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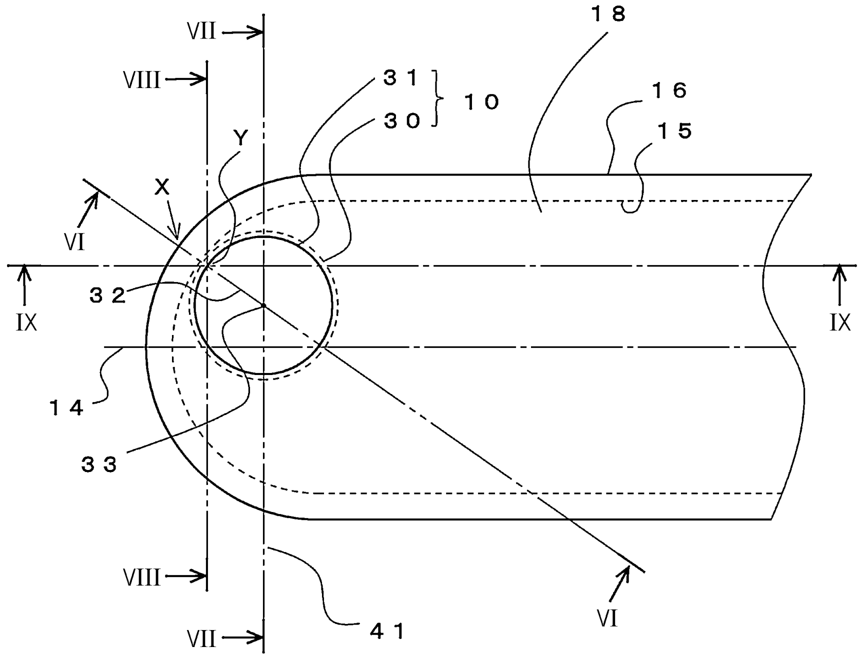
(54) **SUB-NOZZLE FOR AIR JET LOOM**

(57) A sub-nozzle (2) for an air jet loom is provided, the sub-nozzle having a hollow tubular shape having a closed distal end, the sub-nozzle having a distal end portion (13) having an ejection hole (10). In a view in a direction of a center line (26) of the ejection hole, when X is determined as a position that is a position on an outer peripheral edge of the sub-nozzle and that is at a closest distance from a center of the ejection hole, and Y is determined as a position at which a line connecting the center of the ejection hole and the position X intersects with a peripheral edge of the ejection hole, the ejection hole is formed such that a distance between the position X and the position Y is 0.75 mm or less in the view in the direction of the center line.

FIG. 5



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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 having a hollow tubular shape having a closed distal end, the sub-nozzle having a distal end portion having an ejection hole.

2. Description of the Related Art

[0002] Typically, a sub-nozzle for an air jet loom is formed into a hollow tubular shape having a closed distal end as described above, and has a distal end portion having an ejection hole. A plurality of such sub-nozzles are provided in a manner arranged in a weft-insertion direction on a reed holder that supports a reed. The sub-nozzles advance into warp sheds in a manner of pushing warps aside as the reed swings during weaving. Thus, to separate the warps better when the sub-nozzles advance into the warp sheds, the sub-nozzles are formed to each have a small diameter. Moreover, the sub-nozzles each have a wall with a very small thickness accordingly, which is typically 0.5 mm or less.

[0003] In such a sub-nozzle, since the ejection hole is bored in the wall with the small thickness, the ejection hole has a small length in a center-line direction of the ejection hole and has a very small ratio of the length thereof in the center-line direction to the diameter thereof. Thus, with such a sub-nozzle, the degree of spreading of a flow of air jetted from the ejection hole is high, and directivity of a flow of air toward the inside of a weft guide groove is low accordingly, leading to a problem of a small weft conveying force with respect to the pressure of compressed air to be supplied (hereinafter, referred to as "supply pressure").

[0004] As a technology for addressing such a problem, there is a technology disclosed in Japanese Unexamined Utility Model Registration Application Publication No. 61-159386 (hereinafter, referred to as "related art"). More specifically, to address the above-described problem, in the related art, a sub-nozzle has an ejection hole that is provided with a cylindrical member for guiding compressed air in a direction toward the inside of a weft guide groove.

[0005] However, since the sub-nozzle has a small diameter as described above, the ejection hole of course has a further small diameter. The cylindrical member that is attached to such an ejection hole is a very small member. Thus, it is difficult to fabricate such a cylindrical member and to attach the cylindrical member to the ejection hole. Consequently, manufacturing such a sub-nozzle requires many work hours and high manufacturing cost.

[0006] Moreover, in the related art, the cylindrical member is provided to protrude into the sub-nozzle. Due to this, the compressed air supplied to the sub-nozzle and flowing in the sub-nozzle collides with the cylindrical member. Thus, a turbulence occurs in a flow of the compressed air in the sub-nozzle, which may adversely affect jetting of the compressed air from the sub-nozzle and lead to a decrease in the conveying force.

SUMMARY OF THE INVENTION

[0007] Accordingly, an object of the present invention is to provide a sub-nozzle for an air jet loom, the sub-nozzle being capable of increasing a weft conveying force with respect to a supply pressure by increasing directivity of a flow of air without provision of a member, such as a cylindrical member, for guiding compressed air.

[0008] The present invention presupposes a sub-nozzle for an air jet loom, the sub-nozzle having a hollow tubular shape having a closed distal end, the sub-nozzle having a distal end portion having an ejection hole. Based on this, to attain the above-described object, in the presupposed sub-nozzle for the air jet loom, in a view in a direction of a center line of the ejection hole, when X is determined as a position that is a position on an outer peripheral edge of the sub-nozzle and that is at a closest distance from a center of the ejection hole, and Y is determined as a position at which a line connecting the center of the ejection hole and the position X intersects with a peripheral edge of the ejection hole, the ejection hole is formed such that a distance between the position X and the position Y is 0.75 mm or less in the view in the direction of the center line.

[0009] Note that, the "ejection hole" according to the present invention is not limited to an ejection hole formed of a single hole, and includes an ejection hole having a group of a plurality of holes formed in a region where an ejection hole is to be formed. In this case, the position at which the ejection hole is formed is the region where 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.

[0010] In the sub-nozzle for the air jet loom according to the present invention, the ejection hole may be formed such that the center line does not intersect with an axis of the sub-nozzle.

[0011] In the sub-nozzle for the air jet loom according to the present invention, the ejection hole may be formed to have a tapered portion that is a portion formed such that a hole diameter of an inner peripheral surface of the ejection hole gradually increases toward an inner surface of the sub-nozzle.

[0012] With the sub-nozzle for the air jet loom according to the present invention, since the ejection hole is formed at the position at the distance of 0.75 mm or less, a weft conveying force with respect to a supply pressure of compressed air can be increased without provision of a member, such as the cylindrical member of the related art, for guiding the compressed air. The details are described as follows.

[0013] Sub-nozzles typically used for air jet looms include a sub-nozzle in which a front surface having an ejection hole has a planar shape extending to a distal end portion; and a sub-nozzle that does not have such a portion with a planar shape and in which a portion corresponding to the portion with the planar shape has an arc surface, and a sectional shape in a direction orthogonal to an axial direction is formed in an ellipse (oval) or a circle. In such a sub-nozzle, the ejection hole is formed in a manner bored in a peripheral wall of the ejection hole. For example, in a case where an ejection hole is formed such that the center line faces a specific direction, when the center of the ejection hole faces front and is viewed in a direction of the center line (center-line direction), the angle of a direction of the thickness (hereinafter, merely referred to as "thickness direction") of the peripheral wall (including a wall forming a distal end) with respect to the center-line direction increases as the thickness direction is closer to an outer peripheral edge (an edge defining a contour) of the sub-nozzle.

[0014] When an ejection hole formed at a certain position is compared with an ejection hole formed close to the outer peripheral edge of the sub-nozzle with the center-line direction unchanged from the former ejection hole, the angle of the thickness direction of a portion of the latter ejection hole including a peripheral edge portion close to the outer peripheral edge of the sub-nozzle with respect to the center-line direction is larger than that angle of the former ejection hole. That is, in the case of the latter ejection hole, the peripheral edge portion is formed at a larger angle with respect to the thickness direction than that angle of the former ejection hole. As the angle of the boring direction of the peripheral edge portion with respect to the thickness direction is larger, the inner peripheral surface of the ejection hole is longer in the center-line direction in the peripheral edge portion.

[0015] With this regard, in the view in the center-line direction, when X is determined as the position that is the position on the outer peripheral edge of the sub-nozzle and that is at the closest distance from the center of the ejection hole, and Y is determined as the position at which the line connecting the center of the ejection hole and the position X intersects with the peripheral edge of the ejection hole, the ejection hole is formed such that the distance between the position X and the position Y is smaller, and hence the inner peripheral surface of the ejection hole in the peripheral edge portion in the vicinity of the position Y is longer.

[0016] Note that, as the inner peripheral surface of the ejection hole that guides a flow of air to be jetted is longer in the center-line direction, directivity of a flow of air after jetting increases. Since the directivity of the flow of air increases, a weft conveying force with respect to a predetermined supply pressure of compressed air increases. Furthermore, the situation in which the weft conveying force with respect to the predetermined supply pressure of the compressed air increases represents, in other words, that the supply pressure of the compressed air required for obtaining a predetermined weft conveying force can be low. By decreasing the pressure of the compressed air to be supplied to the sub-nozzle during weft insertion, air consumption by weaving can be decreased, promoting energy savings.

[0017] Based on this, the results of assiduous study by the inventors of the present invention showed that, by forming the ejection hole at the position at the distance of 0.75 mm or less, the sub-nozzle can obtain such a conveying force that can decrease the air consumption by a desirable amount. Thus, according to the present invention, in the sub-nozzle for the air jet loom, the ejection hole is formed such that the distance is 0.75 mm or less. Accordingly, the weft conveying force that can decrease the air consumption by a desirable amount can be obtained.

[0018] Moreover, according to the present invention, the directivity of the flow of air is increased to obtain such a conveying force without provision of a cylindrical member for guiding compressed air like the related art. As compared with the related art, manufacturing cost of the sub-nozzle can be significantly decreased, and the above-described conveying force can be stably obtained.

[0019] Moreover, in the sub-nozzle for the air jet loom according to the present invention, the ejection hole is formed such that the center line of the ejection hole does not intersect with the axis of the sub-nozzle. Even when the ejection hole is formed at the same position, as compared with a case where the ejection hole is formed such that the center line intersects with the axis of the sub-nozzle, the peripheral edge portion is formed at a larger angle with respect to the thickness direction. The length in the center-line direction of the inner peripheral surface of the ejection hole is longer. Thus, the above-described advantageous effect of increasing the weft conveying force is attained by a higher degree, and it is possible to decrease the air consumption more effectively.

[0020] Furthermore, since the ejection hole is formed to have a tapered portion like one described above, as a flow of air passes through the tapered portion whose diameter gradually decreases toward the peripheral edge of the ejection hole, the velocity of the flow of air increases. Accordingly, the velocity of flow also increases at the position of a weft traveling in the weft guide groove. As compared with a configuration in which the ejection hole does not have a tapered portion like one described above, the weft conveying force with respect to the same supply pressure increases, and it is possible to decrease the air consumption.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021]

Fig. 1 is a front view of an air jet loom to which the present invention is applied;

Fig. 2 is a view from arrow II in Fig. 1;

Fig. 3 is a front view of a sub-nozzle for the air jet loom according to the present invention;

Fig. 4 is a side view of Fig. 3;

Fig. 5 is an enlarged view of a distal end of the sub-nozzle;

Fig. 6 is a sectional view taken along line VI-VI in Fig. 5;

Fig. 7 is a sectional view taken along line VII-VII in Fig. 5;

Fig. 8 is a sectional view taken along line VIII-VIII in Fig. 5;

Fig. 9 is a sectional view taken along line IX-IX in Fig. 5;

Fig. 10 is a graph showing, regarding the sub-nozzle for the air jet loom according to the present invention, a relationship between a wind velocity ratio of compressed air to be jetted from the sub-nozzle and a distance C; and

Fig. 11 illustrates another example of a sub-nozzle for an air jet loom according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0022] As illustrated in Fig. 1 and Fig. 2, an air jet loom to which a sub-nozzle according to the present invention is applied includes a main-nozzle 1 for weft insertion and a plurality of sub-nozzles 2 arranged along a weft traveling passage to assist traveling 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 cloth fell of a woven cloth.

[0023] The reed 3 is a so-called modified reed and has a configuration in which a large number of modified reed dents 4 each having a recessed portion are arrayed. The modified reed 3 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 the longitudinal direction. Based on this, 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.

[0024] 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 of the reed channels 5 and 6 (the width direction of the modified reed 3) coincides with the width direction of the loom (weaving-width direction). 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.

[0025] Each of the sub-nozzles 2 is attached to a nozzle holder 9, and the nozzle holder 9 is attached to the reed holder 8. Thus, each of the sub-nozzles 2 is arranged, in front of the modified reed 3, in a fixed manner with respect to the reed holder 8. The plurality of sub-nozzles 2 provided on the loom (on the reed holder 8) are arranged at equal intervals in the weaving-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.

[0026] Next, an embodiment of the sub-nozzle in the air jet loom according to the present invention will be described on the basis of Fig. 3 to Fig. 10.

[0027] As illustrated in Figs. 3 and 4, the sub-nozzle 2 is entirely a hollow rod body and is formed in a manner that a distal end thereof is closed and a proximal end thereof is open. In the illustrated example, a proximal end portion 11 that is a portion of the sub-nozzle 2 close to the proximal end is formed such that the shape of a plane section (plane-sectional shape) which is a section in a direction orthogonal to a center axis (hereinafter, merely referred to as "axis") 14 of the sub-nozzle 2 is a circle. In contrast, a main body portion 12 that is a portion closer than the proximal end portion 11 to the distal end and that is a portion including the closed distal end as described above is formed such that the plane-sectional shape is an ellipse. The main body portion 12 is formed such that, in a sectional shape when the main body portion 12 is divided along a major axis 42 of the ellipse that is the plane-sectional shape, and a sectional shape when the main body portion 12 is divided along a minor axis 43 of the ellipse, the distal end of each of the sectional shapes defines an arc shape.

[0028] The main body portion 12 includes a distal end portion 13 according to the present invention, and an intermediate portion 40 that is a portion between the distal end portion 13 and the proximal end portion 11. The distal end portion 13 is a portion in which the ejection hole 10 may be formed. Note that, regarding the main body portion 12, when the main body portion 12 is divided along the major axis 42 of the ellipse that is the above-described plane-sectional shape, and when one of the divided portions is referred to as a front wall portion 18 and the other one of the divided portions is referred to as a rear wall portion 17, the ejection hole 10 is formed in the front wall portion 18 of the distal end portion 13.

[0029] Regarding the ejection hole 10, the ejection hole 10 is formed of a single hole as illustrated in Fig. 5 according to the present embodiment. Note that Fig. 5 is an illustration when the front wall portion 18 in the distal end portion 13 is viewed in a direction of a center line 26 (hereinafter, also referred to as "center-line direction") of the ejection hole 10 (hereinafter, referred to as "front view"). A portion (an outer opening portion 31) of the ejection hole 10 being open in an outer surface 16 of the sub-nozzle 2 has a hole diameter of about 1.6 mm in the present embodiment. The ejection hole 10 is formed such that the position of a center 33 of the ejection hole 10 is located at a position deviated from the axis 14. More specifically, the ejection hole 10 is formed at a position such that, when the sub-nozzle 2 is provided on the loom (on the reed holder 8), the center 33 is located closer than the axis 14 to the modified reed 3.

[0030] Based on this, the ejection hole 10 is formed such that a distance C between a position X and a position Y in the drawing is 0.75 mm or less. The details of the ejection hole 10 are described as follows.

[0031] First, as illustrated in Fig. 5, the position X is a position that is a position on an outer peripheral edge of the sub-nozzle 2 and that is at the closest distance from the center 33 of the ejection hole 10. For example, in the front view, the position X is a position at which, among circles that are depicted to be in contact with the outer peripheral edge of the sub-nozzle 2 about the center 33 of the ejection hole 10, a circle with the smallest radius is in contact with the outer peripheral edge. The position X can be also thus obtained. In the present embodiment, the position X is located on the outer peripheral edge at the distal end formed as described above of the main body portion 12. Note that, while the ejection hole 10 is formed such that the position of the center 33 is deviated from the axis 14 as described above, in the present embodiment, in the front view, the ejection hole 10 is formed at a position at which a line (an imaginary line 32 in the drawing) that passes through the center 33 of the ejection hole 10 and the position X is at an angle of about 70° with respect to a line (an imaginary line 41 in the drawing) that is orthogonal to the axis 14.

[0032] In the present embodiment, the ejection hole 10 is formed such that the center line 26 of the ejection hole 10 extends from the side of an inner surface 15 toward the side of the outer surface 16 of the sub-nozzle 2 and is inclined toward the distal end of the sub-nozzle 2. More specifically, Fig. 6 is a sectional view (a sectional view taken along line VI-VI in Fig. 5) when the sub-nozzle 2 is cut along a plane passing through the center 33 of the ejection hole 10 and the above-described position X. The ejection hole 10 is formed such that the center line 26 is at an angle of about 10° with respect to the direction orthogonal to the axis 14 in that section. Since the position X is the position on the outer peripheral edge of the sub-nozzle 2 when viewed in the direction of the center line 26 as described above, the position X is the position on the outer peripheral edge of the rear wall portion 17 as illustrated in Fig. 6 according to the present embodiment instead of the position on the outer peripheral edge of the front wall portion 18.

[0033] The position Y is, in the front view, a position that is a position on the peripheral edge of the ejection hole 10 and that is a position of a point at which the imaginary line 32 intersects with the peripheral edge of the ejection hole 10. Since Fig. 6 is a sectional view when the sub-nozzle 2 is cut along the plane passing through the center 33 of the ejection hole 10 and the position X as described above, the position Y in Fig. 6 is a position on an edge that is included in an edge of the outer opening portion 31 of the sub-nozzle 2 and that is close to the distal end.

[0034] The distance C between the position X and the position Y when viewed in the center-line direction is a distance between a line (an imaginary line 44 in the drawing) that passes through the position X and that is parallel to the center line 26 and a line (an imaginary line 45 in the drawing) that passes through the position Y and that is parallel to the center line 26 as illustrated in Fig. 6. Based on this, the ejection hole 10 is formed such that the distance C is 0.75 mm or less as described above, and in the present embodiment, the ejection hole 10 is formed at the position at the distance C = 0.5 mm.

[0035] In the present embodiment, the ejection hole 10 is formed such that the center line 26 of the ejection hole 10 does not intersect with the axis 14. More specifically, Fig. 7 is the plane-sectional view (a sectional view taken along line VII-VII in Fig. 5) at the position of the center 33 of the ejection hole 10, and as illustrated in Fig. 7, the ejection hole 10 is formed such that the center line 26 (more accurately, an extension line of the center line 26) thereof does not intersect with the axis 14. That is, the ejection hole 10 is formed such that, when the ejection hole 10 is bored in the sub-nozzle 2, a boring direction of the ejection hole 10 is at a position eccentric from the axis of the sub-nozzle 2.

[0036] In the present embodiment, the ejection hole 10 is formed to have a tapered portion that is a portion formed such that a hole diameter of an inner peripheral surface 34 of the ejection hole 10 gradually increases toward the inner surface 15 of the sub-nozzle 2. More specifically, as illustrated in Fig. 6, the ejection hole 10 is formed to be constituted by a straight portion 27 and a tapered portion 28. The straight portion 27 is a portion close to the outer surface 16 of the sub-nozzle 2 and is a portion in which the inner peripheral surface 34 is formed in parallel to the center line 26 of the ejection hole 10. The tapered portion 28 is a portion closer than the straight portion 27 to the inner surface 15 of the sub-nozzle 2 and is a portion formed such that the hole diameter of the inner peripheral surface 34 gradually increases toward the inner surface 15. Thus, in the ejection hole 10, the hole diameter of the outer opening portion 31 differs from the hole diameter of a portion (an inner opening portion 30) being open in the inner surface 15. The hole diameter of the inner opening portion 30 is larger than the hole diameter of the outer opening portion 31.

[0037] As described above, in the sub-nozzle 2 of the present embodiment, the ejection hole 10 is formed such that the distance C from the position X to the position Y is 0.5 mm. With the sub-nozzle 2 having the thus formed ejection hole 10, the inner peripheral surface 34 of the ejection hole 10 is long in the center-line direction in the vicinity of the position Y, and the length can provide such a conveying force that can decrease the air consumption by a desirable amount. The details are described as follows.

[0038] First, regarding the position Y, as described above, the position Y is the position at which the line connecting the center 33 of the ejection hole 10 and the position X intersects with the peripheral edge of the ejection hole 10, and the position X is the position that is the position on the outer peripheral edge of the sub-nozzle 2 and that is at the closest distance from the center 33 of the ejection hole 10. Thus, the position Y is the position that is the position on the peripheral edge of the ejection hole 10 and that is closest to the outer peripheral edge of the sub-nozzle 2.

[0039] Based on this, when the position of the ejection hole 10 is considered separately in a direction orthogonal to the axis 14 of the sub-nozzle 2 (the width direction) and in a direction of the axis 14 of the sub-nozzle 2 (the axial direction), in the front view, the position in the width direction is recognized in the plane section. As described above, the sub-nozzle 2 of the present embodiment is formed such that the plane-sectional shape is the ellipse. A typical sub-nozzle has a wall with a substantially uniform thickness. Accordingly, the direction of the thickness in the plane section (the thickness direction) has a larger angle at a position closer to the outer peripheral edge of the sub-nozzle 2 with respect to the thickness direction at the position of the center in the width direction.

[0040] Thus, when the ejection hole 10 is bored such that the center-line direction is the specific direction, the angle of the thickness direction at a position on the peripheral edge of the ejection hole 10 in the plane section is larger as the position on the peripheral edge is closer to the outer peripheral edge of the sub-nozzle 2. In other words, in the plane section, the angle of the thickness direction at a position on the peripheral edge of the ejection hole 10 with respect to the center-line direction of the ejection hole 10 is larger as the position on the peripheral edge (the position of the center 33 of the ejection hole 10) is closer to the outer peripheral edge of the sub-nozzle 2.

[0041] In a view at the position Y that is the position on the peripheral edge of the ejection hole 10 and that is closest to the outer peripheral edge of the sub-nozzle 2, the thickness direction at the position Y is at an angle θa with respect to the center-line direction, as illustrated in Fig. 8 (a sectional view taken along line VIII-VIII in Fig. 5) indicating the plane section at the position Y. While the ejection hole 10 is formed such that the distance C is 0.5 mm as described above in the present embodiment, the angle θa is larger as the distance C is smaller (the angle θa is smaller as the distance C is larger). As the angle θa is larger, the length of the inner peripheral surface 34 of the ejection hole 10 at that position is larger in the center-line direction.

[0042] Similarly, the position of the ejection hole 10 in the axial direction is recognized in a section in a direction parallel to the axial direction (a section when divided along the minor axis 43 of the ellipse, hereinafter, referred to as "vertical section"). As described above, the main body portion 12 of the sub-nozzle 2 is formed such that the distal end of the main body portion 12 has an arc shape in the vertical section. Accordingly, when the ejection hole 10 is formed at a position at a small (close) distance from the outer peripheral edge of a portion on the peripheral edge close to the outer peripheral edge of the sub-nozzle, the portion (part) on the peripheral edge is located on an arc surface in the axial direction.

[0043] When the part on the peripheral edge is located on the arc surface in the axial direction in this way and when the ejection hole 10 is bored such that the center-line direction is the specific direction, the thickness direction at the position on the peripheral edge of the ejection hole 10 in the vertical section has a larger angle with respect to the center-line direction as the position on the peripheral edge is closer to the outer peripheral edge of the sub-nozzle 2. Based on this, in the view at the position Y that is the position on the peripheral edge of the ejection hole 10 and that is closest to the outer peripheral edge of the sub-nozzle 2, the thickness direction at the position Y is at an angle θb with respect to the center-line direction, as illustrated in Fig. 9 (a sectional view taken along line IX-IX in Fig. 5). While the ejection hole 10 is formed such that the distance C is 0.5 mm in the present embodiment, the angle θb is larger as the distance C is smaller (the angle θb is smaller as the distance C is larger). As the angle θb is larger, the length of the inner peripheral surface 34 of the ejection hole 10 at that position is larger in the center-line direction.

[0044] Since the ejection hole 10 is formed at the position with the small distance C in this way, at the position Y, which is the position on the peripheral edge of the ejection hole 10, and in the vicinity of the position Y, the length of the inner peripheral surface 34 of the ejection hole 10 in the center-line direction increases in the width direction and the axial direction. Consequently, directivity of a flow of air jetted from the ejection hole 10 increases, and a weft conveying force with respect to a predetermined supply pressure of compressed air can be increased.

[0045] Fig. 10 is a graph showing, regarding the sub-nozzle in which the ejection hole is formed in this way, a relationship between a wind velocity of compressed air jetted from the sub-nozzle, the wind velocity considerably relating to the weft conveying force, and a distance C. The graph shows the relationship 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 distance C; the vertical axis, however, does not represent the above-described wind velocity itself but employs a wind velocity ratio as a parameter. Note that the wind velocity ratio is a ratio in which the wind velocity of a flow of air jetted from an ejection hole of a comparative sub-nozzle is considered as 100 with the same supply pressure. The wind velocity is measured at a predetermined position in a region where a flow of air acts in the weft guide groove of the modified reed. The comparative sub-nozzle in this case is a sub-nozzle having a configuration in which an ejection hole is formed such that, in a front view of a front wall portion, the position of the center of the ejection hole is at a position on the axis of the sub-nozzle and the ejection hole is formed at the distance C of 0.8 mm.

[0047] As read from the graph of Fig. 10, in the sub-nozzle of the present embodiment in which the ejection hole is formed such that the distance C is 0.5 mm, the wind velocity ratio has a value of 105 or more with either of the above-described two types of supply pressures. In other words, in the sub-nozzle 2 of the present embodiment, the wind velocity ratio is increased by 5% or more due to the configuration in which the ejection hole 10 is formed such that the distance C is 0.5 mm. Consequently, in the sub-nozzle 2 of the present embodiment, it is possible to obtain a weft conveying force that can decrease the air consumption by a desirable amount.

[0048] In the present embodiment, the ejection hole 10 is formed such that the center line 26 of the ejection hole 10 does not intersect with the axis 14 of the sub-nozzle 2. As compared with a case where the ejection hole 10 is formed such that the center line 26 of the ejection hole 10 intersects with the axis 14 (in the plane section, the center line 26 is directed toward the center of the sub-nozzle 2), the angle of the center line 26 with respect to the thickness direction of the front wall portion 18 increases. Accordingly, the length in the center-line direction of the inner peripheral surface 34 of the ejection hole 10 increases. Thus, the above-described advantageous effect of increasing the weft conveying force is attained by a higher degree, and consequently, it is possible to decrease the air consumption more effectively.

[0049] Furthermore, in the present embodiment, the ejection hole 10 is formed to have the tapered portion 28. As compared with an ejection hole without a tapered portion, the length in the center-line direction of the inner peripheral surface 34 of the ejection hole 10 further increases. Specifically, as described above, the ejection hole 10 is formed such that the center-line direction of the ejection hole 10 is at an angle with respect to the thickness direction of the front wall portion 18. Moreover, the inner peripheral surface 34 of the ejection hole 10 is formed such that the hole diameter of the inner peripheral surface 34 gradually increases toward the inner surface 15. As compared with a case where an ejection hole is not formed in this way (a case without a tapered portion), the position in the center-line direction of the inner opening portion 30 is located further close to the rear wall portion 17. Thus, the length in the center-line direction of the inner peripheral surface 34 of the ejection hole 10 is longer than that in a case where an ejection hole does not have such a tapered portion. Consequently, the above-described advantageous effect of increasing the weft conveying force is attained by a higher degree, and it is possible to decrease the air consumption more effectively.

[0050] The present invention is not limited to the above-described embodiment (the embodiment), and can be implemented by any of the following modified embodiments.

(1) In the embodiment, the ejection hole 10 is formed such that the hole diameter of the outer opening portion 31 is 1.6 mm. However, the sub-nozzle for the air jet loom according to the present invention is not limited to the sub-nozzle in which the hole diameter of the outer opening portion is thus formed. The sub-nozzle may have an ejection hole formed such that the hole diameter of the outer opening portion differs from the hole diameter of the present embodiment as far as the ejection hole is formed such that the distance between the position X and the position Y (the distance C according to the embodiment) in the view of the ejection hole in the center-line direction is 0.75 mm or less.

(2) In the embodiment, the ejection hole is formed to have the straight portion and the tapered portion. In the straight portion, the inner peripheral surface of the ejection hole is formed in parallel to the center line of the ejection hole. The tapered portion is the portion closer than the straight portion to the inner surface, and in the tapered portion, the hole diameter of the inner peripheral surface gradually increases toward the inner surface. However, in the sub-nozzle according to the present invention, the ejection hole is not limited to the ejection hole formed to have such a tapered portion, and may be formed straight entirely in the center-line direction. Even with such a sub-nozzle, the inner peripheral surface of the ejection hole is long in the center-line direction as described above at the position Y that is the position on the peripheral edge of the ejection hole and the vicinity of the position Y.

Alternatively, the ejection hole may be formed such that the hole diameter of the inner peripheral surface of the ejection hole gradually increases toward the inner surface entirely in the center-line direction of the ejection hole. In the sub-nozzle having the thus formed ejection hole, the length in the center-line direction of the inner peripheral surface of the ejection hole at the position Y and in the vicinity of the position Y is larger than that of an ejection hole having a straight portion like the embodiment.

In the case of the configuration in which the ejection hole has the tapered portion in the portion close to the inner surface as described above, if the thickness of the portion at the distal end of the sub-nozzle is uniform, a step may be generated between the inner peripheral surface of the tapered portion and the inner surface of the portion at the distal end of the sub-nozzle, in accordance with the degree of the increase in diameter of the tapered portion. If such a step is generated, as illustrated in Fig. 11, an inclined surface 35 that has a curved surface shape and that continues to an inner peripheral surface of a tapered portion and to an inner surface at a distal end of the sub-nozzle may be formed at a position inside the portion at the distal end of the sub-nozzle having the step.

(3) In the embodiment, the ejection hole is formed such that the distance C is 0.5 mm. However, in the sub-nozzle according to the present invention, the

position at which the ejection hole is formed is not limited to the position at the distance C of 0.5 mm, and may be located at a position at a distance C of 0.75 mm or less. The details are described as follows.

Typically in a weaving factory, it is desired to decrease air consumption of an air jet loom as a measure for energy conservation. Moreover, the amount of decrease is desirably an amount corresponding to 3% or more of the wind velocity ratio. As read from the graph of Fig. 10, as far as the distance C is 0.75 mm or less, the wind velocity ratio has a value larger than 103 with either of the above-described two types of supply pressures. That is, since the ejection hole of the sub-nozzle is formed such that the distance C is 0.75 mm or less, the wind velocity ratio can be increased by a proportion of 3% or more by which the air consumption is desired to be decreased. Thus, the air consumption can be decreased as described above.

Note that the distance C is the distance between the position Y and the outer peripheral edge of the sub-nozzle in the front view. As the distance decreases, the thickness of the wall of the sub-nozzle in the vicinity of the position Y decreases. As the thickness of the wall decreases, this likely leads to a breakage of the sub-nozzle by the amount of decrease. In contrast, referring to the graph in Fig. 10, it is found that the wind velocity ratio does not change when the distance C is 0.15 mm or less with either of the supply pressures of 0.3 MPa and 0.4 MPa. Thus, the distance C is desirably 0.15 mm or more.

(4) In the embodiment, the ejection hole is formed such that the center line of the ejection hole does not intersect with the axis of the sub-nozzle. However, in the sub-nozzle according to the present invention, the ejection hole may be formed such that the center line of the ejection hole intersects with the axis of the sub-nozzle except a case where the plane-sectional shape of the sub-nozzle is a circle. Even with such a sub-nozzle, the inner peripheral surface of the ejection hole is long in the center-line direction as described above, in the thickness direction of the sub-nozzle at the position Y that is the position on the peripheral edge of the ejection hole, and in the vicinity of the position Y

(5) In the embodiment, in the front view, the ejection hole is formed at the position at which the line (the imaginary line 32, hereinafter referred to as "first imaginary line") that passes through the center of the ejection hole and the position X is at the angle (specifically, the angle of about 70° with respect to the second imaginary line) with respect to the axis of the sub-nozzle and the line (the imaginary line 41, hereinafter referred to as "second imaginary line") that is orthogonal to the axis of the sub-nozzle. However, in the sub-nozzle according to the present invention, the ejection hole may not be formed at such a position.

For example, even in a case where the first imaginary line is formed at the position at an angle with respect to the axis of the sub-nozzle and the second imaginary line in the front view similarly to the embodiment, the ejection hole may be formed at a position at which the angle is larger than or smaller than the angle of the embodiment.

The ejection hole may be formed at a position at which the first imaginary line coincides with the axis of the sub-nozzle in the front view. In this case, the center of the ejection hole is located on the axis of the sub-nozzle in the front view. Even in this case, as it is clear from the description relating to the relationship between the position Y and the shape of the vertical section (the arc surface) for the position of the ejection hole in the axial direction, as the distance C decreases, the length of the inner peripheral surface of the ejection hole at the position Y and in the vicinity of the position Y increases in the center-line direction.

Furthermore, in the front view, the ejection hole may be formed such that the center of the ejection hole is located at the position deviated from the axis of the sub-nozzle, and the ejection hole may be formed at a position at which the first imaginary line is parallel to the second imaginary line. Even in this case, as it is clear from the description relating to the relationship between the position Y and the shape of the plane section (the ellipse) for the position of the ejection hole in the width direction, as the distance C decreases, the length of the inner peripheral surface of the ejection hole at the position Y and in the vicinity of the position Y increases in the center-line direction.

(6) In the embodiment, the configuration of the example in which the ejection hole of the sub-nozzle according to the present invention is formed of the single hole has been described. However, the sub-nozzle according to the present invention is not limited to the sub-nozzle having the single hole functioning as the ejection hole. For example, a plurality of holes may be formed in a region where an ejection hole is to be formed, and a group of the plurality of holes may function as an ejection hole. In this case, the region where the plurality of holes are made in the surface of the sub-nozzle serves as a region corresponding to the outer opening portion of the ejection hole. The position of the center of the region serves as a position corresponding to the center of the ejection hole. Moreover, with such a sub-nozzle, each hole is bored in the same direction, and the center-line direction of the ejection hole serves as the boring direction of the hole.

[0051] The present invention is not limited to the above-described examples, and can be appropriately modified within the scope not departing from the spirit of the present invention.

Claims

1. A sub-nozzle (2) for an air jet loom, the sub-nozzle (2) having a hollow tubular shape having a closed distal end, the sub-nozzle (2) having a distal end portion (13) having an ejection hole (10),
   wherein, in a view in a direction of a center line (26) of the ejection hole (10), when X is determined as a position that is a position on an outer peripheral edge of the sub-nozzle (2) and that is at a closest distance from a center of the ejection hole (10), and Y is determined as a position at which a line connecting the center of the ejection hole (10) and the position X intersects with a peripheral edge of the ejection hole (10),
   the ejection hole (10) is formed such that a distance between the position X and the position Y is 0.75 mm or less in the view in the direction of the center line (26).

2. The sub-nozzle (2) for the air jet loom according to Claim 1, wherein the ejection hole (10) is formed such that the center line (26) does not intersect with an axis (14) of the sub-nozzle (2).

3. The sub-nozzle (2) for the air jet loom according to Claim 1 or 2, wherein the ejection hole (10) is formed to have a tapered portion (28) that is a portion formed such that a hole diameter of an inner peripheral surface (34) of the ejection hole (10) gradually increases toward an inner surface (15) of the sub-nozzle (2).

FIG. 1

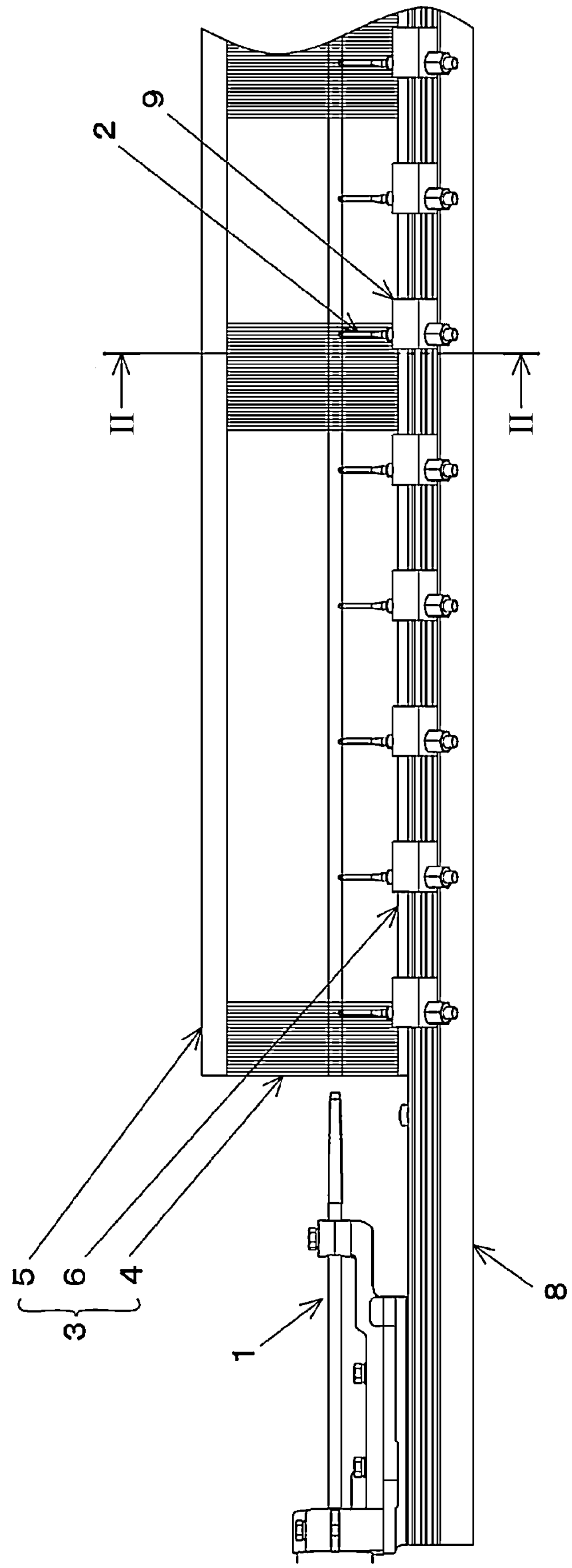


FIG. 2

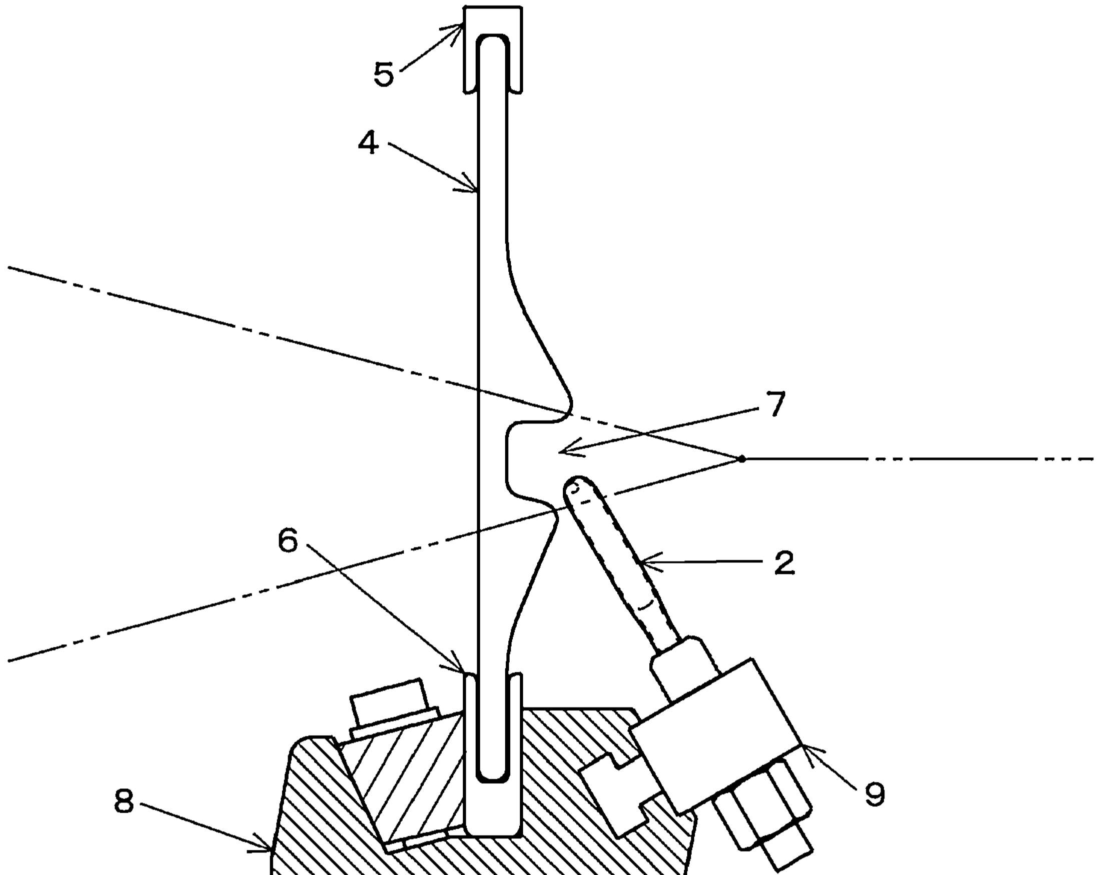


FIG. 3

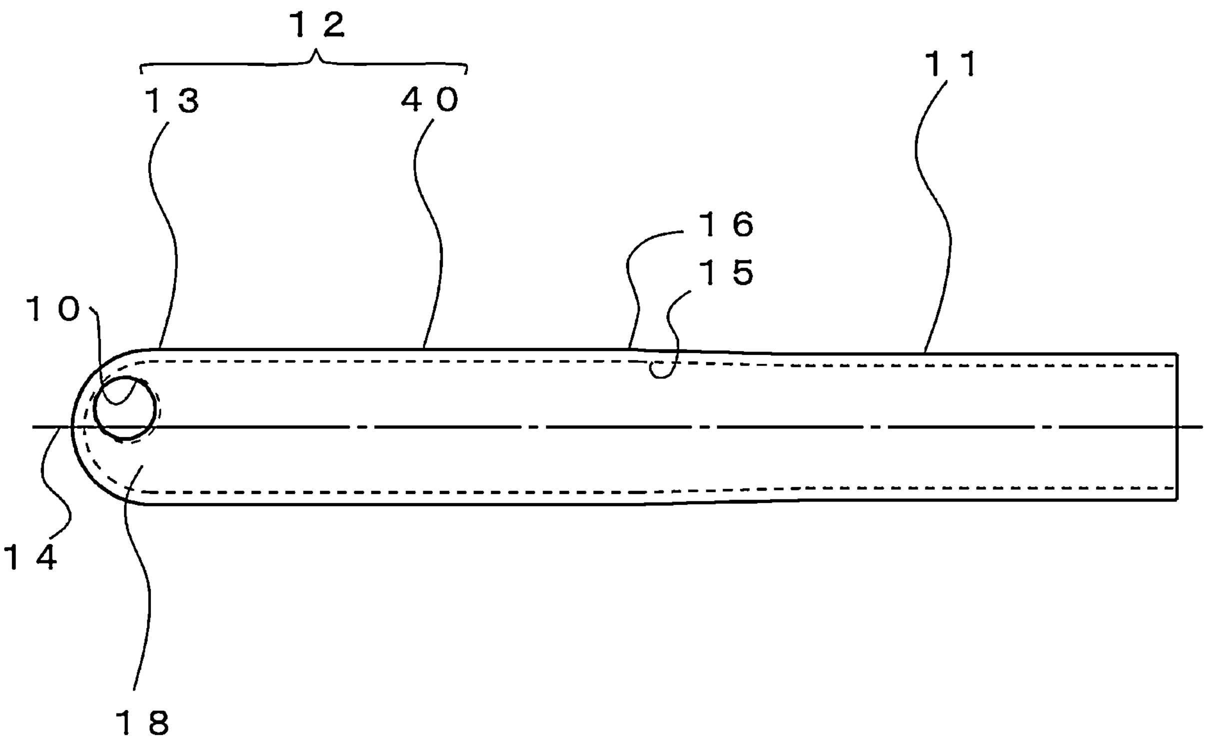


FIG. 4

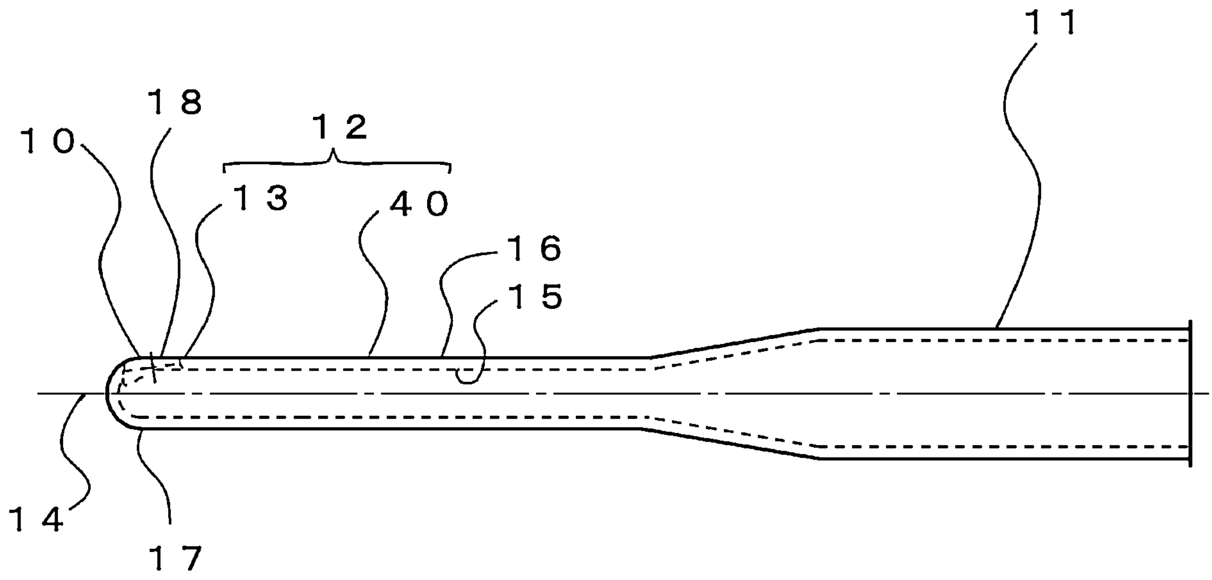


FIG. 5

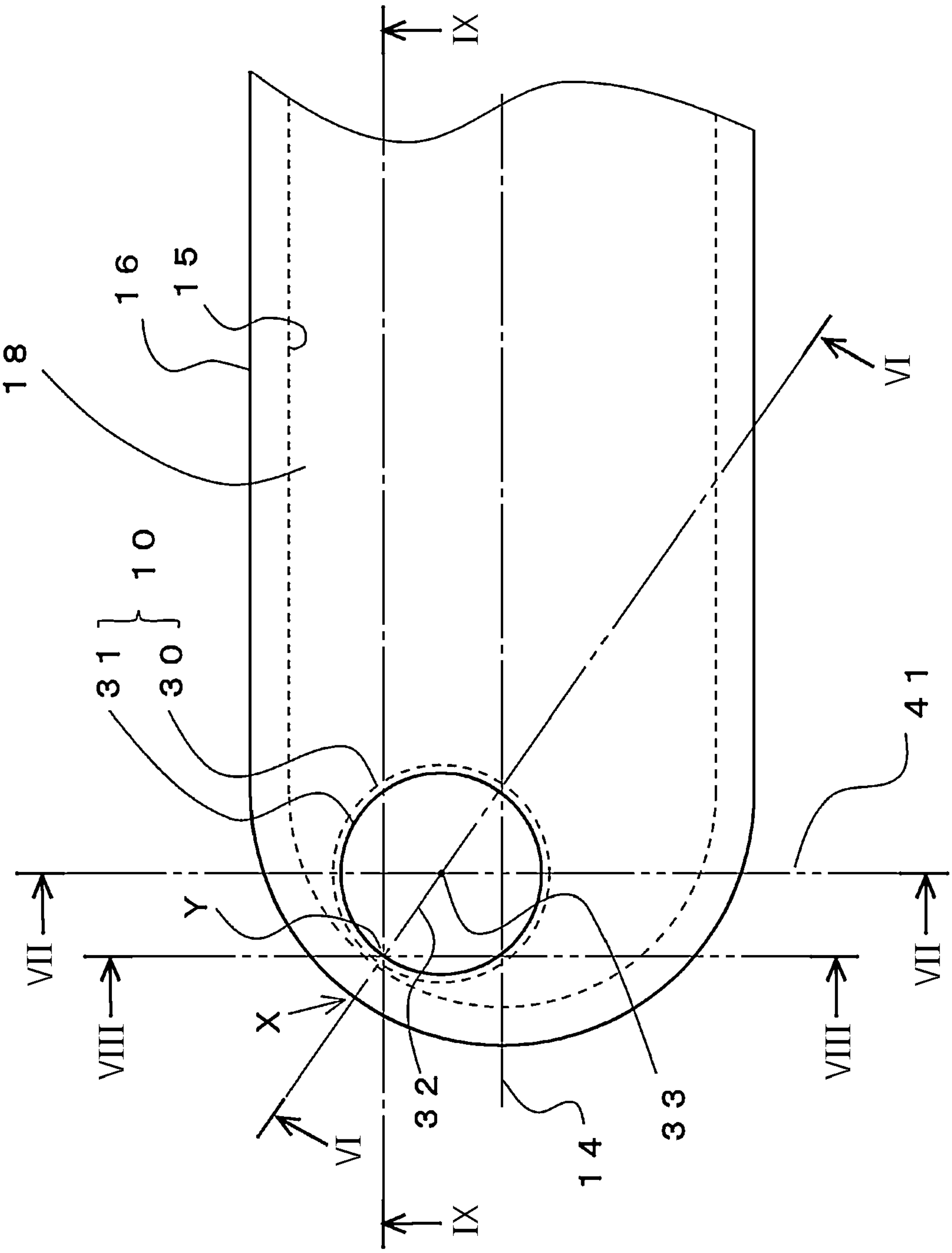


FIG. 6

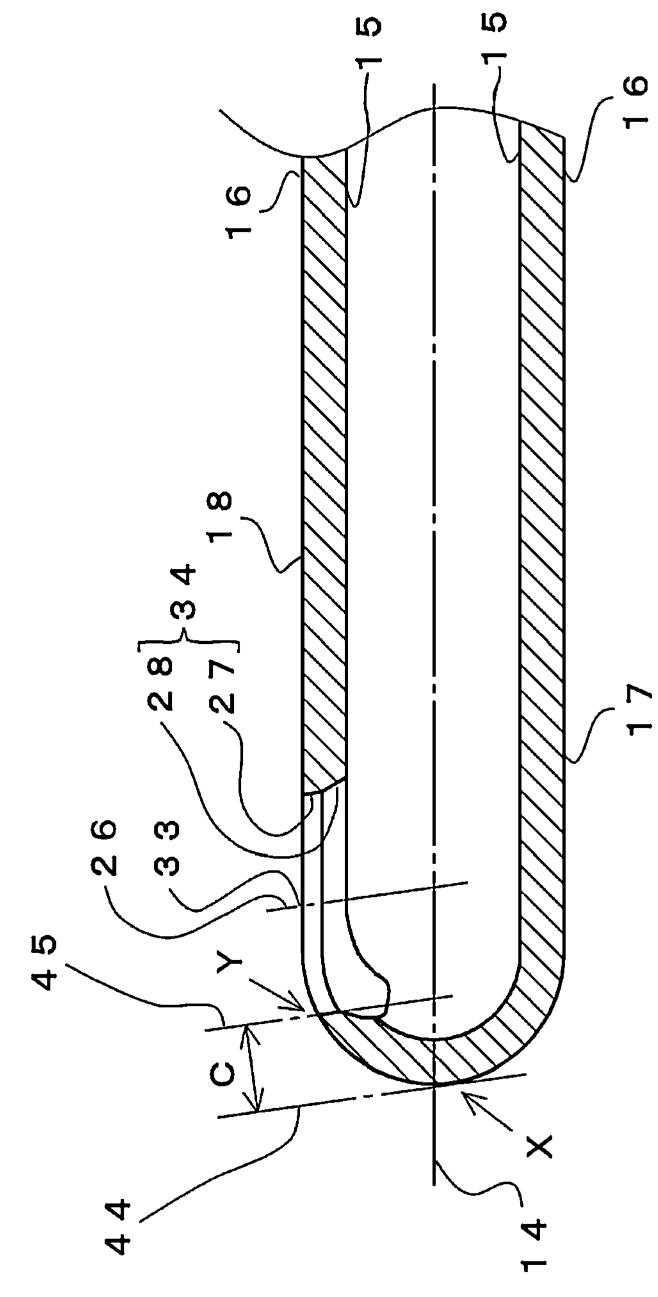
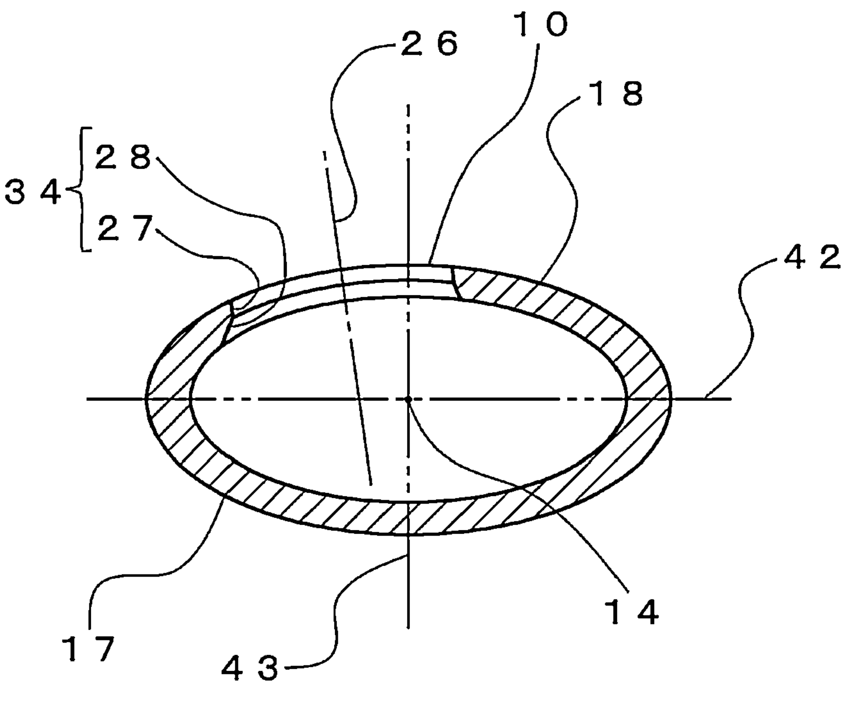


FIG. 7



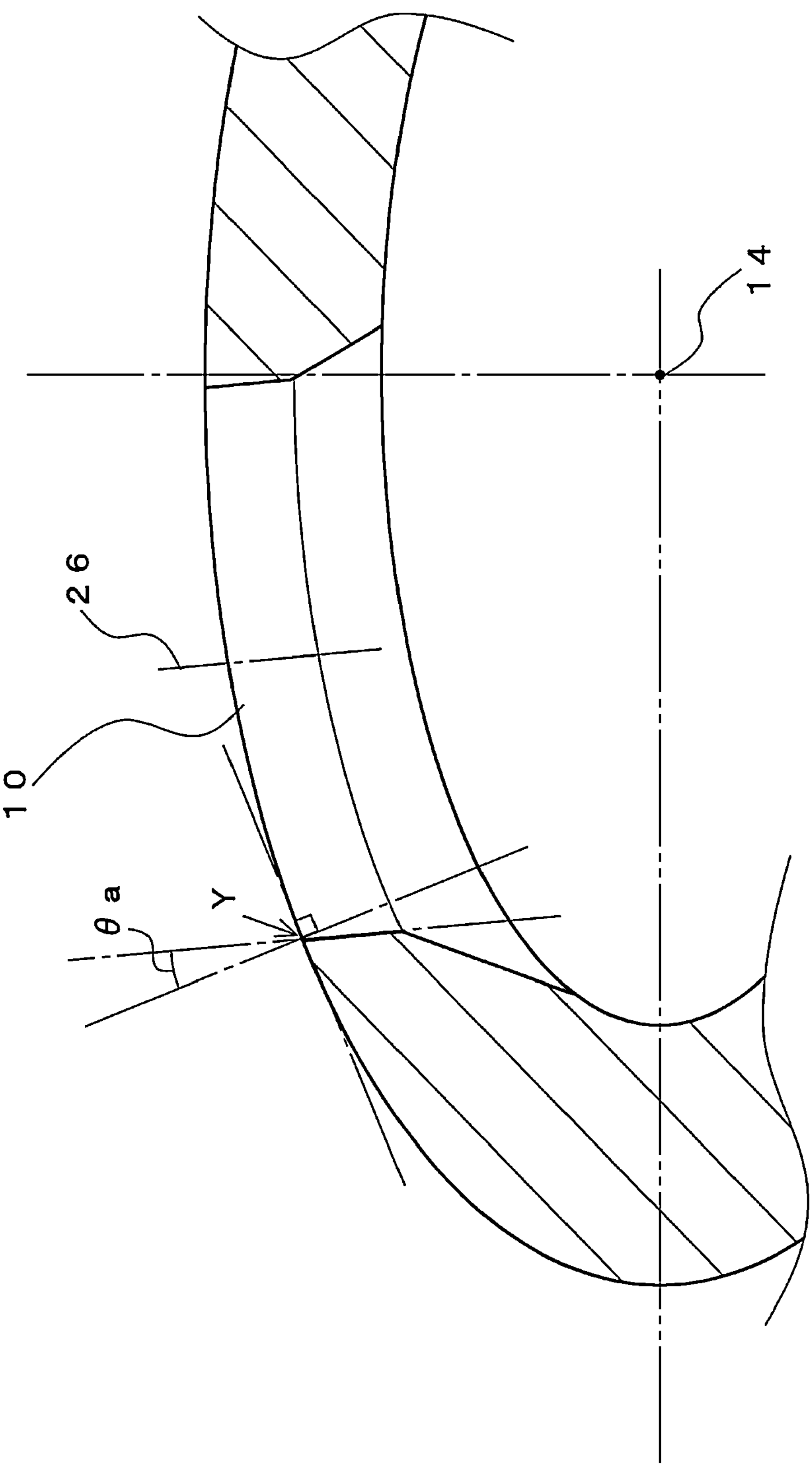


FIG. 8

FIG. 9

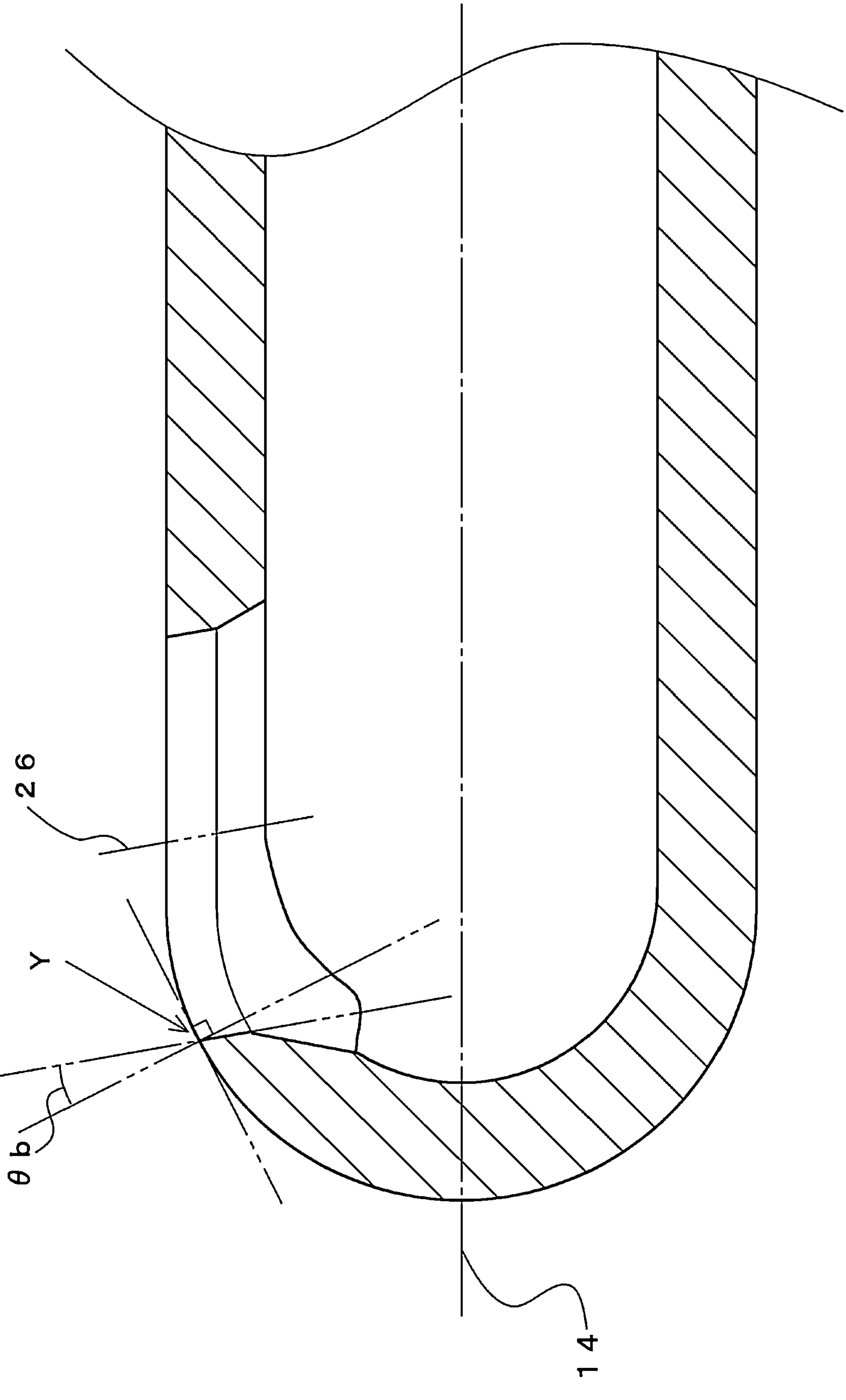


FIG. 10

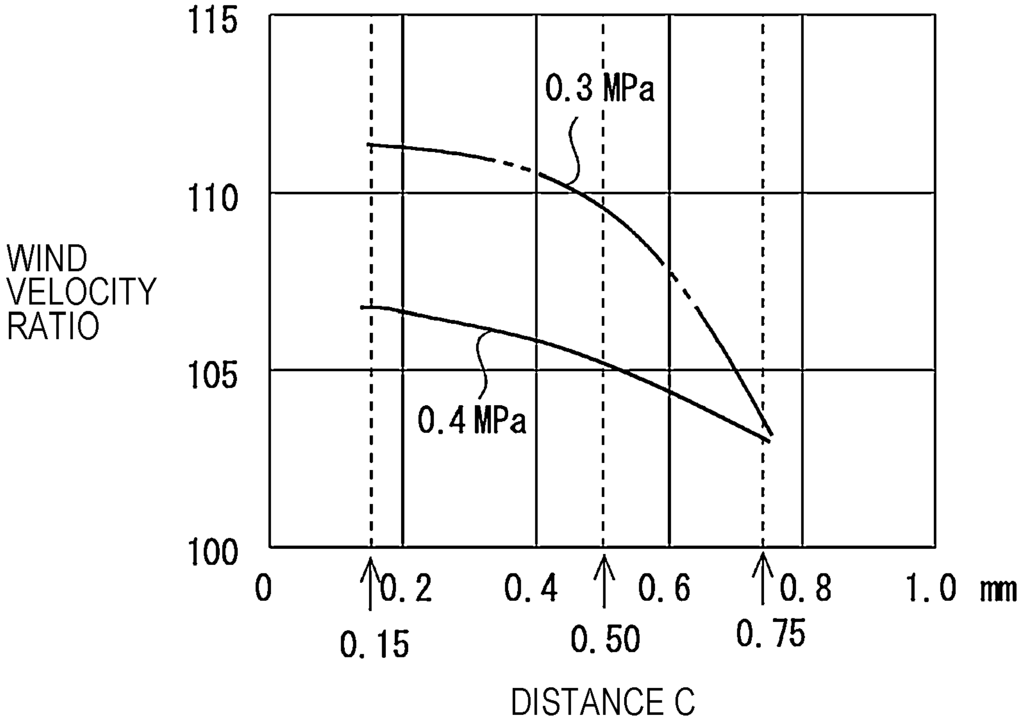
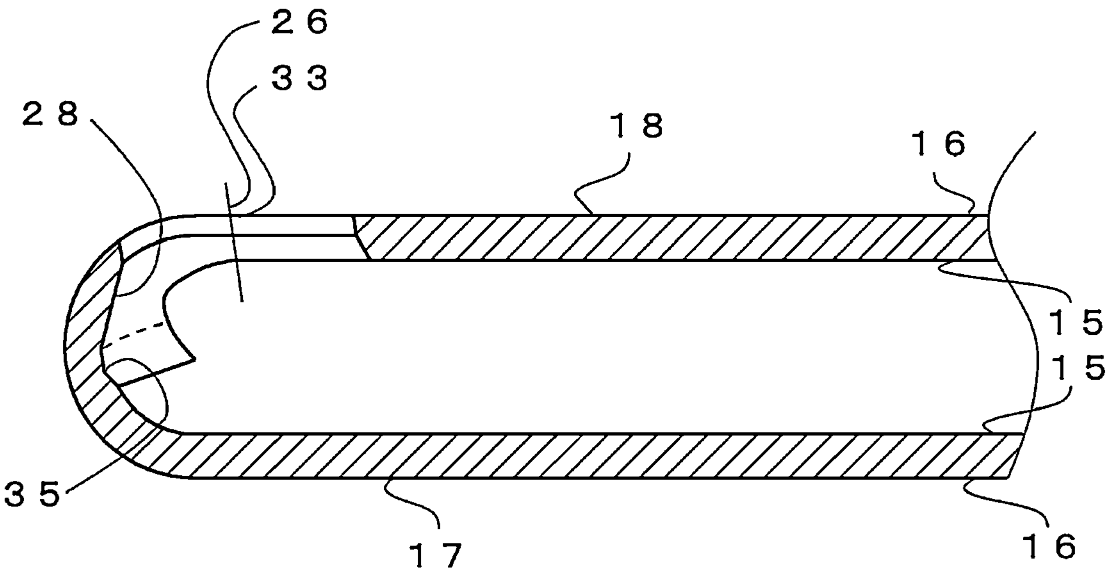

115
110
105
100
WIND
VELOCITY
RATIO
0.3 MPa
0.4 MPa
0
0.2
0.4
0.6
0.8
1.0 mm
0.15
0.50
0.75
DISTANCE C

FIG. 11



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EUROPEAN SEARCH REPORT

Application Number
EP 20 17 1702

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	WO 94/11553 A1 (NIPPON TUNGSTEN [JP]; HOKURIKU SEIKEI IND CO LTD [JP] ET AL.) 26 May 1994 (1994-05-26) * abstract * * claims 1,3 * * figures 1-6,7a,7b,8a,8b,9 * * paragraphs [0001] - [0004], [0013] - [0015], [0019], [0020], [0026], [0028] - [0030], [0038], [0039], [0047], [0053], [0058], [0066], [0068] * -----	1,3 2	INV. D03D47/30
Y	EP 2 610 378 A1 (TOYOTA JIDOSHOKKI KK [JP]) 3 July 2013 (2013-07-03) * abstract * * claims 1,4 * * figures 1-6 * * paragraphs [0001], [0002], [0008], [0011], [0012], [0017] - [0020], [0022] * -----	2	
A	EP 0 707 101 A2 (BORTOLAMAI ANTONIO [CH]) 17 April 1996 (1996-04-17) * abstract * * claim 1 * * figures 1-7 * * column 1, line 1 - line 17 * * column 1, line 43 - line 53 * * column 2, line 20 - line 52 * * column 6, line 52 - column 7, line 19 * * column 7, line 35 - line 39 * * column 7, line 56 - line 58 * -----	1-3	TECHNICAL FIELDS SEARCHED (IPC) D03D

1

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	26 August 2020	Heinzelmann, Eric

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26-08-2020

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