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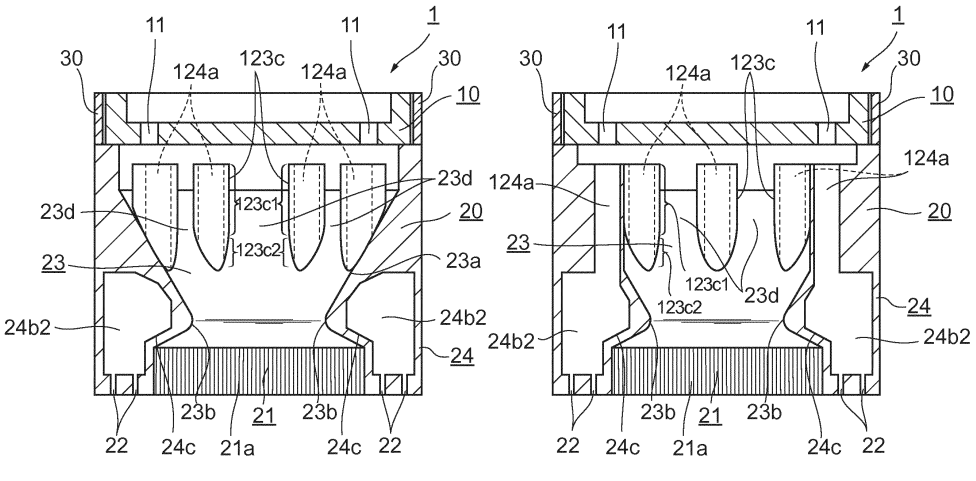
(54) WATER DISCHARGE DEVICE

(57) Water discharge device including: a first member (10) including an injection port (11); a second member (20) including a streaming flow channel (23) with a streaming discharge port (21), and a shower flow channel (24) with a shower discharge port (22); and a flow channel switching mechanism. The shower flow channel (24) includes an air intake section, a storage section (24b2) of water with bubbles, a backflow prevention section, the shower discharge port (22), and a positional displacement prevention section that prevents at least a part of a projected plane, formed by projecting a downstream end of the injection port (11) in an injection direction, from being displaced outside the backflow prevention section due to an impact caused by the water injected through the injection port (11), in a state where water at a maximum flow rate is supplied into the injection port (11), and the entire projected plane passes through an inside of the backflow prevention section.

FIG. 2



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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to a water discharge device that discharges water with bubbles.

Description of the Related Art

[0002] Japanese Patent No. 3729198 discloses a water discharge switching device that includes: a first member provided with an injection port through which water flowing from an upstream side is injected into a downstream side by being increased in flow velocity; a second member including a streaming flow channel provided with a streaming discharge port through which a single water stream is discharged, and a shower flow channel provided with a shower discharge port through which a plurality of water streams are discharged; and a flow channel switching mechanism that turns the second member with respect to the first member to switch between a first state of allowing water injected through the injection port to flow into the streaming flow channel and a second state of allowing water injected through the injection port to flow into the shower flow channel.

[0003] Japanese Patent Laid-Open No. 2014-68678 discloses a shower device that includes: an air intake section through which air is sucked in by using a vacuum created as water injected through an injection port passes through the air intake section; a storage section of water with bubbles that is provided downstream of the air intake section to store water with bubbles produced by mixing of air sucked in through the air intake section into the water injected through the injection port; and a shower discharge port through which the water with bubbles stored in the storage section of water with bubbles is discharged.

[0004] The shower device of Japanese Patent Laid-Open No. 2014-68678 further includes a backflow prevention section that is provided between the air intake section and the storage section of water with bubbles, with a flow channel cross-sectional area larger than that of the injection port as well as smaller than that of the storage section of water with bubbles, to prevent backflow of water with bubbles from the storage section of water with bubbles toward the air intake section. The backflow prevention section is provided to enable an air-passing space between a water stream injected through the injection port and an internal wall surface of the backflow prevention section to be reduced, or to enable flow velocity of air around an injected water stream, passing through the backflow prevention section, to increase. As a result, it is possible to prevent backflow of the water with bubbles stored in the storage section of water with bubbles toward the air intake section.

[0005] The present inventors have studied a case where a shower flow channel of a water discharge switching device, such as disclosed in Japanese Patent No. 3729198, includes a backflow prevention section, such as disclosed in Japanese Patent Laid-Open No. 2014-68678 to unfortunately result in finding out that the following additional problem may occur. Specifically, in a state of allowing water injected through the injection port to flow into the shower flow channel so that water with bubbles is discharged through the shower discharge port, and more particularly, in a state where water supplied to the injection port has a large flow rate, an impact caused by a collision of an injected water stream with the internal wall surface of the storage section of water with bubbles may change a positional relationship between the injection port and an inlet opening of the backflow prevention section. If positional displacement between the injection port and the backflow prevention section causes a part of the injected water stream not to flow into the inside of the backflow prevention section, the part of the injected water that cannot flow into the inside collides with an opening wall of the backflow prevention section to cause an additional problem in which the injected water stream flows back to an air inlet port to significantly reduce the amount of intake air.

[0006] With respect to the problem described above, there is a conceivable method of increasing movement resistance between the first member and the second member to prevent positional displacement. However, if the movement resistance is excessively increased in consideration of only prevention of positional displacement, operability at the time of switching water discharge is deteriorated, whereby it is not preferable. Meanwhile, reduction in the movement resistance between the first member and the second member for improving operability at the time of switching water discharge may cause a problem in which positional displacement between the injection port and the backflow prevention section occurs during discharging shower of water with bubbles to significantly reduce the amount of intake air, as described above.

[0007] The present invention is made in light of the problem described above, and it is an object of the present invention to provide a water discharge device that is capable of switching between streaming discharge of water and discharge of shower of water with bubbles, as well as capable of preventing the amount of intake air from significantly decreasing due to positional displacement between an injection port and a backflow prevention section when shower of water with bubbles is discharged, without deteriorating operability at the time of switching water discharge.

SUMMARY OF THE INVENTION

[0008] In order to solve the problem described above, a water discharge device in accordance with the present invention includes: a first member that is provided with an injection port through which water flowing from an

upstream side is injected to a downstream side by being increased in flow velocity; a second member that includes a streaming flow channel provided with a streaming discharge port through which a single water stream is discharged, and a shower flow channel provided with a shower discharge port through which a plurality of water streams are discharged; a flow channel switching mechanism that switches between a first state of allowing water injected through the injection port to flow into the streaming flow channel, and a second state of allowing the water injected through the injection port to flow into the shower flow channel, by moving either one of the first member and the second member, the shower flow channel including: an air intake section through which air is sucked in by using a vacuum created as the water injected through the injection port passes through the air intake section; a storage section of water with bubbles that is provided downstream of the air intake section to store water with bubbles produced by mixing of air sucked in through the air intake section into the water injected through the injection port; a backflow prevention section that is provided between the air intake section and the storage section of water with bubbles, with a flow channel cross-sectional area larger than that of the injection port as well as smaller than that of the storage section of water with bubbles, to prevent backflow of water with bubbles from the storage section of water with bubbles toward the air intake section; the shower discharge port through which water with bubbles stored in the storage section of water with bubbles is discharged; and a positional displacement prevention section that prevents at least a part of a projected plane, formed by projecting a downstream end of the injection port in an injection direction, from being displaced outside the backflow prevention section due to an impact caused by the water injected through the injection port, in a state where water at a maximum flow rate is supplied into the injection port, and the entire projected plane passes through an inside of the backflow prevention section.

[0009] According to the present invention, the flow channel switching mechanism is provided to switch a course of a water stream (injected water stream) injected through the injection port to either one of the streaming flow channel and the shower flow channel to enable a state of discharging a single water stream (streaming) and a state of discharging a plurality of water streams (shower) to be switched.

[0010] In addition, according to the present invention, the backflow prevention section is provided to enable an air-passing space between an injected water stream and an inner wall of the backflow prevention section to be reduced. Accordingly, flow velocity of air around the injected water stream passing through the backflow prevention section increases to enable water with bubbles stored in the storage section of water with bubbles to be prevented from flowing back toward the air intake section.

[0011] Further, according to the present invention, the positional displacement prevention section is provided to enable the positional relationship between the injection port and an inlet opening of the backflow prevention section to be prevented from being changed due to an impact caused by collision of an injected water stream with an internal wall surface of the storage section of water with bubbles. Accordingly, if a part of the injected water stream does not flow into the inside of the backflow prevention section, the part of the injected water stream that cannot flow into the inside can be prevented from colliding with an opening wall of the backflow prevention section to flow back toward the air inlet port.

[0012] In an aspect of the water discharge device in accordance with the present invention, it is preferable that the flow channel switching mechanism moves either one of the first member and the second member in a first direction when switching the first state to the second state, and that the positional displacement prevention section is provided in the storage section of water with bubbles, and includes a guide portion for guiding the water injected through the injection port to a direction different from the first direction.

[0013] In this preferable aspect, the guide portion is provided to enable collision reaction force that occurs when an injected water stream collides with the internal wall surface of the storage section of water with bubbles to be applied in a direction in which the positional relationship between the injection port and the inlet opening of the backflow prevention section is not changed. Accordingly, it is possible to prevent the positional relationship between the injection port and the inlet opening of the backflow prevention section from being changed due to an impact of the injected water stream, without deteriorating operability at the time of switching water discharge.

[0014] In another aspect of the water discharge device in accordance with the present invention, it is preferable that the guide portion is arranged at a position interfering with the projected plane.

[0015] In this preferable aspect, the positional relationship between the injection port and the guide portion is configured as described above to enable an injected water stream to more reliably collide with the guide portion.

[0016] In yet another aspect of the water discharge device in accordance with the present invention, it is preferable that the positional displacement prevention section is provided in a connection portion between the first member and the second member, and includes an elastic member that serves as movement resistance when either one of the first member and the second member is moved.

[0017] In this preferable aspect, the elastic member is provided to enable either one of the first member and the second member to be movable by being increased in movement resistance. Accordingly, it is possible to further prevent positional displacement between the injection port and the inlet opening of the backflow prevention section, caused by an impact of water injected through the injection port, without deteriorating operability at the

time of switching water discharge.

[0018] In yet another aspect of the water discharge device in accordance with the present invention, it is preferable that the elastic member includes a first region to be a first resistance, and a second region to be a second resistance less than the first resistance, in a moving range when the first state and the second state are switched by the flow channel switching mechanism, and that a position at which the entire projected plane passes through the inside of the backflow prevention section is within the first region.

[0019] In this preferable aspect, a region with large movement resistance and a region with small movement resistance are provided in a moving range of the first member or the second member to allow at least a positon at which all of injected water streams pass through the inside of the backflow prevention section to be within the region with large movement resistance. Accordingly, while a position of the injection port is prevented from being displaced by an impact of water injected through the injection port, it is possible to reduce an operation load at the time of movement as compared with a case where the movement resistance is set large in the entire moving range of the first member and the second member.

[0020] In yet another aspect of the water discharge device in accordance with the present invention, it is preferable that the positional displacement prevention section is acquired by forming the backflow prevention section in a flat shape in flow channel cross section so that a longitudinal direction of the flat shape is a movement direction when the first state and the second state are switched.

[0021] In this preferable aspect, the flow channel cross section of the backflow prevention section is increased in length in the movement direction when the first state and the second state are switched to enable a state where all of injected water passes through the inside of the backflow prevention section to be easily maintained even if the positional relationship between the injection port and the inlet opening of the backflow prevention section is slightly changed by an impact of water injected through the injection port. In addition, the flow channel cross section of the backflow prevention section is reduced in width in a direction orthogonal to the movement direction when the first state and the second state are switched, or a flow channel cross-sectional area is reduced, to also enable water with bubbles stored in the storage section of water with bubbles to be prevented from flowing back toward the air intake section.

[0022] In yet another aspect of the water discharge device in accordance with the present invention, it is preferable that the positional displacement prevention section is acquired by forming the backflow prevention section in a shape in which a flow channel cross-sectional area decreases from an upstream side to a downstream side.

[0023] In this preferable aspect, an inlet opening of the injection port is large enough to enable a state where all of injected water passes through the inside of the backflow prevention section to be easily maintained even if the positional relationship between the injection port and the inlet opening of the backflow prevention section is slightly changed by an impact of water injected through the injection port. In addition, a flow channel cross-sectional area of a downstream portion of the backflow prevention section is small enough to enable water with bubbles stored in the storage section of water with bubbles to be prevented from flowing back toward the air intake section. Further, the flow channel of the backflow prevention section is formed so that the cross-sectional area thereof decreases from the upstream side to the downstream side to enable the water collided with the inner wall by force of an injected water stream to be compressed to the downstream side to prevent the injected water stream from flowing back toward the air intake section even if a part of injected water slightly interferes with the inner wall of the downstream portion of the backflow prevention section.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024]

FIG. 1 is a perspective view showing a faucet unit provided with a discharge port cap in accordance with an embodiment of the present invention;
FIG. 2 is a sectional view showing a general structure of the discharge port cap shown in FIG. 1;
FIG. 3 is a schematic diagram showing a relationship between an injection port, a shower flow channel, and a streaming flow channel of the discharge port cap shown in FIG. 1;
FIG. 4 is a schematic diagram showing a second embodiment of the discharge port cap shown in FIG. 1;
FIG. 5 is a graph showing a relationship between a discharge state and operation resistance when the discharge port cap shown in FIG. 4 is used;
FIG. 6 is a schematic diagram showing an outline of action of discharge port cap shown in FIG. 1;
FIG. 7 is a block diagram showing a general configuration of the discharge port cap shown in FIG. 1;
FIG. 8 is a schematic diagram showing a third embodiment of the discharge port cap shown in FIG. 1;
FIG. 9 is a schematic diagram showing action when the discharge port cap shown in FIG. 8 is used; and
FIG. 10 is a schematic diagram showing a fourth embodiment of the discharge port cap shown in FIG. 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0025] Hereinafter, embodiments of the present invention will be described with reference to the accompanying

drawings. For easy understanding of description, the same component in each of the drawings is designated by the same reference numeral as far as possible without duplicated description on the component.

[0026] An outline of a discharge port cap (water discharge device) 1 of an embodiment of the present invention will be described with reference to FIGS. 1 to 3. FIG. 1 is a perspective view showing an example in which the discharge port cap 1 is used in a washstand S as a component of a faucet device FC. FIG. 2 is a sectional view of the discharge port cap 1, and FIG. 3 is a schematic diagram showing a relationship between an injection port and flow channels for shower discharge and streaming discharge of the discharge port cap 1, and a resistance mechanism.

[0027] The discharge port cap 1 is a component to be used in a discharge port opening portion of the faucet device FC. The faucet device FC, as shown in FIG. 1, for example, is attached to a washbowl of the washstand S, and is formed in an elongated cylindrical shape with stainless steel or the like to discharge water toward a bowl section B for storing or receiving water. The faucet device FC is attached on the periphery of the bowl section, and is connected to a water pipe through which water is supplied.

[0028] As shown in FIG. 1, the discharge port cap 1 is attached to a leading end of the faucet device FC so that an exterior of the discharge port cap 1 is covered with the faucet device FC, and is configured to discharge water supplied through the water pipe as a shower discharge composed of a plurality of thin water streams or as a streaming discharge that is a single collected water stream. In each of the shower discharge and the streaming discharge, air sucked in from the outside is foamed and mixed into water to form water with bubbles, and then the water with bubbles is discharged. The discharge port cap 1 is configured so that the shower discharge and the streaming discharge can be switched by turning the leading end using a flow channel switching mechanism 40.

[0029] Subsequently, with reference to FIGS. 2 and 3, specific structure of the discharge port cap 1 will be described. FIG. 2A is a sectional view taken along the line A-A of FIG. 3A, and FIG. 2B is a sectional view taken along the line B-B of FIG. 3C.

[0030] The discharge port cap 1 as a whole is formed in a cylindrical shape, and includes a first cylindrical unit 10 (first member), and a second cylindrical unit 20 (second member). The discharge port cap 1 is configured so that the shower discharge and the streaming discharge can be switched, as described above, by turning the second cylindrical unit 20 with respect to the first cylindrical unit 10.

[0031] A state shown in each of FIGS. 2A and 3A is a first state in which water is allowed to flow through a streaming flow channel, and air from a shower flow channel is mixed into the water (hereinafter referred to as a "streaming state"), and a state shown in each of FIGS. 2B and 3C is a second state in which water is allowed to flow through the shower flow channel, and air from the streaming flow channel is mixed into the water (hereinafter referred to as a "shower state"). FIG. 3 is a plan view of the first cylindrical unit 10 as viewed from a bottom side of the first cylindrical unit 10 (the second cylindrical unit 20 side in FIG. 2), and the second cylindrical unit 20 is shown with a broken line by allowing a position of the second cylindrical unit 20 to be projected on the first cylindrical unit 10. Each of FIGS. 3A, 3B, 3C, and 3D, shows a state where the second cylindrical unit 20 is turned with respect to the first cylindrical unit 10.

[0032] The first cylindrical unit 10, as shown in FIGS. 2 and 3, includes a plurality of injection ports 11 on the circumference thereof (here, eight ports at equal intervals) into which water is allowed to flow from the water pipe as a supply source, and in which flow velocity is increased to be injected into a downstream side. The injection ports 11 are provided along an outer periphery of the first cylindrical unit 10 at respective positions at which the injection ports 11 communicate with a shower flow channel 24 described later in the shower state shown in FIG. 2(B) and 3C.

[0033] The second cylindrical unit 20 includes a streaming discharge port 21 through which water with bubbles is discharged as a single collected water stream, and a shower discharge port 22 that is arranged in an outer region of the streaming discharge port 21, and through which water with bubbles is discharged like a shower. In addition, the second cylindrical unit 20 includes a streaming flow channel 23 extending from the injection port 11 to the streaming discharge port 21, and the shower flow channel 24 extending from the injection port 11 to the shower discharge port 22.

[0034] The streaming discharge port 21 is formed in a central portion of the second cylindrical unit 20, and is provided with a streaming net 21a in which a large number of fine holes are formed in a lattice shape. Water discharged through the streaming discharge port 21 is reduced in turbulence by passing through the holes of the streaming net 21a to moderately flow, thereby reducing scattering of water on the bowl section B and the like. In addition, the streaming net 21a applies flow channel resistance to water flowing into the streaming discharge port 21 so that water discharged into the streaming flow channel 23 described later is temporarily stored to form an air-liquid interface (described later) between the water stored and air.

[0035] The shower discharge port 22 is composed of a plurality of fine holes formed in a leading end of the shower flow channel 24 described later, and water flowing through the shower flow channel 24 is discharged through the shower discharge port 22 as shower discharge. The shower discharge port 22 also applies flow channel resistance to water flowing through the shower flow channel 24 so that flow velocity is applied to water to be discharged and the water to be discharged is temporarily stored to form an air-liquid interface (described

later) between the water stored and air.

[0036] The streaming flow channel 23 guides water toward the streaming discharge port 21 formed on a central portion side from the injection ports 11 formed on an outer periphery side, and includes a flow channel wall 23a formed in a shape tapered toward the streaming discharge port 21. While the flow channel wall 23a may be basically formed in a shape tapered toward the streaming discharge port 21, in the present embodiment, the streaming net 21a is provided on its upstream side with a constricted portion 23b with a minimum diameter so as to reach the streaming discharge port 21 by increasing a diameter of a portion downstream from the constricted portion 23b.

[0037] The streaming flow channel 23 includes a guide portion 123c that is projected from the flow channel wall 23a to divide the streaming flow channel 23 into a plurality of divided flow channels 23d on the circumstance. The guide portion 123c is provided with a plurality of cylindrical members (here, eight members) on the circumstance so that the cylindrical members project vertically toward the flow channel wall 23a in a tapered shape. Thus, the guide portion 123c as a whole is formed so as to become thinner from an injection port 11 side to a streaming discharge port 21 side. In the present embodiment, particularly, the guide portion 123c includes a first region 123c1 with a uniform width from the injection port 11 side toward the streaming discharge port 21, and a second region 123c2 that gradually decreases in width downstream from the first region 123c1.

[0038] Each of the divided flow channels 23d divided by the guide portion 123c is formed with a uniform width along the first region 123c1 and the second region 123c2, described above, on an upstream side, and gradually increases in width on a downstream side. Then, the divided flow channels 23d merge into one flow channel upstream from the constricted portion 23b.

[0039] In this way, each of the divided flow channels 23d divided by the guide portion 123c regulates a flow of water from the injection port 11 toward the streaming discharge port 21 so that the flow of water does not meander along the flow channel wall 23a as well as does not merge with a flow of water of another divided flow channel 23d. The guide portion 123c ideally regulates water so that the water flows toward a conical center of the flow channel wall 23a in a tapered shape, or that the water flows toward a center axis of an air-liquid interface described later at a minimum distance.

[0040] The shower flow channel 24 guides water from the injection port 11 formed on an outer periphery side toward the shower discharge port 22. Specifically, the shower flow channel 24 is arranged outside the streaming flow channel 23 across the flow channel wall 23a in the second cylindrical unit 20. The shower flow channel 24 includes a plurality of cylindrical vertical holes 124a (backflow prevention section) provided on the circumstance on an upstream side thereof, and a storage section 24b2 of water with bubbles that is provided on a downstream side thereof by circumferentially penetrating through a lower portion of the second cylindrical unit 20 in a doughnut shape to temporarily store water.

[0041] Each of the plurality of vertical holes 124a (here, eight holes at equal intervals) constituting the shower flow channel 24 is provided on an outer periphery side of the second cylindrical unit 20 to align with a position of the injection port 11 on an outer region so that water injected through the injection port 11 flows immediately below in an injection direction. A wall surface of the vertical hole 124a projects into the streaming flow channel 23 to serve as the guide portion 123c in the streaming flow channel 23.

[0042] Meanwhile, the storage section 24b2 of water with bubbles, which is another component of the shower flow channel 24, projects inward in the second cylindrical unit 20 at a portion inclined in a tapered shape in the flow channel wall 23a of the streaming flow channel 23 to increase in volume. This portion projects toward the streaming flow channel 23 to form the constricted portion 23b on a streaming flow channel 23 side across the flow channel wall 23a.

[0043] The storage section 24b2 of water with bubbles includes an annular guide portion 24c at a portion in which the flow channel wall 23a downstream from the portion expands toward the streaming discharge port 21 provided with the streaming net 21a. The guide portion 24c is arranged so that at least a part thereof overlaps with a cross section of the vertical hole 124a. Thus, when the second cylindrical unit 20 of the discharge port cap 1 is turned to switch from the streaming state to the shower state, water flowing into the shower flow channel 24 through the vertical hole 24a first flows immediately below to collide with the guide portion 24c. In the present embodiment, it is desirable that most of water flowing through the vertical hole 24a collides with the guide portion 24c so that the amount of water that does not collide with the guide portion 24c is less than water that collies therewith. In addition, in the present embodiment, it is preferable that the guide portion 24c and the shower discharge port 22 are formed in a fixed manner, such as the guide portion 24c that is formed as a part of the second cylindrical unit 20, and the guide portion 24c that is formed of the same member as that of the shower discharge port 22.

[0044] The shower flow channel 24 is composed of the vertical hole 124a and the storage section 24b2 of water with bubbles, as above, to enable a flow channel cross-sectional area on an upstream side (vertical hole 124a) to be smaller than a flow channel cross-sectional area on a downstream side (storage section 24b2 of water with bubbles), in the shower flow channel 24. Accordingly, at the time of the shower discharge, water flowing into the shower flow channel 24 through the injection port 11 can be powerfully injected through the vertical hole 124a toward the storage section 24b2 of water with bubbles, so that it is possible to prevent water in the shower flow channel 24 from flowing back toward the injection port

11 by flow channel resistance in the shower discharge port 22. The vertical hole 124a is formed so that a flow channel cross-sectional area thereof is slightly larger than that of the injection port 11 to have a space for taking in air in a periphery thereof.

[0045] Meanwhile, as force of water injected through the vertical hole 124a increases at the time of the shower discharge, vibration of the storage section 24b2 of water with bubbles that receives the water and an air-liquid interface formed in the storage section 24b2 of water with bubbles increases, whereby the second cylindrical unit 20 is allowed to be easily moved (or to be easily turned). If the second cylindrical unit 20 is moved, the second cylindrical unit 20 positioned for the shower state may be displaced to a direction of a position for the streaming state.

[0046] In the shower state, water is injected through the injection port 11 toward the shower flow channel 24 to allow vacuum to occur on the streaming flow channel 23 side, and then air is allowed to flow into the shower flow channel 24 through the streaming discharge port 21 via the streaming flow channel 23 by using the vacuum to create water with bubbles.

[0047] Thus, in the shower state, if a positional relationship between the injection port 11 and the vertical hole 124a, positioned for the shower discharge, is changed, the amount of mixing of bubbles in the shower discharge may be reduced.

[0048] For that, the present embodiment includes a positional displacement prevention section that prevents the positional relationship between the injection port 11 and the vertical hole 124a from being changed due to an impact of water injected through the injection port 11. Specifically, the guide portion 24c described above is configured to guide water injected through the injection port 11 radially outward. That is, water is guided in a direction different from a turn direction (first direction) of the second cylindrical unit 20 when the first state is switched to the second state. Accordingly, it is possible to apply collision reaction force that occurs when water injected through the injection port 11 collides with an internal wall surface of the storage section 24b2 of water with bubbles in a direction in which the positional relationship between the injection port 11 and the vertical hole 124a is not changed.

[0049] In addition, the present embodiment includes a resistance mechanism (an elastic member 50, such as rubber and a spring) in a connection portion between the first cylindrical unit 10 and the second cylindrical unit 20, the resistance mechanism applying resistance to movement of changing a position of each of the units so that a positional relationship between the first cylindrical unit 10 and the second cylindrical unit 20 falls within a predetermined range. The predetermined range is set within an allowable range of a change of the positional relationship between the injection port 11 and the vertical hole 124a, in which the amount of mixing of bubbles required at the time of the shower discharge can be secured. The predetermined range tends to decrease as a flow channel cross-sectional area of the vertical hole 124a decreases.

[0050] As shown in FIG. 3, the resistance mechanism in the present embodiment includes a protrusion 131 of the second cylindrical unit 20, and protrusions 112a and 112b of the first cylindrical unit 10. The protrusion 131 of the second cylindrical unit 20 is provided in a surface of a frame portion 30 that is formed in an edge of the second cylindrical unit 20 so as to surround an outer periphery of the first cylindrical unit 10, the surface facing the first cylindrical unit 10. The frame portion 30 may be provided so as to turn in conjunction with the second cylindrical unit 20 when the second cylindrical unit 20 is turned, and may be a member attached to the second cylindrical unit 20, or may be formed integrally with the second cylindrical unit 20. The protrusions 112a and 112b of the first cylindrical unit 10 are provided at respective positions allowing the protrusions 112a and 112b to be brought into contact with the protrusion 131 of the second cylindrical unit 20. The protrusions 112a and 112b are designed so as to be pressed down in a direction to a center axial of the first cylindrical unit 10 upon receiving a load from above a tip of each of them, and so as to return by elastic force if the load is released.

[0051] In the shower state of FIG. 3C, one side of the protrusion 131 of the frame portion 30 is brought into contact with a stopper portion 113a of the first cylindrical unit 10 not to allow the second cylindrical unit 20 and the frame portion 30 to turn further in a counterclockwise direction in FIG. 3C. On the other hand, if the other side of the protrusion 131 of the frame portion 30 is brought into contact with the protrusion 112a of the first cylindrical unit 10 to allow resistance by elastic force of the protrusion 112a to be applied to movement for turning the second cylindrical unit 20 and the frame portion 30 in a clockwise direction in FIG. 3C. Accordingly, it is possible to prevent the second cylindrical unit 20 from being moved by force of water injected through the vertical hole 124a at the time of the shower discharge, so that it is possible to prevent a position of the second cylindrical unit 20 positioned for the shower state from being changed in a direction of a position for the streaming state.

[0052] In the streaming state of FIG. 3A, one side of the protrusion 131 of the frame portion 30 is brought into contact with a stopper portion 113b of the first cylindrical unit 10 not to allow the second cylindrical unit 20 and the frame portion 30 to turn further in a clockwise direction in FIG. 3A. On the other hand, if the other side of the protrusion 131 of the frame portion 30 is brought into contact with the protrusion 112b of the first cylindrical unit 10 to allow resistance by elastic force of the protrusion 112b to be applied to movement for turning the second cylindrical unit 20 and the frame portion 30 in a counterclockwise direction in FIG. 3A. A state of applying resistance in this way is defined as a first resistance portion. Accordingly, it is possible to prevent a position of the second cylindrical unit 20 from being moved at the time of the streaming discharge, so that it is possible to prevent

a position of the second cylindrical unit 20 positioned for the streaming state from being changed in a direction of a position for the shower state.

[0053] FIGS. 3B and 3D show a transition state from the streaming state to the shower state, or a transition state from the shower state to the streaming state. In these states, no resistance is applied to movement for turning the second cylindrical unit 20 and the frame portion 30 until the protrusion 131 of the frame portion 30 is brought into contact with either one of the protrusions 112a and 112b of the first cylindrical unit 10. A resistance portion that applies resistance less than the first resistance portion to movement for turning the second cylindrical unit 20 and the frame portion 30 in this way, is defined as a second resistance portion. If the protrusion 131 of the frame portion 30 is brought into contact with either one of the protrusions 112a and 112b of the first cylindrical unit 10, resistance is applied to movement for turning the second cylindrical unit 20 and the frame portion 30 by elastic force of the protrusions 112a and 112b.

[0054] The resistance mechanism shown in FIG. 3 is provided with the two protrusions 112a and 112b of the first cylindrical unit 10 to prevent movement of the second cylindrical unit 20 during usage of each of the streaming state and the shower state. The protrusions 112a and 112b apply resistance even at the time of switching to the streaming state or the shower state, and thus operability at the time of switching may be deteriorated.

[0055] In the streaming state and the shower state, the shower state is further required to prevent movement of the second cylindrical unit 20 at the time of discharging water, because the shower state has a small allowable range of positional displacement between the injection port 11 and the vertical hole 124a, as well as allows the second cylindrical unit 20 to be easily moved by water injected through the vertical hole 124a.

[0056] Thus, the resistance mechanism may apply resistance during the shower state, in the streaming state and the shower state. In this case, it is desirable that the resistance mechanism applies resistance in a region in which the streaming state is switched to the shower state. Accordingly, it is possible to prevent the positional relationship between the first cylindrical unit 10 and the second cylindrical unit 20 from being changed during the shower state, so that it is possible to prevent possible reduction in the amount of mixing of bubbles, caused by a change of the positional relationship between the first cylindrical unit 10 and the second cylindrical unit 20 at the time of the shower discharge.

[0057] Since the resistance mechanism includes the first region to be a first resistance, and the second region to be a second resistance less than resistance in the first resistance portion, the first resistance may be applied at the time of the shower state. Reducing a region to which resistance is applied enables force required at the time of switching to the shower state to be reduced, thereby enabling deterioration of operability to be prevented. In this case, it is desirable that the resistance mechanism gradually increases resistance to apply larger resistance as the streaming state approaches to the shower state. Accordingly, struck feeling by resistance at the time of switching to the shower state can be lessened, so that it is possible to prevent a user from recognizing that operation is completed by mistake to enable deterioration of operability to be prevented. In a case where the streaming state is changing from the shower state, a change of a positional relationship between the first cylindrical unit 10 and the second cylindrical unit 20 can fall within a predetermined range, whereby it is also possible to prevent possible reduction in the amount of mixing of bubbles caused by the change of the positional relationship between the first cylindrical unit 10 and the second cylindrical unit 20. A variation of the resistance mechanism will be specifically described with reference to FIG. 4.

[0058] FIG. 4 shows a variation (second embodiment) of the resistance mechanism shown in FIG. 3. A resistance mechanism of the variation includes a raised portion 231 of the second cylindrical unit 20, and a protrusion 212 of the first cylindrical unit 10. The raised portion 231 of the second cylindrical unit 20 is formed in a surface of the frame portion 30, the surface facing the first cylindrical unit 10. The raised portion 231 is provided with stopper portions 231a and 231b at opposite ends thereof in a longitudinal direction. One stopper portion 231a is formed so as to be substantially perpendicular to a ridge, and the other stopper portion 231b is formed at an angle from an end of the ridge.

[0059] The protrusion 212 of the first cylindrical unit 10 is provided at a position allowing the protrusion 212 to be brought into contact with the raised portion 231 of the second cylindrical unit 20. The protrusion 212 is designed so as to be pressed down in a direction to the center axial of the first cylindrical unit 10 upon receiving a load from above its tip, and so as to return by elastic force if the load is released.

[0060] In the shower state of FIG. 4C, the stopper portion 231a of the frame portion 30 is brought into contact with a stopper portion 213a of the first cylindrical unit 10 not to allow the second cylindrical unit 20 and the frame portion 30 to turn further in a counterclockwise direction in FIG. 4C. On the other hand, if the stopper portion 231b of the frame portion 30 is brought into contact with the protrusion 212 of the first cylindrical unit 10 to allow resistance by elastic force of the protrusion 212 to be applied to movement for turning the second cylindrical unit 20 and the frame portion 30 in a clockwise direction in FIG. 4C.

[0061] Accordingly, it is possible to prevent the second cylindrical unit 20 from being moved by force of water injected through the vertical hole 124a at the time of the shower discharge, so that it is possible to prevent a position of the second cylindrical unit 20 positioned for the shower state from being changed in a direction of a position for the streaming state. In the streaming state of FIG. 4A, the stopper portion 231b of the frame portion 30 is brought into contact with a stopper portion 213b of

the first cylindrical unit 10 not to allow the second cylindrical unit 20 and the frame portion 30 to turn further in a clockwise direction in FIG. 4A. Meanwhile, the protrusion 212 of the first cylindrical unit 10 is maintained in a state of being pressed down by the raised portion 231 of the frame portion 30 to allow the second cylindrical unit 20 and the frame portion 30 to move.

[0062] FIGS. 4B and 4D show a transition state from the streaming state to the shower state, or a transition state from the shower state to the streaming state. In these states, the protrusion 212 of the first cylindrical unit 10 is maintained in a state of being pressed down by the raised portion 231 of the frame portion 30 to allow the second cylindrical unit 20 and the frame portion 30 to move.

[0063] FIG. 5 is a graph showing a relationship between a discharge state and operation resistance in a variation different from that described above. As shown in FIG. 5, the resistance mechanism applies resistance to movement for turning the second cylindrical unit 20 and the frame portion 30 in a region R in which a state close to the shower state is switched to the shower state in an intermediate region between the streaming state and the shower state. The resistance applied in the region R increases toward the shower state.

[0064] An outline of operation of the discharge port cap 1 configured as described above will be described with reference to FIGS. 6 and 7. FIGS. 6A and 7A show a discharge state where water W is allowed to flow through the streaming flow channel 23 to be mixed with air Air from the shower flow channel 24, as the streaming state of the first state. FIGS. 6B and 7B show a discharge state where water W is allowed to flow through the shower flow channel 24 to be mixed with air Air from the streaming flow channel 23, as the shower state of the second state.

[0065] As shown in FIGS. 6A and 7A, in the streaming state, when water W is supplied through the plurality of injection ports 11 provided in outer regions of the first cylindrical unit 10, the water W flows down in an injection direction to flow into the streaming flow channel 23 to collides with the flow channel wall 23a. Then, the water W is splashed from the flow channel wall 23a, and flows down along the flow channel wall 23a, to be guided toward the streaming discharge port 21. A relationship between the injection port 11 and the second cylindrical unit 20 in this streaming state is shown in FIG. 3A.

[0066] At this time, the shower discharge port 22 serves as an air inlet port, and the shower flow channel 24 serves as an air passage. That is, as shown in FIGS. 6A and 7A, water is injected through the injection port 11 toward the streaming flow channel 23 to cause vacuum in the shower flow channel 24, so that air Air is allowed to flow through the shower discharge port 22 toward the streaming flow channel 23 via the shower flow channel 24. The air Air flows into the streaming flow channel 23 from the storage section 24b2 of water with bubbles through the vertical hole 124a to be sucked into a flow of the water W to form bubbles.

[0067] In the streaming discharge port 21, water temporarily stays on the streaming net 21a to form an air-liquid interface Ia. The water W rushes into the air-liquid interface Ia to be mixed with the foamy air Air to form water Bw with bubbles. The water Bw with bubbles passes through the streaming net 21a to be sequentially discharged through the streaming discharge port 21.

[0068] As shown in FIG. 6B and 7B, in the shower state, when water W is supplied through the plurality of injection ports 11 provided in the outer regions of the first cylindrical unit 10, the water W flows down in the injection direction to flow into the vertical hole 124a of the shower flow channel 24 to be directly guided into the storage section 24b2 of water with bubbles provided immediately below. A relationship between the injection port 11 and the second cylindrical unit 20 in this shower state is shown in FIG. 3C.

[0069] At this time, the streaming discharge port 21 serves as an air inlet port, and the streaming flow channel 23 serves as an air passage. That is, as shown in FIGS. 6B, water is injected through the injection port 11 toward the shower flow channel 24 to cause vacuum in the streaming flow channel 23, so that air Air is allowed to flow through the streaming discharge port 21 toward the shower flow channel 24 via the streaming flow channel 23. The air Air flows into the vertical hole 124a of the shower flow channel 24 through the streaming net 21a, while passing through the streaming flow channel 23, to be sucked into a flow of the water W to form bubbles.

[0070] In the shower flow channel 24, water temporarily stays in the storage section 24b2 of water with bubbles by flow channel resistance in the shower discharge port 22 to form an air-liquid interface Ib. The water W flows into the air-liquid interface Ib to be mixed with the foamy air Air to form water Bw with bubbles. The water Bw with bubbles passes through the shower discharge port 22 to be discharged outside.

[0071] The storage section 24b2 of water with bubbles is configured to guide water injected through the injection port 11 radially outward by using the guide portion 24c described above, so that it is possible to apply collision reaction force that occurs when the water injected through the injection port 11 collides with an internal wall surface of the storage section 24b2 of water with bubbles in a direction in which the positional relationship between the injection port 11 and the vertical hole 124a is not changed.

[0072] The discharge port cap 1 of the present embodiment allows the shower state shown in FIG. 3A to be switched to the streaming state shown in FIG. 3C, or allows the streaming state shown in FIG. 3C to be switched to the shower state shown in FIG. 3A, by turning the second cylindrical unit 20 with respect to the first cylindrical unit 10, whereby the streaming discharge and the shower discharge is performed.

[0073] As described above, the embodiments of the present invention are capable of the following: switching between the streaming state where water is allowed to

flow into the streaming flow channel 23 through the injection port 11 to be mixed with air from the shower flow channel 24, and the shower state where water is allowed to flow into the shower flow channel 24 through the injection port 11 to be mixed with air from the streaming flow channel 23 by changing a relative positional relationship between the first cylindrical unit 10 and the second cylindrical unit 20; preventing backflow of water in the shower flow channel 24 in the shower discharge by setting the flow channel cross-sectional area of the shower flow channel 24 on the upstream side to be less than the flow channel cross-sectional area thereof on the downstream side; and applying resistance to movement for changing a positional relationship between the first cylindrical unit 10 and the second cylindrical unit 20 so that the positional relationship between the first cylindrical unit 10 and the second cylindrical unit 20 falls within a predetermined range, by providing a positional displacement prevention section (the guide portion 24c and a resistance mechanism).

[0074] Accordingly, a change of the positional relationship between the first cylindrical unit 10 and the second cylindrical unit 20 at the time of discharging water can fall within a predetermined range, so that it is possible to prevent possible reduction in the amount of mixing of bubbles, caused by a change of the positional relationship between the first cylindrical unit 10 and the second cylindrical unit 20.

[0075] Subsequently, the discharge port cap 1 in accordance with a third embodiment of the present invention will be described. Although the third embodiment is different from the embodiments described above in that a vertical hole (backflow prevention section) 324a is formed in a flat shape in a flow channel cross section as a positional displacement prevention section so that a longitudinal direction of the flow channel cross section is a turn direction (first direction) of the second cylindrical unit 20 when the first state is switched to the second state, other structures are the same as those of the embodiments described above. Thus, description of the structures common to the embodiments described above will be omitted below.

[0076] As shown in FIG. 8, the vertical hole 324a is formed in a flat shape in flow channel cross section so that the longitudinal direction of the flow channel cross section is the turn direction (first direction) of the second cylindrical unit 20 when the first state is switched to the second state.

[0077] In addition, the vertical hole 324a is formed in the flat shape in flow channel cross section so that a width in a lateral direction orthogonal to the longitudinal direction of the vertical hole 324a is substantially uniform.

[0078] FIG. 9 is a sectional views showing an outline of action of a shower flow channel of the discharge port cap. As shown in FIGS. 9A and 9B, if the injection port 11 is arranged on a center line L of the vertical hole 324a, water from the injection port 11 is injected into the center of the vertical hole 324a to enable water with bubbles to be discharged without reducing the amount of mixing of bubbles.

[0079] In addition, as shown in FIGS. 9C and 9D, even if the injection port 11 is displaced from the center line L of the vertical hole 324a, the flat shape of a flow channel cross-sectional shape of the vertical hole 324a enables a state of allowing all of injected water to flow inside the vertical hole 324a to be easily maintained.

[0080] Further, the flow channel cross section of the vertical hole 324a is reduced in width in a direction orthogonal to the turn direction (first direction) of the second cylindrical unit 20 when the first state is switched to the second state (reduced in flow channel cross-sectional area) to enable water with bubbles stored in the storage section 24b2 of water with bubbles to be prevented from flowing back toward an air intake section 602.

[0081] Subsequently, the discharge port cap 1 in accordance with a fourth embodiment of the present invention will be described. Although the fourth embodiment is different from the embodiments described above in a shape of a vertical hole (backflow prevention section) 424a in which a flow channel cross-sectional area thereof is reduced from an upstream side 425a to a downstream side 425b, as a positional displacement prevention section, other structures are the same as those of the embodiments described above. Thus, description of the structures common to the embodiments described above will be omitted below.

[0082] As shown in FIG. 10, the vertical hole 424a of the present embodiment is formed in an inverted conical shape in flow channel cross section so as to gradually decrease in diameter from an upstream side to a downstream side.

[0083] According to this structure, an inlet opening 426 of the vertical hole is large enough to enable a state where all of injected water passes through the inside of the vertical hole 424a to be easily maintained even if the positional relationship between the injection port 11 and the vertical hole (backflow prevention section) 424a is slightly changed by an impact of water injected through the injection port 11. In addition, a flow channel cross-sectional area of a downstream portion of the vertical hole 424a is small enough to enable water with bubbles stored in the storage section 24b2 of water with bubbles to be prevented from flowing back toward an air intake section 602. Further, the flow channel of the vertical hole 424a is formed so that the cross-sectional area thereof decreases from the upstream side 425a to the downstream side 425b to enable the water collided with the inner wall by force of injected water to be compressed to the downstream side to prevent the injected water from flowing back toward the air intake section 602 even if a part of the injected water slightly interferes with the inner wall of the downstream portion of the vertical hole 424.

[0084] As above, the embodiments of the present invention have been described with reference to the specific examples. However, the present invention is by no means limited by these specific examples. For example,

the shower discharge and the streaming discharge may be switched as described above by sliding the second cylindrical unit 20 with respect to the first cylindrical unit 10. In addition, the shower discharge and the streaming discharge may be switched as described above by turning the first cylindrical unit 10 with respect to the second cylindrical unit 20. Further, no bubble for mixing air may be mixed into water flowing through the streaming flow channel 23 to discharge a single water stream without a bubble. That is, as far as having a feature of the present invention, a modification in which a person skilled in the art appropriately makes a design change to these specific examples is included in the scope of the present invention. For example, each of the elements provided in each of the specific examples described above, and its arrangement, material, condition, shape, and the like, are not limited to the examples shown, and may be appropriately changed. In addition, each of the elements provided in each of the specific examples described above may be combined with each other as far as technically possible, so that a combination of the elements is also included in the scope of the present invention as far as including a feature of the present invention.

Claims

1. A water discharge device comprising:

a first member that is provided with an injection port through which water flowing from an upstream side is injected to a downstream side by being increased in flow velocity;
a second member that includes a streaming flow channel provided with a streaming discharge port through which a single water stream is discharged, and a shower flow channel provided with a shower discharge port through which a plurality of water streams are discharged;
a flow channel switching mechanism that switches between a first state of allowing water injected through the injection port to flow into the streaming flow channel, and a second state of allowing the water injected through the injection port to flow into the shower flow channel, by moving either one of the first member and the second member,
the shower flow channel including:

an air intake section through which air is sucked in by using a vacuum created as the water injected through the injection port passes through the air intake section;
a storage section of water with bubbles that is provided downstream of the air intake section to store water with bubbles produced by mixing of air sucked in through the air intake section into the water injected through the injection port;
a backflow prevention section that is provided between the air intake section and the storage section of water with bubbles, with a flow channel cross-sectional area larger than that of the injection port as well as smaller than that of the storage section of water with bubbles, to prevent backflow of water with bubbles from the storage section of water with bubbles toward the air intake section;
the shower discharge port through which water with bubbles stored in the storage section of water with bubbles is discharged; and
a positional displacement prevention section that prevents at least a part of a projected plane, formed by projecting a downstream end of the injection port in an injection direction, from being displaced outside the backflow prevention section due to an impact caused by the water injected through the injection port, in a state where water at a maximum flow rate is supplied into the injection port, and the entire projected plane passes through an inside of the backflow prevention section.

2. The water discharge device according to claim 1, wherein the flow channel switching mechanism moves either one of the first member and the second member in a first direction when switching the first state to the second state, and wherein the positional displacement prevention section is provided in the storage section of water with bubbles, and includes a guide portion for guiding the water injected through the injection port to a direction different from the first direction.

3. The water discharge device according to claim 2, wherein the guide portion is arranged at a position interfering with the projected plane.

4. The water discharge device according to claim 3, wherein the positional displacement prevention section is provided in a connection portion between the first member and the second member, and includes an elastic member that serves as movement resistance when either one of the first member and the second member is moved.

5. The water discharge device according to claim 4, wherein the elastic member includes a first region to be a first resistance, and a second region to be a second resistance less than the first resistance, in a moving range when the first state and the second state are switched by the flow channel switching mechanism, and wherein a position at which the en-

tire projected plane passes through the inside of the backflow prevention section is within the first region.

6. The water discharge device according to claim 3, wherein the positional displacement prevention section is acquired by forming the backflow prevention section in a flat shape in flow channel cross section so that a longitudinal direction of the flat shape is a movement direction when the first state and the second state are switched.

7. The water discharge device according to claim 3, wherein the positional displacement prevention section is acquired by forming the backflow prevention section in a shape in which a flow channel cross-sectional area decreases from an upstream side to a downstream side.

FIG.1

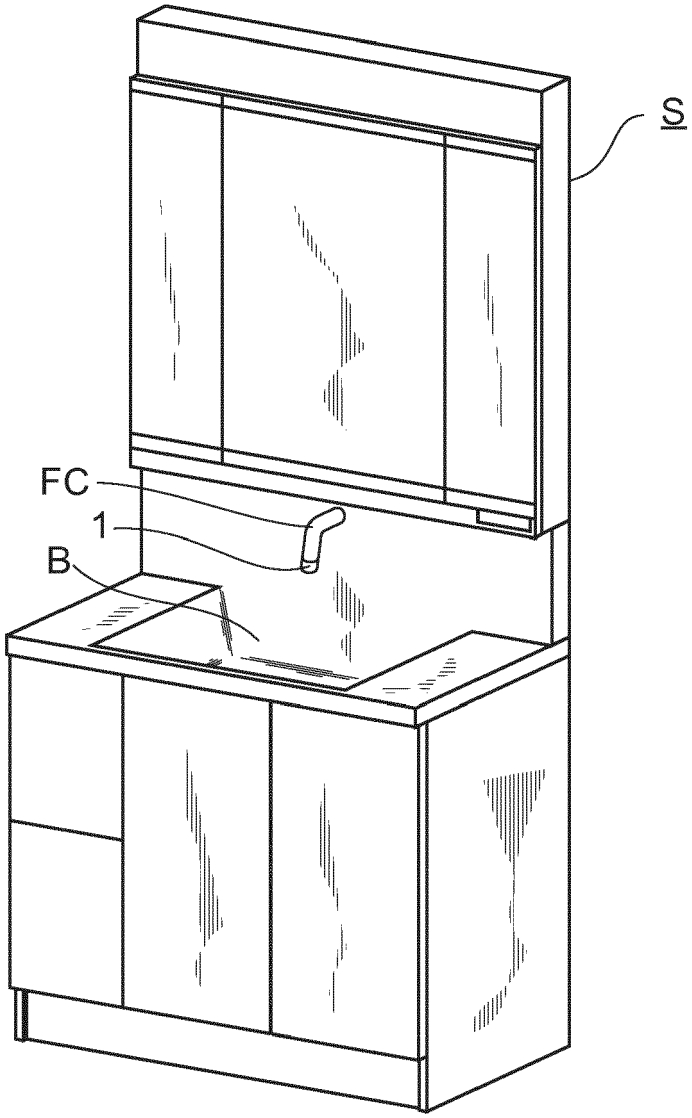


FIG. 2

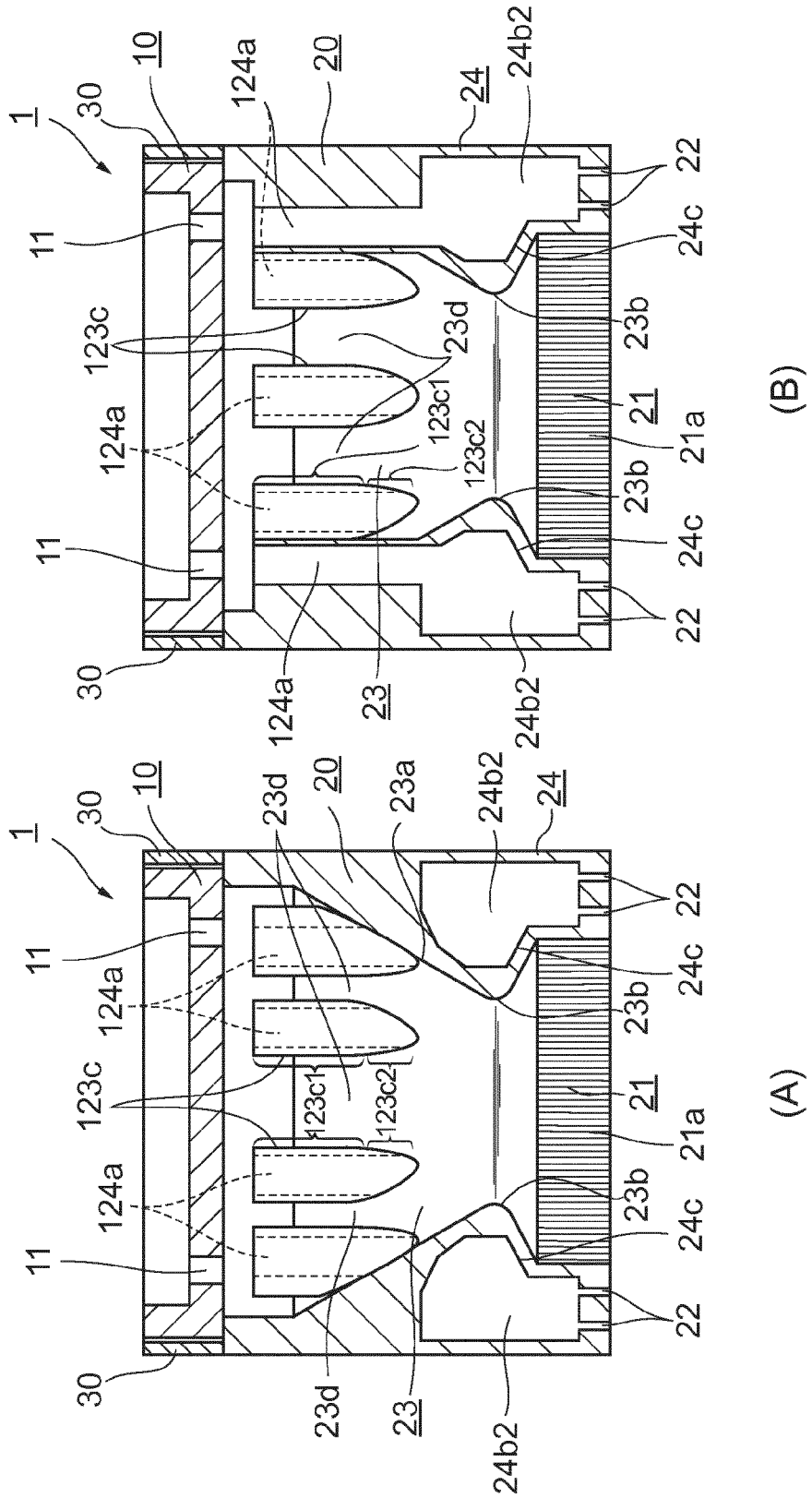

1
10
11
20
21
21a
22
23
23a
23b
23d
24
24b2
24c
30
123c
123c1
123c2
124a
(A)
(B)

FIG. 3

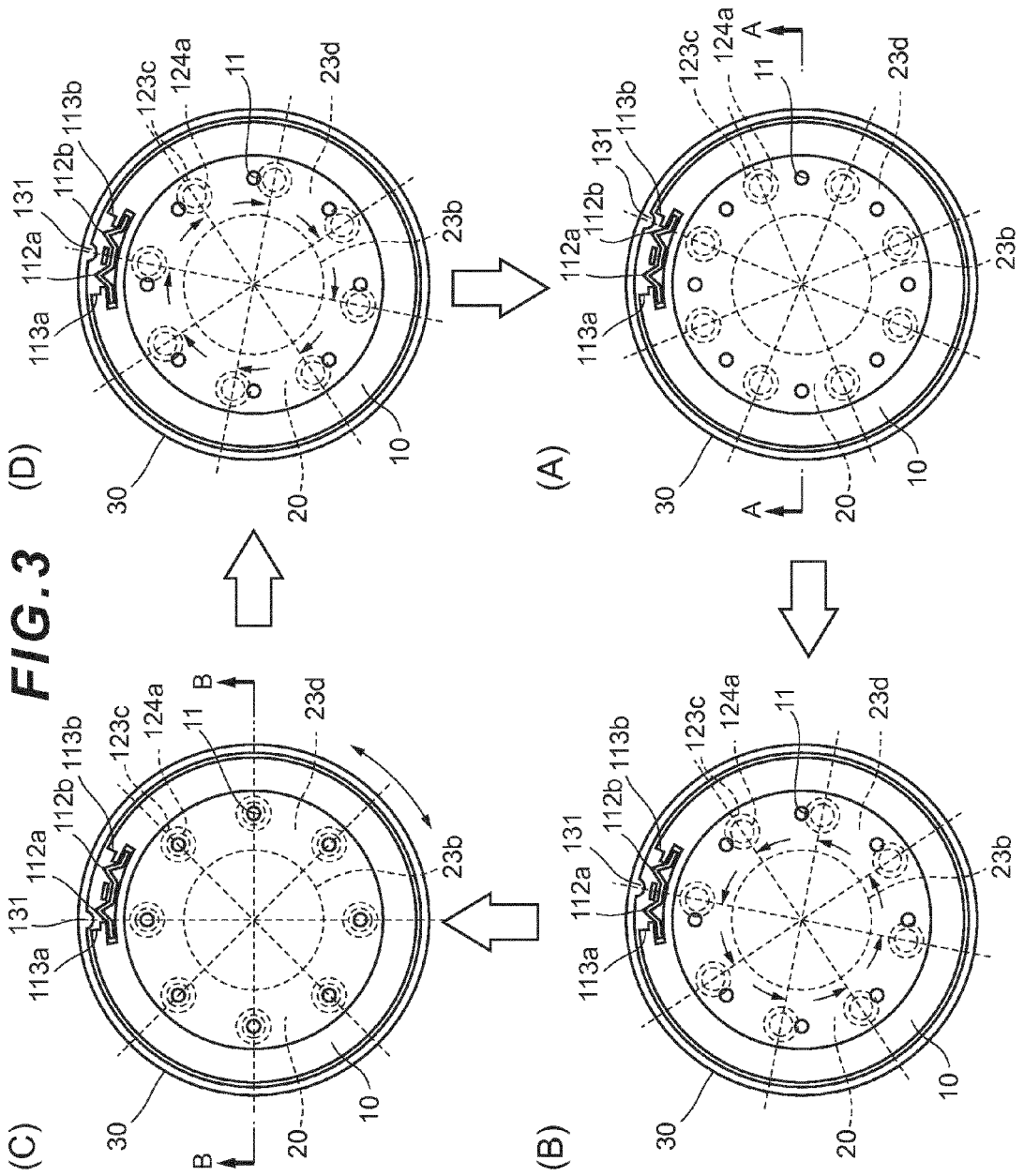


FIG.4

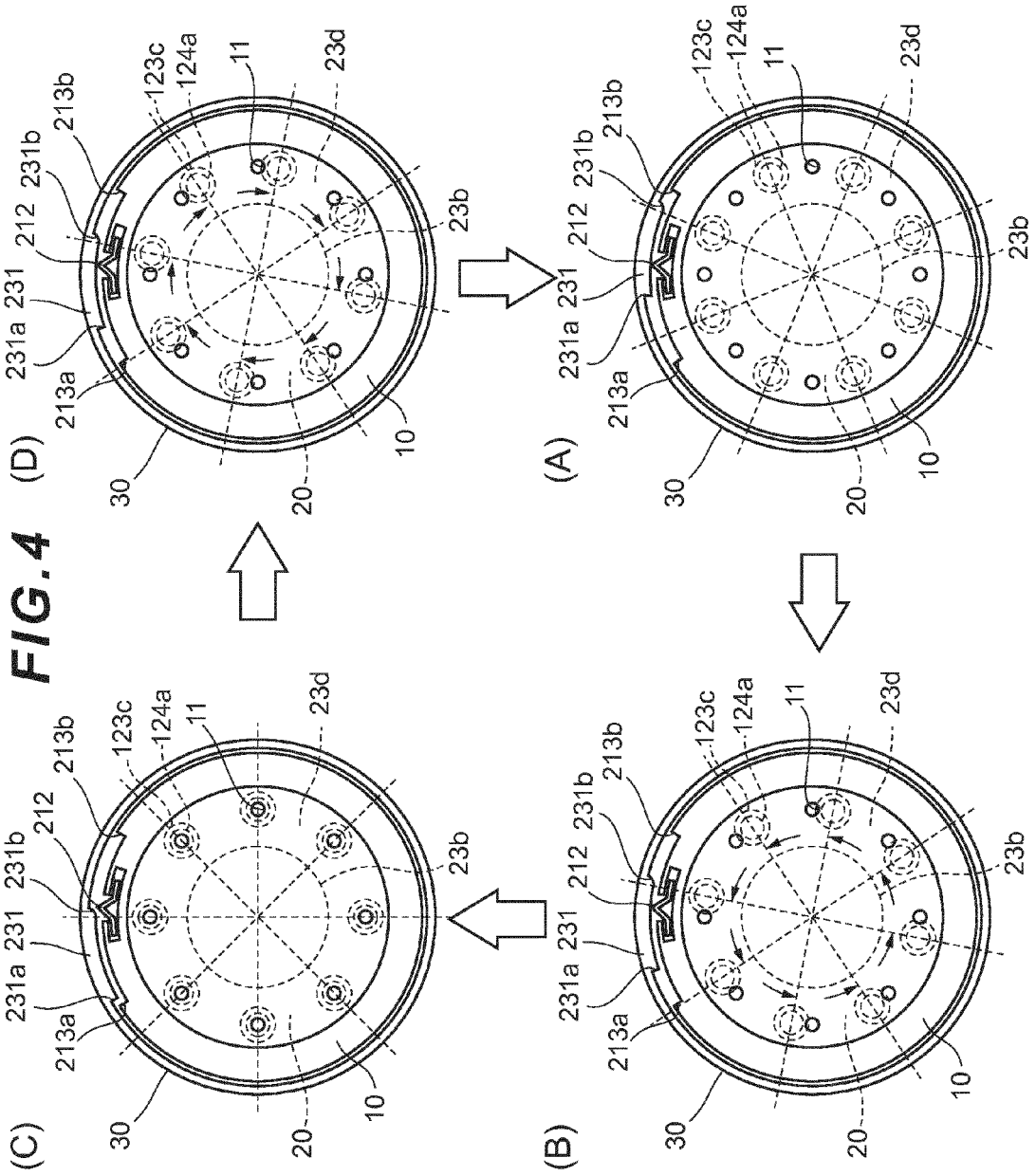


FIG.5

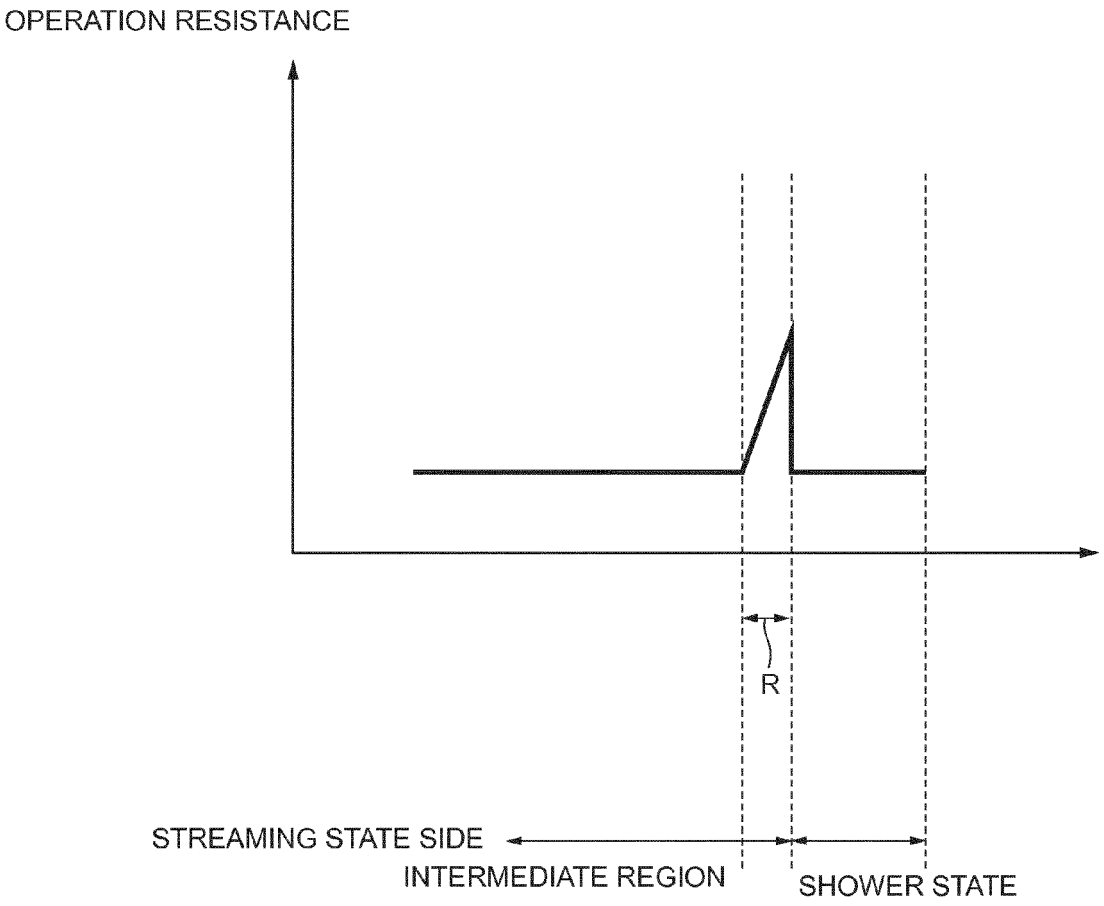

OPERATION RESISTANCE
R
STREAMING STATE SIDE
INTERMEDIATE REGION
SHOWER STATE

FIG.6

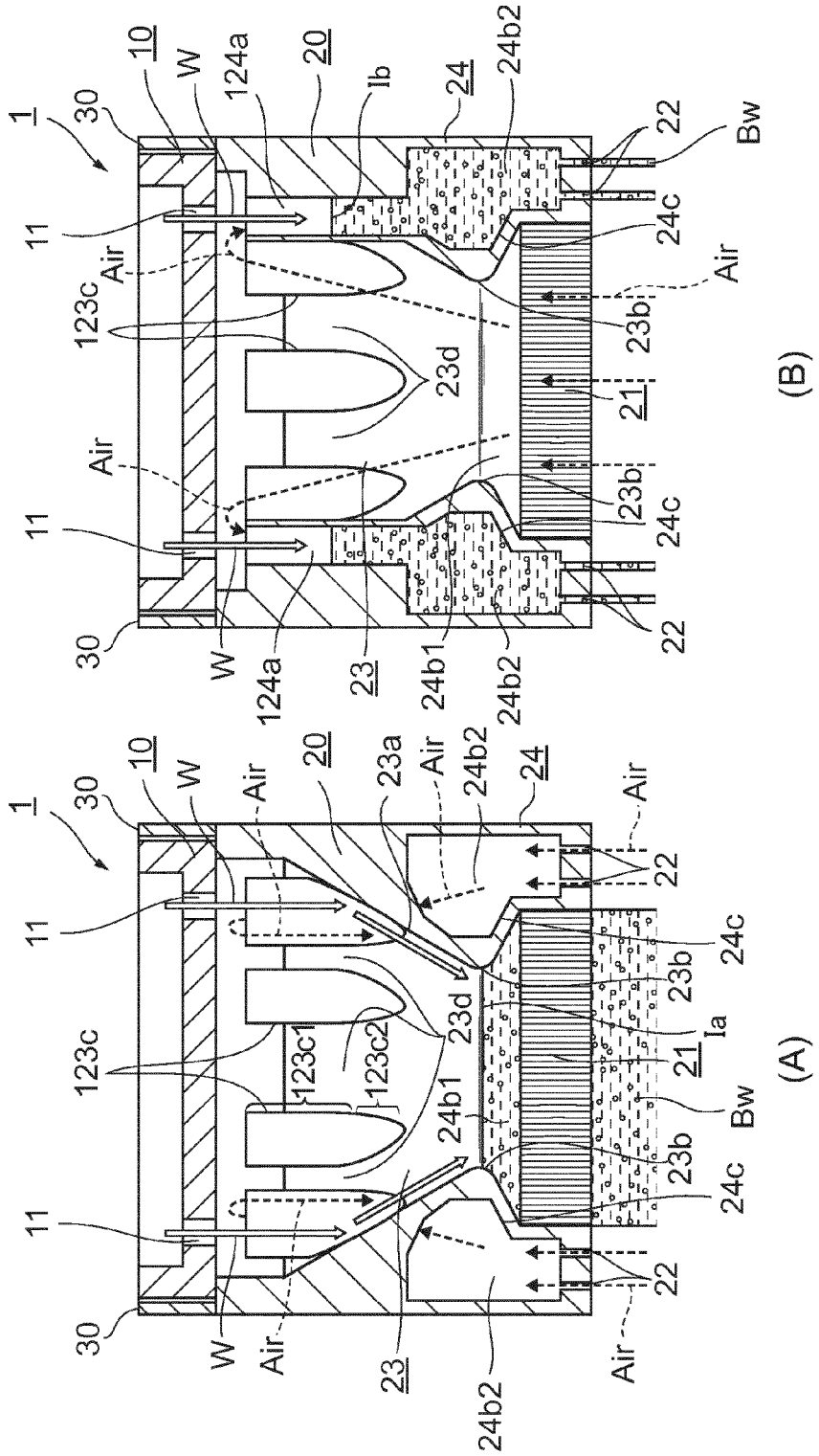

(A)
(B)
1
10
11
20
21
22
23
24
30
W
Air
Bw
123c
123c1
123c2
23a
23b
23d
24b1
24b2
24c
124a
1a
1b

FIG. 7

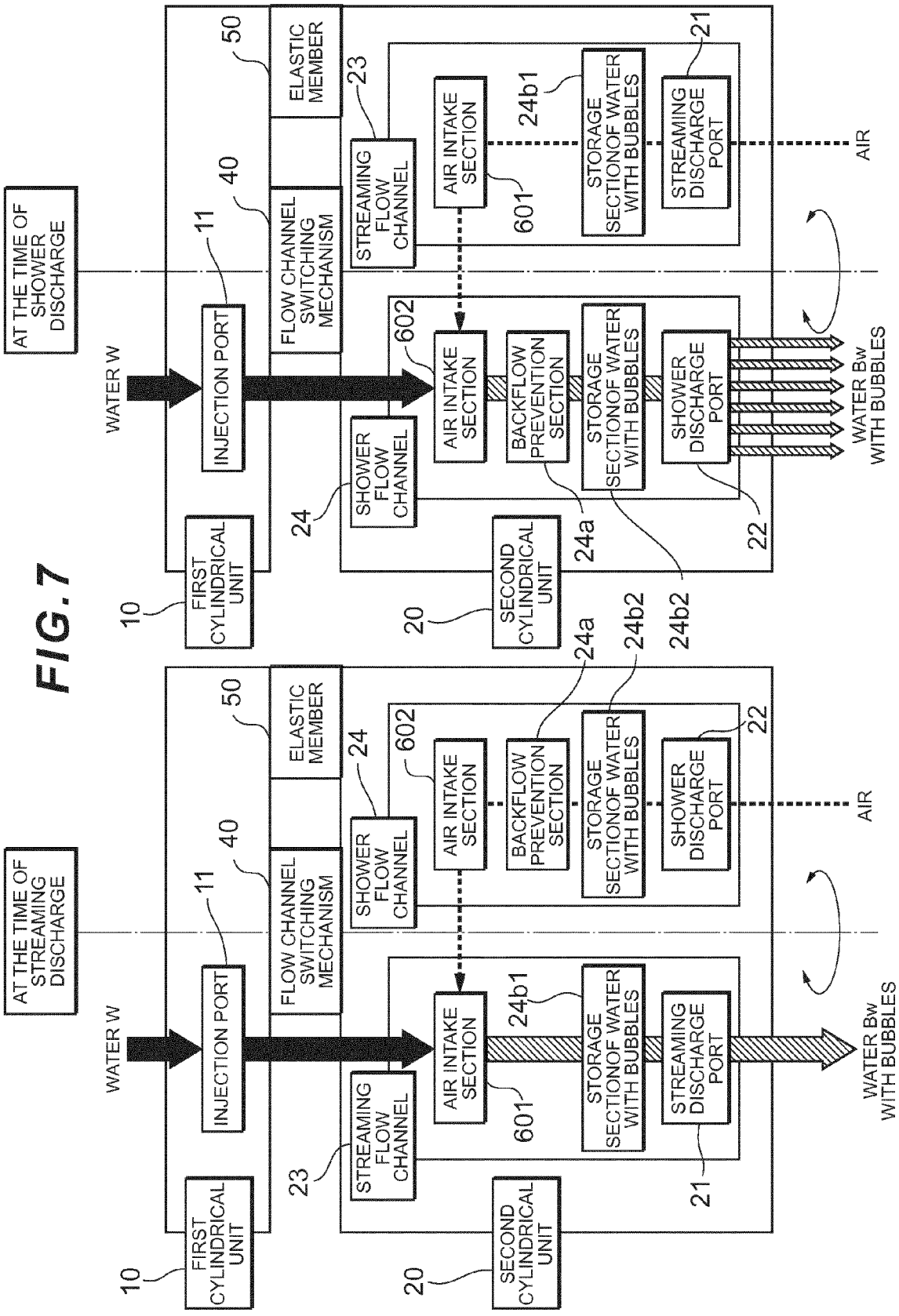

AT THE TIME OF SHOWER DISCHARGE
AT THE TIME OF STREAMING DISCHARGE
WATER W
INJECTION PORT
11
FLOW CHANNEL SWITCHING MECHANISM
40
ELASTIC MEMBER
50
FIRST CYLINDRICAL UNIT
10
SECOND CYLINDRICAL UNIT
20
STREAMING FLOW CHANNEL
23
SHOWER FLOW CHANNEL
24
AIR INTAKE SECTION
601
602
BACKFLOW PREVENTION SECTION
24a
STORAGE SECTIONOF WATER WITH BUBBLES
24b1
24b2
STREAMING DISCHARGE PORT
21
SHOWER DISCHARGE PORT
22
AIR
WATER Bw WITH BUBBLES

FIG. 8

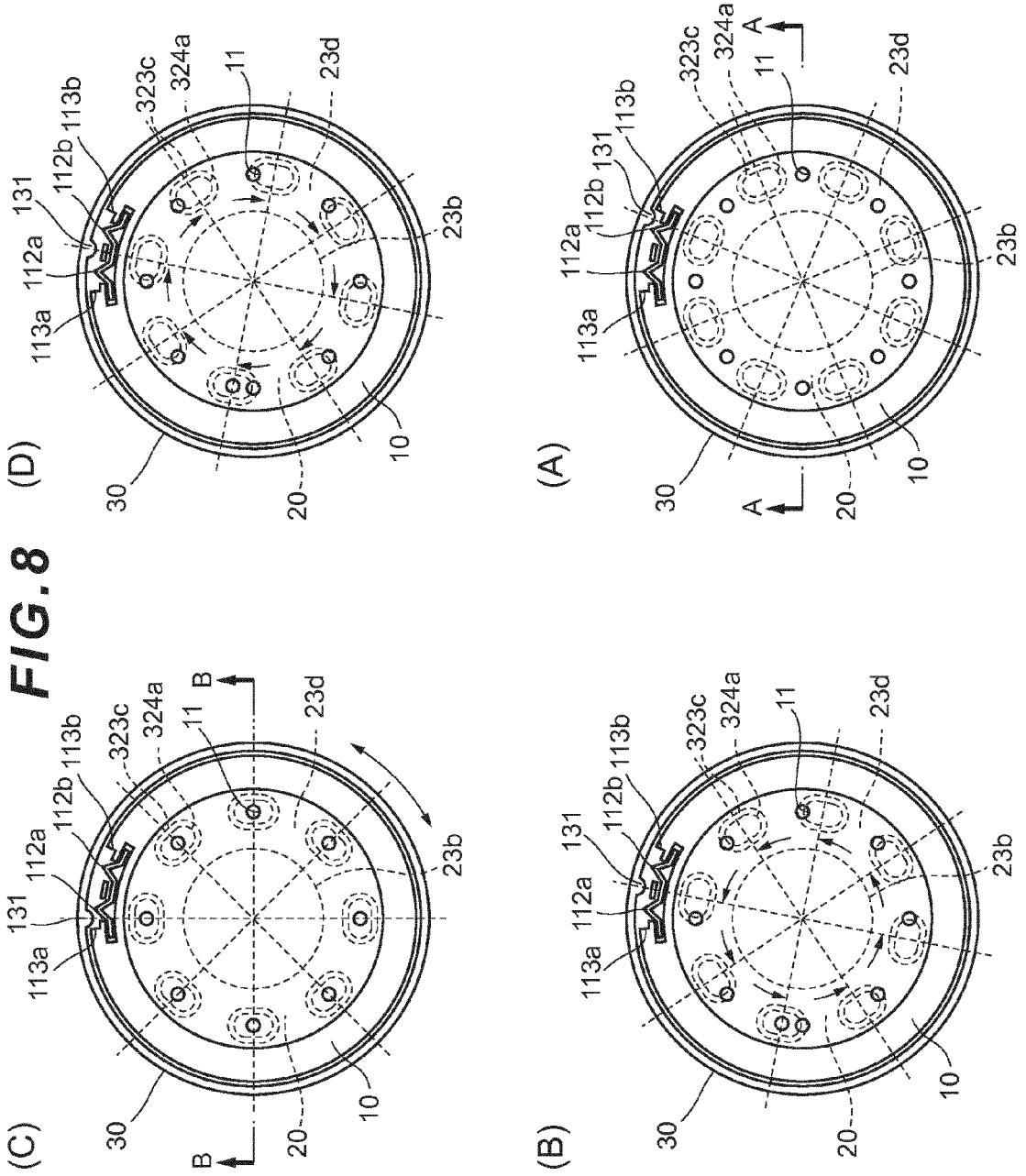


FIG. 9

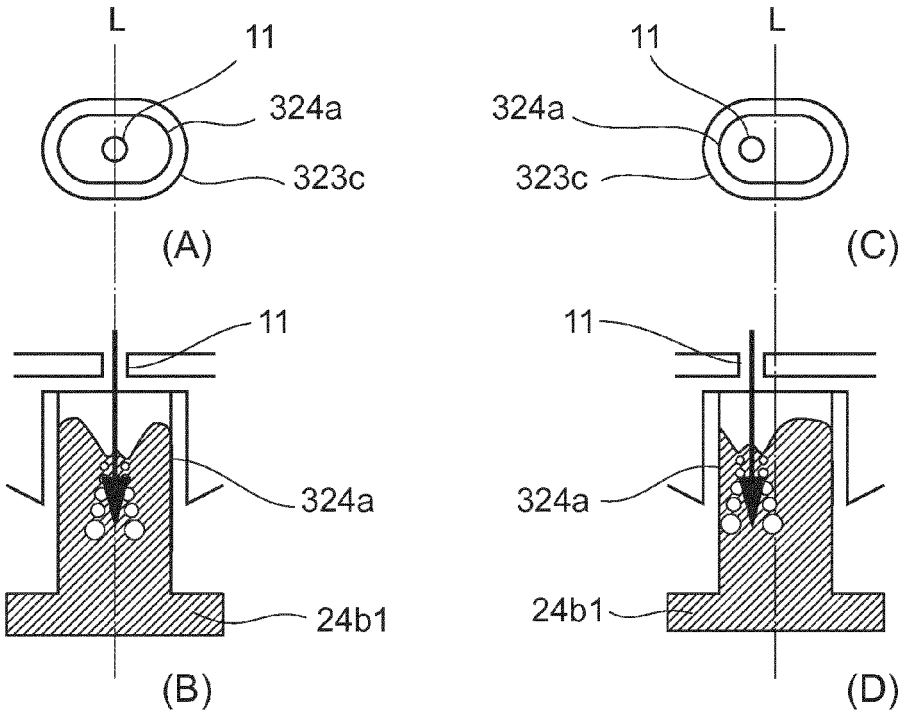
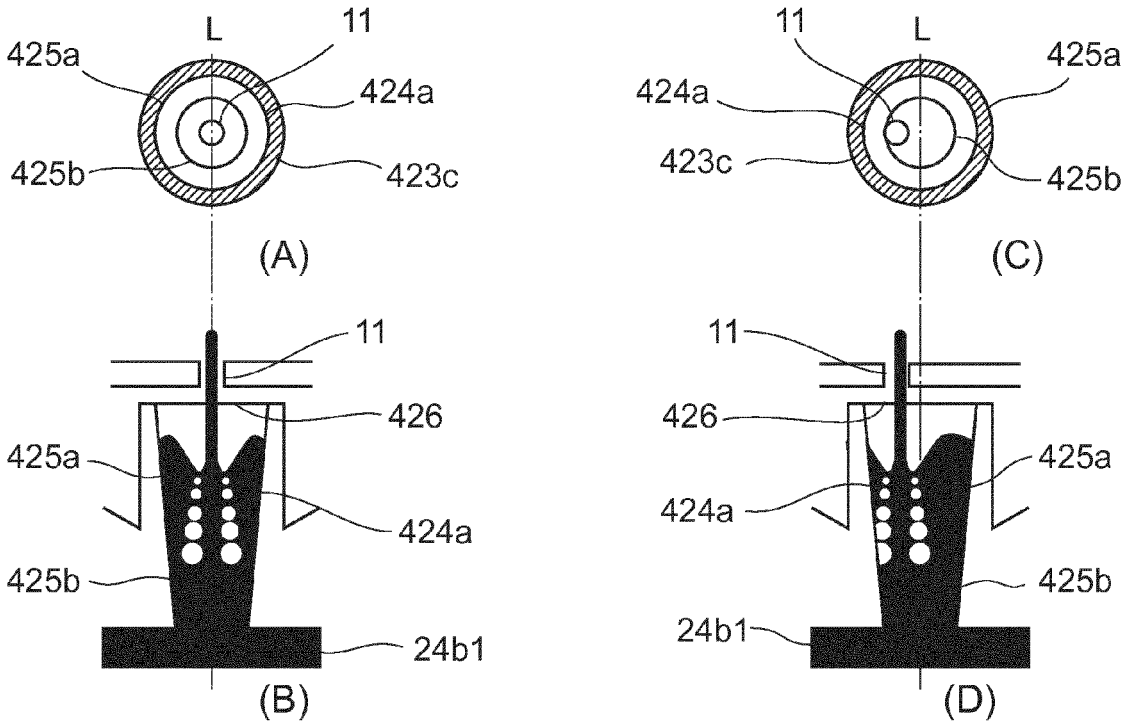


FIG.10


L
11
425a
424a
425b
423c
(A)
11
426
425a
424a
425b
24b1
(B)
11
L
425a
424a
423c
425b
(C)
11
426
425a
424a
425b
24b1
(D)

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EUROPEAN SEARCH REPORT

Application Number
EP 15 19 5618

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E03C
B05B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	10 March 2016	Fajarnés Jessen, A

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L : document cited for other reasons

& : member of the same patent family, corresponding document

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10-03-2016

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

REFERENCES CITED IN THE DESCRIPTION

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- JP 2014068678 A **[0003] [0004] [0005]**