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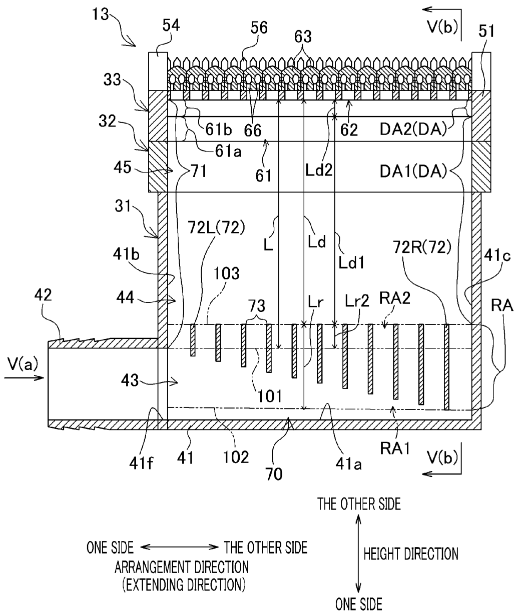
(54) INTERLACING DEVICE AND YARN WINDER

(57) A variation in flow rate of fluid between nozzles is suppressed in an interlacing device which is configured to interlace yarns. An interlacing device 13 includes nozzles 66 which are aligned in an arrangement direction and by which compressed air is ejected onto yarns Y and a supply passage 70 that is arranged to supply the compressed air to the nozzles 66. The supply passage 70 includes an inflow passage 42 which extends at least in the arrangement direction, a chamber 71 which is provided between the inflow passage 42 and the nozzles 66 in a flow direction of the compressed air and extends in the arrangement direction and in the height direction, and a bended passage 43 which is provided between the inflow passage 42 and the chamber 71 in the flow direction and connects a portion extending in the arrangement direction with a portion extending in a height direction. At least in the bended passage 43, at least one flow adjustment fin 72 is provided to extend in the height direction and to at least partially overlap with an opening 41f (entrance of the bended passage) when viewed in an extending direction in which the inflow passage 42 extends.

FIG.4



EP 4 119 708 A1

Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to an interlacing device and a yarn winder including the interlacing device.

[0002] Patent Literature 1 (Japanese Laid-Open Patent Publication No. 2016-160550) discloses an interlacing device configured to interlace yarns and a yarn winder configured to simultaneously form packages by winding the yarns interlaced by the interlacing device. The interlacing device includes nozzles by which fluid is ejected onto the yarns and a supply passage through which the fluid is supplied to the nozzles. The supply passage extends at least in a direction in which the nozzles are aligned. When the fluid is supplied to the supply passage, the fluid flows into the nozzles through the supply passage, the fluid is ejected from each nozzle, and consequently each yarn is interlaced. While Patent Literature 1 does not mention, for example, an entrance of the supply passage is arranged to extend to be substantially in parallel to the supply passage, in order to efficiently supply the fluid to the far side of the supply passage.

SUMMARY OF THE INVENTION

[0003] To suppress a variation in yarn quality between yarns, it is required to uniformize the efficiency of interlace between the yarns as much as possible. As one measure for achieving this, suppression of a variation in flow rate of fluid between the nozzles is desired. In particular, the number of yarns that can be interlaced at once by an interlacing device is recently on the rise, and the suppression of a variation in flow rate between nozzles has become increasingly important.

[0004] An object of the present invention is to suppress a variation in flow rate of fluid between nozzles in an interlacing device which is configured to interlace yarns.

[0005] According to a first aspect of the invention, an interlacing device configured to interlace yarns Y by using fluid includes: nozzles which are aligned in a predetermined first direction and are used for ejecting the fluid onto the yarns; and a supply passage which is arranged to supply the fluid to the nozzles, the supply passage including: an inflow passage which extends at least in the first direction and into which the fluid flows; a chamber which is provided between the inflow passage and the nozzles in a flow direction of the fluid and extends in the first direction and in a second direction intersecting with the first direction; and a bended passage which is provided between the inflow passage and the chamber in the flow direction and connects a portion extending in the first direction with a portion extending in the second direction, at least in the bended passage, at least one flow adjustment fin is provided to extend in the second direction and to at least partially overlap with an entrance of the bended passage when viewed in an extending direction in which the inflow passage extends.

[0006] In an arrangement in which a bended passage is provided in a supply passage, when, for example, high pressure fluid is supplied to the supply passage, a large amount of the fluid tends to reach an end of the bended passage which is on the side far from the entrance in the first direction. On this account, in the first direction, the flow rate at the end portion of the bended passage on the side far from the entrance may be disadvantageously high, and a difference in flow rate may be disadvantageously large between the side far from the entrance and the side close to the entrance.

[0007] According to the aspect above of the present invention, the fluid having flown into the supply passage flows at least in the first direction in the inflow passage, and then the flow direction of the compressed air is changed at the bended passage from a direction having a component extending in the first direction to a direction having at least a component extending in the second direction. At this stage, part of the fluid flowing in the first direction is received by the at least one flow adjustment fin. On this account, it is possible to adjust the flow of the fluid in the bended passage while suppressing a large amount of the fluid from flowing into the space which is on the side far from the inflow passage. For this reason, as compared to a case where no flow adjustment fin is provided, the flow rate of the fluid flowing in the chamber is uniformized in the first direction. It is therefore possible to reduce the variation in flow rate between the nozzles.

[0008] According to a second aspect of the invention, the interlacing device of the first aspect is arranged so that, as the at least one flow adjustment fin, plural flow adjustment fins are provided to be aligned in the first direction, and the flow adjustment fins are arranged so that, the farther a flow adjustment fin is from the inflow passage in the first direction, the larger the area of a part overlapping with the entrance f is when viewed in the extending direction.

[0009] According to this aspect of the present invention, it is possible to effectively avoid a large amount of fluid from reaching the end portion of the bended passage on the side far from the entrance in the first direction. Furthermore, according to the aspect of the present invention, each flow adjustment fin receives a relatively small amount of the fluid. The fluid is therefore substantially evenly distributed in the first direction in the bended passage. On this account, it is possible to effectively reduce, in the first direction, the variation in flow rate of the fluid supplied to the chamber through the bended passage.

[0010] According to a third aspect of the invention, the interlacing device of the first or second aspect is arranged so that, as the at least one flow adjustment fin, plural flow adjustment fins are provided to be aligned in the first direction, and ends of the flow adjustment fins on the side close to the nozzles in the second direction are aligned along the first direction.

[0011] A space is formed between two flow adjustment fins neighboring each other in the first direction (or between a wall forming the bended passage and the flow adjustment fin), and an end portion on the downstream side in the flow direction of this space is regarded as an exit. According to the aspect of the present invention, the distances between the exits and the nozzles in the second direction are substantially identical and do not vary depending on the position in the first direction. Therefore, as compared to, for example, a case where the distance varies depending on the position in the first direction, it is possible to avoid a problem that a variation in flow rate, which is suppressed in the first direction by the flow adjustment fin, is increased in the chamber.

[0012] According to a fourth aspect of the invention, the interlacing device of any one of the first to third aspects is arranged so that the chamber includes a downstream region that is on the side close to the nozzles in the second direction as compared to a flow adjustment region where the at least one flow adjustment fin is provided, and the downstream region is longer than the flow adjustment region in the second direction.

[0013] According to this aspect of the present invention, the fluid having been adjusted by the flow adjustment fin moves for a long distance in the second direction until the fluid reaches the nozzles. On this account, neighboring molecules collide with one another in the fluid having been adjusted by the flow adjustment fin, with the result that the fluid moves while being facilitated to advance more or less linearly along the second direction. It is therefore possible to further effectively reduce the variation in flow rate between the nozzles.

[0014] According to a fifth aspect of the invention, the interlacing device of the fourth aspect is arranged so that the downstream region in the second direction is at least twice as long as the flow adjustment region.

[0015] The inventors of the subject application found that, when the length in the second direction of the downstream region was at least twice as long as the length of the flow adjustment region, the variation in flow rate was particularly evidently decreased.

[0016] According to a sixth aspect of the invention, the interlacing device of any one of the first to fifth aspects is arranged so that the chamber includes: a first downstream region that is provided on the downstream side in the flow direction of the flow adjustment region where the at least one flow adjustment fin is provided; and a second downstream region which is provided on the downstream side in the flow direction of the first downstream region, the second downstream region being shorter than the first downstream region in a third direction that is orthogonal to both the first direction and the second direction.

[0017] In general, provided that the flow rate of fluid is the same, the flow rate is relatively low at a part of the passage where the cross-sectional area is large, whereas the flow rate is relatively high at a part of the passage where the cross-sectional area is small. On this account, the flow rate is high in a nozzle with a small cross-sectional area. In this regard, when the cross-sectional area of the passage is suddenly reduced at a position immediately on the upstream of the nozzle in the flow direction, the flow rate is drastically increased, with the result that the flow of the fluid tends to be disturbed at around the nozzle. According to the aspect of the present invention, the cross-sectional area of the passage in the second downstream region is smaller than the cross-sectional area of the passage in the first downstream region. For this reason, in the chamber, it is possible to decrease the cross-sectional area of the passage (at least stepwise) toward the downstream side in the flow direction. In this way, it is possible to increase the flow rate of the fluid at least stepwise. On this account, it is possible to suppress rapid increase in flow rate at around the nozzles. Consequently, disturbance of the flow of fluid at around the nozzles is suppressed.

[0018] According to a seventh aspect of the invention, the interlacing device of the sixth aspect is arranged so that the second downstream region is longer than the first downstream region in the second direction.

[0019] When fluid moves from the first downstream region having a large cross-sectional area to the second downstream region having a relatively small cross-sectional area, the airflow is disturbed to some degree as a large amount of compressed air enters a relatively narrow passage. When the downstream region is elongated in the height direction, the disturbance of the airflow is effectively suppressed while the compressed air is supplied to the downstream side in the flow direction. Therefore, the variation in flow rate can be further decreased.

[0020] According to an eighth aspect of the invention, a yarn winder includes: the interlacing device of any one of the first to seventh aspects; and a winding unit configured to simultaneously form packages by winding the yarns interlaced by the interlacing device.

[0021] According to this aspect of the present invention, it is possible to suppress the efficiency of interlace from being different between the yarns. It is therefore possible to suppress the variation in quality between the packages that are simultaneously formed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022]

FIG. 1 is a profile of a spun yarn take-up machine including an interlacing device of an embodiment.

FIG. 2 is a perspective view of the interlacing device.

FIG. 3 shows a state in which the interlacing device is viewed in a yarn running direction.

FIG. 4 is a cross section of the interlacing device, which is taken along a direction orthogonal to the yarn running direction.

FIG. 5(a) is a view of the interlacing device viewed along an arrow V(a) in FIG. 4. FIG. 5(b) is a cross section cut along a line V(b)-V(b) in FIG. 4.

FIG. 6 is a perspective view of an interlacing unit.

FIG. 7 is an enlarged view of the FIG. 4 and is a cross sectional view of interlacing pieces and their surroundings.

FIG. 8 is a table showing analysis results of an average flow rate of fluid and a variation in flow rate between nozzles.

Each of FIG. 9(a) and FIG. 9(b) is a table showing part of the analysis results shown in FIG. 8.

Each of FIG. 10(a) and FIG. 10(b) is a table showing part of the analysis result shown in FIG. 8.

FIG. 11 is a table showing part of the analysis results shown in FIG. 8.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0023] The following will describe an embodiment of the present invention. Hereinafter, directions shown in FIG. 1 will be consistently used as an up-down direction and a front-rear direction, for convenience of explanation. The up-down direction is a vertical direction in which the gravity acts. The front-rear direction is a direction which is orthogonal to the up-down direction and in which bobbins B (described later) are aligned. A direction orthogonal to both the up-down direction and the front-rear direction (i.e., a direction perpendicular to the plane of FIG. 1) is set as a left-right direction. A direction in which each yarn Y (described later) runs will be referred to as a yarn running direction.

(Spun Yarn Take-Up Machine)

[0024] The following will outline a spun yarn take-up machine 1 (i.e., a yarn winder of the present invention) of an embodiment, with reference to FIG. 1. FIG. 1 is a profile of the spun yarn take-up machine 1 including an interlacing device 13 (described later) of the present embodiment. The spun yarn take-up machine 1 is configured to simultaneously form packages P by taking up plural (e.g., 32 in the present embodiment) yarns Y spun out from a spinning apparatus 2 and winding the yarns Y onto bobbins B. Each yarn Y is a multifilament yarn having filaments (not illustrated). Each filament is a synthetic fiber made of, e.g., polyester.

[0025] The spun yarn take-up machine 1 includes, for example, a take-up unit 3 and two winding units 4 (winding units 4A and 4b; FIG. 1 shows only the winding unit 4A). The take-up unit 3 is configured to take up the plural (32 in the present embodiment) yarns Y spun out from the spinning apparatus 2. For example, the take-up unit 3 includes a drawing device 10, a first godet roller 11, a second godet roller 12, and an interlacing device 13. The drawing device 10 is provided below the spinning apparatus 2. The drawing device 10 includes unillustrated drawing rollers, and is configured to draw the yarns Y. The first godet roller 11 is a roller having a rotational axis substantially in parallel to the left-right direction. The first godet roller 11 is provided on the downstream side of the downstream side of the drawing device 10 in the yarn running direction. The first godet roller 11 is rotationally driven by an unillustrated motor. The yarns Y spun out from the spinning apparatus 2 are sent to the second godet roller 12 while being aligned in the left-right direction and wound onto the first godet roller 11. The second godet roller 12 is a roller having a rotational axis substantially in parallel to the left-right direction. The second godet roller 12 is provided above and rearward of the first godet roller 11. The second godet roller 12 is rotationally driven by an unillustrated motor. Each of the yarns Y is sent from the first godet roller 11 to the second godet roller 12, and then sent to one of the two winding units 4. A half of the yarns Y is sent to the winding unit 4A and the remaining half of the yarns Y is sent to the winding unit 4B. A yarn path of each yarn Y running from the first godet roller 11 to the second godet roller 12 extends obliquely upward and rearward. The yarn path includes both components in the up-down direction and the front-rear direction, and is substantially orthogonal to the left-right direction. The interlacing device 13 is, for example, provided between the drawing device 10 and the first godet roller 11 in the yarn running direction. Alternatively, the interlacing device 13 may be provided between the first godet roller 11 and the second godet roller 12 in the yarn running direction. Alternatively, two interlacing devices 13 may be provided between the drawing device 10 and the first godet roller 11 in the yarn running direction and between the first godet roller 11 and the second godet roller 12 in the yarn running direction, respectively. The interlacing device 13 is configured to interlace each of the yarns Y (as described later).

[0026] Each of the winding units 4 (winding units 4A and 4B) is configured to simultaneously form packages P by winding the yarns Y onto the bobbins B. For example, in the present embodiment, each of the winding units 4A and 4B is configured to wind 16 yarns Y. The winding units 4A and 4B are provided below the take-up unit 3. The winding units 4A and 4B are aligned in the left-right direction. FIG. 1 shows only the winding unit 4A. In FIG. 1, the winding unit 4B is provided on the side far from the viewer of the figure across the winding unit 4A. (For details, see, e.g., Japanese Laid-Open Patent Publication No. 2020-20069.) The winding unit 4B may be structurally identical with the winding unit 4A. Alternatively, the winding unit 4B may be symmetrical with the winding unit 4A with respect to a flat plane that is in parallel to both the up-down direction and the front-rear direction. Each winding unit 4 includes: fulcrum guides 21; traverse guides 22; a turret 23; two bobbin holders 24; and a contact roller 25.

[0027] Each of the fulcrum guides 21 is a guide about which a yarn Y is traversed by each traverse guide 22. The fulcrum guides 21 are provided for the respective yarns Y. The fulcrum guides 21 are aligned in the front-rear direction. The traverse guides 22 is provided for the respective yarns Y in the same manner as the fulcrum guides 21. The traverse guides 22 are aligned in the front-rear direction. Each of the traverse guides 22 is configured to traverse a corresponding yarn Y in the front-rear direction by being driven by, e.g., an unillustrated traverse motor. The turret 23 is a disc-shaped member having a rotational axis substantially parallel to the front-rear direction. The turret 23 is rotationally driven by a turret motor which is not illustrated. Each of the two bobbin holders 24 has a rotational axis substantially in parallel to the front-rear direction. The bobbin holders 24 are rotatably supported at an upper end portion and a lower end portion of the turret 23. To each bobbin holder 24, the bobbins B provided for the respective yarns Y are attached to be lined up in the front-rear direction. The bobbins B are rotatably supported by each of the two bobbin holder 24. Each of the two bobbin holders 24 is independently rotated and driven by an unillustrated winding motor. The contact roller 25 is a roller having a rotational axis substantially parallel to the front-rear direction, and is provided immediately above the upper bobbin holder 24. The contact roller 25 is configured to make contact with the surfaces of the packages P supported by the upper bobbin holder 24. With this, the contact roller 25 applies a contact pressure to the surfaces of the unfinished packages P, to adjust the shape of each package P.

[0028] In each of the two winding units 4 structured as described above, when the upper bobbin holder 24 is rotationally driven, the yarns Y traversed by the traverse guides 22 are wound onto the bobbins B, with the result that the packages P are formed. When the formation of the packages P is completed, the turret 23 rotates to switch over the upper and lower positions of the two bobbin holders 24. As a result, the bobbin holder 24 having been at the lower position is moved to the upper position, which allows the yarns Y to be wound onto the bobbins B attached to the bobbin holder 24 having been moved to the upper position, to form packages P. The bobbin holder 24 to which the fully-formed packages P are attached is moved to the lower position. The fully-formed packages P are then collected by, e.g., an unillustrated package collector.

(Interlacing Device)

[0029] The structure of the interlacing device 13 will be described with reference to FIG. 2 to FIG. 7. FIG. 2 is a perspective view of the entire interlacing device 13. FIG. 3 shows the interlacing device 13 viewed in the yarn running direction. The yarn running direction (third direction of the present invention) in the interlacing device 13 is a direction substantially in parallel to the direction in which each of later-described interlacing pieces 63 extends. FIG. 4 is a cross section of the interlacing device 13, which is taken along a direction orthogonal to the yarn running direction. FIG. 5(a) is a view of the interlacing device viewed along an arrow V(a) in FIG. 4. FIG. 5(b) is a cross section cut along a line V(b)-V(b) in FIG. 4. FIG. 6 is a perspective view of a later-described interlacing unit 33. FIG. 7 is a cross sectional view taken along a direction orthogonal to the yarn running direction, which shows the interlacing pieces 63 and their surroundings. As described below, the direction in which the interlacing pieces 63 are aligned will be referred to as an arrangement direction (first direction of the present invention). Furthermore, as described below, a direction orthogonal to both the yarn running direction and the arrangement direction will be referred to as a height direction (second direction of the present invention). For convenience, for each of the yarn running direction, the arrangement direction, and the height direction, one side and the other side are defined as shown in FIG. 2.

[0030] The interlacing device 13 is configured to interlace plural (e.g., 32 in the present embodiment) yarns Y by means of, e.g., compressed air (fluid of the present invention). Roughly speaking, to "interlace" is to make filaments (not illustrated) tangled with one another so that the filaments forming each yarn Y are not excessively distant from one another.

[0031] As shown in FIG. 2 to FIG. 5(b), the interlacing device 13 includes, for example, a fluid supplying member 31, a connecting member 32, and an interlacing unit 33. The fluid supplying member 31, the connecting member 32, and the interlacing unit 33 are provided in this order in a predetermined height direction orthogonal to the yarn running direction. Hereinafter, in the height direction, the fluid supplying member 31 side will be referred as one side. Meanwhile, in the height direction, the interlacing unit 33 side will be referred as the other side. Roughly speaking, compressed air flowing from a source 100 (see FIG. 3) to the fluid supplying member 31 is supplied to the interlacing unit 33 through the connecting member 32. Therefore the compressed air is ejected from nozzles 66 (see, e.g., FIG. 4) of the interlacing unit 33 onto the yarns Y. As a result, each yarn Y is interlaced. To put it differently, the interlacing device 13 includes the nozzles 66 by which compressed air is ejected onto the yarns Y and a supply passage 70 that is arranged to supply the compressed air to the nozzles 66 (see FIG. 4). In the present embodiment, the supply passage 70 is composed of the fluid supplying member 31, the connecting member 32, and part of the interlacing unit 33. The supply passage 70 will be detailed later.

[0032] The fluid supplying member 31 is configured to send the compressed air supplied from the source 100 to the downstream side (interlacing unit 33 side) in a flow direction of the compressed air (hereinafter, this direction will be simply referred to as flow direction) . An end portion of the fluid supplying member 31 on the other side in the height direction is fixed to an end portion of the connecting member 32 on one side in the height direction, by means of, for example, screws (not illustrated).

[0033] As shown in FIG. 2 to FIG. 4, the fluid supplying member 31 includes a main body 41 and an inflow passage 42. The main body 41 is a portion that is substantially rectangular parallelepiped in shape. The main body 41 has a bottom surface 41a (see FIG. 3 to FIG. 5(b)) substantially perpendicular to the height direction, inner side surfaces 41b and 41c (see FIG. 3 and FIG. 4), and inner side surfaces 41d and 41e (see FIG. 5(a) and FIG. 5(b)). The bottom surface 41a is a surface that is substantially perpendicular to the height direction and is provided at an end portion of the main body 41 on one side in the height direction. The inner side surface 41b is a surface that extends in the height direction and is provided at an end portion of the main body 41 on one side in the arrangement direction. The inner side surface 41c is a surface that extends in the height direction and is provided at an end portion of the main body 41 on the other side in the arrangement direction. The inner side surface 41b opposes the inner side surface 41c in the arrangement direction. At an end portion on one side in the height direction of a wall having the inner surface 41b, for example, a substantially circular opening 41f (see FIG. 3 to FIG. 5(b)) is formed. The end portion on one side in the arrangement direction of the main body 41 is connected to the inflow passage 42 through the opening 41f. The opening 41f is an entrance of a later-described bended passage 43. The inner side surface 41d is a surface that extends in the height direction and is provided at an end portion of the main body 41 on one side in the yarn running direction. The inner side surface 41e is a surface that extends in the height direction and is provided at an end portion of the main body 41 on the other side in the yarn running direction. The inner side surface 41d opposes the inner side surface 41e in the yarn running direction.

[0034] As shown in FIG. 4, the main body 41 includes: a bended passage 43 that is on one side of the position of the end on the other side in the height direction of the opening 41f; and a chamber formation passage 44 that is on the other side of the position of the end on the other side in the height direction of the opening 41f. The bended passage 43 is a portion connecting a portion extending in the arrangement direction with a portion extending in the height direction. In the flow direction, the bended passage 43 is provided between the inflow passage 42 and the chamber formation passage 44. The bended passage 43 is provided on the other side of the inflow passage 42 in the arrangement direction and is provided on one side of the chamber formation passage 44 in the height direction. To be more specific, a virtual straight line that passes the end of the opening 41f on the other side in the height direction and extends in the arrangement direction when viewed in the yarn running direction is regarded as a straight line 101 (see FIG. 4). The bended passage 43 is a portion that is on one side of the straight line 101 in the height direction. The chamber formation passage 44 is a portion that is on the other side of the bended passage 43 in the height direction (i.e., on the other side of the straight line 101) and extends in the height direction. The chamber formation passage 44 is part of a later-described chamber 71. An end of the chamber formation passage 44 on the other side in the height direction is connected to an end of a later-described connection passage 45 on one side in the height direction.

[0035] The inflow passage 42 is a portion on the upstream side of the main body 41 in the flow direction. The inflow passage 42 is, for example, provided to extend along the arrangement direction. Therefore, in the present embodiment, the arrangement direction is the direction in which the inflow passage 42 extends. The inflow passage 42 is provided on one side of the main body 41 in the arrangement direction. The inflow passage 42 is connected to the bended passage 43 through the opening 41f. To the inflow passage 42, for example, a leading end portion of an unillustrated hose extending from the source 100 (see FIG. 3) is attached.

[0036] The connecting member 32 is, for example, substantially rectangular parallelepiped in shape. The connecting member 32 connects the fluid supplying member 31 with the interlacing unit 33. The connecting member 32 is provided on the downstream side of the fluid supplying member 31 and on the upstream side of the interlacing unit 33 in the flow direction. An end portion on one side in the height direction of the connecting member 32 is fixed to an end portion on the other side in the height direction of the main body 41 of the fluid supplying member 31. An end portion of the connecting member 32 on the other side in the height direction is fixed to an end portion on one side in the height direction of the interlacing unit 33, by means of, for example, screws (not illustrated) . The connecting member 32 has a connection passage 45 penetrating the same in the height direction. The connection passage 45 is part of the later-described chamber 71. In the present embodiment, the cross-sectional area of the connection passage 45 taken along the direction orthogonal to the height direction is, for example, substantially identical with the cross-sectional area of the chamber formation passage 44 taken along the direction orthogonal to the height direction.

[0037] The interlacing unit 33 is configured to interlace the yarns Y by ejecting compressed air supplied from the source 100 onto the yarns Y. As shown in FIG. 6, the interlacing unit 33 includes a base member 51, an interlacing portion 52, two guide supporting members 53 and 54, and two regulatory guide members 55 and 56.

[0038] The base member 51 is substantially rectangular parallelepiped in shape. An end portion on one side in the height direction of the base member 51 is fixed to an end portion on the other side in the height direction of the connecting member 32. In the base member 51, a main passage 61 and branch passages 62 are formed. The main passage 61 and the branch passages 62 are arranged to allow compressed air to flow toward the other side in the height direction. The main passage 61 is a passage formed to extend between an end on one side in the height direction of the base member 51 and a part of the base member 51 on the other side in the height direction. In the arrangement direction, the main passage 61 extends from a position where a nozzle 66 that is the outermost one among the nozzles 66 on one side is provided to a position where a nozzle 66 that is the outermost one among the nozzles 66 on the other side is provided. The main passage 61 is part of the later-described chamber 71. The main passage 61 will be detailed later. The branch passages 62 are passages branched from the main passage 61. The branch passages 62 are provided at an end portion on the other side in the height direction of the base member 51 and are aligned in the arrangement direction. Each of the branch passages 62 is, for example, connected to two nozzles 66 among the later-described nozzles 66.

[0039] As shown in FIG. 6 and FIG. 7, the interlacing portion 52 includes plural (16 in the present embodiment) interlacing pieces 63 that are aligned in the arrangement direction. Each of the interlacing pieces 63 extends in the yarn running direction. The interlacing pieces 63 are fixed to an end face of the base member 51 on the other side in the height direction. For example, each of the interlacing pieces 63 is provided with, as shown in FIG. 7, two yarn running spaces 64 (yarn running spaces 64a and 64b), two yarn insertion slits 65 (yarn insertion slits 65a and 65b), and two nozzles 66 (nozzles 66a and 66b). The two yarn running spaces 64 penetrate the interlacing piece 63 in the yarn running direction. One yarn Y runs in each yarn running space 64. The two yarn running spaces 64 include a yarn running space 64a provided on one side in the arrangement direction and a yarn running space 64b provided on the other side in the arrangement direction. The yarn insertion slit 65a is, for example, provided on one side in the arrangement direction of the yarn running space 64a. The yarn insertion slit 65a extends in the yarn running direction along the yarn running space 64a. The yarn insertion slit 65b is, for example, provided on the other side in the arrangement direction of the yarn running space 64b. The yarn insertion slit 65b extends in the yarn running direction along the yarn running space 64b. The nozzles 66 are provided on the other side in the height direction of the branch passages 62 and on one side in the height direction of the corresponding yarn running space 64. To put it differently, the nozzles 66 are provided on the downstream side in the flow direction of the branch passages 62 and on the upstream side in the flow direction of the corresponding yarn running spaces 64. In the present embodiment, each nozzle 66 extends at least in the height direction. Each nozzle 66 may have, for example, a component extending in the yarn running direction (i.e., may be tilted relative to the height direction) . Each interlacing piece 63 may not be arranged to interlace two yarns Y. For example, the interlacing portion 52 may include 32 interlacing pieces (not illustrated) each of which is arranged to interlace a corresponding yarn Y.

[0040] The guide supporting member 53 is a member that supports the regulatory guide member 55. As shown in FIG. 6, the guide supporting member 53 is a roughly U-shaped plate member. The guide supporting member 53 is fixed to a side surface on one side in the yarn running direction of the base member 51. The guide supporting member 54 is a member that supports the regulatory guide member 56. Being similar to the guide supporting member 54, the guide supporting member 53 is a roughly U-shaped plate member. The guide supporting member 54 is fixed to a side surface on the other side in the yarn running direction of the base member 51. In place of the base member 51 and the guide supporting members 53 and 54, one base member 51 (not illustrated) may be provided. In this base member (not illustrated), a base unit (not illustrated) having the function of the base member 51 and a guide supporter (not illustrated) functioning as the guide supporting members 53 and 54 may be integrally formed.

[0041] The regulatory guide members 55 and 56 are members configured to regulate the movement of the yarns Y in the arrangement direction. As shown in FIG. 6, the regulatory guide member 55 is fixed to the guide supporting member 53. The regulatory guide member 56 is fixed to the guide supporting member 54. Each of the regulatory guide members 55 and 56 has plural guide grooves 57 that are aligned in the arrangement direction. The yarns Y are inserted into the respective guide grooves 57.

[0042] The compressed air supplied to the interlacing device 13 having the structure described above flows into the nozzles 66 through the inflow passage 42, the bended passage 43, the chamber formation passage 44, the connection passage 45, the main passage 61, and the branch passages 62 in this order. Among these members, the inflow passage 42 is the most upstream member in the flow direction. From each of the nozzles 66, the compressed air is ejected into the corresponding yarn running space 64. In this way, the yarn Y running in the yarn running space 64 is interlaced.

[0043] In regard to the above, to suppress a variation in yarn quality between yarns Y, it is required to uniformize the efficiency of interlace between the yarns Y as much as possible. As one measure for achieving this, suppression of a variation in flow rate of compressed air between the nozzles 66 is desired. In order to suppress the variation in flow rate of compressed air, the interlacing device 13 is structured as described below.

(Details of Interlacing Device)

[0044] The interlacing device 13 will be detailed with reference to FIG. 4 to FIG. 5(b). To begin with, the above-described supply passage 70 is briefly explained again. The supply passage 70 includes the above-described inflow passage 42, the above-described bended passage 43, and the chamber 71. These components are provided in this order in the flow direction, and the inflow passage 42 is the most upstream component. The chamber 71 is, for example, composed of the chamber formation passage 44 formed in the fluid supplying member 31, the connection passage 45 formed in the connecting member 32, and the main passage 61 formed in the base member 51 of the interlacing unit 33. In the height direction, the chamber 71 extends from the position of an end on one side of the chamber formation passage 44 to the position of an end on the other side of the main passage

61. Furthermore, in the present embodiment, in the arrangement direction, the chamber 71 extends from a position where a nozzle 66 that is the outermost one on one side is provided to a position where a nozzle 66 that is the outermost one on the other side is provided.

[0045] At least in the bended passage 43, at least one flow adjustment fin 72 is provided. In the present embodiment, plural flow adjustment fins 72 are provided. Each of the flow adjustment fins 72 extends, for example, along the height direction. The flow adjustment fins 72 are, for example, aligned in the arrangement direction at substantially equal intervals. When viewed in the arrangement direction (i.e., the direction in which the inflow passage 42 extends), the flow adjustment fins 72 partially overlap the opening 41f (see FIG. 5(a) and 5(b)). When viewed in the arrangement direction, the length in the height direction of the overlapping part where each flow adjustment fin 72 overlaps the opening 41f is preferably different between the flow adjustment fins 72. To be more specific, the farther a flow adjustment fin 72 is from the opening 41f in the arrangement direction, the longer the overlapping part is in the height direction. To put it differently, the flow adjustment fins 72 are arranged so that, the farther a flow adjustment fin 72 is from the inflow passage 42 in the arrangement direction, the larger the area of the overlapping part when viewed in the arrangement direction is (see FIG. 5(a) and FIG. 5(b)). In other words, the flow adjustment fins 72 are arranged so that, the farther a flow adjustment fin 72 is from the inflow passage 42 in the arrangement direction, the closer the flow adjustment fin 72 is to the bottom surface 41a in the height direction. In the arrangement direction, the length in the height direction of the overlapping part between the flow adjustment fin 72 (flow adjustment fin 72L) that is closest to the opening 41f and the opening 41f is the shortest. In the arrangement direction, the length in the height direction of the overlapping part between the flow adjustment fin 72 (flow adjustment fin 72R) that is farthest from the opening 41f and the opening 41f is the longest.

[0046] It is preferable that, in the height direction, the positions of ends on the other side (i.e., the side close to the nozzles 66) of the flow adjustment fins 72 are substantially the same (see FIG. 4). To put it differently, ends on the other side in the height direction of the flow adjustment fins 72 are preferably aligned along the arrangement direction. In other words, a passage is formed between two flow adjustment fins 72 neighboring each other in the arrangement direction (or between the inner side surface 41b and the flow adjustment fin 72L, or between the inner side surface 41c and the flow adjustment fin 72R), and an end portion on the other side in the height direction of this passage is regarded as an exit 73 (see FIG. 4). It is preferable that the positions in the height direction of the exits 73 are substantially identical.

[0047] In the supply passage 70, a region where the flow adjustment fins 72 are provided will be referred to as a flow adjustment region RA (see FIG. 4, FIG. 5(a), and FIG. 5(b)). To be more specific, the flow adjustment region RA is a region where the flow adjustment fins 72 are provided when viewed in the arrangement direction (see FIG. 5(a) and FIG. 5(b)). To be further specific, a virtual straight line passing through an end on one side in the height direction of the flow adjustment fin 72R and being in parallel to the arrangement direction when viewed in the yarn running direction is regarded as a straight line 102 (see FIG. 4). Moreover, a virtual straight line passing through ends on the other side in the height direction of the flow adjustment fins 72 and being in parallel to the arrangement direction when viewed in the yarn running direction is regarded as a straight line 103 (see FIG. 4). In this case, the flow adjustment region RA is a region surrounded by the straight lines 102 and 103, the inner side surface 41c, the inner side surface 41b, and a virtual extension surface extending toward one side in the height direction from the inner side surface 41b, when viewed in the yarn running direction.

[0048] The flow adjustment region RA is preferably provided to protrude toward both the bended passage 43 and the chamber 71. In other words, in the height direction, ends on the other side of the flow adjustment fins 72 preferably protrude toward the other side in the height direction to some degree, as compared to the bended passage 43 (i.e., protrude into the chamber 71). This flow adjustment region RA includes: a first flow adjustment region RA1 on the bended passage 43 side (on one side in the height direction of the above-described straight line 101); and a second flow adjustment region RA2 on the chamber 71 side (on the other side in the height direction of the straight line 101).

[0049] Typically, when high-pressure compressed air is supplied, a large amount of the compressed air tends to reach an end portion of the bended passage 43, which is on the side far from the inflow passage 42 in an extending direction in which the inflow passage 42 extends (in the arrangement direction in the present embodiment) To put it differently, in the bended passage 43, the compressed air tends to simply pass through the space on the side close to the inflow passage 42 in the extending direction. On this account, an amount of the compressed air supplied to the space on the side close to the inflow passage 42 in the extending direction may be relatively small. This may cause a variation in flow rate of the compressed air between the nozzles 66 in the arrangement direction. In this connection, in the present embodiment, the plural flow adjustment fins 72 are provided at least in the bended passage 43 as described above. This makes it possible to suppress a large amount of the compressed air from reaching the end portion of the bended passage 43, which is on the side far from the inflow passage 42 in the extending direction. Furthermore, in the present embodiment, the flow adjustment fins 72 are arranged so that, the farther a flow adjustment fin 72 is from the inflow passage 42 in the extending direction, the larger the area of the part overlapping with the opening 41 is when viewed in the extending direction (see FIG. 5(a) and FIG. 5(b)). With this arrangement, each flow adjustment fin 72 receives a relatively small amount of the compressed air. The compressed air is therefore substantially evenly distributed in the arrangement direction in the bended passage 43. The compressed air that is substantially evenly distributed in this way is sent to the chamber 71. In the present embodiment, the distances between the exits 73 and the nozzles 66 in the height direction are substantially identical and do not vary depending on the position in the arrangement direction. On this account, as compared to, for example, a case where the distance varies depending on the position in the arrangement direction, it is possible to avoid a problem that a variation in flow rate, which is suppressed in the arrangement direction by the flow adjustment fins 72, is increased on the downstream side in the flow direction.

(Chamber)

[0050] The following will describe the structure of the chamber 71. The chamber 71 is a space for allowing the compressed air adjusted by the flow adjustment fins 72 to smoothly flow toward the other side in the height direction. For example, as described above, the chamber 71 is composed of the chamber formation passage 44, the connection passage 45, and the main passage 61. The chamber 71 includes the above-described second flow adjustment region RA2 (region where a part of each flow adjustment fin 72 on the other side in the height direction is provided) and a downstream region DA that is provided on the other side in the height direction of the second flow adjustment region RA2. The length in the height direction of the entire chamber 71 is, for example, L. The length in the height direction of the second flow adjustment region RA2 is, for example, Lr2. The length in the height direction of the downstream region DA is, for example, Ld.

[0051] In addition to the above, the downstream region DA includes, for example, a first downstream region DA1 and a second downstream region DA2 (see FIG. 4 and FIG. 5(a)). The first downstream region DA1 is a region that is provided on the other side in the height direction of the second flow adjustment region RA2 and is substantially rectangular parallelepiped in shape. The first downstream region DA1 is, for example, composed of: a region of the chamber formation passage 44, where no flow adjustment fin 72 is formed (i.e., a region on the other side in the height direction of the straight line 103); the connection passage 45; and a first main passage 61a. No component is provided in the first downstream region DA1. The second downstream region DA2 is a region that is provided on the other side in the height direction of the first downstream region DA1 and is substantially rectangular parallelepiped in shape. The second downstream region DA2 is, for example, composed of a second main passage 61b. No component is provided in the second downstream region DA2. As shown in FIG. 5(a), the length of the second downstream region DA2 in the yarn running direction is shorter than the length of the first downstream region DA1 in the yarn running direction. To put it differently, the second downstream region DA2 is narrower in width than the first downstream region DA1 in the yarn running direction. In the present embodiment, in the above-described main passage 61, a part in the height direction of the first downstream region DA1 and the second downstream region DA2 are provided. The main passage 61 therefore includes the first main passage 61a forming part of the first downstream region DA1 and the second main passage 61b forming part of the second downstream region DA2 (see FIG. 4 and FIG. 5(a)). On this account, in the main passage 61 (chamber 71), the cross-sectional area of the passage decreases stepwise toward the downstream side in the flow direction. In general, provided that the flow rate of fluid is the same, the flow rate is relatively low at a part of the passage where the cross-sectional area is large, whereas the flow rate is relatively high at a part of the passage where the cross-sectional area is small. It is therefore possible to increase the flow rate of the fluid stepwise. On this account, it is possible to suppress rapid increase in flow rate at around the nozzles 66. Consequently, disturbance of the flow of fluid at around the nozzles 66 is suppressed.

[0052] The inventors of the subject application focused on whether the length in the height direction of each type of regions concerning the chamber 71 influenced on the flow adjustment effect. As shown in FIG. 4, assume that, for example, the length in the height direction of the entire chamber 71 is L. Assume that the length in the height direction of the downstream region DA is Ld. Assume that the length in the height direction of the first downstream region DA1 is Ld1. Assume that the length in the height direction of the second downstream region DA2 is Ld2. Assume that the length in the height direction of the second flow adjustment region RA2 is Lr2. How the flow rate of compressed air and a variation in flow rate between the nozzles 66 were changed in response to a change in at least one of these conditions (L, Ld, Ld1, Ld2, and Lr2) was studied. Through the below-described fluid analysis, the inventors of the subject application found that those conditions influenced on the flow rate and the variation in flow rate.

(Conditions of Analysis)

[0053] The fluid analysis performed by the inventors of the subject application will be explained with reference to tables shown in FIG. 8 to FIG. 11. Conditions that are in common between Examples 1 to 9 and Comparative Examples 1 and 2 shown in FIG. 8 are as follows. The type of the fluid was air (compressed air). The pressure of the compressed air was set at 0.35 MPa. The inner diameter of the inflow passage 42 (i.e., the diameter of the opening 41f) was set at 25 mm. The diameter of the opening 41f and the length in the height direction of the bended passage 43 was arranged to be identical. The length between the bended passage 43 and the chamber

71 in the arrangement direction (i.e., the distance from the inner side surface 41b to the inner side surface41c in the arrangement direction) was set at 130 mm. The length in the yarn running direction of the first downstream region DA1 was set at 28 mm. The length in the yarn running direction of the second downstream region DA2 was set at 10 mm. The number of the flow adjustment fins 72 was set at 11. The flow adjustment fins 72 were aligned in the arrangement direction at substantially equal intervals. The length of the protrusion of the flow adjustment fin 72L from the straight line 101 in the height direction was set at 3 mm. The length of the protrusion of the flow adjustment fin 72R from the straight line 101 in the height direction was set at 24 mm. In other words, when the length in the height direction of the flow adjustment region RA is Lr (see FIG. 4), Lr is a result of Lr2 + 24 mm. The lengths of the protrusions of the flow adjustment fins 72 increased toward the other side in the arrangement direction in the form of a linear function. The nozzles 66 were arranged to extend to be in parallel to the height direction. The number of the nozzles 66 was set at 32. It is noted that the common conditions described above were conveniently set as examples for analyzing the dependency of the flow rate of the compressed air and the variation in flow rate between the nozzles 66 on the length of the chamber 71 in the height direction. Please therefore be informed that, even though the above-described common conditions are changed to some extent, the analysis results would qualitatively remain more or less the same.

[0054] The following will describe the details of the analysis conditions and analysis results with reference to FIG. 8 to FIG. 11. FIG. 8 to FIG. 11 show tables indicating the details of the analysis conditions and analysis results. FIG. 8 shows the analysis conditions and analysis results of all Examples (Examples 1 to 9) and Comparative Examples (Comparative Examples 1 and 2). FIG. 9(a) to FIG. 11 show Examples and Comparative Examples that are sorted by type of setting of conditions. In FIG. 9(a) to FIG. 11, a parameter in which a condition was changed is surrounded by a thick frame.

[0055] As specific conditions, FIG. 8 to FIG. 11 show the presence or absence of the flow adjustment fins 72, L, Ld, Ld1, Ld2, Lr2, and Lr. The total sum of Ld and Lr2 is L. The total sum of Ld1 and Ld2 is Ld. In Comparative Examples 1 and 2, because of the absence of the flow adjustment fins 72, only L and Ld2 can be defined among L, Ld, Ld1, Ld2, Lr2, and Lr. On this account, the values of Ld, Ld1, Lr2, and Lr are not shown in Comparative Examples 1 and 2 (see FIG. 8 and FIG. 9(a)). Furthermore, as analysis results, an average flow rate at the leading end of each of 32 nozzles 66 and a variation in flow rate between the 32 nozzles 66 are shown. The average flow rate is an average of flow rates of compressed air at the above-described 32 parts, and is expressed in units of m/s. The variation in flow rate is a variation coefficient (expressed in units of %) obtained by dividing a standard deviation of flow rates at the above-described 32 parts by an average flow rate. The larger the average flow rate is, the more the yarn Y is expected to be easily interlaced. The smaller the variation in flow rate is, the more the easiness of interlace is expected to be uniformized between the yarns Y.

(Dependency on Presence and Absence of Fins)

[0056] To begin with, as shown in FIG. 9(a), cases where the flow adjustment fins 72 were provided in the supply passage 70 (Examples 1 and 6) were compared with cases where the fins were not provided (Comparative Examples 1 and 2), in terms of the average flow rate and the variation in flow rate. In the comparison, examples and comparative examples having the same L and the same Ld2 were compared with each other in terms of the average flow rate and the variation in flow rate. That is to say, Example 1 and Comparative Example 1 were compared in terms of the average flow rate and the variation in flow rate, and Example 6 and Comparative Example 2 were compared in terms of the average flow rate and the variation in flow rate. In any case, when the flow adjustment fins 72 were provided, the average flow rate was high and the variation in flow rate was small as compared to the cases where flow adjustment fins 72 were not provided. To be more specific, the average flow rate and the variation in flow rate in Comparative Example 1 were 369.1 m/s and 0.43%, whereas the average flow rate and the variation in flow rate in Example 1 were 371.7 m/s and 0.26%. The average flow rate and the variation in flow rate in Comparative Example 2 were 379.8 m/s and 0.62%, whereas the average flow rate and the variation in flow rate in Example 6 were 382.5 m/s and 0.10%. In this way, as the analysis results, good flow adjustment effects were achieved with the flow adjustment fins 72.

(Dependency on Ld1 and Dependency on Ld2)

[0057] In addition to the above, the inventors of the subject application scrutinized whether a better effect was achieved when the length of the chamber 71 in the height direction was changed. As shown in FIG. 9(b), the inventors of the subject application changed the length (Ld1) in the height direction of the first downstream region DA1 within a range of 10 to 1087 mm (Examples 1 to 4). In accordance with the change of Ld1, Ld was changed, too. It was confirmed that, as Ld1 increased, the average flow rate was increased and the variation in flow rate was decreased at least until Ld1 reached 587 mm (Example 3). Meanwhile, no significant difference was observed between a case where Ld1 was 587 mm (Example 3) and a case where Ld1 was 1087 mm (Example 4). Therefore, in consideration of the avoidance of increase in size of the apparatus, for example, Ld1 is preferably arranged to be roughly 600 mm or less. In Examples 1 to 4, Ld2 were not the same (Ld2 in Example 1 was 9 mm whereas Ld2 in Examples 2 to 4 was 14 mm) . On this account, the inventors of the subject application evaluated an influence of a difference in Ld2 on, for example, the variation in flow rate, as detailed below.

[0058] As shown in FIG. 10(a), the inventors of the subject application changed the length (Ld2) in the height direction of the second downstream region DA2 within a range of 9 to 91 mm (Examples 1 and 5 to 7). In accordance with the change of Ld2, Ld was changed, too. In Examples 1 and 5 to 7, Ld1 was 10 mm. The analysis results show that, as Ld2 was increased, the average flow rate was increased and/or the variation in flow rate was decreased. For example, when Example 1 (in which Ld2 was 9 mm) was compared with Example 5 (in which Ld2 was 27 mm), the variation in flow rate was more or less the same in both examples, i.e., 0.26%. Meanwhile, while the average flow rate was 371.7 m/s in Example 1, the average flow rate in Example 5 was large, i.e., 378.7 m/s. When Ld2 was equal to or larger than 46 mm (Examples 6 and 7), the variation in flow rate was significantly decreased (to be equal to or smaller than 0.10%) .

[0059] In the above-described Examples 2 to 4 used for analyzing the dependency of the factors such as the variation in flow rate on Ld1, Ld2 was set at 14 mm. 14 mm is a value between Ld2 in Example 1 (9 mm) and Ld2 in Example 5 (27 mm). Because no difference was observed in the variation in flow rate between Example 1 and Example 5, it is considered that a difference in Ld2 does not influence on a difference in the variation in flow rate between Example 1 and Examples 2 to 4. It is therefore concluded that, in Examples 1 to 4, the difference in the variation in flow rate was caused simply by the difference in Ld1.

[0060] When no flow adjustment fin 72 was provided (Comparative Examples 1 and 2), the variation in flow rate was not decreased even if Ld2 was increased, and the variation in flow rate was disadvantageously increased in the analysis results (see FIG. 9(a)). On this account, it was found that the decrease of the variation in flow rate by the elongation of Ld2 (Ld) presupposed the existence of the flow adjustment fins 72.

[0061] As described above, according to the analysis results, as the flow adjustment fins 72 were provided and the downstream region DA was increased in size in the height direction by increasing Ld1 and/or Ld2, the average flow rate was increased and the variation in flow rate was decreased. The inventors of the subject application interpreted the results as follows. The molecules of the compressed air whose variation in flow rate has been reduced to some degree by the flow adjustment fins 72 flow in the downstream region DA of the chamber 71 more or less evenly in the height direction, while colliding with one another in the arrangement direction. As a result, a variation of speed components of the molecules of the compressed air is gradually decreased in the arrangement direction, and hence the molecules are facilitated to advance more or less linearly along the height direction. On this account, the speed components in the height direction are further uniformized in the arrangement direction. This effect becomes more conspicuous when the downstream region DA (i.e., a region where nothing is provided) is elongated in the height direction. For the reason described above, the inventors of the subject application considered that the effect of increase in average flow rate and/or decrease in variation in flow rate was achieved by elongating the downstream region DA. As described above, in Comparative Examples, when the chamber 71 was elongated (Example 2), the variation in flow rate was not reduced but increased. Taking account of this result, the inventors of the subject application considered that the effects described above were achieved on the premise that the compressed air was adjusted to some degree by the flow adjustment fins 72.

[0062] As shown in FIG. 10(b), the inventors of the subject application obtained analysis results (Examples 2 and 7) of cases where L remained the same and Ld1 and Ld2 were varied. As Ld1 was arranged to be longer than Ld2, the variation in flow rate was significantly reduced. The inventors of the subject application considered the reason of this as follows. When fluid moves from the first downstream region DA1 having a large cross-sectional area to the second downstream region DA2 having a relatively small cross-sectional area, the airflow is disturbed to some degree as a large amount of compressed air enters a relatively narrow passage. The inventors of the subject application considered that, when the second downstream region DA2 is elongated in the height direction, the disturbance of the airflow would be effectively suppressed while the compressed air is supplied to the downstream side in the flow direction, with the result that variation in flow rate can be suppressed.

[0063] As shown in FIG. 11, the inventors of the subject application obtained analysis results (Examples 2, 8, and 9) of cases where L remained the same and Lr2 was varied. The results show that the variation in flow rate was not reduced even if Lr2 was increased. In Examples 8 and 9, the length (Lr) in the height direction of the flow adjustment region RA was elongated whereas the length (Ld) in the height direction of the downstream region DA was shortened. For this reason, it is considered that an influence of the decrease of Ld was significant in Examples 8 and 9.

[0064] Based on the above, in the chamber 71, it is preferable that the length (Ld) in the height direction of the downstream region DA where nothing is provided is arranged to be long. For example, when the length (Ld) of the downstream region DA is longer than the length (Lr) of the flow adjustment region RA where the flow adjustment fins 72 are provided, further increase of the average flow rate and/or further decrease of the variation in flow rate can be achieved. Furthermore, taking account of Examples 2 to 4, 6, and 7, it was found that the variation in flow rate was further significantly decreased (the variation in flow rate became 0.2% or less) when Ld was at least about twice as large as Lr.

[0065] As described above, the compressed air having flown into the supply passage 70 flows at least in the arrangement direction in the inflow passage 42, and then the flow direction of the compressed air is changed at the bended passage 43 from the arrangement direction to a direction having at least a component in the height direction. At this stage, part of the compressed air flowing in the extending direction of the inflow passage 42 is received by the flow adjustment fins 72. On this account, it is possible to adjust the flow of the compressed air in the bended passage 43 while suppressing a large amount of the compressed air from flowing into the space which is on the side far from the inflow passage 42. For this reason, as compared to a case where no flow adjustment fin 72 is provided, the flow rate of the compressed air flowing in the chamber 71 is uniformized in the arrangement direction. It is therefore possible to reduce the variation in flow rate between the nozzles 66.

[0066] In addition to the above, the flow adjustment fins 72 are arranged so that, the farther a flow adjustment fin 72 is from the inflow passage 42 in the arrangement direction, the larger the area of the part overlapping with the opening 41f is when viewed in the extending direction. This makes it possible to effectively suppress a large amount of the compressed air from reaching the end portion of the bended passage 43, which is on the side far from the opening 41f in the extending direction. Furthermore, according to the present embodiment, each flow adjustment fin 72 receives a relatively small amount of the compressed air. The compressed air is therefore substantially evenly distributed in the extending direction (arrangement direction) in the bended passage 43. On this account, it is possible to effectively reduce, in the arrangement direction, the variation in flow rate of the compressed air supplied to the chamber 71 through the bended passage 43.

[0067] Meanwhile, ends of the flow adjustment fins 72 on the side close to the nozzles 66 in the height direction are aligned along the arrangement direction. On this account, the distances between the exits 73 and the nozzles 66 in the height direction are substantially identical and do not vary depending on the position in the arrangement direction. Therefore, as compared to, for example, a case where the distance varies depending on the position in the arrangement direction, it is possible to avoid a problem that a variation in flow rate, which is suppressed in the arrangement direction by the flow adjustment fins 72, is increased in the chamber 71.

[0068] In addition to the above, the downstream region DA is preferably longer than the flow adjustment region RA in the height direction. With this arrangement, the compressed air having been adjusted by the flow adjustment fins 72 moves for a long distance in the height direction until the compressed air reaches the nozzles 66. On this account, neighboring molecules collide with one another in the compressed air having been adjusted by the flow adjustment fins 72, with the result that the compressed air move while being facilitated to advance more or less linearly along the height direction. It is therefore possible to further effectively reduce the variation in flow rate between the nozzles 66.

[0069] In addition to the above, the inventors of the subject application found that, when the length in the height direction of the downstream region DA was at least twice as long as the length in the height direction of the flow adjustment region RA, the variation in flow rate was particularly evidently decreased.

[0070] In addition to the above, the chamber 71 includes the first downstream region DA1 and the second downstream region DA2 that is shorter in the yarn running direction than the first downstream region DA1. In other words, the cross-sectional area of the passage in the second downstream region DA2 is smaller than the cross-sectional area of the passage in the first downstream region DA1. For this reason, in the chamber 71, the cross-sectional area of the passage decreases stepwise toward the downstream side in the flow direction. It is therefore possible to increase the flow rate of the compressed air stepwise. On this account, it is possible to suppress rapid increase in flow rate at around the nozzles 66. Consequently, disturbance of the flow of the compressed air at around the nozzles 66 is suppressed.

[0071] In addition to the above, it is further preferable that the second downstream region DA2 is longer than the first downstream region DA1 in the height direction. When fluid moves from the first downstream region DA1 having a large cross-sectional area to the second downstream region DA2 having a relatively small cross-sectional area, the airflow is disturbed to some degree as a large amount of compressed air enters a relatively narrow passage. When the second downstream region DA2 is elongated in the height direction, the disturbance of the airflow is effectively suppressed while the compressed air was supplied to the downstream side in the flow direction, with the result that variation in flow rate can be suppressed.

[0072] In addition to the above, in the present embodiment, it is possible to suppress the efficiency of interlace by the interlacing device 13 from being different between the yarns Y. It is therefore possible to suppress the variation in quality between the packages P that are simultaneously formed by the spun yarn take-up machine 1.

[0073] 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) In the embodiment above, the length in the yarn running direction of the first downstream region DA1 of the chamber 71 is constant. However, the disclosure is not limited to this. For example, the length in the yarn running direction of the chamber formation passage 44 may be different from the length in the yarn running direction of the connection passage 45. For example, in the yarn running direction, the connection passage 45 may be shorter than (i.e., narrower than) the chamber formation passage 44. In

this case, the chamber formation passage 44 is equivalent to the first downstream region of the present invention and the connection passage 45 is equivalent to the second downstream region of the present invention.

(2) In the embodiment above, the downstream region DA of the chamber 71 includes the first downstream region DA1 and the second downstream region DA2. However, the disclosure is not limited to this. The downstream region DA may include only one of the first downstream region DA1 and the second downstream region DA2.

(3) In the embodiment above, the downstream region DA is preferably longer than the flow adjustment region RA in the height direction. In this regard, the flow adjustment effect thanks to the flow adjustment fins 72 can be obtained even when the downstream region DA is equal to or shorter in length than the flow adjustment region RA in the height direction.

(4) In the embodiment above, the ends on the other side in the height direction of the flow adjustment fins 72 are aligned in the arrangement direction. However, the disclosure is not limited to this. The positions of the ends on the other side in the height direction of the flow adjustment fins 72 may be different from one another in the height direction.

(5) In the embodiment above, the flow adjustment fins 72 are arranged so that, the farther a flow adjustment fin 72 is from the inflow passage 42 in the arrangement direction, the larger the area of the part overlapping with the inflow passage 42 is when viewed in the extending direction. However, the disclosure is not limited to this. For example, the lengths of the protrusions of the flow adjustment fins 72 toward the one side in the height direction may be substantially identical between the flow adjustment fins 72.

(6) In the embodiment above, the bended passage 43 is provided with plural flow adjustment fins 72. However, the disclosure is not limited to this. For example, depending on the length of the bended passage 43 in the arrangement direction, the number of the flow adjustment fins 72 may be only one.

(7) In the embodiment above, the supply passage 70 is composed of the fluid supplying member 31, the connecting member 32, and the base member 51 of the interlacing unit 33. However, the disclosure is not limited to this. For example, the fluid supplying member 31 and the connecting member 32 may be integrally formed as a single member by means of, for example, welding. Alternatively, the interlacing device 13 may not include the connecting member 32. In this case, the main body 41 of the fluid supplying member 31 and the base member 51 of the interlacing unit 33 may be fixed to each other by screwing.

(8) The side surfaces forming the chamber 71 (e.g., the inner side surfaces 41b to 41e) may not extend to be substantially in parallel to the height direction. The side surfaces may be, for example, tilted relative to the height direction. For example, the cross-sectional area of the downstream region DA taken along the direction orthogonal to the height direction may decrease toward the other side in the height direction. On the contrary, the cross-sectional area may increase toward the other side in the height direction.

(9) In the embodiment above, the arrangement direction is substantially orthogonal to the height direction. However, the disclosure is not limited to this. The arrangement direction may not be substantially orthogonal to the height direction. Furthermore, while in the embodiment above the extending direction in which the inflow passage 42 extends is substantially in parallel to the arrangement direction, the disclosure is not limited to this arrangement. The extending direction may be tilted relative to the arrangement direction.

(10) The interlacing device 13 may be applied to a textile machine configured to handle running yarns Y, which is different from the spun yarn take-up machine 1.

Claims

1. An interlacing device 13 configured to interlace yarns Y by using fluid, comprising:

nozzles 66 which are aligned in a predetermined first direction and are used for ejecting the fluid onto the yarns Y; and
a supply passage 70 which is arranged to supply the fluid to the nozzles 66,
the supply passage 70 including:

an inflow passage 42 which extends at least in the first direction and into which the fluid flows;
a chamber 71 which is provided between the inflow passage 42 and the nozzles 66 in a flow direction of the fluid and extends in the first direction and in a second direction intersecting with the first direction; and
a bended passage 43 which is provided between the inflow passage 42 and the chamber 71 in the flow direction and connects a portion extending in the first direction with a portion extending in the second direction,
at least in the bended passage 43, at least one flow adjustment fin 72 is provided to extend in the second direction and to at least partially overlap with an entrance 41f of the bended passage 43 when viewed in an extending direction in which the inflow passage 42 extends.

2. The interlacing device 13 according to claim 1, wherein,

as the at least one flow adjustment fin 72, plural flow adjustment fins 72 are provided to be aligned in the first direction, and
the flow adjustment fins 72 are arranged so that, the farther a flow adjustment fin 72 is from the inflow passage 42 in the first direction, the larger the area of a part overlapping with the entrance 41f is when viewed in the extending direction.

3. The interlacing device 13 according to claim 1 or 2, wherein,

as the at least one flow adjustment fin 72, plural flow adjustment fins 72 are provided to be aligned in the first direction, and
ends of the flow adjustment fins 72 on the side close to the nozzles 66 in the second direction are aligned along the first direction.

4. The interlacing device 13 according to any one of claims 1 to 3, wherein,

the chamber 71 includes a downstream region DA that is on the side close to the nozzles 66 in the second direction as compared to a flow adjustment region RA where the at least one flow adjustment fin 72 is provided, and
the downstream region DA is longer than the flow adjustment region RA in the second direction.

5. The interlacing device 13 according to claim 4, wherein, the downstream region DA in the second direction is at least twice as long as the flow adjustment region RA.

6. The interlacing device 13 according to any one of claims 1 to 5, wherein,
the chamber 71 includes:

a first downstream region DA1 that is provided on the downstream side in the flow direction of the flow adjustment region RA where the at least one flow adjustment fin 72 is provided; and
a second downstream region DA2 which is provided on the downstream side in the flow direction of the first downstream region DA1, the second downstream region DA2 being shorter than the first downstream region DA1 in a third direction that is orthogonal to both the first direction and the second direction.

7. The interlacing device 13 according to claim 6, wherein, the second downstream region DA2 is longer than the first downstream region DA1 in the second direction.

8. A yarn winder 1 comprising:

the interlacing device 13 of any one of claims 1 to 7; and
a winding unit 4 which is configured to simultaneously form packages P by winding the yarns Y interlaced by the interlacing device 13.

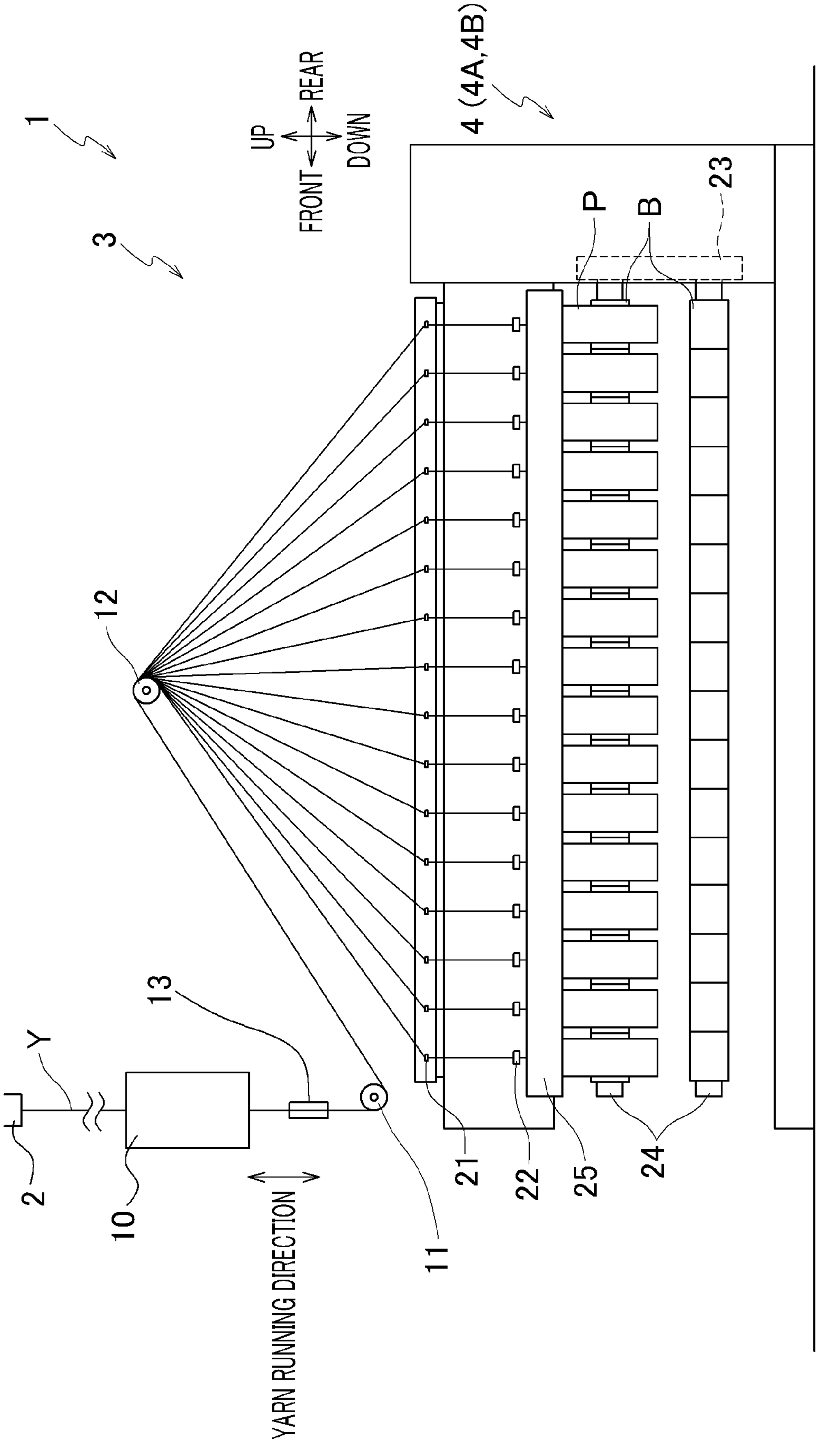

1
3
UP
DOWN
FRONT
REAR
4 (4A,4B)
P
B
23
12
13
Y
2
10
YARN RUNNING DIRECTION
11
21
22
25
24

FIG.1

FIG.2

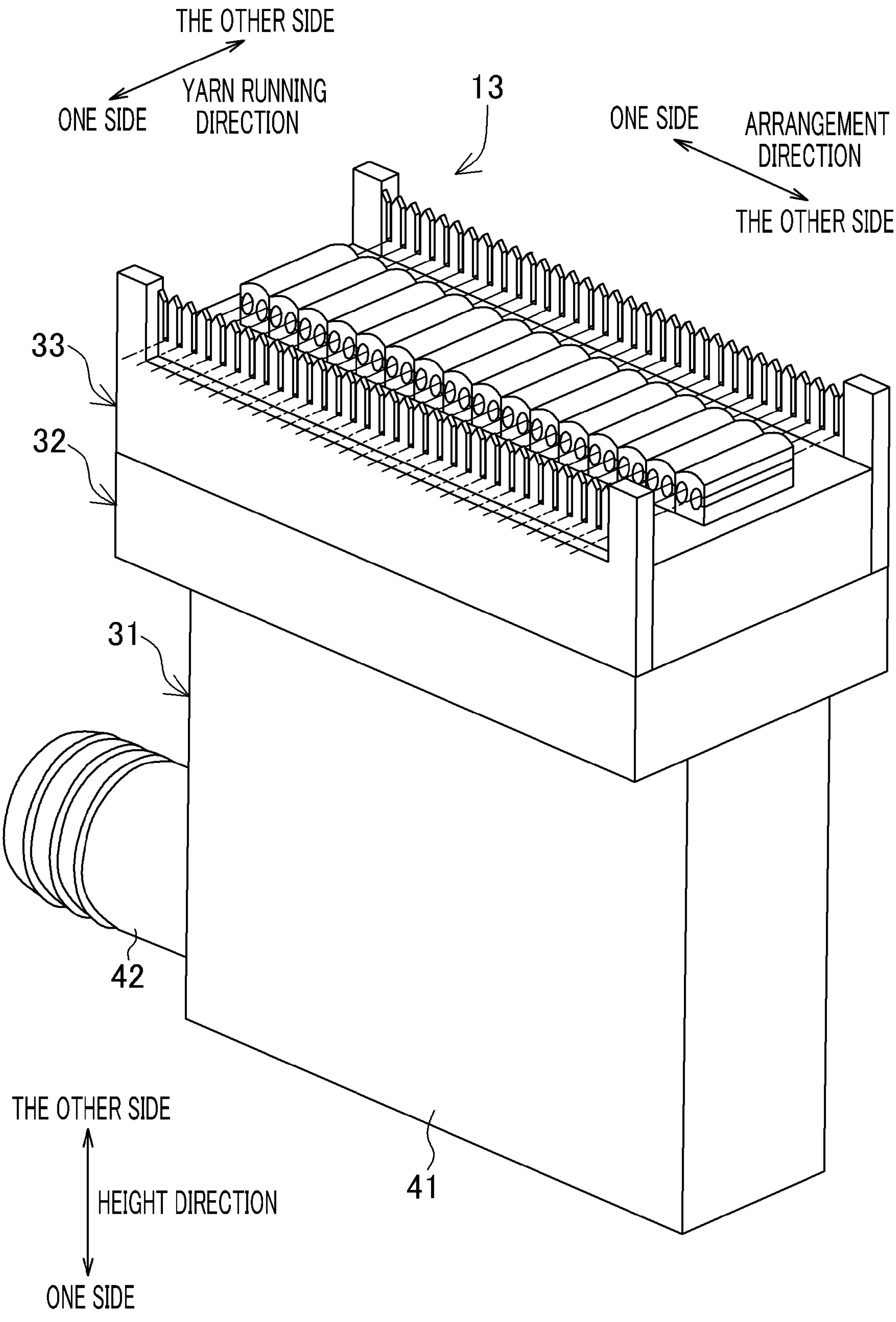
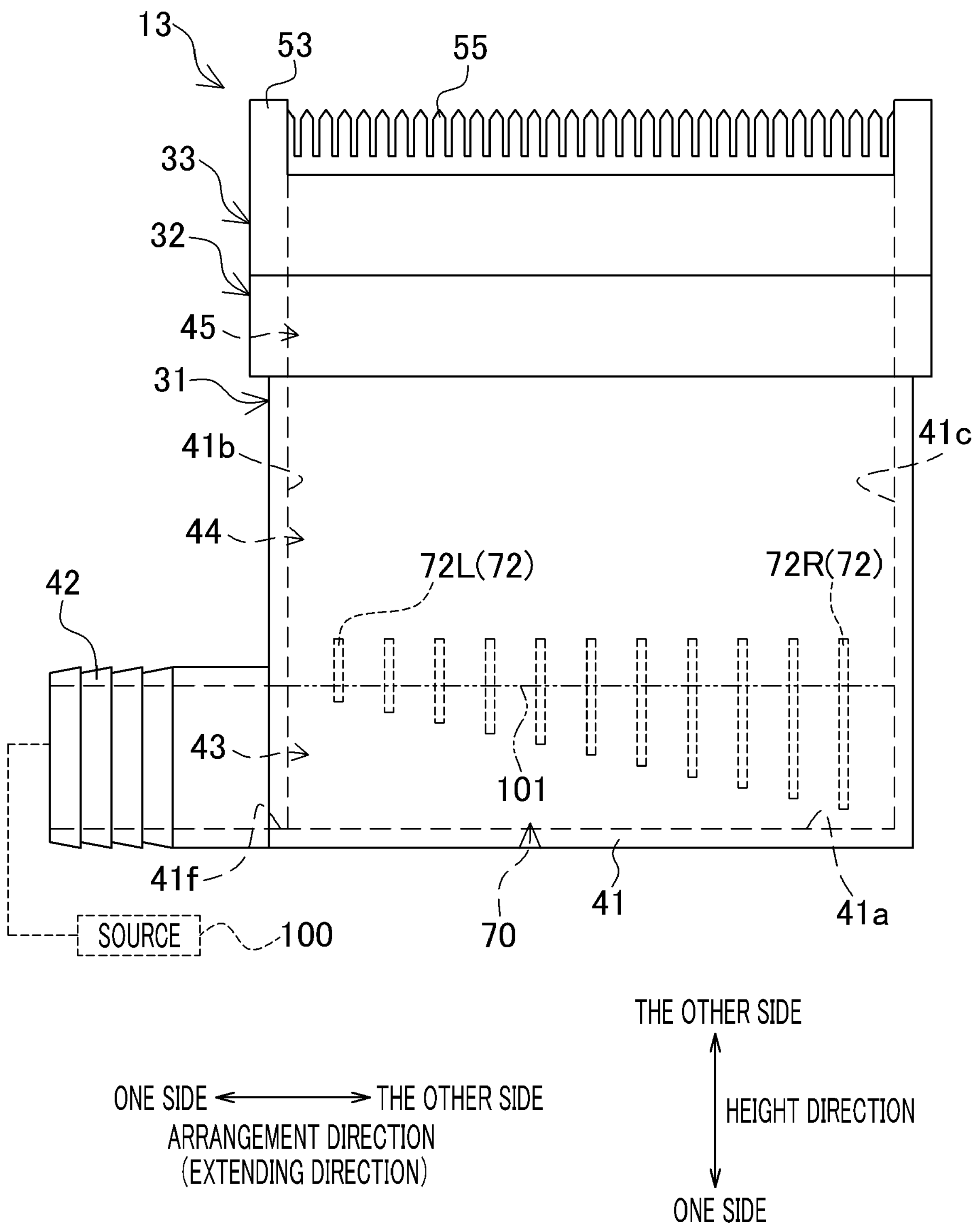

THE OTHER SIDE
ONE SIDE
YARN RUNNING DIRECTION
13
ONE SIDE
ARRANGEMENT DIRECTION
THE OTHER SIDE
33
32
31
42
41
THE OTHER SIDE
HEIGHT DIRECTION
ONE SIDE

FIG.3



13
53
55
33
32
45
31
41b
41c
44
72L(72)
72R(72)
42
43
101
41f
70
41
41a
SOURCE
100
THE OTHER SIDE
ONE SIDE
THE OTHER SIDE
ARRANGEMENT DIRECTION
(EXTENDING DIRECTION)
HEIGHT DIRECTION
ONE SIDE

FIG.4

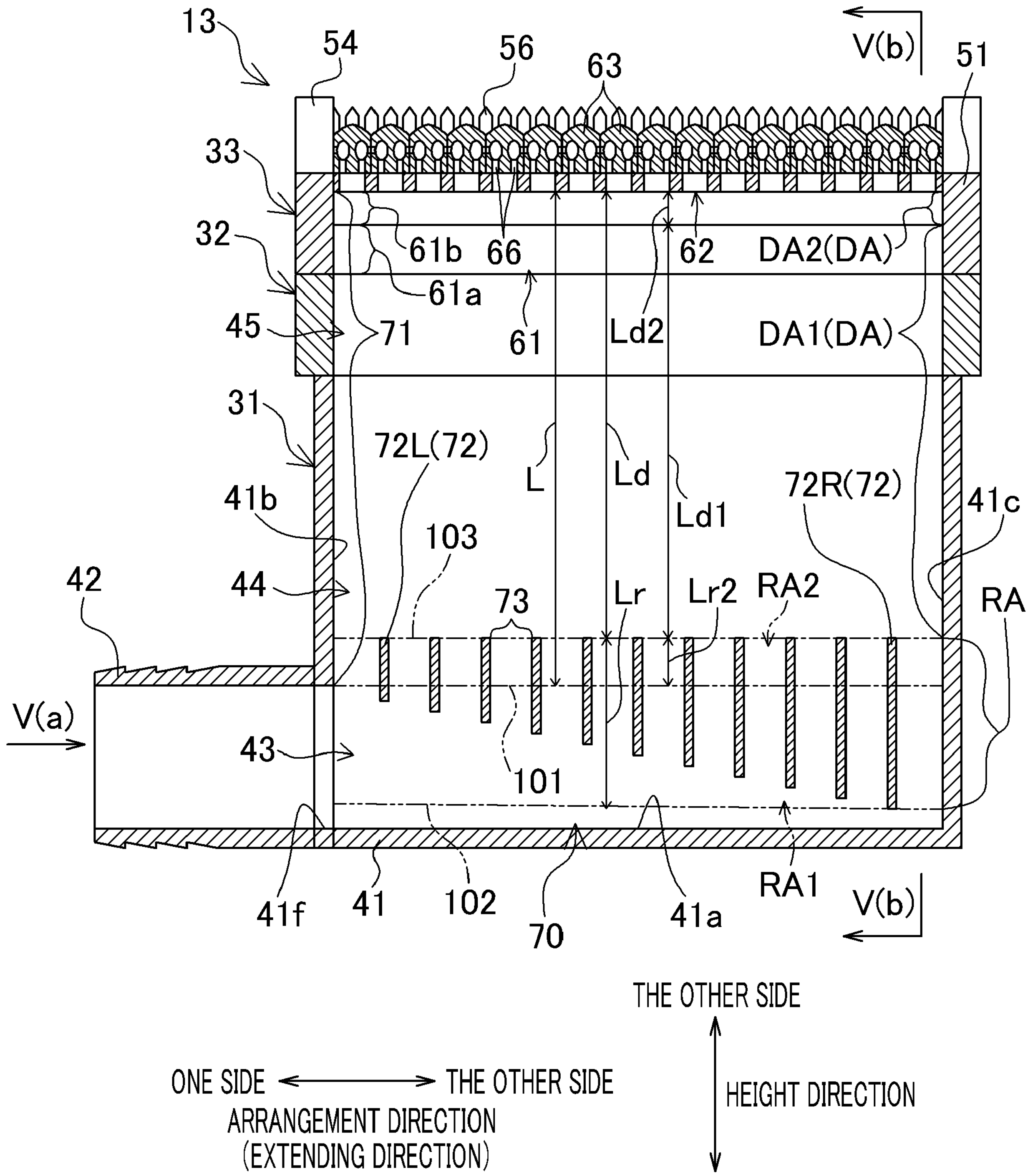

13
54
56
63
V(b)
51
33
32
61b
66
62
DA2(DA)
61a
45
71
61
Ld2
DA1(DA)
31
72L(72)
L
Ld
Ld1
72R(72)
41c
41b
103
42
44
73
Lr
Lr2
RA2
RA
V(a)
43
101
41f
41
102
70
41a
RA1
V(b)
THE OTHER SIDE
ONE SIDE
THE OTHER SIDE
ARRANGEMENT DIRECTION
(EXTENDING DIRECTION)
HEIGHT DIRECTION
ONE SIDE

FIG.5

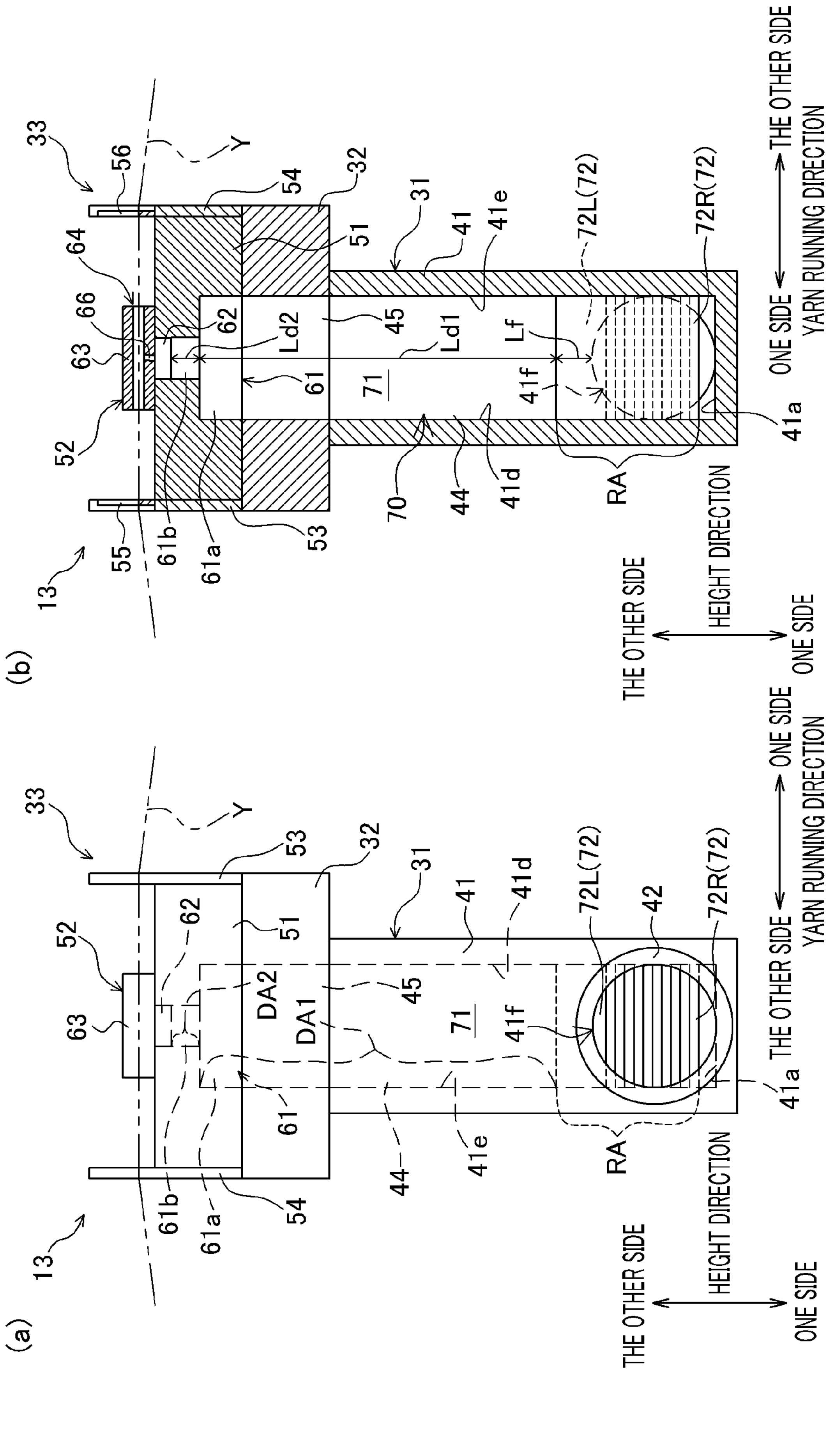

(a)
(b)
13
33
Y
52
63
62
61
61a
61b
51
53
54
55
56
64
66
32
31
41
41a
41d
41e
41f
42
44
45
70
71
DA1
DA2
Ld1
Ld2
Lf
72L(72)
72R(72)
RA
THE OTHER SIDE
HEIGHT DIRECTION
ONE SIDE
YARN RUNNING DIRECTION

FIG.6

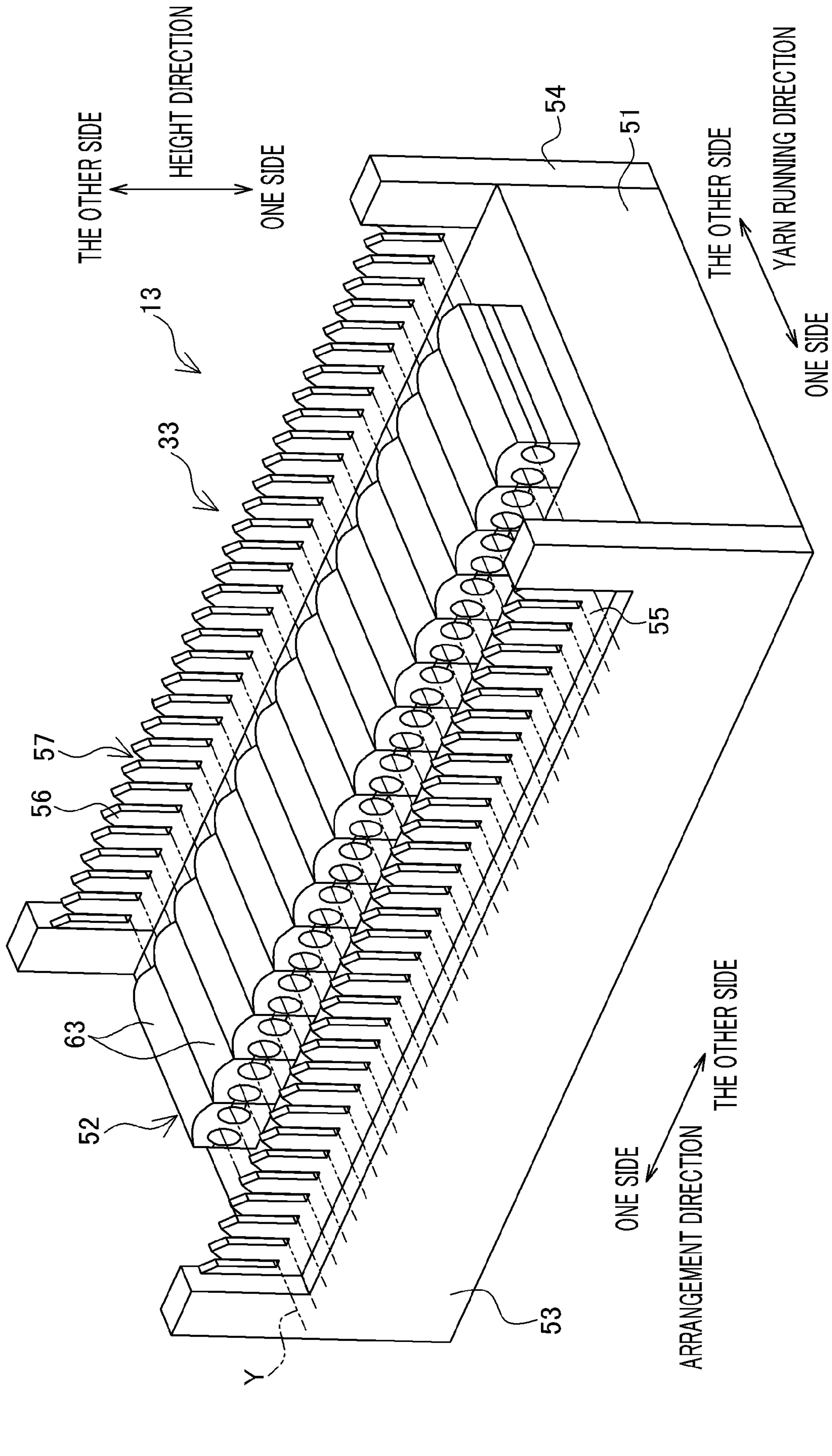

THE OTHER SIDE
HEIGHT DIRECTION
ONE SIDE
13
33
54
51
THE OTHER SIDE
YARN RUNNING DIRECTION
ONE SIDE
55
57
56
63
52
53
Y
ONE SIDE
ARRANGEMENT DIRECTION
THE OTHER SIDE

FIG.7

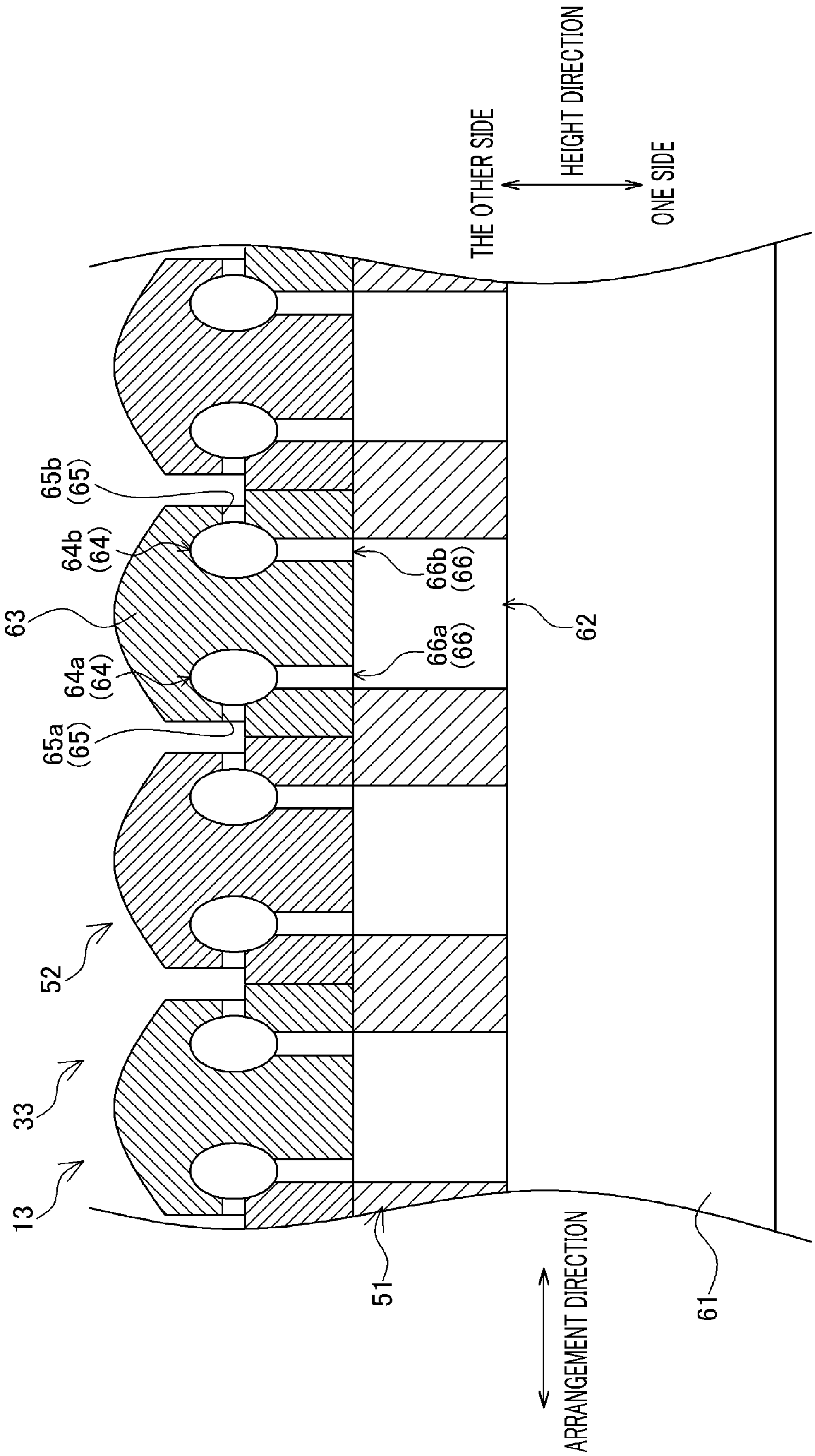

THE OTHER SIDE
HEIGHT DIRECTION
ONE SIDE
65b
(65)
64b
(64)
63
64a
(64)
65a
(65)
52
33
13
66b
(66)
66a
(66)
62
51
ARRANGEMENT DIRECTION
61

FIG.8

FLUID ANALYSIS RESULTS (ALL EXAMPLES AND COMPARATIVE EXAMPLES)

	PRESENCE OR ABSENCE OF FINS	L(mm)	Ld (mm)	Ld1 (mm)	Ld2 (mm)	Lr2 (mm)	Lr (mm)	AVERAGE FLOW RATE (m/s)	VARIATION IN FLOW RATE BETWEEN NOZZLES (%)
EXAMPLE1	PRESENT	28	19	10	9	9	33	371.7	0.26
EXAMPLE2	PRESENT	110	101	87	14	9	33	381.4	0.18
EXAMPLE3	PRESENT	610	601	587	14	9	33	386.4	0.06
EXAMPLE4	PRESENT	1110	1101	1087	14	9	33	386.0	0.07
EXAMPLE5	PRESENT	46	37	10	27	9	33	378.7	0.26
EXAMPLE6	PRESENT	65	56	10	46	9	33	382.5	0.10
EXAMPLE7	PRESENT	110	101	10	91	9	33	384.1	0.05
EXAMPLE8	PRESENT	110	72	58	14	38	62	382.3	0.20
EXAMPLE9	PRESENT	110	43	29	14	67	91	382.6	0.21
COMPARATIVE EXAMPLE1	ABSENT	28	–	–	9	–	–	369.1	0.43
COMPARATIVE EXAMPLE2	ABSENT	65	–	–	46	–	–	379.8	0.62

FIG.9

(a) FLUID ANALYSIS RESULTS (DEPENDENCY ON PRESENCE OR ABSENCE OF FINS)

	PRESENCE OR ABSENCE OF FINS	L(mm)	Ld (mm)	Ld1 (mm)	Ld2 (mm)	Lr2 (mm)	Lr (mm)	AVERAGE FLOW RATE (m/s)	VARIATION IN FLOW RATE BETWEEN NOZZLES (%)
EXAMPLE1	PRESENT	28	19	10	9	9	33	371.7	0.26
COMPARATIVE EXAMPLE1	ABSENT	28	-	-	9	-	-	369.1	0.43
EXAMPLE6	PRESENT	65	56	10	46	9	33	382.5	0.10
COMPARATIVE EXAMPLE2	ABSENT	65	-	-	46	-	-	379.8	0.62

(b) FLUID ANALYSIS RESULTS (DEPENDENCY ON LENGTH (Ld1) IN HEIGHT DIRECTION OF FIRST SPACE)

	PRESENCE OR ABSENCE OF FINS	L(mm)	Ld (mm)	Ld1 (mm)	Ld2 (mm)	Lr2 (mm)	Lr (mm)	AVERAGE FLOW RATE (m/s)	VARIATION IN FLOW RATE BETWEEN NOZZLES (%)
EXAMPLE1	PRESENT	28	19	10	9	9	33	371.7	0.26
EXAMPLE2	PRESENT	110	101	87	14	9	33	381.4	0.18
EXAMPLE3	PRESENT	610	601	587	14	9	33	386.4	0.06
EXAMPLE4	PRESENT	1110	1101	1087	14	9	33	386.0	0.07

FIG.10

(a) FLUID ANALYSIS RESULTS (DEPENDENCY ON LENGTH (Ld2) IN HEIGHT DIRECTION OF SECOND SPACE)

	PRESENCE OR ABSENCE OF FINS	L(mm)	Ld (mm)	Ld1 (mm)	Ld2 (mm)	Lr2 (mm)	Lr (mm)	AVERAGE FLOW RATE (m/s)	VARIATION IN FLOW RATE BETWEEN NOZZLES (%)
EXAMPLE1	PRESENT	28	19	10	9	9	33	371.7	0.26
EXAMPLE5	PRESENT	46	37	10	27	9	33	378.7	0.26
EXAMPLE6	PRESENT	65	56	10	46	9	33	382.5	0.10
EXAMPLE7	PRESENT	110	101	10	91	9	33	384.1	0.05

(b) FLUID ANALYSIS RESULTS (COMPARISON BETWEEN EXAMPLES HAVING SAME Ld1+Ld2)

	PRESENCE OR ABSENCE OF FINS	L(mm)	Ld (mm)	Ld1 (mm)	Ld2 (mm)	Lr2 (mm)	Lr (mm)	AVERAGE FLOW RATE (m/s)	VARIATION IN FLOW RATE BETWEEN NOZZLES (%)
EXAMPLE2	PRESENT	110	101	87	14	9	33	381.4	0.18
EXAMPLE7	PRESENT	110	101	10	91	9	33	384.1	0.05

FIG.11

FLUID ANALYSIS RESULTS (DEPENDENCY ON LENGTH (Lf) OF PROTRUSION OF FIN TOWARD THE OTHER SIDE IN HEIGHT DIRECTION)

	PRESENCE OR ABSENCE OF FINS	L(mm)	Ld (mm)	Ld1 (mm)	Ld2 (mm)	Lr2 (mm)	Lr (mm)	AVERAGE FLOW RATE (m/s)	VARIATION IN FLOW RATE BETWEEN NOZZLES (%)
EXAMPLE2	PRESENT	110	101	87	14	9	33	381.4	0.18
EXAMPLE8	PRESENT	110	72	58	14	38	62	382.3	0.20
EXAMPLE9	PRESENT	110	43	29	14	67	91	382.6	0.21

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EUROPEAN SEARCH REPORT

Application Number
EP 22 18 1219

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The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	8 December 2022	Barathe, Rainier

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Application Number
EP 22 18 1219

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The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	8 December 2022	Barathe, Rainier

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