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(54) MELT SPINNING DEVICE

SCHMELZSPINNVORRICHTUNG

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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a melt spinning device.

[0002] Patent Literature 1 (DE102013012869A1) recites a melt spinning device which is configured to spin yarns. The melt spinning device includes spinning packs which respectively have spinnerets where molten polymer is spun out as filaments, and cooling cylinders which are arranged below the spinnerets to cool the respective spun-out filaments by cooling wind.

[0003] Now, immediately after the filaments are spun out from the spinnerets, the filaments generate monomer gas from which polymer is made. When the monomer gas is cooled and solidified, the monomer gas adheres to the spinnerets to form icicle-like formations, and clogs filters provided in the cooling cylinders, for example, with the result that cooling wind supplied to the filaments from the cooling cylinders may be disturbed and quality of yarns may be deteriorated. Furthermore, generally, below the melt spinning device, an oil guide is provided to supply a yarn with oil. When the solidified monomer gas adheres to the oil guide, adverse effects such as deterioration of quality of yarns occur. In this regard, the above-described melt spinning device further includes ring-shaped pipes (hereinafter, referred to as exhaust rings), which are arranged between spinnerets and cooling cylinders, and provided so as to surround each of filaments that has just been spun out from the spinnerets. In the peripheral walls of each of the pipes, a plurality of holes are formed at regular intervals to suck out gas in the exhaust ring. Through these holes, the gas, which is directly under the spinneret, is sucked out.

[0004] JPH06306704A recites a melt spinning chimney which is provided below a spinneret.

[0005] US4712988A and US3632719A recite apparatuses for cooling spun out filaments.

SUMMARY OF THE INVENTION

[0006] When monomer gas is sucked out from the inside of the exhaust ring and air flow around filaments that has just been spun out from the spinnerets is disturbed, yarns tend to sway and, as a result, deterioration of quality of the yarns may be caused. Furthermore, when, for example, gas is sucked drastically in some exhaust rings, suction quantity of gas is dispersed between a plurality of exhaust rings. Therefore, the degree of sway of the filaments, and the like tend to be different between a plurality of exhaust rings, and, as a result, the quality of yarns tends to be dispersed. Especially in recent years, the demand for manufacture of yarns, which are made of filaments thinner than conventional ones (for example, 0.55 dtex per filament (0.5DPF) or less), is growing, and hence the above-described problem has become still more remarkable.

[0007] An object of the present invention is to suppress disturbance of air flow around filaments that has just been spun out, and reduce dispersion of suction quantity of gas between a plurality of exhaust rings.

[0008] According to the first aspect of the invention, a melt spinning device comprises: a spinning unit which includes spinnerets, and is configured to spin out filaments from the spinnerets; cooling cylinders which are respectively disposed below the spinnerets; a cooling unit which is configured to cool the filaments spun out from the spinnerets; and an exhaust unit which is disposed between the spinning unit and cooling unit in a traveling direction of the filaments, and is configured to suck and discharge gas which is generated from the spun out filaments, the exhaust unit including: a suction device which is configured to suck the gas; exhaust rings which are respectively arranged between the spinnerets and the cooling cylinders, and which are provided so as to surround the filaments that are spun out from the spinnerets; and an enclosure member which is connected to the suction device, and disposed so as to surround the exhaust rings, and in the member, an internal space, where the gas which was spun out from inside of the exhaust rings flow, is formed, exhaust holes to suck and discharge the gas being formed in a peripheral wall of each exhaust ring, the area of each of the exhaust holes of each of the exhaust rings being 30 mm^2 or less, the percentage of the sum of the area of the exhaust holes relative to the internal area of each of the exhaust rings being 2.5 % or less.

[0009] In the present invention, gas is sucked and discharged through exhaust holes of an exhaust ring arranged between spinneret and cooling cylinder (that is, around filaments that have just been spun out). As a result of an earnest examination by the present inventors, it has been found that the area of exhaust holes greatly relates to reduction of disturbance of air flow and dispersion of suction quantity of gas between exhaust rings, as follows.

[0010] To begin with, the present inventors found that by making the area of each exhaust hole be equal to or smaller than 30mm^2 so as to increase passage resistance of each exhaust hole, it was possible to suppress suction of gas in a concentrated manner through exhaust holes at a position where gas easily flowed, such as exhaust holes arranged at a position which was relatively close to the suction device in a suction direction of gas. That is, by making passage resistance of each exhaust hole higher, gas was likely to be sucked evenly through each exhaust hole, and concentration of an air flow inside an exhaust ring to one or some of exhaust holes was restrained, with the result that disturbance of air flow inside the exhaust ring could be suppressed. In addition to the area of each exhaust hole, the present inventors paid attention to the percentage of the sum of the area of the exhaust holes relative to the internal area of an exhaust ring (hereinafter, referred to as opening ratio). That is, the present inventors found that by arranging the opening ratio to be equal to or lower than 2.5%, it was possible to suppress suction quantity of gas per unit time from being excessively large relative to the capacity of the internal space of an exhaust ring, with the result that disturbance of air flow inside the exhaust ring could be suppressed.

[0011] Furthermore, the present inventors found that, by making the area of each exhaust hole smaller, it was possible to reduce dispersion of suction quantity of gas between exhaust rings. That is, they found that by restraining concentration of air flow to one or some of exhaust holes, as compared to cases where air flow concentrated to one or some of exhaust holes, flow rate dispersion in the whole internal space of an member could be reduced, and dispersion of suction quantity of gas between exhaust rings could be suppressed. Furthermore, they found that, by making the opening ratio small to suppress drastic discharge of gas from the inside of an exhaust ring, as compared to cases where gas was drastically discharged, disturbance of air flow in the internal space of the enclosure member could be suppressed, and hence dispersion of suction quantity of gas between exhaust rings could be reduced.

[0012] As described above, by arranging the area and opening ratio of each exhaust hole to be equal to or smaller than predetermined values, disturbance of air flow around filaments that have just been spun out is restrained, and dispersion of suction quantity of gas between the exhaust rings is reduced.

[0013] According to the second aspect of the invention, the melt spinning device of the first aspect is arranged such that the area of each exhaust hole is 13 mm^2 or less.

[0014] In the present invention, by further restraining concentration of air flow inside an exhaust ring to one or some of exhaust holes, disturbance of air flow around filaments that have just been spun out can be significantly restrained, and dispersion of suction quantity of gas between exhaust rings can be significantly reduced.

[0015] According to the third aspect of the invention, the melt spinning device of the first or second aspect is arranged such that the percentage of the sum of the area of the exhaust holes relative to the internal area of the exhaust ring is 1.25 % or less.

[0016] In the present invention, by arranging the percentage to be equal to or smaller than 1.25% so as to further suppress drastic sucking of gas inside an exhaust ring, disturbance of air flow around filaments that have just been spun out can be significantly restrained, and dispersion of suction quantity of gas between the exhaust rings can be significantly reduced.

[0017] According to the fourth aspect of the invention, the melt spinning device of any one of the first to third aspects is arranged such that the area of each exhaust hole is 7 mm^2 or more.

[0018] When each exhaust hole is too small, the exhaust hole may be clogged when gas reaching the exhaust hole solidifies inside or around the exhaust hole. Therefore, to restrain the exhaust holes from being clogged, it is preferable that the area of each exhaust hole is 7 mm^2 or more.

[0019] According to the fifth aspect of the invention, the melt spinning device of any one of the first to fourth aspects is arranged such that the exhaust holes of each exhaust ring are provided at equal intervals in the circumferential direction of each exhaust ring.

[0020] In the present invention, providing the exhaust holes of each exhaust ring at regular intervals in the circumferential direction facilitates even discharge of gas in the circumferential direction of each exhaust ring. Because the flow rate of gas around each exhaust ring is close to even, flow rate dispersion in the whole internal space of the enclosure member can be reduced as compared to cases where the flow rate around each exhaust ring is dispersed greatly. It is therefore possible to suppress dispersion of suction quantity of gas between exhaust rings.

[0021] According to the sixth aspect of the invention, the melt spinning device of any one of the first to fifth aspects is arranged such that each of the exhaust holes has a circular shape.

[0022] In the present invention, making each of the exhaust holes have a smooth and circular shape suppresses the possibility of generation of turbulent flow, when gas is discharged.

[0023] Suction quantity of gas per unit time may need to be changed by changing the total area of the exhaust holes, depending on the thickness or types of yarns to be spun out. In the present invention, because the exhaust holes have circular shapes, each exhaust hole can be closed by using a typical pin or the like. Alternatively, by forming female screws in the exhaust holes, each of the exhaust holes can be closed by using typical screws or the like. That is, the total area of the exhaust holes is changeable by increasing or decreasing the number of pins, screws, or the like which close the exhaust holes. With this arrangement, cost and labor are saved because it is unnecessary to replace the exhaust rings to change the total area of the exhaust holes, and it is easy to change the total area.

[0024] According to the seventh aspect of the invention, the melt spinning device of any one of the first to sixth aspects is arranged such that the spinning unit is capable of spinning out filaments whose thickness is 0.55 dtex per filament (0.5DPF) or less.

[0025] Thin and light filaments that are 0.55 dtex per filament (0.5DPF) or less tend to sway by disturbance of air flow and, as a result, as compared to filaments with conventional thickness, deterioration of quality of the yarns may be caused. In the present invention, because disturbance of air flow around filaments that have just been spun out can be suppressed, it is possible to particularly effectively restrain dispersion in yarn quality in an arrangement of spinning out thin filaments.

[0026] According to the eighth aspect of the invention, the melt spinning device of any one of the first to seventh aspects is arranged such that the enclosure member comprises: a passage reduction part whose passage width is arranged to be narrowed toward the downstream side in a suction direction in which the gas is sucked; a linear part whose passage width is constant, and which is arranged on the suction device side of the passage reduction part, in the suction direction; and a curved part which is disposed between the passage reduction part and the linear part, and has a curved passage.

[0027] In the enclosure member, for example, if a corner is formed by a passage reduction part and a linear part, air flow toward a suction device tends to be stripped at the corner, with the result that whirls are generated and pressure loss may occur. In the present invention, smooth air flow from the passage reduction part toward the linear part along the curved part is facilitated. This restrains air flow from being stripped, and therefore restrains generation of whirls.

[0028] According to the ninth aspect of the invention, the melt spinning device of any one of the first to eighth aspects is arranged such that the enclosure member is divided into a first member on the upstream side and a second member on the downstream side, in a suction direction in which the gas is sucked, and, the second member is attachable to and detachable from the first member.

[0029] When gas being sucked solidifies inside the internal space of the enclosure member, the internal space is narrowed, and the suction force may be decreased. In the present invention, because the enclosure member is divided into the first member and the second member and the second member is attachable to and detachable from the first member, maintenance inside the enclosure member can be easily done. It is therefore possible to restrain the suction force from being decreased.

BRIEF DESCRIPTION OF THE DRAWINGS

[0030]

FIG. 1 is a cross section of a melt spinning device of an embodiment of the present invention.

FIG. 2 is a cross section taken along a line II-II in FIG. 1.

FIG. 3 is a plan view of an exhaust device.

FIG. 4 is a cross section taken along a line IV-IV in FIG. 3.

FIG. 5 is a cross-section of a part of a connecting member.

FIG. 6 is a table showing conditions in each of examples and comparative examples, and data indicating dispersion in suction quantity of gas, which is obtained through fluid analysis.

FIGs. 7(a) to 7(f) show arrangement examples of exhaust holes of an exhaust ring.

FIG. 8 shows examples and comparative examples which are reordered in an ascending order of the percentage of the sum of the area of exhaust holes in the internal area of an exhaust ring.

FIG. 9 is a graph showing open area ratio dependency of dispersion in suction quantity in an exhaust ring.

FIG. 10 is a graph showing open area ratio dependency of dispersion in suction quantity between exhaust rings.

FIG. 11 is a table showing analysis results relating to dependency on arrangement of exhaust holes.

FIG. 12 is a table showing experimentation results of quality of yarns.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0031] The following will describe an embodiment of the present invention with reference to FIG. 1 to FIG. 12.

(Outline of Melt Spinning Device)

[0032] To begin with, the structure of a melt spinning device 1 will be described with reference to FIG. 1 and FIG. 2. FIG. 1 is a cross section of a melt spinning device of the present embodiment. FIG. 2 is a cross section taken along a line II-II in FIG. 1. The description below is given on the premise that the up-down direction, front-back direction, and left-right direction in FIG. 1 and FIG. 2 are respectively the up-down direction, front-back direction, and left-right direction relative to the melt spinning device 1 in the present embodiment. The melt spinning device 1 includes a spinning beam 2 (spinning unit of the present invention), a yarn cooler 3 (cooling unit of the present invention), an exhaust device 4 (exhaust unit of the present invention), and an oil guide 5.

[0033] The spinning beam 2 is provided to spin out yarns Y made from molten polymer. The spun molten polymer in the present embodiment is, for example, nylon 6 (PA6). The spinning beam 2 is provided with a plurality of pack housings 11. To the pack housings 11, spinning packs 12 are attached, respectively. In the present embodiment, to twelve pack housings 11, twelve spinning packs 12 are attached, respectively. The pack housings 11 (spinning packs 12) are staggered to form two lines along the left-right direction. To each of the spinning packs 12, molten polymer is supplied from an unillustrated pipe or the like.

[0034] A spinneret 13 in which nozzles 14 are formed is provided at a lower end portion of each of the spinning packs 12. The spinning packs 12 spin out molten polymer as filaments f from each of the nozzles 14 of the spinneret 13. To put it differently, one multi-filament yarn (yarn Y) formed of plural filaments f is spun out from one spinneret 13. In the present embodiment, aperture area of each of the nozzles 14 is, for example, 0.017mm^2 ($\varphi 0.15$) to 0.07mm^2 ($\varphi 0.30$), and the spinning beam 2 can spin filaments f which are thinner than 0.55 dtex per filament (0.5DPF) or less. Here, immediately after the filaments f are spun out, monomer (ε-caprolactam in the present embodiment) gas from which polymer is made is generated from the filaments f. The monomer gas is sucked and discharged by the exhaust device 4. Note that the details will be described later.

[0035] The yarn cooler 3 is provided to cool filaments f which are spun out from the spinning packs 12. The yarn cooler 3 is located below the spinning beam 2. As shown FIG. 1 and FIG. 2, the yarn cooler 3 includes: a box 20; cooling cylinders 21 (yarn cooling unit(s) of the present invention) accommodated in the box 20; partitioning cylinders 22; and the like.

[0036] As shown in FIG. 1, the internal space of the box 20 is partitioned into the upper half and the lower half by a flow adjustment plate 23. The flow adjustment plate 23 is formed by a material such as punching metal having a flow adjustment function, and the flow adjustment plate 23 is arranged horizontally. In the upper space (above the flow adjustment plate 23) of the box 20, cooling cylinders 21 are provided directly below the respective spinning packs 12. As shown in FIG. 2, the cooling cylinders 21 are staggered along the left-right direction in accordance with the arrangement of the spinning packs 12. The wall of each cooling cylinder 21 is, in a manner similar to the flow adjustment plate 23, made of a material having flow adjustment capability such as punching metal. In the lower space (under the flow adjustment plate 23) of the box 20, partitioning cylinders 22 are provided directly below the cooling cylinders 21. Being different from the cooling cylinders 21, the wall of each partitioning cylinder 22 is made of an air-impermeable material. A filament f passes through the internal spaces of the cooling cylinder 21 and the partitioning cylinder 22 which are directly below the spinning pack 12 in this order.

[0037] A duct 25 is coupled to a lower portion of a rear side of the box 20 (see FIG. 1). The duct 25 is connected to a compressed air source (not illustrated). The compressed air source feeds air for cooling filaments f to the duct 25. The air from the compressed air source is supplied to the lower space of the box 20 through the duct 25.

[0038] The cooling air having flown into the lower space of the box 20 is adjusted upward while passing through the flow adjustment plate 23 which is provided horizontally, and reaches the upper space of the box 20. The flow of air having entered the upper space of the box 20 is adjusted when passing through the wall of each cooling cylinder 21, and flows into each cooling cylinder 21. In the cooling cylinder 21, the air is blown to the filaments f from the entire outer circumference of the cooling cylinder 21, with the result that the filaments f are cooled. Because the wall of each partitioning cylinder 22 is air-impermeable, the cooling air does not directly flows from the lower space of the box 20 into the partitioning cylinder 22.

[0039] The exhaust device 4 sucks and discharges monomer gas which is generated from molten polymer that has just been spun out from nozzles 14 of the spinneret 13. Note that the details will be described later.

[0040] The oil guide 5 is configured to supply a yarn Y with oil. The oil guide 5 is provided below the cooling cylinders 21 and partitioning cylinders 22. The yarn Y having been cooled in the cooling cylinder 21 comes into contact with the oil guide 5. During this contact, the oil guide 5 discharges oil to the yarn Y so that the oil is applied to the yarn Y. The yarn Y to which the oil has been applied by the oil guide 5 is taken up by a take-up roller (not illustrated) provided below the oil guide 5. The yarn Y is then sent to a winding device (not illustrated) and is wound onto a bobbin (not illustrated) at the winding device.

(Structure of Exhaust Device)

[0041] Now, the structure of the exhaust device 4 will be described with reference to FIGs. 3 to 5. FIG. 3 is a plan view of the whole exhaust device 4. FIG. 4 is a cross section taken at the IV-IV line in FIG. 3. FIG. 5 is a cross section of a part of an enclosure member 31 which will be described later.

[0042] The exhaust device 4 is configured to suck and discharge gas including monomer gas which is generated from molten polymer that has just been spun out (hereinafter, such gas is simply referred to as gas). As shown in FIG. 3, the exhaust device 4 includes an enclosure member 31, plural exhaust rings 32 (twelve in the present embodiment), a duct 33, and a suction pump 34 (suction device of the present invention). To summarize, when the suction pump 34 is operated, the exhaust device 4 sucks gas from the inside of the exhaust rings 32 which are attached to the enclosure member 31 and surrounded by the enclosure member 31. Then, the exhaust device 4 sucks and discharges the gas through the internal space 44 (see FIG. 4) of the enclosure member 31, and the duct 33 (see arrows in FIG. 3). The following will describe its details.

[0043] The enclosure member 31 is configured to surround the exhaust rings 32 which are attached to the enclosure member 31, and let gas which is discharged from the inside of the exhaust rings 32 flow to the suction pump 34 side. The enclosure member 31 has a generally flat shape on the whole. In the enclosure member 31, the internal space 44 (see FIG. 4) is formed by plates 41 and 42 (see FIG. 4) which are substantially horizontally provided and vertically lined up and a side wall 43 (see FIG. 4 and FIG. 5), which connects the outer peripheries of plates 41 and 42 with each other. The enclosure member 31 is connected to the suction pump 34 through the duct 33. The enclosure member 31 is divided into one first member 31a which is a rear part of the enclosure member 31 (upstream side in the direction where gas is sucked) and two second members 31b which are arranged in front of the first member 31a (downstream side in the suction direction). (See FIGs. 3 to 5, and note that the details will be described later.)

[0044] The enclosure member 31 includes an enclosure member part 50 surrounding the exhaust rings 32 and two passage parts 60 which are arranged to be closer to the suction pump 34 than to the enclosure member part 50. (In FIG. 3 and FIG. 5, the enclosure member part 50 and two passage parts 60 are divided by a two-dot chain line 101.) The enclosure member part 50 is rectangular when viewed from the above (see FIG. 3), and is provided between the spinning beam 2 and the yarn cooler 3 in the up-down direction (see FIG. 4). In enclosure member part 50, fitting holes 51 are formed so that the exhaust rings 32 are fitted therewith. The fitting holes 51, in accordance with the spinnerets 13, are staggered to form two lines along the left-right direction. The two passage parts 60 are parts connected to the front end of the enclosure member part 50. The two passage part 60 are lined up in the left-right direction, and each passage part has a generally triangle shape when viewed from the above. The front end portion of each of the two passage parts 60 is attached to the duct 33.

[0045] As shown in FIG. 3 and FIG. 5, each passage part 60 includes, in this order from the rear side, a passage reduction part 61 (between two-dot chain line 101 and two-dot chain line 102), a curved part 62 (between two-dot chain line 102 and two-dot chain line 103), and a linear part 63 (a part on the front side of two-dot chain line 103). The passage reduction part 61 is arranged in front of the rear end of the passage part 60, and the width of the passage in this part is narrowed toward the front side in a tapered manner (that is, toward the downstream side in the suction direction). The curved part 62 is provided between the passage reduction part 61 and the linear part 63 in the suction direction. The inner wall surface 64 of the curved part 62 (see bold lines in FIG. 5) is curved so that the passage width is narrowed toward the suction pump 34. The linear part 63 is arranged on the downstream side of the passage reduction part 61 and the curved part 62 in the suction direction, and the passage width of this part is constant. The front end portion of the linear part 63 is connected to the duct 33. Gas tends to flow smoothly along the inner wall surface 64 of the curved part 62, when flowing from the passage reduction part 61 to the linear part 63. Therefore, problems such as generation of vortexes by separation of air flow are suppressed.

[0046] As described above, in the suction direction, the enclosure member 31 is divided into the first member 31a on the exhaust ring 32 side and the two second members 31b on the suction pump 34 side. For further details, as shown in FIGs. 3 to 5, the enclosure member 31 is divided into the first member 31a forming the whole enclosure member part 50 and rear part of the two passage parts 60, and the two second members 31b forming the front part of the two passage parts 60. In the first member 31a, plates 41a and 42a (see FIG. 4) and the side wall 43a (see FIG. 4 and FIG. 5) form the internal space 44a. In the second member 31b, plates 41b and 42b (see FIG. 4) and the side wall 43b (see FIG. 5) form the internal space 44b. As shown in FIG. 3 and FIG. 5, the passage reduction part 61 of the passage part 60 is divided into a first passage reduction part 61a in the first member 31a and a second passage reduction part 61b in the second member 31b. The curved part 62 and the linear part 63 of the passage part 60 are formed in the second member 31b.

[0047] The first member 31a and the second member 31b are usually fixed by, for instance, a bolt 104 and a nut 105 (see FIG. 4). At maintenance time, by detaching the bolt 104 and the nut 105, the second member 31b can be detached from the first member 31a. That is, the second member 31b can be attached to/detached from the first member 31a. This makes it easy to clean the inside of the enclosure member 31, especially of the passage part 60, at maintenance time.

[0048] The exhaust rings 32 are configured to discharge gas, which is generated from filaments f that has just been spun out, to the outside in the radial direction. As shown in FIG. 4, the exhaust rings 32 are members provided between the spinning packs 12 and the cooling cylinders 21 in the up-down direction. Each exhaust ring 32 is provided so as to enclose the filaments f that has just been spun out. The exhaust rings 32 are respectively fitted to the fitting holes 51 formed in the enclosure member 31, and are attached so as to be enclosed by the enclosure member 31. In the peripheral wall 71 of each exhaust ring 32, exhaust holes 72 are formed in a row along the circumferential direction of each exhaust ring 32. Thanks to the exhaust holes 72, the internal space of the exhaust ring 32 communicates with the internal space 44 of the enclosure member 31. When the suction pump 34 is operated, gas which is generated from filaments f that has just been spun out is sucked and discharged from the inside of the exhaust ring 32 to the internal space 44 of the enclosure member 31 through the exhaust holes 72.

[0049] Each of the exhaust holes 72 has, for example, a circular shape (see FIG. 4). In this manner, making each of the exhaust holes 72 have a smooth shape suppresses the possibility of generation of turbulent flow, when the gas is discharged. In addition, the circular shape of each exhaust hole 72 allows general pins (not illustrated) or the like to be inserted into the exhaust holes 72. With this arrangement, in accordance with the number of the pins to be inserted to the exhaust holes 72, the total sum of the aperture area (total aperture area) of the exhaust holes 72 can be varied. To be able to vary the total aperture area, in the peripheral wall 71 of the exhaust holes 72, female screws (not illustrated) may be formed to be screwed with a screw (not illustrated) or the like.

[0050] The duct 33 connects the enclosure member 31 with the suction pump 34. The duct 33 includes two upstream portions 81 and one downstream portion 82. The two upstream portions 81 (upstream portion 83 on the left side, and upstream portion 84 on the right side) are attached to the two second members 31b of the enclosure member 31, respectively. The two upstream portions 81 are connected to the upstream side end portion of the downstream portion 82, and, there, the two upstream portions join together. The downstream end portion of the downstream portion 82 is connected to the suction pump 34. The second member 31b of the enclosure member 31 can be disconnected from the first member 31a, and moved relative to the first member 31a.

[0051] The suction pump 34 is configured to suck and discharge monomer gas from the inside of the exhaust rings 32. As the suction pump 34, for example, a water jet pump is used. With this arrangement, it is possible to generate minute suction force (for example, -5Pa), and monomer gas can be dissolved in water and discharged. The suction pump 34 is not limited to the water jet pump, and, for example, a blower may be used.

[0052] In the exhaust device 4 with the above structure, when the suction pump 34 is operated, by the suction force of the suction pump 34, monomer gas is sucked and discharged after passing through the exhaust holes 72 of the exhaust rings 32, the internal space 44 of the enclosure member 31, and the duct 33 in this order (see arrows in FIG. 3).

[0053] Here, when thin filaments f are being spun out, and monomer gas is sucked out from the inside of the exhaust rings 32, air flow around the filaments f that have just been spun out from the spinnerets 13 is disturbed, yarns tend to sway and, as a result, deterioration of quality of the yarns may be caused. For example, when gas is spun out drastically from the inside of the exhaust rings 32, air flow around the filaments f tend to be disturbed. Furthermore, when, for example, gas is sucked drastically in some exhaust rings 32, suction quantity of gas is dispersed between a plurality of exhaust rings 32. In such a case, the degree of sway of yarns and the like tends to be different between the exhaust rings 32, and, as a result, the quality of yarns tends to be dispersed. Therefore, when thin filaments f are spun out, simply sucking gas is not sufficient enough, and a technology of sucking gas while suppressing disturbance of air flow and dispersion of suction quantity of gas between the exhaust rings 32 is especially required.

[0054] In this regard, the present inventors pay attention to, for example, the sizes of the exhaust holes 72 formed in each exhaust ring 32. That is, through fluid analysis to be described below, the inventors have found it possible to suppress disturbance of air flow and dispersion of suction quantity of gas between the exhaust rings 32, by regulating properly (1) size of each exhaust hole 72, (2) percentage of the sum of the area of the exhaust holes 72 in the internal area of each exhaust ring 32, (hereinafter, referred to as opening ratio), and (3) arrangement of the exhaust holes 72.

(Analysis Conditions)

[0055] The following describes a fluid analysis carried out by the present inventors. Common conditions for all analytical models are as follows. The exhaust rings 32 (twelve rings) were staggered as shown in FIG. 3. In addition, suction force of the suction pump was -5Pa.

[0056] Next, the details of the analysis conditions and the analysis results will be described with reference to FIGs. 6 to 11. FIG. 6 is a table showing details of analysis conditions and analysis results of all examples (examples 1 to 8) and comparative examples (comparative examples 1 to 4). In FIG. 6, examples and comparative examples are shown in an ascending order of the area of each exhaust hole 72 (see a thick-bordered frame). FIGs. 7(a) to 7(f) show arrangement examples of exhaust holes of an exhaust ring. FIGs. 7(a) to 7(c) are side views of exhaust rings 32, and FIGs. 7(d) to 7(f) are cross sections of exhaust rings 32 which are taken along the direction orthogonal to in the up-down direction. FIG. 8 is a table in which examples 1 to 8 and comparative examples 1 to 3 are reordered in an ascending order of the opening ratio (see a thick-bordered frame). FIG. 9 is a graph showing opening ratio dependency of dispersion in suction quantity (in an exhaust ring 32), which will be described later. FIG. 10 is a graph showing opening ratio dependency of dispersion in suction quantity (between exhaust rings 32). FIG. 11 is a table showing dependency of dispersion in suction quantity on the arrangement of plural exhaust holes 72 (see a thick-bordered frame).

[0057] In FIGs. 6, 8, and 11, as specific conditions, from left to right of the sheet, the following seven conditions are described: (1) shapes of exhaust holes 72; (2) size of each exhaust hole 72; (3) the number of exhaust holes 72; (4) arrangement of exhaust holes 72; (5) total sum of area of exhaust holes 72 (total area of holes); (6) internal area of exhaust rings 32; and (7) opening ratio.

[0058] As shown in FIG. 6, the shapes of the exhaust holes 72 (the above (1)) were circle and slit. In the above condition (4), exhaust holes 72 were arranged at regular intervals in the circumferential direction of an exhaust ring 32, or arranged at the both side faces in the left-right direction in a concentrated manner. FIGs. 7(a) and 7(d) illustrate the exhaust ring 32 of example 2 (circular exhaust holes 72a are arranged at regular intervals in an exhaust ring 32a). FIGs. 7(b) and 7(e) illustrate the exhaust ring 32 of example 4 (circular exhaust holes 72b are arranged at the both side faces in the left-right direction of an exhaust ring 32b in a concentrated manner). FIGs. 7(c) and 7(f) illustrate the exhaust ring 32 of comparative example 4 (slit-like exhaust holes 72c are arranged at regular intervals in an exhaust ring 32c).

[0059] In FIG. 6, FIG. 8, and FIG. 11, as analysis results, suction quantity of gas per unit time, dispersion of suction quantity of gas in one exhaust ring 32 (CV%), dispersion of suction quantity of gas between exhaust rings 32 (CV%), and judgement (OK or NG) are described. The suction quantity of gas per unit time is an average value of suction quantity per one exhaust ring 32. That is, the average value is calculated by dividing the total sum of suction quantity of gas sucked from the inside of twelve exhaust rings 32 per unit time by the number of exhaust rings 32.

[0060] As dispersion of suction quantity of gas in one exhaust ring 32 (hereinafter, referred to as dispersion in ring), the following values are described. For each exhaust ring 32, standard deviation of data of suction quantity of gas per unit time in exhaust holes 72 was calculated. Then, each of the standard deviations was divided by the average value of the data of suction quantity (that is, CV% of each of twelve exhaust rings 32 was calculated). Furthermore, an average value of the twelve sets of CV% was calculated. The average value of CV% calculated in this way is referred to as dispersion in ring.

[0061] As dispersion of suction quantity of gas between twelve exhaust rings 32 (hereinafter, referred to as dispersion between rings), the following values are described. For each exhaust ring 32, suction quantity of gas per unit time was calculated (that is, data of suction quantity in each of twelve exhaust rings 32 was calculated). Then, standard deviation of the twelve sets of suction quantity data was divided by an average value of the twelve sets of data (that is, CV% was calculated) . The CV% calculated in this way is referred to as dispersion between rings.

[0062] As describe below, dispersion in ring is an index of disturbance of air flow inside of the exhaust ring 32 (that is, degree of yarn sway). For example, when suction quantity of an exhaust hole 72 of an exhaust ring 32 is large as compared to the other exhaust holes 72 (in other words, gas is unevenly discharged from one or some of exhaust holes 72, and air flow in the exhaust ring 32 tends to be disturbed), the value of dispersion in ring is large. On the contrary, when the value of dispersion in ring is small, as compared to cases where the value is large, it is suggested that gas tends to be evenly discharged from the exhaust holes 72 and disturbance of air flow inside the exhaust ring 32 (that is, around filaments f that have just been spun out) is suppressed.

[0063] The value of dispersion between rings is large in such cases where suction quantity of gas in one or some of exhaust rings 32 is large/small as compared to the other exhaust rings 32 (that is, the degree of sway of yarns and the like tends to be different between the exhaust rings 32, and, as a result, the quality of yarns tends to be inconsistent). On the contrary, when the value of dispersion between rings is small, as compared to cases where the value is large, it is suggested that gas is evenly sucked from the exhaust rings 32.

[0064] Judgement was made as follows: an example in which both values of dispersion in ring and dispersion between rings are 2% or less was judged as "OK", whereas an example in which either value was more than 2% was judged as "NG". The following will describe analysis results.

(Dependency on Size of Exhaust Hole)

[0065] As shown in FIG. 6, the size of each exhaust hole 72 of an exhaust ring 32 was changed in the range of 7.1 mm^2 to 57mm^2, and comparisons between examples 1 to 8 and comparative examples 1 to 4 in relation to dispersion in ring and dispersion between rings were conducted. As a result, when the size of each exhaust hole 72 was 7.1 mm^2 (φ3) or 12.6 mm^2 (φ4) (examples 1 to 6), both values of dispersion in ring and dispersion between rings were 2% or less (OK). When the size of each exhaust hole 72 was 28.3 mm^2 (φ6), examples and comparative examples were divided into those judged as "OK" (examples 7 and 8), and those judged as "NG" (comparative examples 1 to 3). When the size of each exhaust hole 72 was 57 mm^2 (comparative example 4), judgement was "NG", and especially, the value of dispersion between rings was high, i.e., 3.1%. Values of dispersion in ring and dispersion between rings tended to be large as the size of each exhaust hole 72 was increased.

[0066] The present inventors interpreted the above result as follows. To begin with, the present inventors considered that by making area of each exhaust hole 72 smaller to make passage resistance higher, it would be possible to restrain gas from being sucked in a concentrated manner through exhaust holes 72 at a position where gas flowed easily, such as those at a position which was close to the connecting portion with the duct 33. That is, by making passage resistance of each exhaust hole 72 higher, gas was likely to be sucked evenly through each exhaust hole 72, and concentration of an air flow to one or some of exhaust holes 72 was restrained, with the result that the value of dispersion in ring was small. Based on the above, the present inventors considered that disturbance of air flow around filaments f that have just been spun out could be suppressed.

[0067] The present inventors considered that making area of each exhaust hole 72 smaller, would suppress dispersion of suction quantity of gas between exhaust rings 32. That is, they considered that by restraining concentration of air flow to one or some of exhaust holes 72, as compared to cases where air flow concentrated to one or some of exhaust holes 72, flow rate dispersion in the whole internal space 44 of the enclosure member 31 could be reduced, and dispersion between rings could be suppressed.

[0068] Based on the above, to make values of dispersion in ring and dispersion between rings small, it is necessary to arrange the area of each exhaust hole 72 to be at least approximately 30 mm^2 or less in order to increase the resistance of each exhaust hole 72. More preferably, by setting the area of each exhaust hole 72 at approximately 13 mm^2 or less to further increase the resistance of each exhaust hole 72, it is possible to make dispersion in ring and dispersion between rings small.

[0069] Here, it does not mean that the smaller the area of exhaust holes 72 the better. When monomer gas solidifies inside or around exhaust holes 72, exhaust holes 72 may be clogged. Therefore, to restrain exhaust holes 72 from being clogged, it is preferable that the area of each exhaust hole 72 is 7 mm^2 or more.

(Opening Ratio Dependency)

[0070] Next, based on the above-described analysis result of dependency on the size of each exhaust hole 72, the present inventors paid attention to the following point. That is, even if the size of each exhaust hole 72 is same, values of dispersion in ring and dispersion between rings vary according to the numbers of exhaust holes 72 (in other words, the total aperture area in each exhaust ring 32). More specifically, the present inventors assumed that dispersion in ring and dispersion between rings might be influenced by the percentage of the total aperture area in the internal area of an exhaust ring 32, that is, an opening ratio.

[0071] Then, as shown in FIG. 8, the present inventors changed conditions of the total aperture area of each exhaust ring 32 and conditions of the internal area of an exhaust ring 32 to vary the opening ratio in the range of 0.70 % to 3.88 % (see a thick-bordered frame in FIG. 8), and conducted comparisons between examples 1 to 8 and comparative examples 1 to 3 in relation to dispersion in ring and dispersion between rings. The total aperture area of the exhaust ring 32 was changed in the range of 71 mm^2 to 396 mm^2. The internal area of the exhaust ring 32 was 10207 mm^2 (inner diameter φ was 114 mm) or 12076 mm^2 (inner diameter φ was 124 mm). In addition, in FIG. 8, only examples (examples 1 to 8) and comparative examples (comparative examples 1 to 3), in which the shape of each exhaust hole 72 is circular, are shown.

[0072] FIG. 9 is a graph showing the dependency on the size of each exhaust hole 72 and the opening ratio dependency of dispersion in ring. When the area of each exhaust hole 72 was 28.3 mm^2 or less and the opening ratio was approximately 3% or less, dispersion in ring was 2% or less. In addition, when the opening ratio was approximately 1.25 % or less, dispersion in ring was further reduced to 1.5 % or less. FIG. 10 is a graph showing the dependency on the size of each exhaust hole 72 and the opening ratio dependency of dispersion between rings. When the area of each exhaust hole 72 was 28.3 mm^2 or less and the opening ratio was approximately 2.5% or less, dispersion between rings was 2% or less. In addition, when the opening ratio was approximately 1.25% or less, dispersion between rings was further reduced to 1% or less. Furthermore, when the area of exhaust holes 72 was 57 mm^2 (comparative example 4), even though the opening ratio was low, i.e., 1.80 %, dispersion between rings was large, i.e., 3.1%. That is, as described above, not only the opening ratio should be low but also the area of each exhaust hole 72 should be small.

[0073] Thus, when the opening ratio was approximately 2.5 % or less (examples 1 to 8), dispersion in ring and dispersion between rings were small, i.e., 2 % or less, whereas, when the opening ratio was 2.5 % or more (comparative examples 1 to 3), dispersion between rings was far larger than 2 %. Furthermore, when the opening ratio was approximately 1.25 % or less (examples 1 to 4), dispersion in ring was smaller than 1.5 % and dispersion between rings was smaller than 1 %. As such, satisfactory results were obtained.

[0074] The present inventors interpreted the above result as follows. When the opening ratio was high, suction quantity of gas per unit time was large in comparison with the capacity of the internal space of the exhaust ring 32, with the result that air flow around filaments f that have just been spun out tended to be disturbed. In addition, when the opening ratio was high, gas was likely to be drastically discharged from the inside of the exhaust ring 32 and air flow in the internal space 44 of the enclosure member 31 was likely to be disturbed, with the result that dispersion between rings was large. On the other hand, by suppressing the opening ratio, it would be possible to suppress suction quantity from being excessively increased relative to the capacity of the internal space of exhaust ring 32, with the result that disturbance of air flow inside the exhaust ring 32 could be suppressed. Furthermore, by suppressing the opening ratio, it would be possible to suppress gas from being drastically discharged from the inside of the exhaust ring 32, with the result that dispersion between rings could be reduced.

[0075] Between examples (examples 2 and 3) or between comparative examples (comparative examples 2 and 3) which were same except in the internal area of the exhaust ring 32, the internal area of the exhaust ring 32 was large (in other words, the opening ratio was low) dispersion in ring and dispersion between rings were large in an example and a comparative example in which the internal area of the exhaust ring 32 was large (in other words, the opening ratio was low). This was because, in a condition where the internal area of exhaust ring 32 was large, as compared to a condition where the internal area was small, an interval between adjacent exhaust rings 32 was narrow, and streams of discharged gas collided with each other, and the air flow tends to be disturbed.

[0076] Based on the above, to reduce dispersion in ring and dispersion between rings, the area of each exhaust hole 72 should be approximately 30 mm^2 or less, and the opening ratio should be 2.5 % or less. More preferably, the opening ratio should be 1.25 % or less. With this arrangement, gas is sucked more slowly, and dispersion in ring and dispersion between rings can be considerably reduced.

(Dependency on Arrangement of Exhaust Holes)

[0077] As shown in FIG. 11, fluid analysis of dependency on arrangement of exhaust holes 72 was conducted. That is, in examples where conditions are same except for the arrangement of exhaust holes 72 of each exhaust ring 32, examples in which the exhaust holes 72 were arranged at equal intervals (see FIG. 7(d)), and examples in which the exhaust holes 72 were arranged at the both side faces (see FIG. 7(e)) in a concentrated manner, were compared with one another in terms of dispersion in ring and dispersion between rings. Specifically, example 2 and example 4 were compared and example 7 and example 8 were compared. As a result, when exhaust holes 72 were arranged at equal intervals, the value of dispersion in ring was slightly large, and the value of dispersion between rings was slightly suppressed.

[0078] The present inventors interpreted the above result, as follows. Since exhaust holes 72 of each exhaust ring 32 were arranged at equal intervals, gas tended to be discharged evenly in the circumferential direction of each exhaust ring 32. Because the flow rate of gas around each exhaust ring 32 was close to even, flow rate dispersion in the whole internal space 44 of the enclosure member 31 could be reduced, as compared to cases where the flow rate around each exhaust ring 32 dispersed greatly. Thus, it was considered that dispersion of suction quantity of gas between exhaust rings 32 could be suppressed. Based on the above, to reduce dispersion between rings, it is preferable to arrange exhaust holes 72 at equal intervals in the circumferential direction of an exhaust ring 32.

[0079] When exhaust holes 72 are arranged at the both side faces in a concentrated manner, the exhaust holes 72 are close to one another. Therefore, suction quantity of gas from each exhaust hole 72 tended to be similar, as a result, dispersion in ring tended to be small. On the other hand, as compared to the condition where exhaust holes 72 were arranged at equal intervals, it seems that dispersion between rings is slightly large because gas is unlikely to be discharged evenly in the circumferential direction of each exhaust ring 32.

(Evaluation Result of Yarn Quality)

[0080] Next, the present inventors picked out some conditions from examples and comparative examples based on the above analysis result, and conducted a pilot experiment of yarn quality. The result will be described below with reference to FIG. 12.

[0081] As shown in FIG. 12, with regard to examples 2, 5, and 6, and comparative example 2, yarns ware actually produced and the yarn property was evaluated. To begin with, common conditions were as follows: diameter of spinneret was φ 85 mm; inner diameter of an exhaust ring 32 was φ 114 mm (internal area, 10207 mm^2); and thickness of yarn was 0.45 dtex per filament (0.41DPF). In addition, the shape of each of exhaust holes 72 was circular, and the opening ratio was changed in the range of 1.23 % to 3.88 % (see the left thick-bordered frame), and four kinds of yarns were produced. Evaluation of yarn quality was made based mainly on a test result of U % (see the right thick-bordered frame). U % is a yarn property showing variations of thickness of yarns. The smaller this value, the less dyeing unevenness and the better yarn quality. Judgement was made as follows: cases where U % was 0.6 % or less were judged as "OK", whereas cases where U % was more than 0.6 % were judged as "NG".

[0082] As a result, in examples 2, 5, and 6, U % was 0.6 % or less (OK), and, in comparative example 2, U % was more than 0.6 % (NG). The smaller the opening ratio and the values of dispersion in ring and dispersion between rings were, the smaller U % was, and the yarn quality was improved. Based on this result, it was confirmed that, when the opening ratio and the values of dispersion in ring and dispersion between rings were small, yarns with better quality could be produced, and that the analysis result was in consistency with the pilot experiment.

[0083] As described above, by making the area of each exhaust hole 72 be equal to or smaller than 30mm^2 so as to increase passage resistance of the exhaust hole 72, it is possible to suppress drastic discharge of gas and sucking of gas in a concentrated manner through an exhaust hole 72 at a position where gas easily flows. That is, by making the resistance of each exhaust hole 72 bigger, gas is likely to be sucked evenly through each exhaust hole 72, and to suppress concentration of the air flow to one or some of the exhaust holes 72 inside the exhaust ring 32. Furthermore, by arranging the opening ratio to be equal to or lower than 2.5%, it is possible to suppress suction quantity of gas per unit time from being excessively large relative to the capacity of the internal space of an exhaust ring, with the result that disturbance of air flow inside the exhaust ring 32 can be suppressed.

[0084] Furthermore, by making the area of each exhaust hole 72 smaller, it is possible to suppress the dispersion of suction quantity of gas between exhaust rings 32. That is, by restraining the concentration of air flow to one or some of the exhaust holes 72, as compared to cases where air flow concentrates to one or some of the exhaust holes 72, the flow rate dispersion in the whole internal space 44 of the enclosure member 31 can be reduced, and the dispersion of suction quantity of gas between the exhaust rings 32 can be suppressed. Furthermore, by decreasing the opening ratio so as to suppress rapid gas discharge from the inside of the exhaust ring 32, it is possible to restrain disturbance of air low in the internal space 44 of the enclosure member 31 as compared to cases where gas is rapidly discharged, and hence the dispersion in suction quantity of gas between the exhaust rings 32 is restrained.

[0085] As described above, by arranging the area and opening ratio of each exhaust hole 72 to be equal to or smaller than predetermined values, the disturbance of air flow around filaments f that have just been spun out is restrained, and the dispersion of suction quantity of gas between the exhaust rings 32 is reduced.

[0086] Further preferably, by arranging the area of each exhaust hole 72 to be equal to or smaller than 13 mm^2 so as to further suppress the concentration of air flow inside the exhaust ring 32 to one or some of the exhaust holes 72, the disturbance of air flow around filaments f that have just been spun out is significantly restrained, and the dispersion of suction quantity of gas between the exhaust rings 32 is significantly reduced.

[0087] Further preferably, by arranging the opening ratio to be equal to or smaller than 1.25% so as to further suppress drastic sucking of gas inside the exhaust ring 32, the disturbance of air flow around filaments f that have just been spun out is significantly restrained, and the dispersion of suction quantity of gas between the exhaust rings 32 is significantly reduced.

[0088] Furthermore, by arranging the area of each exhaust hole 72 to be 7 mm^2 or more, it is possible to restrain the clogging of the exhaust hole 72.

[0089] Furthermore, providing the exhaust holes 72 of each exhaust ring 32 at regular intervals in the circumferential direction facilitates even discharge of gas in the circumferential direction of each exhaust ring 32. Because the flow rate of gas around each exhaust ring 32 is close to even, flow rate dispersion in the whole internal space 44 of the enclosure member 31 can be reduced as compared to cases where the flow rate around each exhaust ring 32 is dispersed greatly. It is therefore possible suppress the dispersion of the suction quantity of gas between the exhaust rings 32.

[0090] In addition to the above, making each of the exhaust holes 72 have a smooth circular shape suppresses the possibility of generation of turbulent flow, when the gas is discharged. Furthermore, each exhaust hole 72 can be closed by using a typical pin or screw. The total aperture area is therefore changeable by increasing or decreasing the number of pins or screws which close the exhaust holes 72. With this arrangement, because it is unnecessary to replace the exhaust ring 32 to change the total aperture area, and it is easy to change the total aperture area, cost and labor are saved.

[0091] In addition to the above, because the disturbance of air flow around filaments f that have just been spun out can be suppressed, it is possible to particularly effectively restrain the dispersion in yarn quality in an arrangement of spinning out thin filaments f which are equal to or lower than 0.55 dtex per filament (0.5DPF).

[0092] In addition to the above, smooth gas flow from the passage reduction part 61 toward the linear part 63 along the curved part 62 is facilitated. This restrains air flow from being stripped, and therefore restrains generation of whirls.

[0093] Furthermore, because the enclosure member 31 is divided into the first member 31a and the second member 31b and the second member 31b is attachable to and detachable from the first member 31a, maintenance inside the enclosure member 31 can be easily done. It is therefore possible to restrain the suction force from being decreased.

[0094] In particular, a gas passage may be clogged when monomer gas solidifies at around the curved part 62 and the linear part 63. The arrangement in which the enclosure member 31 is divided and the second member 31b is attachable to and detachable from the first member 31a is very effective for restraining the clogging of the passage.

[0095] The following will describe modifications of the above-described embodiment. The members identical with those in the embodiment above will be denoted by the same reference numerals and the explanations thereof are not repeated.

(1) While in the embodiment above the curved part 62 is provided between the passage reduction part 61 and the linear part 63 of the enclosure member 31, the disclosure is not limited to this arrangement. For example, when a corner is formed by the passage reduction part 61 and the linear part 63, generation of whirls may be restrained by slowly sucking gas.

(2) While in the embodiment above the enclosure member 31 is divided into the first member 31a and the second member 31b, the disclosure is not limited to this arrangement. Even when the enclosure member 31 is not divided, for example, the passage part 60 may be cleaned in such a way that the monomer is vaporized again by heating the enclosure member 31 at the time of maintenance and the gas is sucked by driving the suction pump 34. Alternatively, solidification of monomer gas may be restrained in such a way that an unillustrated heater or a heat insulating material is attached to the enclosure member 31 to keep the temperature of the internal space 44 to be constant.

(3) While in the embodiment above the spinning beam 2 spins out filaments f which are equal to or lower than 0.55 dtex per filament (0.5DPF), the disclosure is not limited to this arrangement. Even when thick filaments f are spun out, suppression of gas flow disturbance by restraining dispersion of suction quantity of gas is effective for the improvement of yarn quality.

(4) The shape of each exhaust hole 72 of the exhaust ring 32 may not be circular, and may be elliptic, for example.

(5) While in the embodiment above the spinning beam 2 spins out nylon 6 as polymer, the disclosure is not limited to this arrangement. The present invention can be applied to cases where polymer such as another type of nylon or polyester is spun out, as a matter of course.

Claims

1. A melt spinning device (1) comprising: a spinning unit (2) which includes spinnerets (13), and is configured to spin out filaments (f) from the spinnerets (13);
cooling cylinders (21) which are respectively disposed below the spinnerets (13); a cooling unit (3) which is configured to cool the filaments (f) spun out from the spinnerets (13); and
an exhaust unit (4) which is disposed between the spinning unit (2) and cooling unit (3) in a traveling

direction of the filaments (f), and is configured to suck and discharge gas which is generated from the spun out filaments (f),
the exhaust unit (4) including:

> a suction device (34) which is configured to suck the gas;
> exhaust rings (32) which are respectively arranged between the spinnerets (13) and the cooling cylinders (21), and which are provided so as to surround the filaments (f) that are spun out from the spinnerets (13); and
> an enclosure member (31) which is connected to the suction device (34), and disposed so as to surround the exhaust rings (32), and in the member (31), an internal space (44), where the gas which was spun out from inside of the exhaust rings (32) flow, is formed,
> exhaust holes (72) to suck and discharge the gas being formed in a peripheral wall (71) of each exhaust ring (32),
> the area of each of the exhaust holes (72) of each of the exhaust rings (32) being 30 mm^2 or less,
> the percentage of the sum of the area of the exhaust holes (72) relative to the internal area of each of the exhaust rings (32) being 2.5 % or less.

2. The melt spinning device (1) according to claim 1, wherein, the area of each of the exhaust holes (72) is 13 mm^2 or less.

3. The melt spinning device (1) according to claim 1 or 2, wherein, the percentage of the sum of the area of the exhaust holes (72) relative to the internal area of the each of the exhaust rings (32) is 1.25 % or less.

4. The melt spinning device (1) according to any one of claims 1 to 3, wherein, the area of each of the exhaust holes (72) is 7 mm^2 or more.

5. The melt spinning device (1) according to any one of claims 1 to 4, wherein, the exhaust holes (72) of each of the exhaust rings (32) are disposed at equal intervals in the circumferential direction of each of the exhaust rings (32) .

6. The melt spinning device (1) according to any one of claims 1 to 5, wherein, each of the exhaust holes (72) has a circular shape.

7. The melt spinning device (1) according to any one of claims 1 to 6, wherein, the spinning unit (2) is capable of spinning out filaments (f) whose thickness is 0.55 dtex per filament (0.5DPF) or less.

8. The melt spinning device (1) according to any one of claims 1 to 7, wherein, the enclosure member (31) comprises:

> a passage reduction part (61) whose passage width is arranged to be narrowed toward the downstream side in a suction direction in which the gas is sucked;
> a linear part (63) whose passage width is constant, and which is arranged on the suction device (34) side of the passage reduction part (61), in the suction direction; and
> a curved part (62) which is disposed between the passage reduction part (61) and the linear part (63) and has a curved passage.

9. The melt spinning device (1) according to any one of claims 1 to 8, wherein, the enclosure member (31) is divided into a first member (31a) on the upstream side and a second member (31b) on the downstream side, in a suction direction in which the gas is sucked, and,
the second member (31b) is attachable to and detachable from the first member (31a).

Patentansprüche

1. Schmelzspinnvorrichtung (1), umfassend: eine Spinneinheit (2), die Spinndüsen (13) einschließt, und die konfiguriert ist, Filamente (f) aus den Spinndüsen (13) herauszuspinnen;
Kühlzylinder (21), die jeweils unterhalb der Spinndüsen (13) angeordnet sind; eine Kühleinheit (3), die konfiguriert ist, die aus den Spinndüsen (13) herausgesponnenen Filamente (f) zu kühlen; und
eine Auslasseinheit (4), die zwischen der Spinneinheit (2) und der Kühleinheit (3) in einer Laufrichtung der Filamente (f) angeordnet ist und konfiguriert ist, Gas anzusaugen und abzulassen, das aus den herausgesponnenen Filamenten (f) erzeugt wird,
wobei die Auslasseinheit (4) einschließt:

> eine Ansaugvorrichtung (34), die konfiguriert ist, das Gas anzusaugen;
> Auslassringe (32), die jeweils zwischen den Spinndüsen (13) und den Kühlzylindern (21) angeordnet sind und die so bereitgestellt sind, dass sie die aus den Spinndüsen (13) herausgesponnenen Filamente (f) umgeben; und
> ein Gehäuseelement (31), das mit der Ansaugvorrichtung (34) verbunden und so angeordnet ist, dass es die Auslassringe (32) umgibt, und wobei in dem Element (31) ein Innenraum (44) gebildet ist, in dem das Gas aus dem Inneren des Flusses der Auslassringe (32) herausgesponnen wird,
> Auslasslöcher (72) zum Ansaugen und Ablassen des in einer Umfangswand (71) jedes Aus-

lassrings (32) gebildeten Gases,
wobei die Fläche jedes der Auslasslöcher (72) jedes der Auslassringe (32) 30 mm^2 oder weniger beträgt,
der Prozentsatz der Summe der Fläche der Auslasslöcher (72) relativ zur Innenfläche jedes der Auslassringe (32) 2,5 % oder weniger beträgt.

2. Schmelzspinnvorrichtung (1) nach Anspruch 1, wobei die Fläche jedes der Auslasslöcher (72) 13 mm^2 oder weniger beträgt.

3. Schmelzspinnvorrichtung (1) nach Anspruch 1 oder 2, wobei der Prozentsatz der Summe der Fläche der Auslasslöcher (72) relativ zur Innenfläche jedes der Auslassringe (32) 1,25 % oder weniger beträgt.

4. Schmelzspinnvorrichtung (1) nach einem der Ansprüche 1 bis 3, wobei die Fläche jedes der Auslasslöcher (72) 7 mm^2 oder mehr beträgt.

5. Schmelzspinnvorrichtung (1) nach einem der Ansprüche 1 bis 4, wobei die Auslasslöcher (72) jedes der Auslassringe (32) in gleichen Abständen in Umfangsrichtung jedes der Auslassringe (32) angeordnet sind.

6. Schmelzspinnvorrichtung (1) nach einem der Ansprüche 1 bis 5, wobei jedes der Auslasslöcher (72) eine kreisförmige Form aufweist.

7. Schmelzspinnvorrichtung (1) nach einem der Ansprüche 1 bis 6, wobei die Spinneinheit (2) Filamente (f) herausspinnen kann, deren Dicke 0,55 dtex pro Filament (0,5 DPF) oder weniger beträgt.

8. Schmelzspinnvorrichtung (1) nach einem der Ansprüche 1 bis 7, wobei das Gehäuseelement (31) umfasst:

einen Durchgangsreduzierungsteil (61), dessen Durchgangsbreite so angeordnet ist, dass sie in einer Ansaugrichtung, in der das Gas angesaugt wird, zur stromabwärtigen Seite hin verengt wird;
einen linearen Teil (63), dessen Durchgangsbreite konstant ist und der auf der Seite der Ansaugvorrichtung (34) des Durchgangsreduzierungsteils (61) in Ansaugrichtung angeordnet ist; und
einen gekrümmten Teil (62), der zwischen dem Durchgangsreduzierungsteil (61) und dem linearen Teil (63) angeordnet ist und einen gekrümmten Durchgang aufweist.

9. Schmelzspinnvorrichtung (1) nach einem der Ansprüche 1 bis 8, wobei das Gehäuseelement (31) in ein erstes Element (31a) auf der stromaufwärtigen Seite und ein zweites Element (31b) auf der stromabwärtigen Seite, in einer Ansaugrichtung unterteilt ist, in der das Gas angesaugt wird, und
das zweite Element (31b) an dem ersten Element (31a) anbringbar und von diesem abnehmbar ist.

Revendications

1. Dispositif de filage en fusion (1) comprenant : une unité de filage (2) qui inclut des filières (13), et est configurée pour extraire des filaments (f) depuis les filières (13) ;
des cylindres de refroidissement (21) qui sont respectivement disposés en dessous des filières (13) ;
une unité de refroidissement (3) qui est configurée pour refroidir les filaments (f) extraits depuis les filières (13) ; et
une unité d'échappement (4) qui est disposée entre l'unité de filage (2) et l'unité de refroidissement (3) dans une direction de déplacement des filaments (f), et est configurée pour aspirer et libérer du gaz qui est généré depuis les filaments extraits (f),
l'unité d'échappement (4) incluant :

un dispositif d'aspiration (34) qui est configuré pour aspirer le gaz ;
des anneaux d'échappement (32) qui sont respectivement agencés entre les filières (13) et les cylindres de refroidissement (21), et qui sont fournis de manière à entourer les filaments (f) qui sont extraits depuis les filières (13) ; et
un élément d'enceinte (31) qui est raccordé au dispositif d'aspiration (34), et disposé de manière à entourer les anneaux d'échappement (32), et dans l'élément (31), un espace interne (44), où le gaz qui a été extrait de l'intérieur des anneaux d'échappement (32) circule, est formé,
des trous d'échappement (72) pour aspirer et libérer le gaz étant formé dans une paroi périphérique (71) de chaque anneau d'échappement (32),
l'aire de chacun des trous d'échappement (72) de chacun des anneaux d'échappement (32) étant de 30 mm^2 ou moins,
le pourcentage de la somme de l'aire des trous d'échappement (72) par rapport à l'aire interne de chacun des anneaux d'échappement (32) étant de 2,5 % ou moins.

2. Dispositif de filage en fusion (1) selon la revendication 1, dans lequel, l'aire de chacun des trous d'échappement (72) est de 13 mm^2 ou moins.

3. Dispositif de filage en fusion (1) selon la revendication 1 ou 2, dans lequel, le pourcentage de la somme de l'aire des trous d'échappement (72) par rapport à l'aire interne de chacun des anneaux d'échappement (32) est de 1,25 % ou moins.

4. Dispositif de filage en fusion (1) selon l'une quelconque des revendications 1 à 3, dans lequel, l'aire de chacun des trous d'échappement (72) est de 7 mm^2 ou plus.

5. Dispositif de filage en fusion (1) selon l'une quelconque des revendications 1 à 4, dans lequel, les trous d'échappement (72) de chacun des anneaux d'échappement (32) sont disposés à des intervalles égaux dans la direction circonférentielle de chacun des anneaux d'échappement (32).

6. Dispositif de filage en fusion (1) selon l'une quelconque des revendications 1 à 5, dans lequel, chacun des trous d'échappement (72) présente une forme circulaire.

7. Dispositif de filage en fusion (1) selon l'une quelconque des revendications 1 à 6, dans lequel, l'unité de filage (2) est capable d'extraire des filaments (f) dont l'épaisseur est de 0,55 dtex par filament (0,5 DPF) ou moins.

8. Dispositif de filage en fusion (1) selon l'une quelconque des revendications 1 à 7, dans lequel, l'élément d'enceinte (31) comprend :

une partie de réduction de passage (61) dont la largeur de passage est agencée pour être réduite vers le côté aval dans une direction d'aspiration dans laquelle le gaz est aspiré ;
une partie linéaire (63) dont la largeur de passage est constante, et qui est agencée sur le côté de dispositif d'aspiration (34) de la partie de réduction de passage (61), dans la direction d'aspiration ; et
une partie incurvée (62) qui est disposée entre la partie de réduction de passage (61) et la partie linéaire (63) et présente un passage incurvé.

9. Dispositif de filage en fusion (1) selon l'une quelconque des revendications 1 à 8, dans lequel, l'élément d'enceinte (31) est divisé en un premier élément (31a) sur le côté amont et un second élément (31b) sur le côté aval, dans une direction d'aspiration dans laquelle le gaz est aspiré, et,
le second élément (31b) peut être attaché à et détaché du premier élément (31a).

FIG.1

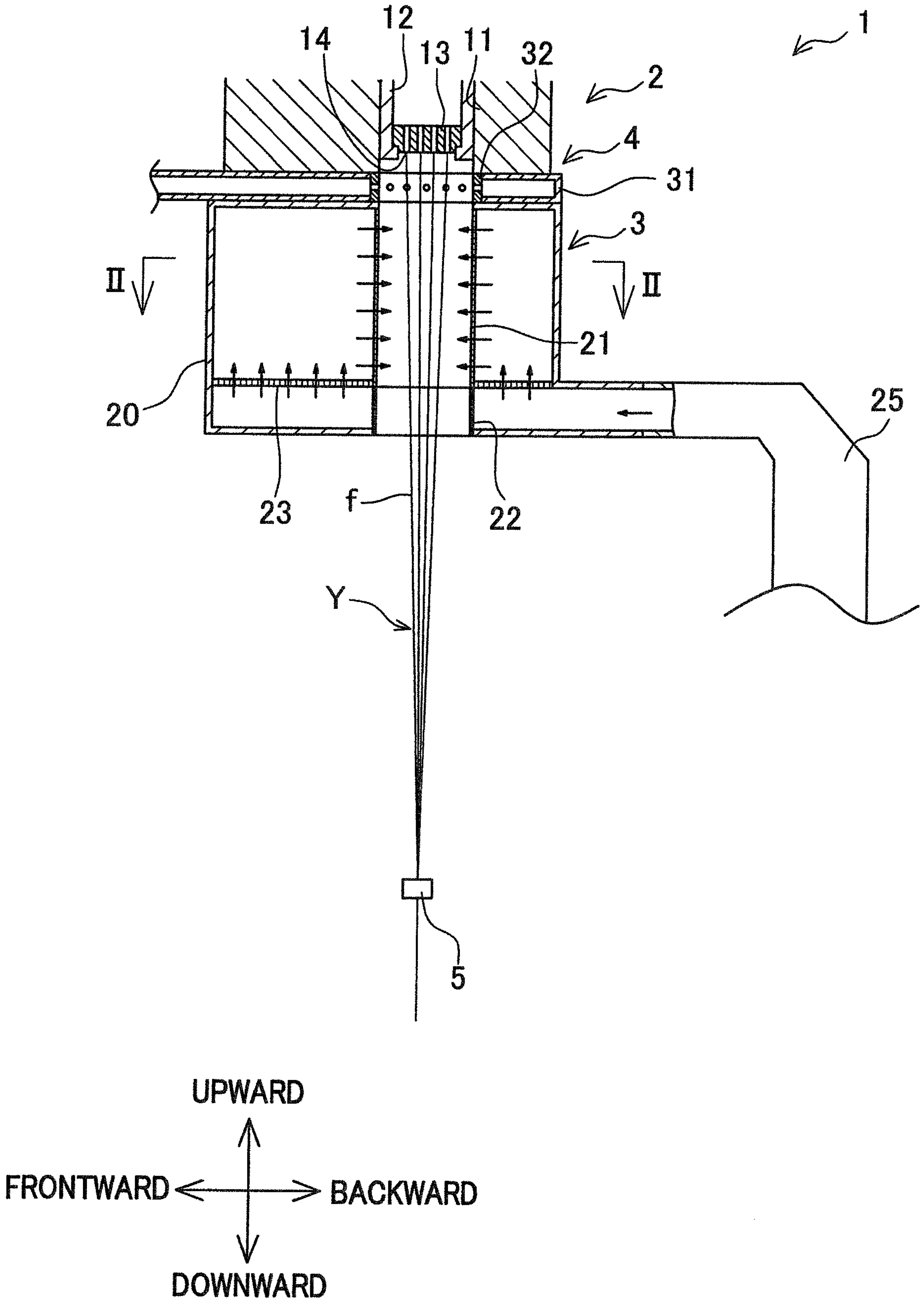

1
2
4
3
12
14
13
11
32
31
II
II
21
20
23
22
25
f
Y
5
UPWARD
FRONTWARD
BACKWARD
DOWNWARD

FIG.2

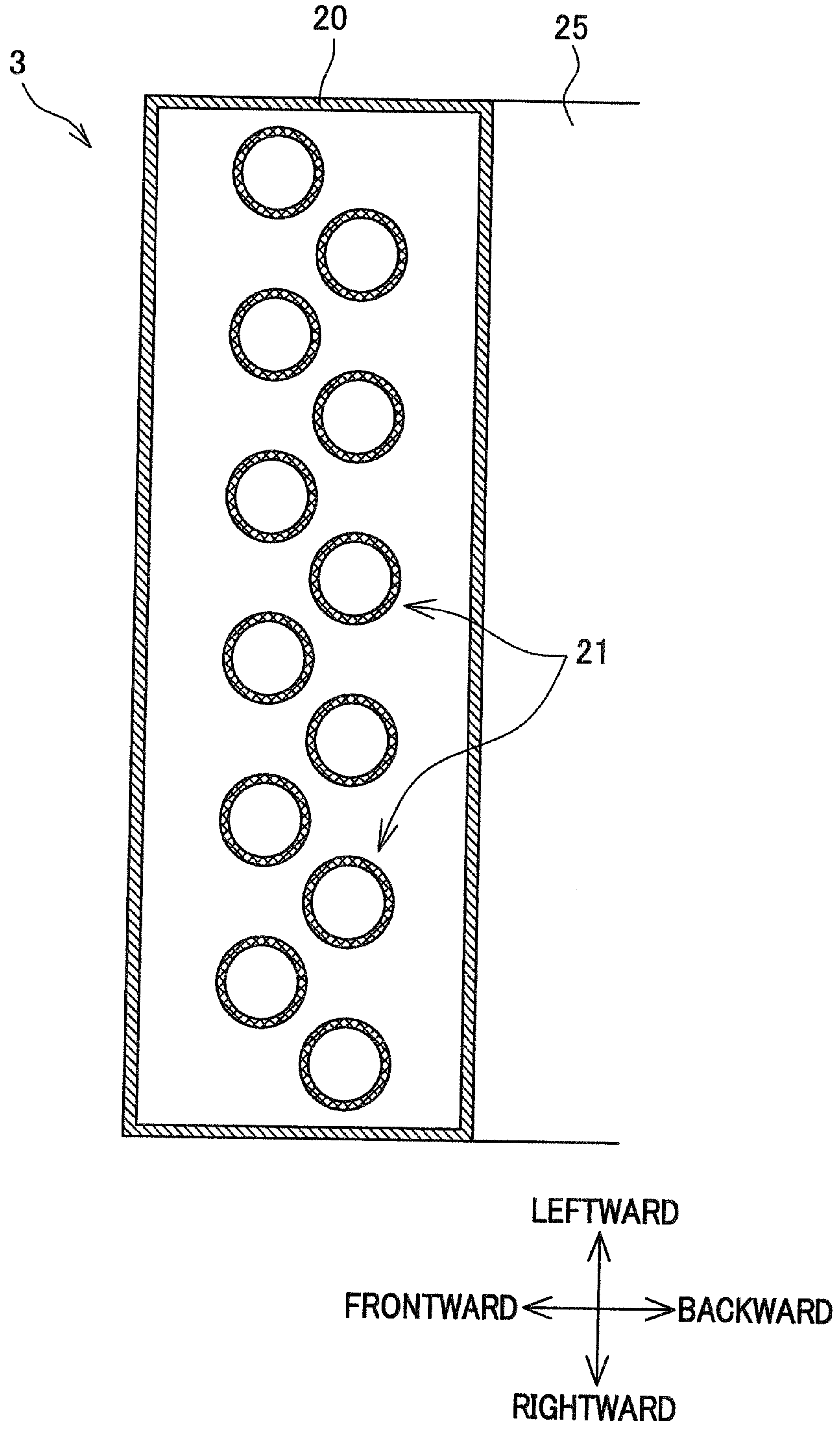


FIG.3

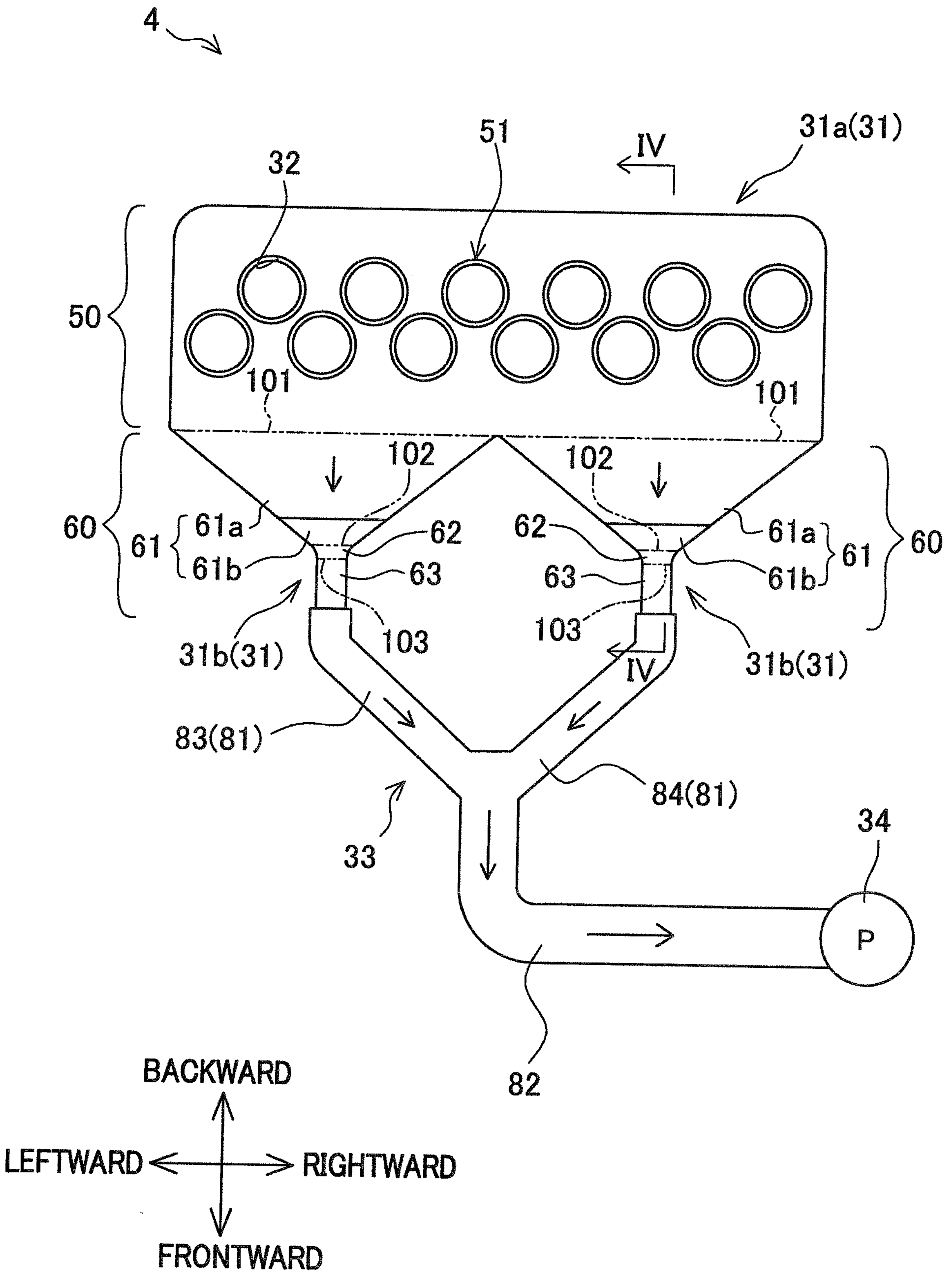

4
32
51
IV
31a(31)
50
101
101
102
102
60
61
61a
61b
62
62
63
63
61a
61b
61
60
31b(31)
103
103
IV
31b(31)
83(81)
84(81)
33
34
P
82
BACKWARD
LEFTWARD
RIGHTWARD
FRONTWARD

FIG.4

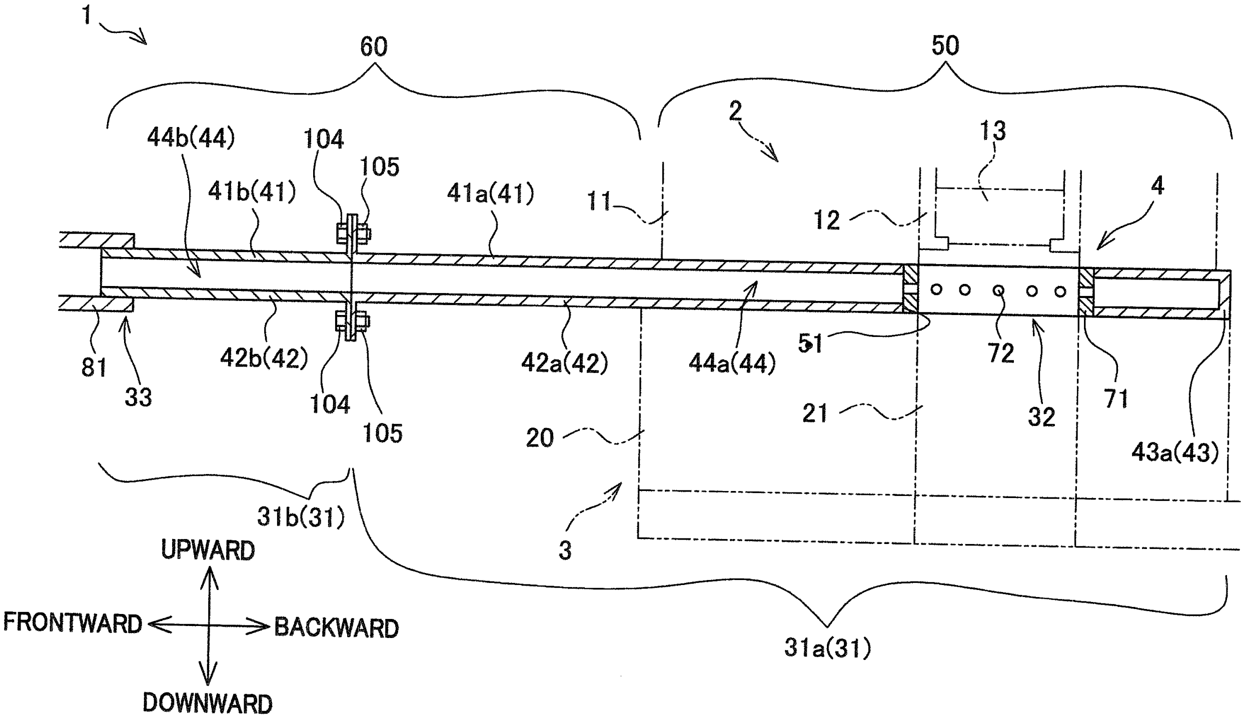

1
60
50
2
13
4
44b(44)
104
105
41b(41)
41a(41)
11
12
81
33
42b(42)
104
105
42a(42)
44a(44)
51
72
32
71
43a(43)
20
21
3
31b(31)
31a(31)
UPWARD
FRONTWARD
BACKWARD
DOWNWARD

FIG.5

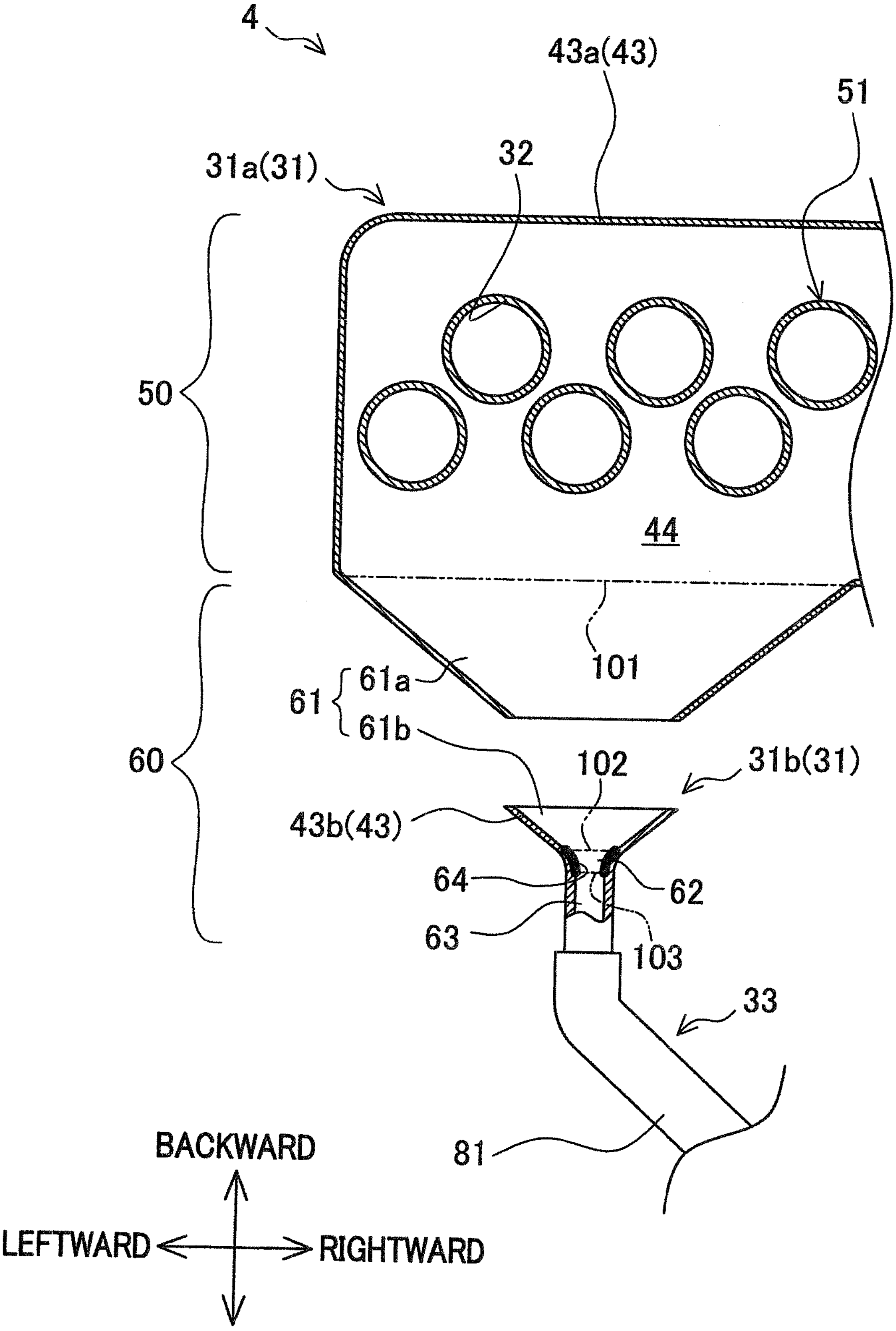
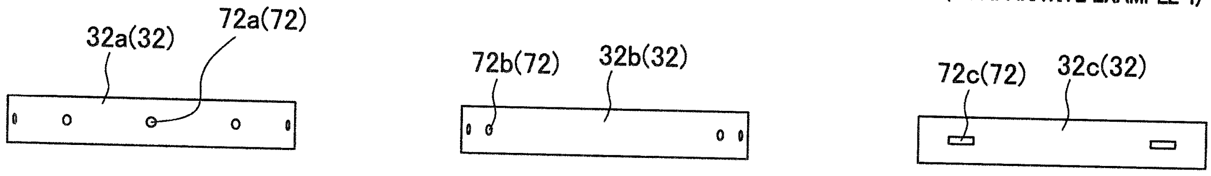

4
43a(43)
51
32
31a(31)
50
44
101
60
61
61a
61b
102
31b(31)
43b(43)
64
62
63
103
33
81
BACKWARD
LEFTWARD
RIGHTWARD
FRONTWARD

FIG.6

ANALYSIS CONDITIONS AND ANALYSIS RESULTS(SIZE OF EACH EXHAUST HOLE IN ASCENDING ORDER)

	SHAPE OF HOLE	SIZE OF EACH HOLE	THE NUMBER OF HOLES	ARRANGEMENT OF HOLES	THE TOTAL AREA OF HOLES [mm^2]	THE INTERNAL AREA OF A RING [mm^2]	OPENING RATIO	AVERAGE SUCTION QUANTITY IN ONE RING [g/min]	DISPERSION OF SUCTION QUANTITY IN A RING (CV%)	DISPERSION OF SUCTION QUANTITY BETWEEN RINGS (CV%)	JUDGEMENT
EXAMPLE 1	CIRCLE	ϕ 3(7.1mm^2)	10	AT REGULAR INTERVALS	71	10207	0.70%	11.9	0.53%	0.34%	OK
EXAMPLE 2	CIRCLE	ϕ 4(12.6mm^2)	10	AT REGULAR INTERVALS	126	10207	1.23%	20.0	0.90%	0.60%	OK
EXAMPLE 3	CIRCLE	ϕ 4(12.6mm^2)	10	AT REGULAR INTERVALS	126	12076	1.04%	18.6	1.36%	0.96%	OK
EXAMPLE 4	CIRCLE	ϕ 4(12.6mm^2)	10	AT BOTH SIDE FACES IN A CONCENTRATED MANNER	126	10207	1.23%	20.1	0.56%	0.92%	OK
EXAMPLE 5	CIRCLE	ϕ 4(12.6mm^2)	14	AT BOTH SIDE FACES IN A CONCENTRATED MANNER	176	10207	1.72%	25.8	0.87%	1.34%	OK
EXAMPLE 6	CIRCLE	ϕ 4(12.6mm^2)	20	AT REGULAR INTERVALS	251	10207	2.46%	31.6	1.69%	1.47%	OK
EXAMPLE 7	CIRCLE	ϕ 6(28.3mm^2)	6	AT REGULAR INTERVALS	170	10207	1.67%	26.5	1.61%	1.66%	OK
EXAMPLE 8	CIRCLE	ϕ 6(28.3mm^2)	6	AT BOTH SIDE FACES IN A CONCENTRATED MANNER	170	10207	1.67%	26.5	0.85%	1.76%	OK
COMPARATIVE EXAMPLE 1	CIRCLE	ϕ 6(28.3mm^2)	10	AT BOTH SIDE FACES IN A CONCENTRATED MANNER	283	10207	2.77%	34.0	1.26%	3.29%	NG
COMPARATIVE EXAMPLE 2	CIRCLE	ϕ 6(28.3mm^2)	14	AT BOTH SIDE FACES IN A CONCENTRATED MANNER	396	10207	3.88%	42.0	3.09%	4.28%	NG
COMPARATIVE EXAMPLE 3	CIRCLE	ϕ 6(28.3mm^2)	14	AT BOTH SIDE FACES IN A CONCENTRATED MANNER	396	12076	3.28%	36.4	6.70%	8.04%	NG
COMPARATIVE EXAMPLE 4	SLIT	19 × 3(57mm^2)	4	AT REGULAR INTERVALS	228	12668	1.80%	33.6	2.01%	3.12%	NG

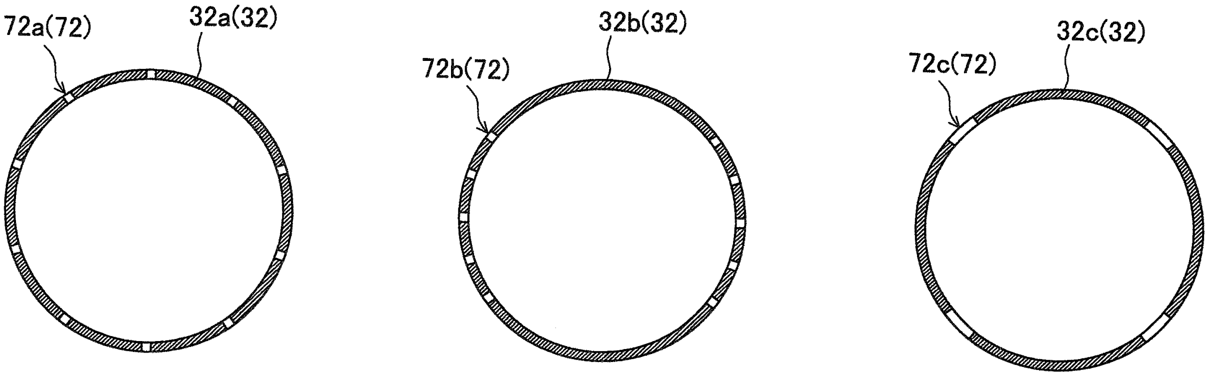
FIG.7



(a) CIRCLE, AT REGULAR INTERVALS (EXAMPLE 2)

(b) CIRCLE, AT BOTH SIDE FACES IN A CONCENTRATED MANNER (EXAMPLE 4)

(c) SLIT, AT REGULAR INTERVALS (COMPARATIVE EXAMPLE 4)



(d) CIRCLE, AT REGULAR INTERVALS (EXAMPLE 2)

(e) CIRCLE, AT BOTH SIDE FACES IN A CONCENTRATED MANNER (EXAMPLE 4)

(f) SLIT, AT REGULAR INTERVALS (COMPARATIVE EXAMPLE 4)

FIG.8

ANALYSIS CONDITIONS AND ANALYSIS RESULTS(OPENING RATIO IN ASCENDING ORDER)

	SHAPE OF HOLE	SIZE OF EACH HOLE	THE NUMBER OF HOLES	ARRANGEMENT OF HOLES	THE TOTAL AREA OF HOLES [mm^2]	THE INTERNAL AREA OF A RING [mm^2]	OPENING RATIO	AVERAGE SUCTION QUANTITY IN ONE RING [g/min]	DISPERSION OF SUCTION QUANTITY IN A RING (CV%)	DISPERSION OF SUCTION QUANTITY BETWEEN RINGS (CV%)	JUDGEMENT
EXAMPLE 1	CIRCLE	ϕ3(7.1mm^2)	10	AT REGULAR INTERVALS	71	10207	0.70%	11.9	0.53%	0.34%	OK
EXAMPLE 3	CIRCLE	ϕ4(12.6mm^2)	10	AT REGULAR INTERVALS	126	12076	1.04%	18.6	1.36%	0.96%	OK
EXAMPLE 2	CIRCLE	ϕ4(12.6mm^2)	10	AT REGULAR INTERVALS	126	10207	1.23%	20.0	0.90%	0.60%	OK
EXAMPLE 4	CIRCLE	ϕ4(12.6mm^2)	10	AT BOTH SIDE FACES IN A CONCENTRATED MANNER	126	10207	1.23%	20.1	0.56%	0.92%	OK
EXAMPLE 7	CIRCLE	ϕ6(28.3mm^2)	6	AT REGULAR INTERVALS	170	10207	1.67%	26.5	1.61%	1.66%	OK
EXAMPLE 8	CIRCLE	ϕ6(28.3mm^2)	6	AT BOTH SIDE FACES IN A CONCENTRATED MANNER	170	10207	1.67%	26.5	0.85%	1.76%	OK
EXAMPLE 5	CIRCLE	ϕ4(12.6mm^2)	14	AT BOTH SIDE FACES IN A CONCENTRATED MANNER	176	10207	1.72%	25.8	0.87%	1.34%	OK
EXAMPLE 6	CIRCLE	ϕ4(12.6mm^2)	20	AT REGULAR INTERVALS	251	10207	2.46%	31.6	1.69%	1.47%	OK
COMPARATIVE EXAMPLE 1	CIRCLE	ϕ6(28.3mm^2)	10	AT BOTH SIDE FACES IN A CONCENTRATED MANNER	283	10207	2.77%	34.0	1.26%	3.29%	NG
COMPARATIVE EXAMPLE 3	CIRCLE	ϕ6(28.3mm^2)	14	AT BOTH SIDE FACES IN A CONCENTRATED MANNER	396	12076	3.28%	36.4	6.70%	8.04%	NG
COMPARATIVE EXAMPLE 2	CIRCLE	ϕ6(28.3mm^2)	14	AT BOTH SIDE FACES IN A CONCENTRATED MANNER	396	10207	3.88%	42.0	3.09%	4.28%	NG

FIG.9

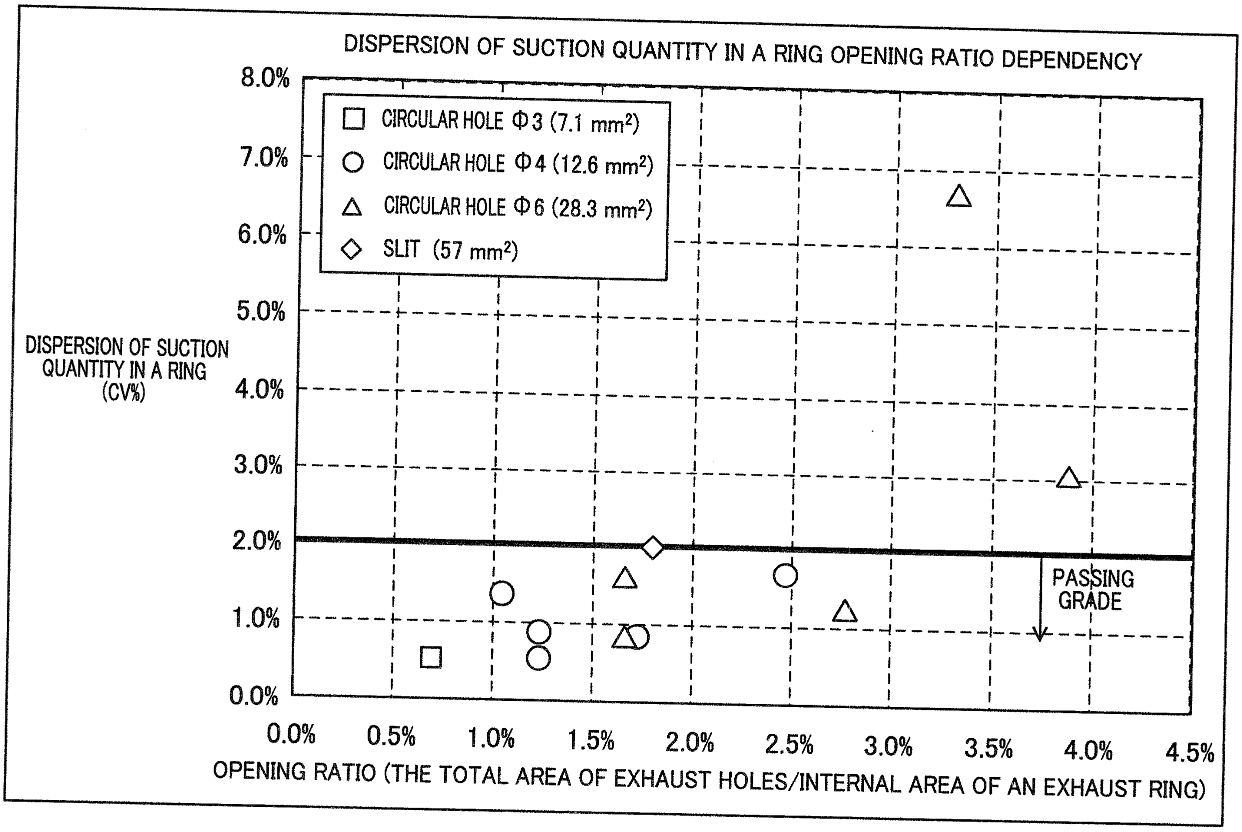

DISPERSION OF SUCTION QUANTITY IN A RING OPENING RATIO DEPENDENCY
□ CIRCULAR HOLE Φ3 (7.1 mm²)
○ CIRCULAR HOLE Φ4 (12.6 mm²)
△ CIRCULAR HOLE Φ6 (28.3 mm²)
◇ SLIT (57 mm²)
DISPERSION OF SUCTION QUANTITY IN A RING (CV%)
8.0%
7.0%
6.0%
5.0%
4.0%
3.0%
2.0%
1.0%
0.0%
0.0%
0.5%
1.0%
1.5%
2.0%
2.5%
3.0%
3.5%
4.0%
4.5%
OPENING RATIO (THE TOTAL AREA OF EXHAUST HOLES/INTERNAL AREA OF AN EXHAUST RING)
PASSING GRADE

FIG.10

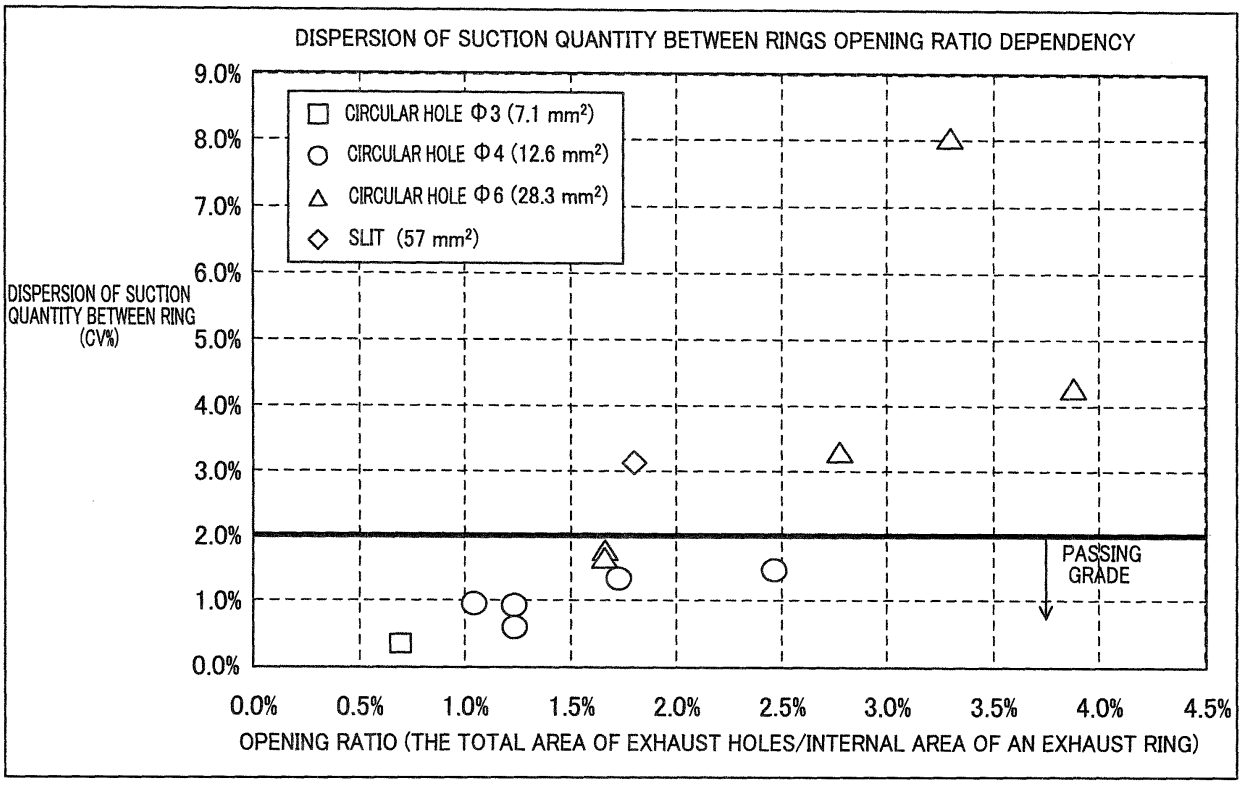

DISPERSION OF SUCTION QUANTITY BETWEEN RINGS OPENING RATIO DEPENDENCY
DISPERSION OF SUCTION QUANTITY BETWEEN RING (CV%)
9.0%
8.0%
7.0%
6.0%
5.0%
4.0%
3.0%
2.0%
1.0%
0.0%
□ CIRCULAR HOLE Φ3 (7.1 mm²)
○ CIRCULAR HOLE Φ4 (12.6 mm²)
△ CIRCULAR HOLE Φ6 (28.3 mm²)
◇ SLIT (57 mm²)
PASSING GRADE
0.0%
0.5%
1.0%
1.5%
2.0%
2.5%
3.0%
3.5%
4.0%
4.5%
OPENING RATIO (THE TOTAL AREA OF EXHAUST HOLES/INTERNAL AREA OF AN EXHAUST RING)

FIG.11

ANALYSIS CONDITIONS AND ANALYSIS RESULTS(DEPENDENCY ON ARRANGEMENT OF EXHAUST HOLES)

	SHAPE OF HOLE	SIZE OF EACH HOLE	THE NUMBER OF HOLES	ARRANGEMENT OF HOLES	THE TOTAL AREA OF HOLES [mm^2]	THE INTERNAL AREA OF A RING [mm^2]	OPENING RATIO	AVERAGE SUCTION QUANTITY IN ONE RING [g/min]	DISPERSION OF SUCTION QUANTITY IN A RING (CV%)	DISPERSION OF SUCTION QUANTITY BETWEEN RINGS (CV%)	JUDGEMENT
EXAMPLE 2	CIRCLE	$\phi 4(12.6mm^2)$	10	AT REGULAR INTERVALS	126	10207	1.23%	20.0	0.90%	0.60%	OK
EXAMPLE 4	CIRCLE	$\phi 4(12.6mm^2)$	10	AT BOTH SIDE FACES IN A CONCENTRATED MANNER	126	10207	1.23%	20.1	0.56%	0.92%	OK
EXAMPLE 7	CIRCLE	$\phi 6(28.3mm^2)$	6	AT REGULAR INTERVALS	170	10207	1.67%	26.5	1.61%	1.66%	OK
EXAMPLE 8	CIRCLE	$\phi 6(28.3mm^2)$	6	AT BOTH SIDE FACES IN A CONCENTRATED MANNER	170	10207	1.67%	26.5	0.85%	1.76%	OK

FIG.12

EVALUATION RESULT OF YARN QUALITY(EXAMPLE2,5,6、COMPARATIVE EXAMPLE 2)

	SIZE OF EACH HOLE	THE NUMBER OF HOLES	ARRANGEMENT OF HOLES	THE TOTAL AREA OF HOLES [mm^2]	THE INTERNAL AREA OF A RING [mm^2]	OPENING RATIO	AVERAGE SUCTION QUANTITY IN ONE RING [g/min]	DISPERSION OF SUCTION QUANTITY IN A RING (CV%)	DISPERSION OF SUCTION QUANTITY BETWEEN RINGS (CV%)	YARN PROPERTY (U%)	JUDGEMENT
EXAMPLE 2	φ4(12.6mm^2)	10	AT REGULAR INTERVALS	126	10207	1.23%	20.0	0.90%	0.60%	0.41	OK
EXAMPLE 5	φ4(12.6mm^2)	14	AT BOTH SIDE FACES IN A CONCENTRATED MANNER	176	10207	1.72%	25.8	0.87%	1.34%	0.49	OK
EXAMPLE 6	φ4(12.6mm^2)	20	AT REGULAR INTERVALS	251	10207	2.46%	31.6	1.69%	1.47%	0.59	OK
COMPARATIVE EXAMPLE 2	φ6(28.3mm^2)	14	AT BOTH SIDE FACES IN A CONCENTRATED MANNER	396	10207	3.88%	42.0	3.09%	4.28%	0.70	NG

REFERENCES CITED IN THE DESCRIPTION

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- US 4712988 A **[0005]**
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