified reed and has a configuration in which a large number of modified reed dents 4 each including a recessed portion are arranged. The modified reed 3 itself is a known configuration, and thus, detailed description thereof is omitted. In each of the reed dents 4, the recessed portion is formed at a substantially center portion thereof in a longitudinal direction. Based on the above, the large number of reed dents 4 are arrayed and integrated together by upper and lower reed channels 5 and 6 to thereby constitute the modified reed 3. As a result of the large number of reed dents 4 being thus arrayed, the modified reed 3 has a weft guide groove 7 formed by the recessed portion of each of the reed dents 4.

[0023] On the loom, the modified reed 3 is attached at the lower reed channel 6 to a reed holder 8 and disposed such that the longitudinal direction (the width direction of the modified reed 3) of the reed channels 5 and 6 coincides with the width direction (loom-width direction) of the loom. In the air jet loom, the main-nozzle 1 is also attached to the reed holder 8, and the main-nozzle 1 is arranged, on the reed holder 8, on a thread supply side

of the modified reed 3.

[0024] Each of the sub-nozzles 2 is attached to a nozzle holder 9 and arranged, on the front side of the modified reed 3, in a fixed manner with respect to the reed holder 8 as a result of the nozzle holder 9 being attached to the reed holder 8. The plurality of sub-nozzles 2 disposed on the loom (on the reed holder 8) are arranged at equal intervals in the loom-width direction (the width direction of the modified reed 3). In addition, each of the sub-nozzles 2 is arranged such that an ejection hole 10 thereof faces the weft guide groove 7.

[0025] Next, an embodiment of the sub-nozzle 2 in the air jet loom of the present invention will be described on the basis of Fig. 3 to Fig. 6.

[0026] The sub-nozzle 2 is a hollow rod body as a whole and includes a cylindrical portion 11 having a cylindrical shape and opening at one end thereof, and a flat portion 12 formed close to the other end of the cylindrical portion 11 and having a hollow tube shape extending along a center axis 14 of the cylindrical portion 11. Note that, in the following description, the center axis 14 of the cylindrical portion 11 of the sub-nozzle 2 is simply referred to as the "center axis 14".

[0027] The flat portion 12 has a shape flattened, with respect to the cylindrical portion 11, from two sides in a direction orthogonal to the center axis 14 and is formed such that a sectional shape in the direction orthogonal to the center axis 14 is a substantially-elliptical flat shape. The flat portion 12 includes a closed end portion on a side opposite to the cylindrical portion side in the center axis direction, and the closed portion is a distal end portion.

[0028] More specifically, the flat portion 12 includes a rear wall portion 17 at which an inner surface 15 and an outer surface 16 are formed in a flat surface shape, and a front wall portion 18 facing the rear wall portion 17 and at which, as with the rear wall portion 17, the inner surface 15 and the outer surface 16 are formed in a flat surface shape. The flat portion 12 is formed such that the rear wall portion 17 and the front wall portion 18 are connected to each other at the peripheries thereof other than the peripheries close to the cylindrical portion 11 by a side wall portion 19.

[0029] At the rear wall portion 17 of these wall portions, each of the inner surface 15 and the outer surface 16 is a single flat surface extending in a direction substantially parallel to the center axis 14 of the sub-nozzle 2. In other words, a section at which the inner surface 15 and the outer surface 16 are each formed by a single flat surface is the rear wall portion 17.

[0030] The front wall portion 18 is formed to slightly curve, on a side close to the distal end portion, toward the rear wall portion 17 when viewed in a direction parallel to the width direction of the rear wall portion 17. Consequently, the front wall portion 18 is formed such that the outer surface 16 includes a first flat surface portion 20 close to the cylindrical portion 11, and a second flat surface portion 21 closer than the first flat surface portion

20 to the distal end portion, the second flat surface portion 21 inclining with respect to the first flat surface portion 20. Note that the first flat surface portion 20 is a flat surface substantially parallel to the rear wall portion 17 described above. The second flat surface portion 21 is a flat surface approaching the rear wall portion 17 toward the distal end portion of the sub-nozzle 2. At the front wall portion 18, the inner surface 15 is formed substantially parallel to the first flat surface portion 20 and the second flat surface portion 21 positioned on the outer side thereof, and the wall thickness of the inner surface 15 is substantially constant throughout.

[0031] As described above, the side wall portion 19 is a section connecting the periphery of the rear wall portion 17 and the periphery of the front wall portion 18 to each other. More specifically, the side wall portion 19 is formed by a section (side end section) connecting a side end of the rear wall portion 17 and a side end of the front wall portion 18 to each other on each of two sides in the width direction, and a section (distal end section 22) connecting a distal end of the rear wall portion 17 and a distal end of the front wall portion 18 to each other on the distal end portion side in the center axis direction. Each of the sections thereof is formed such that the inner surface 15 and the outer surface 16 each has a substantially circular arc shape protruding outward. In the present embodiment, the rear wall portion 17 is formed such that the position thereof (an edge close to the distal end portion) is positioned closer than a distal end edge 24 of the front wall portion 18 to the cylindrical portion 11 in the center axis direction. Consequently, the distal end section 22 is formed to extend toward the rear wall portion 17 to connect the two distal end edges to each other.

[0032] In the side wall portion 19, for the purpose of improving handling of warps, the distal end section 22 is formed such that, when viewed from the front (when viewed in a form facing the first flat surface portion 20 of the front wall portion 18), an outer edge 23 has a circular arc shape. Moreover, an inner edge 29, which is a section of the inner surface 15 positioned on the inner side of the outer edge 23, also has a similar substantially circular arc shape.

[0033] The front wall portion 18 is formed such that, when viewed from the front, the distal end edge 24 has a substantially circular arc shape so as to correspond to the shape of the distal end section 22 of the side wall portion 19. Note that the front wall portion 18 is formed such that, when viewed from the front, the distal end edge 24 is positioned on the inner side of the inner edge 29 of the side wall portion 19. The side wall portion 19 connects the front wall portion 18 and the rear wall portion 17 to each other and is formed such that, as described above, each of the inner surface 15 and the outer surface 16 has a substantially circular arc shape protruding outward. Consequently, the direction of the wall thickness of each section of the side wall portion 19 differs from the direction of the wall thickness of the section of the front wall portion 18 at which the second flat surface portion 21 is formed.

[0034] In the sub-nozzle 2 of the present embodiment described above, a section between the cylindrical portion 11 and the flat portion 12 is an inclined portion 25 at which the inner surface 15 and the outer surface 16 incline with respect to the direction of the center axis 14 in a form connecting the cylindrical portion 11 and the flat portion 12 that have different sectional shapes, as described above, to each other. In other words, the sub-nozzle 2 of the present embodiment includes the thus formed inclined portion 25 between the cylindrical portion 11 and the flat portion 12.

[0035] In the sub-nozzle 2 for the air jet loom described above, the ejection hole 10 is formed close to the front wall portion 18 at the flat portion 12. Based on the above, in the present embodiment, the ejection hole 10 is formed, close to the distal end section 22, across the second flat surface portion 21 and the side wall portion 19. In the present embodiment, the second flat surface portion 21 corresponds to the distal end-side flat surface portion of the present invention. Regarding the sub-nozzle 2 of the present invention in which the ejection hole 10 is thus formed, an example thereof, mainly the ejection hole 10, will be described below as a configuration of the present embodiment. In the following description, "upstream side" denotes a side close to the inner surface 15 in the direction of an axis 26 of the ejection hole 10 (hereinafter also simply referred to as "axial direction"), and "downstream side" denotes a side close to the outer surface 16 in the axial direction.

[0036] First, in the sub-nozzle 2 of the present embodiment, the ejection hole 10 is formed by a single hole in which the direction of the axis 26 thereof substantially coincides with the direction of the wall thickness of a section (ejection hole formation section) of the front wall portion 18 at which the second flat surface portion 21 is formed. Specifically, the ejection hole 10 in the sub-nozzle 2 of the present embodiment is formed such that the direction of the axis 26 thereof forms a slight angle with respect to the direction of the wall thickness of the ejection hole formation section. Note that, in the present invention, the direction of the axis 26 of the ejection hole 10 is considered to substantially coincide with the direction of the wall thickness of the ejection hole formation section, when forming an angle within a range of approximately 10° with respect to the direction of the wall thickness of the ejection hole formation section.

[0037] The ejection hole 10 is formed such that an inner circumferential surface 34, which is a section close to the outer surface 16, is constituted by a straight portion 27, which is a section formed parallel to the axis 26, and a tapered portion 28, which is a section closer than the straight portion 27 to the inner surface 15, at which the inner circumferential surface 34 is formed to gradually increase the hole diameter toward the inner surface 15. Consequently, the hole diameter of the ejection hole 10 opening at the outer surface 16 and the hole diameter of the ejection hole 10 opening at the inner surface 15 differ from each other, and the hole diameter on the side (up-

stream side) close to the inner surface 15 is larger.

[0038] Based on the above, the ejection hole 10 is formed, close to the distal end portion of the sub-nozzle 2, such that the straight portion 27 is arranged across the second flat surface portion 21 and the side wall portion 19. Specifically, the ejection hole 10 in the sub-nozzle 2 of the present embodiment is formed such that, when viewed from the front, the straight portion 27 opens, at a position in the outer surface 16 of the sub-nozzle 2, across the second flat surface portion 21 and the distal end section 22 of the side wall portion 19. In addition, the ejection hole 10 opens at the inner surface 15 of the sub-nozzle 2 at an upstream side end of the tapered portion 28 and is formed such that, in a positional relation between an inner opening portion 30, which is a section opening at the inner surface 15, and the inner edge 29 of the distal end section 22 of the side wall portion 19, a space (distance) between portions thereof closest to each other is 0.05 mm.

[0039] In addition, the ejection hole 10 is formed such that, when viewed from the front, the position of the center of the hole is a position closer than the center axis 14 to the modified reed 3. More specifically, the sub-nozzle 2 is arranged on the loom (on the reed holder 8) in a state in which, as described above, the ejection hole 10 is directed toward the weft guide groove 7 of the modified reed 3; the direction is a direction in which the ejection hole 10 is directed toward a side opposite to the thread supply side by deviating from the position of the weft guide groove 7 facing the sub-nozzle 2. Based on the above, the ejection hole 10 is formed such that, when the sub-nozzle 2 thus arranged on the loom is viewed from the front, a closest section of an outer opening portion 31, which is a section opening at the outer surface 16 of the straight portion 27, closest to the outer edge 23 of the distal end section 22 parallel to the inner edge 29 is positioned closer than the center axis 14 to the modified reed 3.

[0040] In the ejection hole 10, the straight portion 27 is formed to be a hole whose radius is smaller (substantially half in the illustrated example) than a distance from the aforementioned closest section to an intersection point between the center axis 14 and a straight line (virtual line 32) extending toward the center axis 14 from the aforementioned closest section when the sub-nozzle 2 is viewed from the front, the straight line passing a center 33 of the outer opening portion 31. More specifically, in the sub-nozzle 2 of the present embodiment, the ejection hole 10 is formed such that the radius of the outer opening portion 31 is 0.8 mm (the hole diameter is 1.6 mm). Consequently, the ejection hole 10 is formed such that the position of the center 33 of the hole (the outer opening portion 31) is positioned closer than the center axis 14 to the modified reed 3 when the sub-nozzle 2 is viewed from the front.

[0041] In the sub-nozzle 2 in which the ejection hole 10 is thus formed, as described above, the direction of the axis 26 of the ejection hole 10 substantially coincides

with the direction of the wall thickness of the ejection hole formation section. The ejection hole 10 is thus in a state in which the axis 26 forms an angle with respect to the direction of the wall thickness of the distal end section 22 of the side wall portion 19. Consequently, the ejection hole 10 has a shape in which the axial-direction length of the inner circumferential surface 34 of a section formed at the side wall portion 19 is longer than the axial-direction length of the inner circumferential surface 34 of a section formed at the ejection hole formation section. In other words, the thus formed ejection hole 10 of the sub-nozzle 2 of the present embodiment is formed such that the inner circumferential surface 34 includes a section having a long axial-direction length compared to an ejection hole formed so as to open only at the second flat surface portion.

[0042] Moreover, as described above, the ejection hole 10 is formed to include the tapered portion 28 on the upstream side. Consequently, the axial-direction length of the inner circumferential surface 34 of a section of the ejection hole 10 formed at the side wall portion 19 is longer compared to a case in which the ejection hole includes no such a tapered portion. More specifically, as described above, the direction of the axis 26 of the ejection hole 10 forms an angle with respect to the direction of the wall thickness of the side wall portion 19. Accordingly, as a result of the ejection hole 10 being formed to include the tapered portion 28 on the upstream side, at the section of the ejection hole 10 formed at the side wall portion 19, the position of the inner opening portion 30 in the axial direction is a position on the further upstream side compared to a case in which the ejection hole includes no such a tapered portion. Consequently, the axial-direction length of the inner circumferential surface 34 of the section of the ejection hole 10 formed at the side wall portion 19 is longer compared to a case in which the ejection hole includes no such a tapered portion.

[0043] According to the sub-nozzle 2 for the air jet loom described above, as a result of the ejection hole 10 being formed such that the outer opening portion 31 is arranged, as described above, across the second flat surface portion 21 and the side wall portion 19, the ejection hole 10 is formed such that a portion of the inner circumferential surface 34 is long in the axial direction, compared to an ejection hole including an outer opening portion formed to open only at the second flat surface portion. Moreover, in the present embodiment, due to the ejection hole 10 being formed to include the tapered portion 28 on the upstream side as described above, the axial-direction length of the inner circumferential surface 34 of the section of the ejection hole 10 formed at the side wall portion 19 is increased as described. Consequently, converging of a flow of air jetted from the ejection hole 10 is improved, and it is thus possible to obtain a larger weft conveying force without increasing the pressure of compressed air to be supplied to the sub-nozzle 2. In other words, according to the sub-nozzle 2, it is possible to obtain a desired conveying force with compressed air

having a lower pressure. Consequently, it is possible to reduce air consumption for weft insertion.

[0044] In the sub-nozzle 2 of the present embodiment, as described above, the ejection hole 10 is formed such that a distance between the inner opening portion 30, which is a section opening at the inner surface 15 of the tapered portion 28, and the inner edge 29 of the distal end section 22 at the side wall portion 19 is 0.05 mm at a closest section where the inner opening portion 30 and the inner edge 29 are closest to each other. Consequently, the aforementioned effect of improving the weft conveying force is achieved by a higher degree. More details are as follows.

[0045] Figs. 7A and 7B are graphs each showing, regarding the sub-nozzle 2 in which the ejection hole 10 is formed on the basis of the present invention, a relation between the wind velocity of compressed air jetted from the sub-nozzle 2, the wind velocity considerably relating to the weft conveying force, and a distance (hereinafter referred to as the "shortest distance") at the aforementioned closest section. Fig. 7A shows the relation regarding the sub-nozzle 2 of the present embodiment in which the ejection hole 10 is formed such that the hole diameter of the outer opening portion 31 is 1.6 mm. The graph shows the relation for each of cases in which two different types (0.3 MPa and 0.4 MPa) of the pressures (supply pressures) of compressed air to be supplied to the sub-nozzle 2 are set.

[0046] Moreover, in the graph, the horizontal axis represents the aforementioned shortest distance C; the vertical axis, however, does not represent the aforementioned wind velocity itself but employs a wind velocity ratio as a parameter. Note that the wind velocity ratio is a ratio in which the flow velocity (wind velocity) of a flow of air jetted from an ejection hole of a sub-nozzle for comparison is considered 100 with the same supply pressure. The wind velocity is measured at a predetermined position in a region in which the flow of air acts in the weft guide groove 7 of the modified reed 3. The sub-nozzle for comparison in this case is a sub-nozzle having a so-called general configuration in which an ejection hole is formed such that, when viewed from the front, the position of the center of an outer opening portion is positioned on a center axis and such that the outer opening portion opens only at a second flat surface portion (distal end-side flat surface portion).

[0047] As read from the graph of Fig. 7A, in the sub-nozzle 2 of the present embodiment in which the ejection hole 10 is formed such that the shortest distance C is 0.05 mm, the wind velocity ratio has a value of 110 or more with each of the supply pressures of the aforementioned two types. In other words, in the sub-nozzle 2 of the present embodiment, the wind velocity ratio is increased by 10% due to the configuration in which the ejection hole 10 is formed such that the shortest distance C is 0.05 mm. Consequently, in the sub-nozzle 2 of the present embodiment, it is possible to achieve the aforementioned effect of improving the weft conveying force

by a higher degree.

[0048] An embodiment (hereinafter referred to as "the aforementioned embodiment") of the sub-nozzle 2 for the air jet loom according to the present invention has been described above; however, the present invention is not limited to that described in the aforementioned embodiment. The present invention can be carried out in the following another embodiment (modification).

(1) In the aforementioned embodiment, the ejection hole is formed such that the hole diameter of the outer opening portion is 1.6 mm. The sub-nozzle of the present invention is however not limited to the sub-nozzle having such a hole diameter of the outer opening portion. The ejection hole may be formed such that the hole diameter of the outer opening portion is a hole diameter differing from that in the aforementioned embodiment, provided that the ejection hole is formed such that the outer opening portion is arranged across the distal end-side flat surface portion and the side wall portion.

Shortest Distance C

[0049] (2) In the aforementioned embodiment, the sub-nozzle has a configuration in which the ejection hole is formed such that the shortest distance C is 0.05 mm. The sub-nozzle of the present invention is however not limited to the sub-nozzle having such a configuration. For example, the ejection hole may be formed such that the shortest distance C is 0.25 mm or less. Even in the configuration, it is possible to achieve the aforementioned effect of improving the weft conveying force by a higher degree. Details are as follows.

[0050] As understood from the graph of Fig. 7A described above, in each of the cases with the supply pressures of 0.3 MPa and 0.4 MPa, the tendency is substantially inverse proportional such that the wind velocity ratio increases as the shortest distance C decreases.

[0051] Meanwhile, in general, as a part of energy saving in weaving factories, air consumption is required to be reduced in air jet looms. Regarding the reduction amount thereof, a wind velocity ratio is required to be increased by 5% or more. Considering the above, it is read from the graph of Fig. 7A that, when the shortest distance C is 0.25 mm or less, the wind velocity ratio has a value greater than 105 with each of the supply pressures of the aforementioned two types.

[0052] Fig. 7B is a graph showing, regarding the sub-nozzle of the present invention in which the ejection hole is formed such that the radius of the outer opening portion is 0.85 mm (the hole diameter is 1.7 mm), a relation between the wind velocity ratio and the shortest distance C and shows the aforementioned relation regarding a sub-nozzle in which the hole diameter of the outer opening portion differs from the hole diameter in the aforementioned embodiment. Note that, as with Fig. 7A, the graph also shows the relation for each of cases in which

two different types (0.3 MPa and 0.4 MPa) of the supply pressures are set.

[0053] Moreover, also in the graph of Fig. 7B, the tendency is substantially inverse proportional such that the wind velocity ratio increases as the shortest distance C decreases in each of the cases with the supply pressures of the aforementioned two types. It is read from the graph that, when the shortest distance C is 0.25 mm or less, the wind velocity ratio has a value greater than 105.

[0054] As understood from the above, it is read from each of the graphs of Figs. 7A and 7B that, when the shortest distance C is 0.25 mm or less in the sub-nozzle according to the present invention, the wind velocity ratio has a value greater than 105. In other words, forming the ejection hole of the sub-nozzle such that the shortest distance C is 0.25 mm or less enables an improvement of the wind velocity ratio by the aforementioned required ratio, which is 5% or more, regardless of the hole diameter of the outer opening portion. Consequently, according to the sub-nozzle, the aforementioned effect of improving the weft conveying force is achieved by a higher degree at which the wind velocity ratio is improved by 5% or more.

[0055] (3) Regarding the sub-nozzle of the present invention, a configuration has been described above by presenting an example in which the ejection hole is formed in an arrangement based on the shortest distance C. Note that, in the sub-nozzle of the present invention, the aforementioned effect can be obtained as a result of the axial-direction length of the inner circumferential surface of the section of the ejection hole formed at the side wall portion being increased, as described above, and the degree of the effect corresponds to the ratio (area ratio) of the section of the ejection hole formed at the side wall portion to the entirety thereof. Meanwhile, when the ejection hole is formed in an arrangement based on the shortest distance C as described above, the area ratio varies depending on the hole diameter of the outer opening portion, even when the shortest distance C is the same. Here, to obtain a predetermined effect regardless of the hole diameter, when the ejection hole is to be formed in the sub-nozzle of the present invention, an arrangement of the ejection hole may be determined based on the area ratio, and the ejection hole is formed on the basis of the arrangement.

[0056] Based on the above, as a result of the ejection hole being formed such that the area ratio is 3% or more, the sub-nozzle is enabled to achieve the aforementioned effect of improving the weft conveying force by a higher degree constantly regardless of the hole diameter of the outer opening portion. Details are as follows.

[0057] Fig. 8 is a graph showing, regarding the sub-nozzle in which the ejection hole is formed on the basis of the present invention, a relation between the wind velocity ratio and the area ratio and differs from each of Figs. 7A and 7B in terms of parameter of the horizontal axis being area ratio. As with Figs. 7A and 7B, the graph of Fig. 8 shows the relation for each of cases in which

two types (0.3 MPa and 0.4 MPa) of pressures of compressed air to be supplied to the sub-nozzle are set.

[0058] Meanwhile, in the sub-nozzle of the aforementioned embodiment in which the ejection hole is formed such that the hole diameter of the outer opening portion is 1.6 mm and such that the shortest distance C is 0.05 mm, the aforementioned area ratio is 7%. In the sub-nozzle, the wind velocity ratio increases by 10%, as described in the aforementioned embodiment, and, also in the light of the area ratio (7%), the wind velocity ratio is naturally identical thereto, as understood from the graph of Fig. 8. In other words, in the sub-nozzle in which the ejection hole is formed such that the area ratio is 7%, the wind velocity ratio is increased by 10%.

[0059] Based on the above, considering that increasing the wind velocity ratio by 5% or more is required, as described above, regarding a reduction of air consumption in the air jet loom, it is read from the graph of Fig. 8 that, when the area ratio is 3% or more, the wind velocity ratio has a value greater than 105 in each of the cases with the aforementioned two types of the hole diameters of the outer opening portion. Consequently, according to the sub-nozzle, the aforementioned effect of improving the weft conveying force is achieved by a higher degree at which the wind velocity ratio is improved by 5% or more regardless of the hole diameter of the outer opening portion.

[0060] The ejection hole is formed in an arrangement in which the ejection hole becomes closer to the inner edge of the side wall portion at the distal end section as the area ratio thereof increases. When the area ratio of the ejection hole is more than 20%, the arrangement thereof becomes an arrangement in which the ejection hole is excessively close to the inner edge of the side wall portion at the distal end section, which may make processing thereof difficult. Accordingly, considering the difficulty in the processing of the ejection hole, the area ratio thereof is preferably 20% or less.

[0061] (4) Regarding the arrangement of the ejection hole in which the outer opening portion is formed across the side wall portion and the distal end-side flat surface portion, the ejection hole in the sub-nozzle of the aforementioned embodiment is formed such that a section of the outer opening portion close to the side wall portion opens at the distal end section of the side wall portion and formed as a whole to be positioned on the distal-end side of the sub-nozzle. In the sub-nozzle of the present invention, however, the ejection hole may not be formed such that the aforementioned section close to the side wall portion opens at the distal end section of the side wall portion, provided that the ejection hole is formed closer than the first flat surface portion to the distal end portion.

[0062] In other words, even in existing general sub-nozzles, a position at which an ejection hole is formed is not limited to the distal-end side of the sub-nozzle, and, in some of the existing general sub-nozzles, the ejection hole is formed closer to the cylindrical portion 11 than to

a portion of the sub-nozzle in the vicinity of the distal end portion. Accordingly, also in the sub-nozzle of the present invention, a position at which the ejection hole is formed is not limited to a position on the distal-end side of the sub-nozzle, such as that in the aforementioned embodiment, and may be a position at which the section of the outer opening portion close to the side wall portion opens closer to the cylindrical portion 11 than to the distal end section of the side wall portion.

[0063] (5) In the aforementioned embodiment, the ejection hole is formed to include the straight portion close to the outer surface and formed to include the tapered portion on the upstream side thereof. In the sub-nozzle of the present invention, however, the ejection hole is not limited to the ejection hole thus formed to include the tapered portion on the upstream side and may be formed in a straight shape throughout in the axial direction thereof. In such a sub-nozzle, the size of the inner opening portion differs from that of the sub-nozzle of the aforementioned embodiment, and the aforementioned shortest distance C is a distance at a closest section where the inner opening portion and the inner edge of the side wall portion are closest to each other in that case.

[0064] In addition, the ejection hole may be formed as a tapered portion whose inner circumferential surface gradually increases the hole diameter toward the inner surface throughout in the axial direction of the ejection hole. In the sub-nozzle in which the ejection hole is thus formed, the axial-direction length of the inner circumferential surface of a section of the ejection hole formed at the side wall portion is longer compared to that including the straight portion as in the case with the aforementioned embodiment.

[0065] In a configuration including the tapered portion at the section of the ejection hole on the upstream side as described above, however, when the wall thickness of the distal end of the sub-nozzle is left to be constant, a step may be generated between the inner circumferential surface of the tapered portion and the inner surface of the distal end of the sub-nozzle, depending on the degree of an increase in diameter of the tapered portion. When such a step is generated, an inclined surface 35 that has a curved surface shape and that is in continuous with the inner circumferential surface of the tapered portion and the inner surface of the distal end of the sub-nozzle may be formed, as illustrated in Fig. 9, at a position inside the distal end of the sub-nozzle where the step is generated.

[0066] (6) In the aforementioned embodiment, when the ejection hole is viewed from the front, the opening portion, which is a section that opens at a surface of the sub-nozzle, is formed in a circular shape. In the sub-nozzle of the present invention, however, the opening portion of the ejection hole may be formed in a shape other than a circular shape. For example, in the sub-nozzle in which the inner circumferential surface is formed, as described above, to gradually increase the hole diameter toward

the inner surface throughout in the axial direction, when the ejection hole is viewed from the front, the shape of the outer opening portion at the section formed at the side wall portion is a shape other than a circular shape.

5 The sub-nozzle having such an ejection hole is also the sub-nozzle of the present invention.

[0067] The sub-nozzle of the present invention is not limited to a sub-nozzle in which a single hole functions as the ejection hole and may be, for example, a sub-nozzle configured such that a plurality of holes are formed at a region where the ejection hole should be formed, and a group of the plurality of holes functions as the ejection hole. In this case, on the surface of the sub-nozzle, the region at which the plurality of holes open is a region corresponding to the outer opening portion of the ejection hole, and the position of the center of the region is a position corresponding to the center of the outer opening portion. On the inner surface of such a sub-nozzle, the region at which the plurality of holes open is a region corresponding to the inner opening portion, and the aforementioned shortest distance C is a distance at a closest section where the region and the inner edge of the side wall portion are closest to each other.

25 (7) In the aforementioned embodiment, the front wall portion is formed to include, at the outer surface, the first flat surface portion close to the cylindrical portion and the second flat surface portion (distal end-side flat surface portion) closer than the first flat surface portion to the distal end portion. In the sub-nozzle based on the present invention, however, the front wall portion is not limited to the thus formed front wall portion. For example, the front wall portion may be formed to include, as an alternative to the first flat surface portion, a first surface portion that is formed in a curved surface shape. In addition, the front wall portion may have a configuration including no first flat surface portion (first surface portion) and may be formed in a shape in which, on the side of the distal end portion of the sub-nozzle, only the distal end-side flat surface portion faces the rear wall portion.

30 (8) In the aforementioned embodiment, the side wall portion is formed such that the inner surface and the outer surface thereof each form a substantially circular arc shape protruding outward. In the sub-nozzle based on the present invention, however, the side wall portion is not limited to the thus formed side wall portion. For example, the side wall portion may be formed such that the section in continuous with the distal end-side flat surface portion is a flat surface inclined with respect to the distal end-side flat surface portion. Even in this case, in the ejection hole formed such that the outer opening portion or the region corresponding to the outer opening portion is arranged across the flat surface and the distal end-side flat surface portion, the inner circumferential surface of the section formed close to the flat surface is formed to be long in the axial direction compared

to an ejection hole formed to open only at the distal end-side flat surface portion.

(9) In the aforementioned embodiment, the inner surface and the outer surface of the rear wall portion are each formed by a single flat surface. In the sub-nozzle based on the present invention, however, the rear wall portion is not limited to the thus formed rear wall portion. For example, the inner surface and the outer surface of the rear wall portion may be formed to each form a plurality of flat surfaces, or the inner surface and the outer surface may be formed to be curved surfaces.

[0068] Further, the present invention is not limited to any of the embodiments described above and can be modified, as appropriate, within the spirit thereof.

Claims

1. A sub-nozzle (2) for an air jet loom, the sub-nozzle (2) comprising:

a cylindrical portion (11) that is open at one end thereof and to be connected to a compressed-air supply source; and

a flat portion (12) formed close to another end of the cylindrical portion (11) and having an ejection hole (10), the flat portion (12) being formed in a hollow tube shape as a result of a front wall portion (18) and a rear wall portion (17) facing each other being connected to each other by a side wall portion (19), the flat portion (12) including a distal end portion closed by the side wall portion (19),

wherein the front wall portion (18) of the flat portion (12) is formed to include a distal end-side flat surface portion (21) formed close to the distal end portion at an outer surface (16) of the front wall portion (18), the distal end-side flat surface portion (21) inclining so as to approach the rear wall portion (17) toward the distal end portion, and

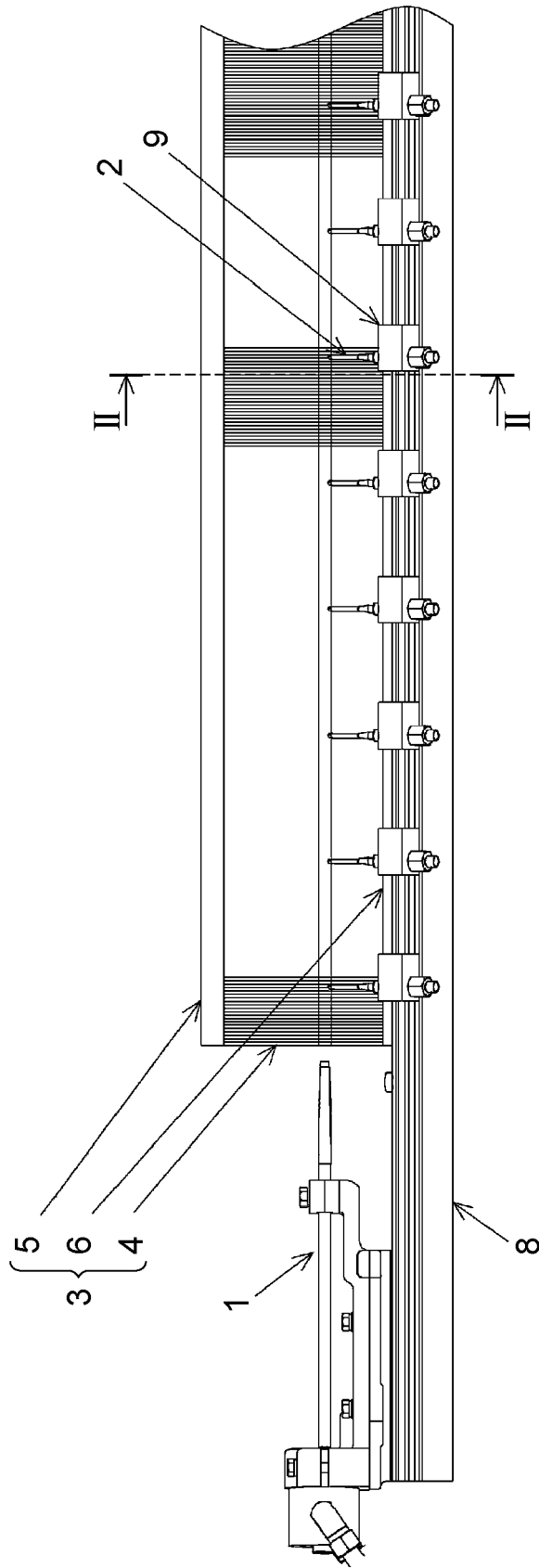
wherein the ejection hole (10) is formed across the distal end-side flat surface portion (21) and the side wall portion (19).

2. The sub-nozzle (2) for the air jet loom according to Claim 1, wherein the ejection hole (10) is formed such that a position a center thereof is a position closer than a center axis (14) of the sub-nozzle (2) to a reed when the front wall portion (18) is viewed from a front and such that, of a distance from a section of an inner surface (15) positioned inside an outer edge (23) of the side wall portion (19), a distance from a closest section of the section is 0.25 mm or less.

3. The sub-nozzle (2) for the air jet loom according to any one of Claims 1 and 2, wherein the ejection hole (10) is formed such that an inner circumferential surface thereof includes a tapered portion (28), the tapered portion (28) being a section formed to gradually increase a hole diameter toward the inner surface (15).

4. The sub-nozzle (2) for the air jet loom according to any one of Claims 1 to 3, wherein a ratio of an area of a section of the ejection hole (10) opening at the side wall portion (19) relative to a whole area of an opening portion, the opening portion being a section of the ejection hole (10) opening at a surface of the sub-nozzle (2), is 3% to 20%.

FIG. 1



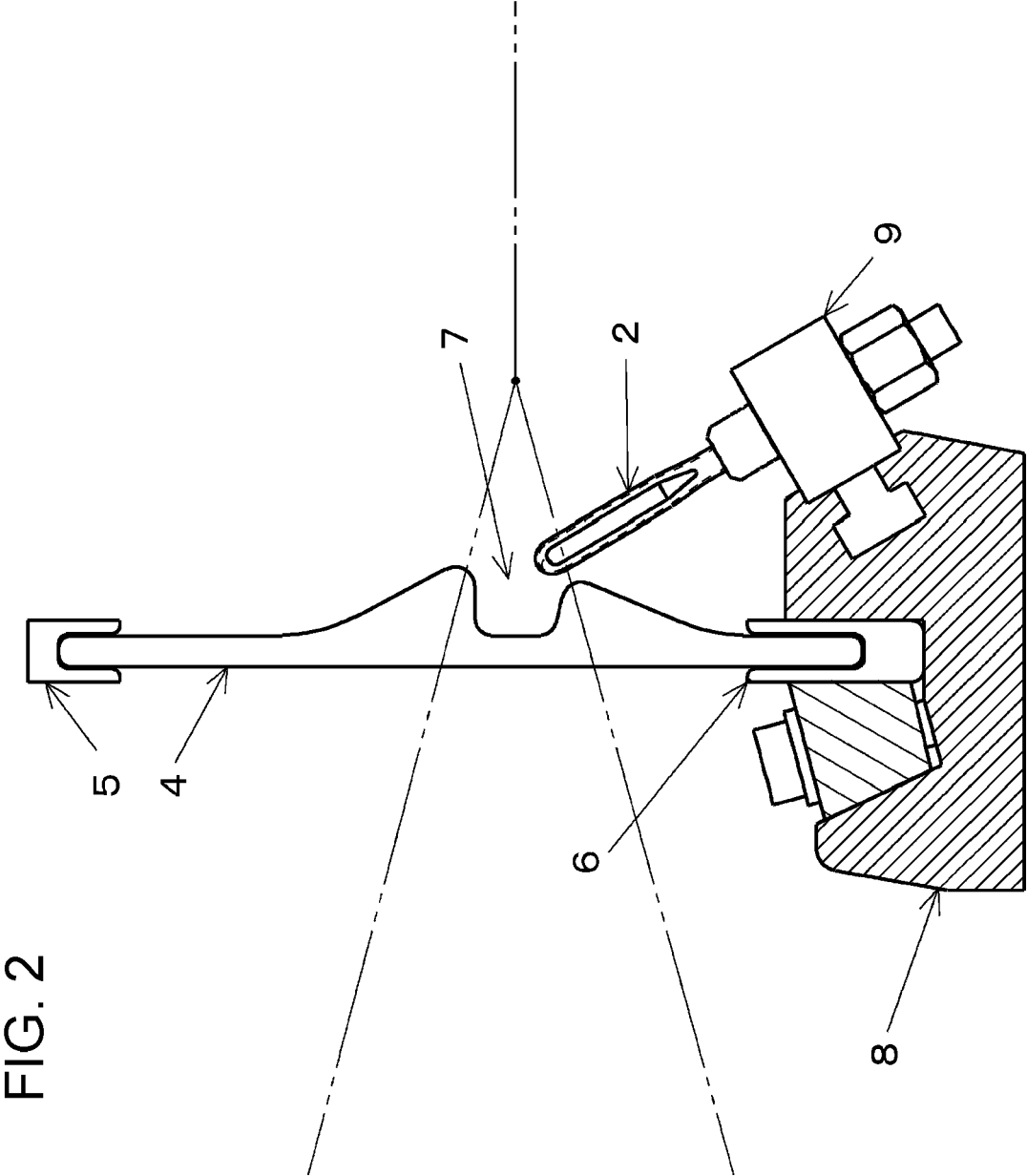


FIG. 3

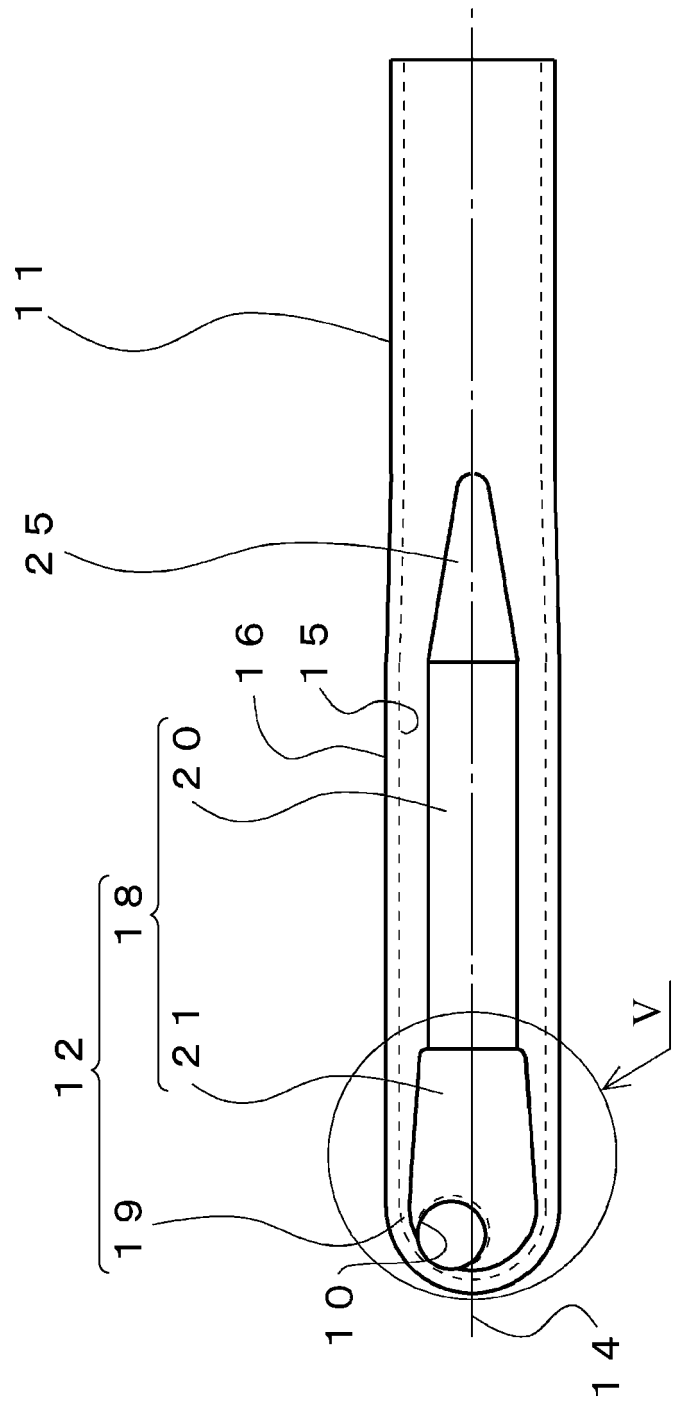


FIG. 4

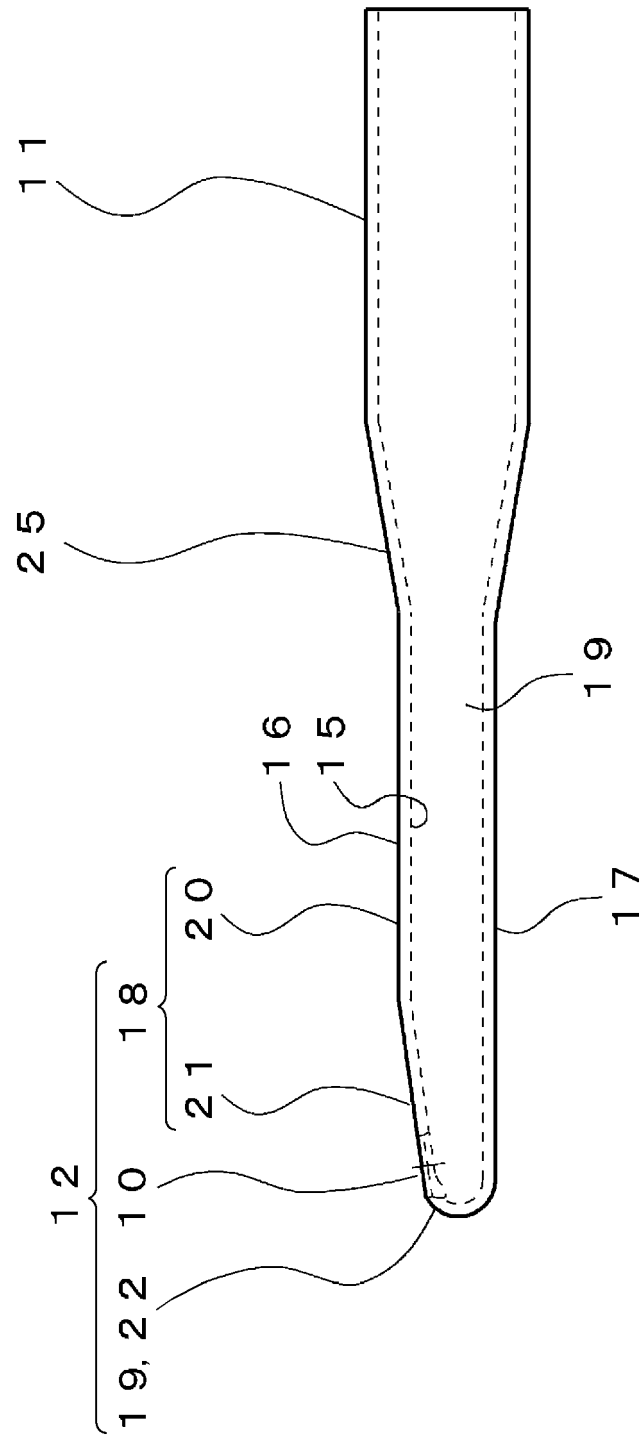


FIG. 5

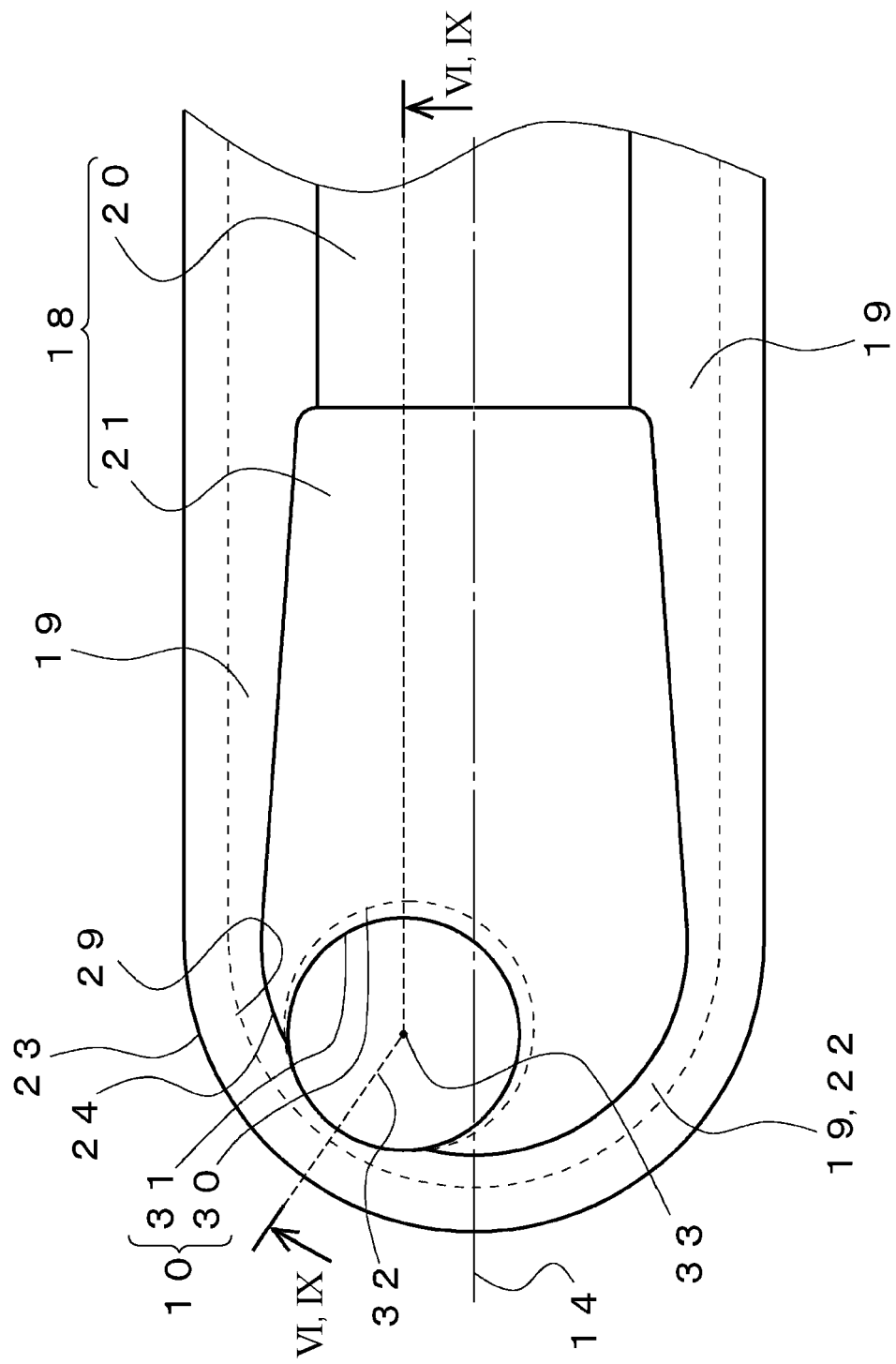


FIG. 6

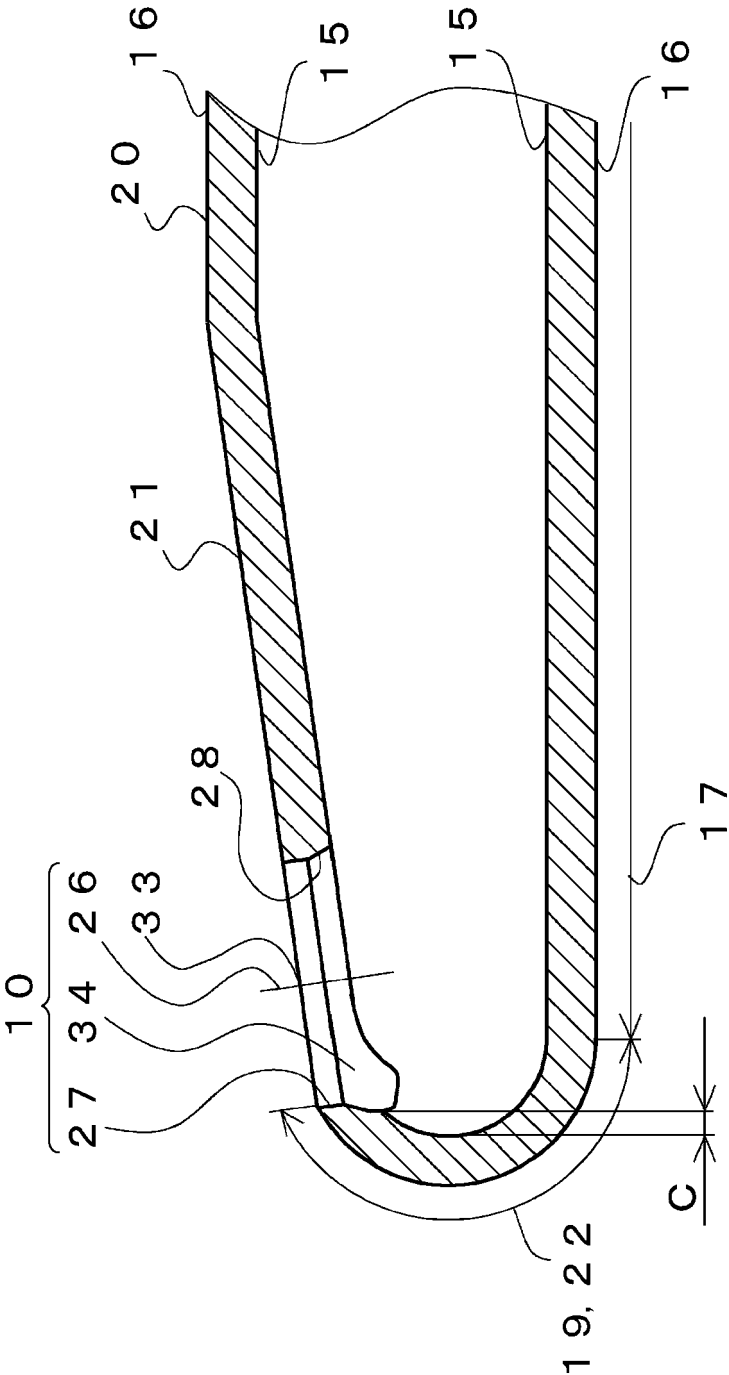


FIG. 7B

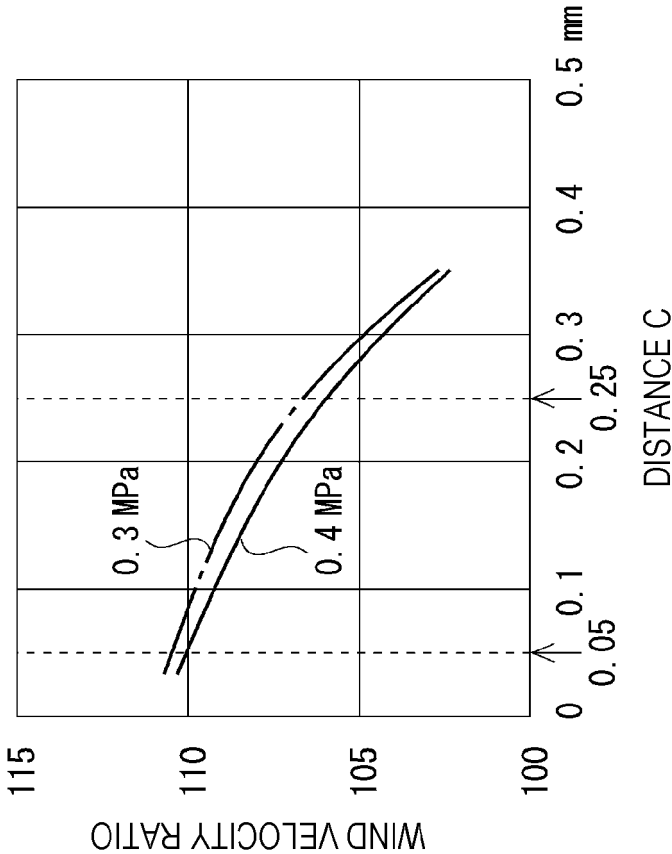


FIG. 7A

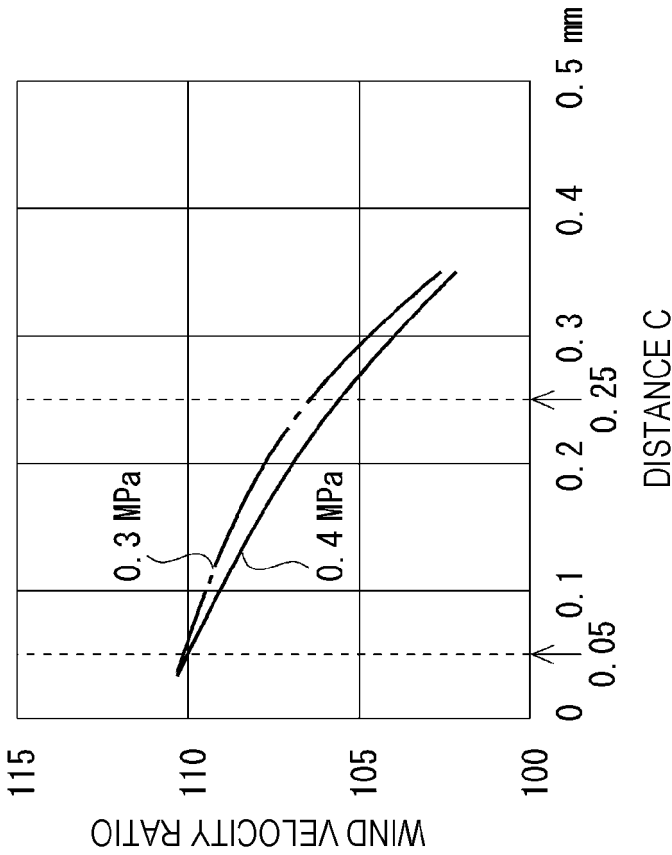


FIG. 8

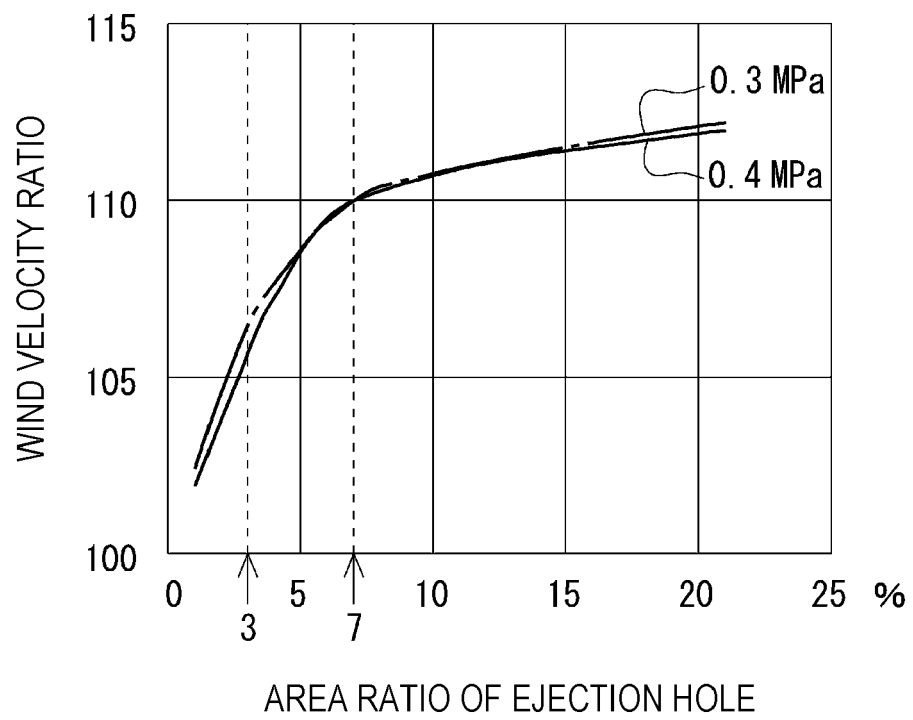
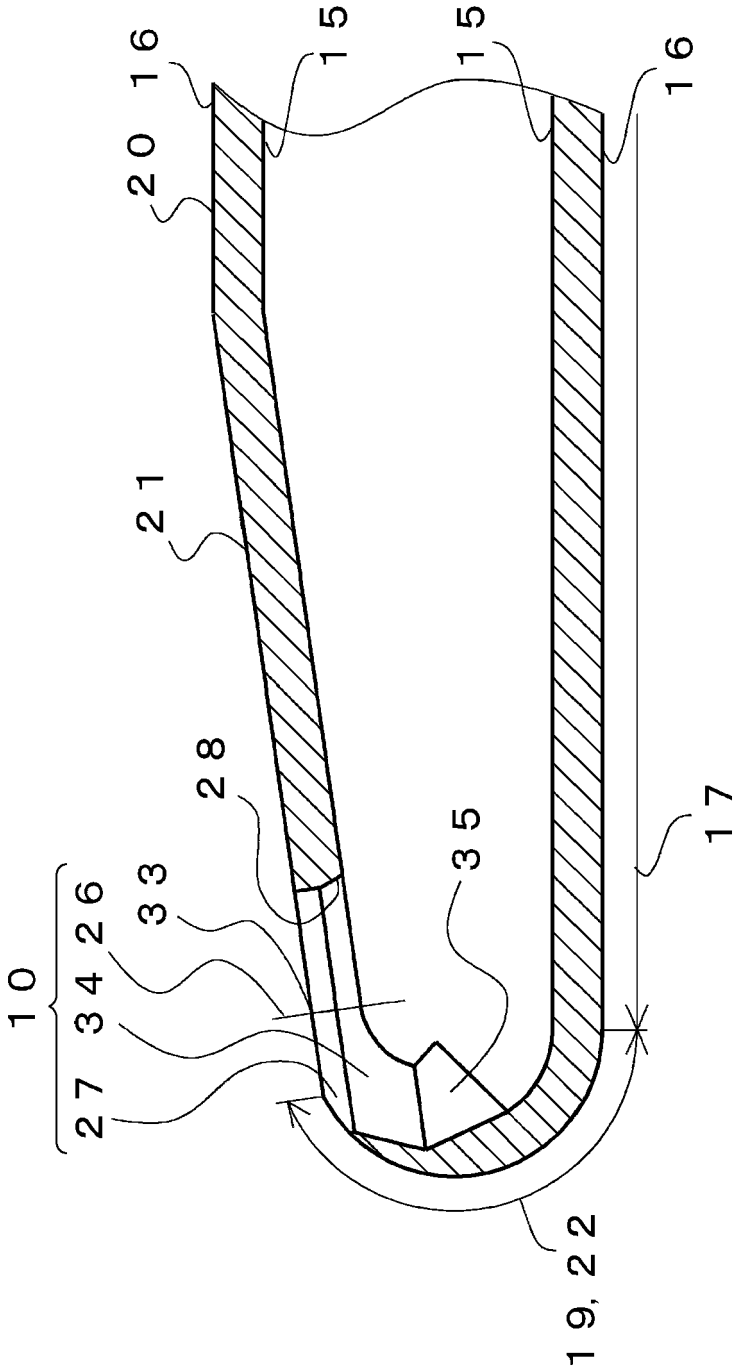


FIG. 9





EUROPEAN SEARCH REPORT

Application Number
EP 19 19 9242

5

10

15

20

25

30

35

40

45

50

55

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	EP 1 143 054 A1 (TSUDAKOMA IND CO LTD [JP]) 10 October 2001 (2001-10-10) * paragraph [0019] - paragraph [0029] * * figures 1-3 *	1-4	INV. D03D47/30
A	EP 2 610 378 A1 (TOYOTA JIDOSHOKKI KK [JP]) 3 July 2013 (2013-07-03) * paragraph [0017] - paragraph [0024] * * figures 1-6 *	1-4	
A	DE 197 51 354 C1 (DORNIER GMBH LINDAUER [DE]) 17 June 1999 (1999-06-17) * column 2, line 14 - line 64 * * figures 1, 2 *	1-4	
			TECHNICAL FIELDS SEARCHED (IPC)
			D03D
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 11 February 2020	Examiner Hausding, Jan
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03/82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 19 19 9242

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

11-02-2020

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 1143054 A1	10-10-2001	CN 1316557 A	10-10-2001
		DE 60101176 T2	29-07-2004
		EP 1143054 A1	10-10-2001
		JP 2001295159 A	26-10-2001
		KR 20010094960 A	03-11-2001

EP 2610378 A1	03-07-2013	CN 103184648 A	03-07-2013
		EP 2610378 A1	03-07-2013
		JP 5692055 B2	01-04-2015
		JP 2013136846 A	11-07-2013

DE 19751354 C1	17-06-1999	AT 201728 T	15-06-2001
		DE 19751354 C1	17-06-1999
		DE 59800797 D1	05-07-2001
		EP 0968327 A1	05-01-2000
		JP 2000508391 A	04-07-2000
		US 6138719 A	31-10-2000
		WO 9927171 A1	03-06-1999

ORM P0459

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 8060492 A [0002] [0006]