



(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
18.12.2013 Bulletin 2013/51

(51) Int Cl.:
E03D 11/02 (2006.01) E03D 11/18 (2006.01)

(21) Application number: **12744346.3**

(86) International application number:
PCT/JP2012/051631

(22) Date of filing: **26.01.2012**

(87) International publication number:
WO 2012/108269 (16.08.2012 Gazette 2012/33)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

- **WATARI, Kojiro**
Tokyo 136-8535 (JP)
- **YAMAI, Hitomi**
Tokyo 136-8535 (JP)
- **HAIDA, Shuhei**
Tokyo 136-8535 (JP)
- **SAKAKIBARA, Keisuke**
Tokyo 136-8535 (JP)

(30) Priority: **10.02.2011 JP 2011027353**
20.07.2011 JP 2011159250
18.01.2012 JP 2012008284

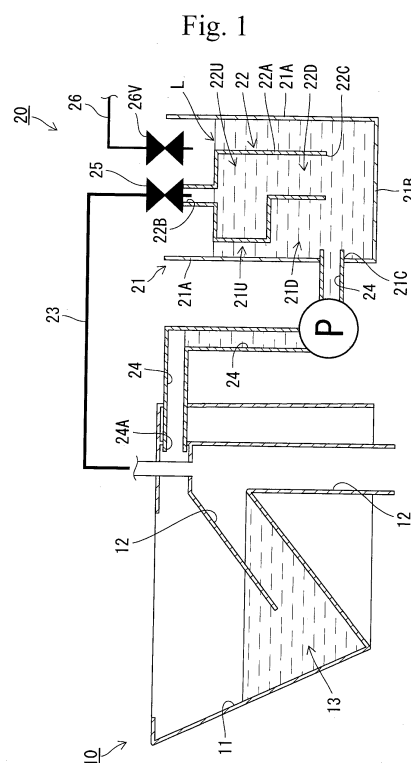
(71) Applicant: **Lixil Corporation**
Koto-ku
Tokyo 136-8535 (JP)

(74) Representative: **Müller-Boré & Partner**
Patentanwälte
Grafinger Straße 2
81671 München (DE)

(72) Inventors:
• **KITAMURA, Satoshi**
Tokyo 136-8535 (JP)

(54) **TOILET CLEANING DEVICE, AND FLUSH TOILET**

(57) Providing a toilet flushing device and a flush toilet both of which can desirably execute toilet flushing. A toilet flushing device (20) includes a first tank (21) storing flush water, a second tank (22) having a lower opening (22C) communicating with the first tank (21) and having a lower region (22D) and an upper region (22U) with a larger capacity per unit height than the lower region (22D), an air passage (23) communicating between the second tank (22) and a toilet drainage (12) via a position located higher than a maximum storage water level (L) in the first tank (21), a water-supply passage (24) communicating between the first tank (21) and a toilet bowl (11) and a on-off valve (25) which maximizes a flow rate of an air in the air passage (23) with a delay to initiation of supply of flush water stored in the first tank (21) through the water-supply passage (24) into the toilet bowl (11), the air flowing from the toilet drainage (12) side to the second tank (22) side.



Description

Technical Field

[0001] The present invention relates to a toilet flushing device and a flush toilet.

Background Art

[0002] Patent Document 1 discloses a conventional flush toilet provided with a toilet body and a toilet flushing device. In this flush toilet, the toilet flushing device supplies flush water to the toilet body to execute toilet flushing. The toilet body has a toilet bowl and a toilet drainage communicating with a downstream side of the toilet bowl. The toilet flushing device has a tank, a hollow pipe, an exhaust passage and a water-supply path. The tank is provided for storing flush water to be supplied to the toilet body. The hollow pipe is accommodated in the tank so as to extend vertically and has a lower end which is open in the tank. The exhaust passage communicates between an upper end of the hollow pipe and the toilet drainage of the toilet body through a location located higher than a maximum storage water level in the tank. The water-supply path communicates between the tank and the toilet bowl of the toilet body.

[0003] A water level in the tank drops in the above-described flush toilet since flush water stored in the tank is supplied through the water-supply path into the toilet bowl upon execution of toilet flushing. Furthermore, a water level in the hollow pipe also drops slightly after drop of the water level in the tank. As a result, the hollow pipe sucks air in the toilet drainage through the exhaust passage.

[0004] Upon execution of toilet flushing, the flush water supplied to the toilet bowl flows into the toilet drainage and the hollow pipe sucks air in the toilet drainage in the above-described flush toilet. This can cause a siphon effect in the toilet drainage with use of a smaller amount of flush water, with the result that sewage or the like in the toilet bowl can be discharged out of the toilet body using the siphon effect caused in the toilet drainage.

[0005] Furthermore, Patent Document 2 discloses a second conventional flush toilet provided with another toilet flushing device. The second flush toilet includes a toilet body and the toilet flushing device. In this flush toilet, the toilet flushing device supplies flush water to the toilet body to execute toilet flushing. The toilet flushing device has a tank, a jet pump, a case and a water-supply path. The tank is provided for storing flush water to be supplied to the toilet body. The jet pump has a nozzle and a throat disposed at a position opposed to the nozzle with a space therebetween. The jet pump is disposed so as to be located under flush water in the tank. The case encloses the jet pump and has an open upper end. The case is disposed so that the upper end thereof is located lower than a maximum water level of flush water in the tank. The case has an opening formed through a side thereof

and a lid opening and closing the opening. The water-supply path communicates between the jet pump and the toilet body.

[0006] When jetted from the nozzle of the toilet flushing device, flush water is caused to flow into the throat while drawing flush water in the case. Thus, flush water that can be supplied through the water-supply path to the toilet body contains flush water ejected from the nozzle and flush water drawn into the ejected flush water, whereupon a flow rate (a cubic volume of fluid moving per unit time) of the flush water supplied to the toilet body can be increased.

[0007] Furthermore, an amount of flush water to be supplied to the toilet body can be increased and decreased by opening and closing the lid of the opening formed through the side of the case of the toilet flushing device. More specifically, flush water outside the case is allowed to flow through the opening into the case while the opening of the case is open. Accordingly, flush water outside the case can also be drawn by the jet pump thereby to be supplied through the water-supply path to the toilet body.

[0008] On the other hand, when a water level of the flush water in the tank reaches the upper end of the case while the opening of the case is closed by the lid, the flush water outside the case cannot then flow into the case. Accordingly, after the water level of flush water in the tank has reached the upper end of the case, only the flush water in the case is drawn by the jet pump thereby to be supplied through the water-supply path to the toilet body.

[0009] Thus, an amount of flush water that can be supplied to the toilet body is smaller when the opening of the case is closed by the lid than when the opening is open. Consequently, the toilet flushing device can execute one toilet flushing (full flush) using a larger amount of flush water and another toilet flushing (partial flush) using a smaller amount of flush water.

Prior Art Document

Patent Documents

[0010]

Patent Document 1: Japanese Utility Model Application Publication No. JP-U-H05-57080

Patent Document 2: Japanese Patent Application Publication No. JP-A-2004-156382

Summary of the Invention

Problem to Be Overcome By the Invention

[0011] In the flush toilet of Patent Document 1, however, a water level of the flush water in the hollow pipe is kept slightly higher than a water level of flush water in the tank (the condition where a difference between water

levels in the tank and the hollow pipe is small) and then drops. Accordingly, the hollow pipe sucks air in the toilet drainage by a weaker suction power from start to end of air sucking. As a result, there is a possibility that the hollow pipe cannot desirably suck air in the toilet drainage for occurrence and continuation of siphon effect in the toilet drainage. More specifically, since the suction power of the hollow pipe is weak, there is a possibility that the siphon effect does not occur in the toilet drainage. Furthermore, the negative force in the toilet drainage is rendered stronger than the suction power of the hollow pipe after occurrence of the siphon effect in the toilet drainage, whereupon there is a possibility that air would flow back into the toilet drainage with the result of early termination of siphon effect. Accordingly, there is a possibility that the flush toilet of Patent Document 1 cannot desirably discharge sewage or the like in the toilet bowl by execution of toilet flushing.

[0012] The first invention and the second invention have been made in view of the foregoing circumstances and an object of the first invention and the second invention is to provide a toilet flushing device which can desirably execute toilet flushing and a flush toilet provided with the toilet flushing device.

[0013] Furthermore, in the flush toilet of Patent Document 1, when configurations of the toilet bowl and the toilet drainage differ from one flush toilet to another, there is a case where flow rates of flush water in the toilet drainage differ from one flush toilet to another even if flush water is supplied to the toilet bowls has the same flow rate. The flow rate of the flush water in the toilet drainage affects suction power force by which the hollow pipe sucks air in the toilet drainage and a discharging force by which sewage or the like in the toilet drainage is discharged.

[0014] Accordingly, since the suction power of the hollow pipe sucking air from the toilet drainage is too strong in the case of the toilet body where the flow rate of the flush water in the toilet drainage is high, there is a possibility that sewage flowing in the toilet drainage may be drawn into the exhaust passage. When the sewage is drawn into the exhaust passage thereby to clog the exhaust passage, the siphon effect may not be caused to occur in the toilet drainage desirably in subsequent toilet flushing. On the other hand, in the case of the toilet body where the flow rate of the flush water in the toilet drainage is low, although sewage may not be drawn into the exhaust passage, there is a possibility that the siphon effect cannot be caused to occur in the toilet drainage desirably with the result that a discharging force by which sewage or the like is discharged out of the toilet body may be reduced. Thus, sewage or the like in the toilet bowl may not be discharged desirably by the execution of toilet flushing in the flush toilet of Patent document 1 when configurations of the toilet bowl and the toilet drainage differ from one flush toilet to another.

[0015] A third invention was made in view of the foregoing circumstances and an object of the third invention

is to provide a toilet flushing device which can desirably execute toilet flushing and a flush toilet provided with the toilet flushing device.

[0016] Furthermore, the jet pump needs to be located under flush water in the tank in order that the toilet flushing device may draw the flush water in the tank by the jet pump. As a result, the jet pump needs to be disposed near the bottom of the tank for the purpose of effectively using the flush water stored in the tank for toilet flushing.

[0017] When the jet pump is disposed near the tank bottom and the tank is disposed so as to be located lower than the upper surface of the toilet body, the water-supply path communicating between the jet pump and the toilet body is rendered longer and the rising slope of the water-supply path is rendered steeper. When the water-supply path is rendered longer and/or when the rising slope of the water-supply path is rendered steeper, pressure loss of flush water passing through the water-supply path is increased and the flow rate of the flush water supplied into the toilet body is reduced, with the result that the toilet flushing would become insufficient.

[0018] A fourth invention was made in view of the foregoing circumstances and an object of the fourth invention is to provide a toilet flushing device which has a sufficient degree of freedom in the installation position and can execute toilet flushing desirably and a flush toilet provided with the toilet flushing device.

Means for Overcoming the Problem

[0019] A toilet flushing device of a first invention which supplies flush water to a toilet body including a toilet bowl and a toilet drainage communicating with a downstream side of the toilet bowl, the toilet flushing device comprising a first tank which stores flush water; a second tank having a lower opening communicating with the first tank and an interior including a lower region and an upper region having a smaller capacity per unit height than the lower region; an air passage communicating between the second tank and the toilet drainage via a position located higher than a maximum storage water level in the first tank; a water-supply passage communicating between the first tank and the toilet bowl; and a delay unit which maximizes a flow rate of an air in the air passage with a delay to initiation of supply of flush water stored in the first tank through the water-supply passage into the toilet bowl, the air flowing from the toilet drainage side to the second tank side.

[0020] The toilet flushing device executes toilet flushing by supplying flush water stored in the first tank through the water-supply passage to the toilet bowl. In this case, with drop of the water level in the second tank, the second tank sucks air in the toilet drainage via the air passage. Consequently, a siphon effect can be caused in the toilet drainage even in the use of a smaller amount of flush water, whereby sewage or the like in the toilet bowl can desirably be discharged.

[0021] Furthermore, when an air in the air passage

flows from the toilet drainage side to the second tank side, the flow rate of the air is maximized by the delay unit with a delay to initiation of toilet flushing. This can delay drop of water level in the second tank. Consequently, the water level in the first tank drops in the interim faster than the water level in the second tank, whereupon the water level difference between the first and second tanks can be increased. Since the water level difference between the first and second tanks is proportionate to a degree of suction power of the second tank, the second tank has such a high suction power as to draw in the air in the toilet drainage at a stroke. Consequently, the toilet flushing device can reliably cause a siphon effect in the toilet drainage.

[0022] Furthermore, the upper region of the second tank interior has a larger capacity per unit height than the lower region of the second tank interior. As a result, the water level in the second tank drops slowly even when the flow rate of the air in the air passage flowing from the toilet drainage to the second tank side is maximized by the delay unit and flush water in the second tank flows into the first tank at a high flow rate. This prevents a sudden reduction in the water level difference between the first and second tanks. Consequently, the toilet flushing device can maintain a high suction power of the second tank.

[0023] Thus, the toilet flushing device can long maintain a condition where the suction power of the second tank is stronger than a negative pressure in the toilet drainage due to the siphon effect caused in the toilet drainage. Accordingly, the air can be prevented from counter-flowing from the second tank side into the toilet drainage during the duration of siphon effect. Consequently, the toilet flushing device can continue the siphon effect and desirably discharge sewage or the like in the toilet bowl outside the toilet body using the siphon effect.

[0024] Consequently, the toilet flushing device according to the first invention can desirably execute toilet flushing.

[0025] A toilet flushing device of a second invention which supplies flush water to a toilet body including a toilet bowl and a toilet drainage communicating with a downstream side of the toilet bowl, the toilet flushing device comprising a first tank configured to store flush water and having an interior including a lower region and an upper region having a smaller capacity per unit height than the lower region; a second tank having a lower opening communicating with the first tank; an air passage communicating between the second tank and the toilet drainage via a position located higher than a maximum storage water level in the first tank; a water-supply passage communicating between the first tank and the toilet bowl, and a delay unit which maximizes a flow rate of an air in the air passage with a delay to initiation of supply of flush water stored in the first tank through the water-supply passage into the toilet bowl, the air flowing from the toilet drainage side to the second tank side.

[0026] This toilet flushing device also executes toilet

flushing by supplying flush water stored in the first tank through the water-supply passage to the toilet bowl. In this case, with drop of the water level in the second tank, the second tank sucks air in the toilet drainage via the air passage. Consequently, a siphon effect can be caused in the toilet drainage even in the use of a smaller amount of flush water, whereby sewage or the like in the toilet bowl can desirably be discharged.

[0027] Furthermore, when an air in the air passage flows from the toilet drainage side to the second tank side, the flow rate of the air is maximized by the delay unit with a delay to initiation of toilet flushing. This can delay drop of water level in the second tank. Consequently, the water level in the first tank drops in the interim faster than the water level in the second tank, whereupon the water level difference between the first and second tanks can be increased. In particular, since the first tank has an interior including a lower region and an upper region having a smaller capacity per unit height than the lower region, the water level in the first tank can rapidly drop upon initiation of toilet flushing. This increases the water level difference between the first and second tanks, whereby the second tank has such a high suction power as to suck air in the toilet drainage at a stroke. Consequently, the toilet flushing device can reliably cause a siphon effect in the toilet drainage.

[0028] Furthermore, the second tank sucks the air in the toilet drainage and causes flush water to flow into the first tank. However, since the lower region of the first tank interior has a larger capacity per unit height than the upper region of the first tank, an amount of increase in the water level of the flush water in the first tank can be reduced. This can suppress reduction in the water level difference between the first and second tanks and further suppress reduction in the suction power of the second tank. Consequently, the toilet flushing device can maintain a higher suction power of the second tank.

[0029] Thus, the toilet flushing device can long maintain a condition where the suction power of the second tank is stronger than a negative pressure in the toilet drainage due to the siphon effect caused in the toilet drainage. Accordingly, the air can be prevented from counter-flowing from the second tank side into the toilet drainage during the duration of siphon effect. Consequently, the toilet flushing device can continue the siphon effect and desirably discharge sewage or the like in the toilet bowl outside the toilet body using the siphon effect.

[0030] Consequently, the toilet flushing device according to the second invention can desirably execute toilet flushing.

[0031] A flush toilet comprises a toilet body having a toilet bowl and a toilet drainage communicating with a downstream side of the toilet bowl, and the toilet flushing device according to the first or second invention. The flush toilet can reliably cause a siphon effect in the toilet drainage and maintain the siphon effect, as described above. Consequently, the flush toilet can desirably discharge sewage or the like in the toilet bowl outside the

toilet body using the siphon effect. Accordingly, the flush toilet can desirably execute toilet flushing.

[0032] A toilet flushing device according to a third invention, which supplies flush water to a toilet body including a toilet bowl and a toilet drainage communicating with a downstream side of the toilet bowl, comprises a first tank into which flush water flows and which stores the flush water, a second tank communicating with a lower part of the first tank, an air passage communicating between the second tank and the toilet drainage, a water-supply passage communicating between the first tank and the toilet bowl, and a flush water control unit configured to control a flow rate of the flush water supplied from the first tank to the toilet bowl.

[0033] The flush water control unit controls a flow rate of flush water supplied from the first tank to the toilet bowl according to configurations of the toilet bowl and the toilet drainage, whereupon the toilet flushing device can desirably execute the toilet flushing. More specifically, when a flow rate of flush water supplied to the toilet bowl is rendered lower in the case where a flow rate of flush water in the toilet drainage is high, sewage or the like can be prevented from being drawn into the air passage. Consequently, the second tank can suck the air in the toilet drainage with the result that the siphon effect can reliably be caused in the toilet drainage. Furthermore, when a flow rate of flush water supplied to the toilet bowl is rendered higher in the case where a flow rate of flush water in the toilet drainage is low, the siphon effect can reliably be caused in the toilet drainage. Thus, the toilet flushing device can desirably discharge sewage or the like in the toilet bowl outside the toilet body using the siphon effect.

[0034] Consequently, the toilet flushing device according to the third invention can desirably execute toilet flushing.

[0035] A flush toilet comprises a toilet body having a toilet bowl and a toilet drainage communicating with a downstream side of the toilet bowl, and the toilet flushing device according to the third invention. The flush toilet can reliably cause a siphon effect in the toilet drainage and maintain the siphon effect, as described above. Consequently, the flush toilet can desirably discharge sewage or the like in the toilet bowl outside the toilet body using the siphon effect. Accordingly, the flush toilet can desirably execute toilet flushing.

[0036] A toilet flushing device according to a fourth invention, which supplies flush water to a toilet body, comprises a first tank into which flush water flows and which stores the flush water, a third tank having an inlet through which flush water flows from a lower part of the first tank thereto and an outlet provided above the inlet and communicating with the toilet body, the third tank being maintained in a state full of flush water under an influence of pressure of flush water in the first tank when air is prevented from flowing through the inlet from the first tank in a case where flush water is supplied to the toilet body, a jet pump disposed at a position where the jet pump is

opposed to the outlet in the third tank with a space therebetween, the jet pump having a nozzle ejecting flush water toward the outlet, and a water-supply passage communicating between the outlet and the toilet body.

[0037] The third tank is provided with the inlet so that flush water can flow from a lower part of the first tank into the third tank. Accordingly, air is not allowed to flow from the first tank through the inlet into the third tank until the water level of the flush water in the first tank drops below the inlet of the third tank. Consequently, the third tank can be kept full of flush water by the influence of pressure of flush water in the first tank. In other words, almost all the flush water in the first tank can be caused to flow into the third tank. The flush water having flowed in the third tank can be supplied through the water-supply passage into the toilet body by the jet pump. Consequently, the toilet flushing device can supply flush water to the toilet body at a high flow rate. Thus, the toilet flushing device can use almost all the flush water stored in the first and third tanks and can desirably execute toilet flushing.

[0038] Furthermore, although the jet pump is disposed in an upper interior of the third tank, since the third tank can be kept full of flush water until almost all the flush water in the first tank flows into the third tank, the jet pump can draw the flush water in the third tank in the interim with the result that flush water can be supplied to the water-supply passage.

[0039] Furthermore, since the jet pump can be disposed in the upper interior of the third tank as described above, the length of the water-supply passage can be prevented from being increased and the rising slope of the water-supply passage can be prevented from becoming steep even when the toilet flushing device (the first and third tanks and the like) is disposed lower than an upper surface of the toilet body. This can reduce pressure loss of the flush water passing through the water-supply passage. Consequently, the toilet flushing device can supply flush water to the toilet body at a high flow rate. Furthermore, the toilet flushing device can supply almost all the flush water stored in the first and third tanks to the toilet body.

[0040] Accordingly, the toilet flushing device according to the fourth invention has a degree of freedom in the installation position and can desirably execute toilet flushing.

[0041] Furthermore, in a flush toilet comprising a toilet body and the toilet flushing device according to the fourth invention, the toilet flushing device can be disposed lower than the upper surface of the toilet body and flush water can desirably be supplied to the toilet body, as described above. Accordingly, the flush toilet has a degree of freedom in the installation position and can desirably execute toilet flushing.

Brief Description of the Drawings

[0042]

Fig. 1 is a schematic view of a flush toilet according to embodiment 1;

Fig. 2 is a schematic view of the flush toilet in an initial state of toilet flushing;

Fig. 3 is a schematic view of the flush toilet, showing the state thereof before a second tank sucks air during toilet flushing;

Fig. 4 is a schematic view of the flush toilet, showing the state thereof in the case where the second tank starts sucking air during toilet flushing;

Fig. 5 is a schematic view of the flush toilet, showing the state thereof in the case where the negative pressure in a toilet drainage has become maximum in the midst of toilet flushing;

Fig. 6 is a graph showing changes in the flow rate in a pump employed in embodiment 1;

Fig. 7 is a schematic view of the flush toilet according to embodiment 2;

Fig. 8 is a schematic view of the flush toilet, showing the initial state thereof in toilet flushing;

Fig. 9 is a schematic view of the flush toilet, showing the state thereof before the second tank sucks air during toilet flushing;

Fig. 10 is a schematic view of the flush toilet, showing the state thereof in the case where the second tank starts sucking air during toilet flushing;

Fig. 11 is a schematic view of the flush toilet, showing the state thereof in the case where the negative pressure in a toilet drainage has become maximum in the midst of toilet flushing;

Figs. 12A and 12B are schematic view of a first tank with an upper part thereof recessed inward, Fig. 12C is a schematic view of another first tank having an upper inside on which an individual rectangular parallelepiped part is mounted, Fig. 12D is a schematic view of a second tank having an outer envelope with an upper part enlarged in the right-left horizontal direction relative to a lower part thereof, and Fig. 12E is a schematic view of another second tank having an outer envelope narrowed downwardly gradually inward, all showing other forms of first and second tanks;

Figs. 13A and 13B show a second tank having a partition wall formed with an orifice and another second tank having a partition wall formed with an orifice and a float accommodated below the partition wall, both showing other forms of the delay unit, respectively;

Fig. 14 is a schematic view of the flush toilet according to another embodiment;

Fig. 15 is a schematic view of the flush toilet according to embodiment 3;

Fig. 16 is a schematic view of the flush toilet according to embodiment 4;

Fig. 17 is a schematic view of the flush toilet according to embodiment 5;

Fig. 18 is a schematic view of the flush toilet according to embodiment 6;

Fig. 19 is a schematic view of the flush toilet according to embodiment 7;

Fig. 20 is a schematic view of the flush toilet in the toilet flushing state thereof;

Fig. 21 is a schematic view of the flush toilet, showing the state where the flush toilet terminates supply of flush water to the toilet body;

Fig. 22 is a schematic view of the flush toilet, showing the state where flush water is supplied to the first and third tanks;

Figs. 23A and 23B are schematic views of extended and shrunk states of a bellows part of a side of the third tank in the flush toilet according to embodiment 8, respectively;

Figs. 24A and 24B are schematic views of the toilet flushing devices according to embodiment 9, to which third tanks with the side having a longer longitudinal dimension and a shorter longitudinal dimension are mounted, respectively; and

Fig. 25 is a schematic view of the flush toilet according to embodiment 10.

Mode for Carrying Out the Invention

[0043] Preferred forms of the first invention and the second invention will now be described.

[0044] The first tank in the first invention may have an interior including a lower region and an upper region having a smaller capacity per unit height than the lower region. In this case, the water level in the first tank can be caused to drop suddenly upon initiation of toilet flushing since the upper region of the first tank interior has a smaller capacity per unit height than the lower region. Consequently, the difference between water levels of the first and second tanks can be rendered larger from the very beginning of the second tank sucking air in the toilet drainage, whereupon the second tank can suck the air in the toilet drainage by a strong suction power.

[0045] Furthermore, the second tank sucks air in the toilet drainage and causes flush water to flow into the first tank in the toilet flushing device. However, since the lower region of the first tank interior has a larger capacity than the upper region thereof, a rise in the water level of the flush water in the first tank can be reduced. This can suppress reduction in the difference between the water levels in the first and second tanks and reduction in the suction power of the second tank. In particular, the water level in the second tank can be caused to slowly drop and the rise in the water level in the first tank can be reduced by the combination of the first tank and the second tank in which the upper region of the interior thereof has a larger capacity than the lower region of the interior thereof. Consequently, the first and second tanks can be kept in the condition where a sufficient difference between the water levels in the first and second tanks is ensured.

[0046] In the first or second invention, the lower opening of the second tank may communicate with the first

tank at a location lower than a minimum storage water level of the first tank. In this case, the lower opening of the second tank is normally closed by the flush water stored in the first tank and is not opened in the first tank. Consequently, the air (odor) in the toilet drainage can reliably be prevented from being released through the air passage into the first tank.

[0047] The delay unit in the first or second invention may be an on-off valve which is provided in the air passage so as to open and close the air passage. In this case, the second tank can suck air through the air passage from the toilet drainage by opening the on-off valve with a delay to initiation of supply of flush water stored in the first tank through the water-supply passage into the toilet bowl. Thus, the timing for the second tank to start sucking the air in the toilet drainage can easily be controlled. Consequently, the toilet flushing device can suck the air in the toilet drainage in order that a siphon effect may be caused in the toilet drainage.

[0048] The second tank in the first or second invention may be accommodated in the first tank. In this case, the first and second tanks can communicate with each other just by accommodating the second tank into the first tank and fixing the second tank to the first tank. This requires no member for connecting the first and second tanks to each other. Furthermore, there is no possibility that water would leak from the connection between the first and second tanks.

[0049] Next, embodiments 1 and 2 according to the first invention and the second invention will be described with reference to the accompanying drawings.

<Embodiment 1>

[0050] The flush toilet of embodiment 1 includes a toilet body 10 and a toilet flushing device 20 supplying flush water to the toilet body 10 as shown in Fig. 1. The toilet body 10 includes a toilet bowl 11 and a toilet drainage 12 communicating with a downstream side of the toilet bowl 11. A water sealing portion 13 retaining flush water is formed by a lower part of the toilet bowl 11 and an upstream of the toilet drainage 12.

[0051] The toilet flushing device 20 is located in the rear of the toilet body 10 and a large part of the toilet flushing device 20 is disposed lower than an upper surface of the toilet body 10. Consequently, the flush toilet achieves low silhouette. The toilet flushing device 20 includes a first tank 21, a second tank 22, an air passage 23, a water-supply passage 24 and an on-off valve 25 serving as a delay unit.

[0052] The first tank 21 has an upper end which is upwardly open and includes a vertically extending peripheral wall 21A and a bottom wall 21B closing a lower end of the peripheral wall 21A. The peripheral wall 21A includes a lower part through which a drain outlet 21C is formed. The water-supply passage 24 has an end connected to the drain outlet 21C. Flush water is adapted to flow through a tank water-supply passage 26 into the first

tank 21. Thus, the first tank 21 is configured to store flush water. The tank water-supply passage 26 has an upstream end communicating with a water pipe serving as a water supply source. Furthermore, the tank water-supply passage 26 has a downstream end provided with a water-supply valve 26V.

[0053] The second tank 22 is hollow and includes an outer envelope 22A which has an upper end surface formed with a connecting hole 22B and a lower end that is downwardly open thereby to serve as a lower opening 22C. The air passage 23 has one end connected to the connecting hole 22B. The outer envelope 22A includes an upper part enlarged longer in one horizontal direction as compared with a lower part thereof. As a result, the second tank 22 is formed so that an upper region 22U has a larger capacity per unit height than a lower region 22D. The second tank 22 is accommodated in and fixed to the first tank 21 so that the upper surface of the outer envelope 22A is located substantially at the same height as a maximum storage water level L of the first tank 21. The lower opening 22C of the second tank 22 is open in the first tank 21. Accordingly, flush water flows through the lower opening 22C into the second tank 22, whereby the second tank 22 can store flush water at the same water level as in the first tank 21. Thus, the communication between the first and second tanks 21 and 22 can be completed only by accommodating and fixing the second tank 22 in the first tank 21. This requires no member for connecting the first and second tanks 21 and 22 to each other. Furthermore, there is no possibility that water would leak from the connection between the first and second tanks 21 and 22.

[0054] The upper region 21U of the interior of the first tank 21 has a smaller capacity per unit height than the lower region 21D of the lower region of the interior of the first tank 21 by accommodating and fixing in the first tank 21 the second tank 22 in which the upper part of the outer envelope 22A is enlarged to be longer in the horizontal direction than the lower part thereof.

[0055] The air passage 23 has one end connected to the communicating hole 22B of the second tank 22. The air passage 23 extends from the upper end opening of the first tank 21 to the toilet body 10 side and has the other end connected to an upper part of the toilet drainage 12 located at the downstream side relative to the water sealing portion 13. As a result, the air passage 23 communicates between the second tank 22 and the toilet drainage 12 via a position located higher than a maximum storage water level L in the first tank 21. An on-off valve 25 serving as a delay unit is provided in the midst of the air passage 23. The on-off valve 25 is configured to be controlled by a control device (not shown), thereby being capable of opening and closing the air passage 23.

[0056] The water-supply passage 24 has one end connected to the drain outlet 21C of the first tank 21 and the other end disposed in the rear of the toilet bowl 11 and serving as a spout 24A formed so that flush water is ejected along an upper peripheral edge of the toilet bowl 11.

Accordingly, flush water ejected from the spout 24A flows along the surface of the toilet bowl 11 in one direction thereby to be capable of forming a swirl flow in the toilet bowl 11. A pump P is provided in the middle of the water-supply passage 24 for pressure-feeding the flush water stored in the first tank 21 to the toilet bowl 11 side. The pump P has a flow rate adjusting function of increasing and decreasing a flow rate of the pressure-fed flush water.

[0057] A toilet flushing process executed by thus configured flush toilet will now be described.

[0058] The first tank 21 stores flush water at a maximum storage water level L in a standby state before toilet flushing, as shown in Fig. 1. The second tank 22 also stores flush water at the same water level as the first tank 21. In the standby state, the on-off valve 25 provided in the air passage 23 and the water-supply valve 26V provided in the tank water-supply passage 26 are closed. The flush water is stored in the water sealing portion 13, thereby forming a water seal.

[0059] When a toilet flush button (not shown) is operated, the pump P is operated, whereby toilet flushing is started. The pump P pressure-feeds flush water to the toilet bowl 11 side at an initial stage of the operation (0 to t₁ sec.), while gradually increasing a flow rate, as shown in Fig. 6. Consequently, air is vented from the pump P with the result that noise due to air entrainment can be avoided. Furthermore, since the upper region 21U of the first tank 21 has a smaller capacity per unit height than the lower region 21D, the water level drops at a stroke in the first tank 21, whereby a water level difference is provided between the first and second tanks 21 and 22, as shown in Fig. 2. Additionally, the water level in the toilet bowl 11 of the toilet body 10 is increased.

[0060] Upon elapse of t₁ sec., the flow rate of flush water pressure-fed by the pump P is increased to q₁ L/min. (t₁ sec. to t₂ sec.). This also increases the flow rate of flush water overflowing the toilet bowl 11 from the water sealing portion 13 of the toilet body 10 to the downstream side of the toilet drainage 12, as shown in Fig. 3. The water level in the first tank 21 further drops, resulting in a further increase in the water level difference between the first and second tanks 21 and 22. Consequently, the second tank 22 can produce suction power sufficient to suck air from the toilet drainage 12.

[0061] When operation of the pump P is continued, flush water overflowing from the water sealing portion 13 of the toilet body 10 to the downstream side of the toilet drainage 12 forms a water screen in the downstream of the toilet drainage 12, thereby closing the downstream of the toilet drainage 12, as shown in Fig. 4. In this state, the toilet flushing device 20 opens the on-off valve 25 provided in the air passage 23. Since the air is allowed to flow from the toilet drainage 12 side to the second tank 22 side in the air passage 23, the second tank 22 sucks the air in the toilet drainage 12 with drop of the water level in the second tank 22. More specifically, the on-off valve 25 serves as a delay device opened with a delay

to initiation of supply of flush water stored in the first tank 21 through the water-supply passage 24 into the toilet bowl 11 (initiation of toilet flushing by operation of the pump P), thereby rendering maximum the flow rate of the air flowing from the toilet drainage 12 side to the second tank 22 side in the air passage 23.

[0062] Furthermore, the second tank 22 starts to suck the air in the toilet drainage 12 upon opening of the on-off valve 25. Accordingly, the timing when the second tank 22 starts to suck the air in the toilet drainage 12 can easily be controlled by controlling the opening of the on-off valve 25. Consequently, the toilet flushing device 20 can properly suck the air in the toilet drainage 12 so that the siphon effect is caused in the toilet drainage 12.

[0063] A closed space is defined in the toilet drainage 12 by the water screen formed in the downstream of the toilet drainage 12. The second tank 22 sucks the air in the closed space. Consequently, since the flush toilet can reliably reduce the air in the toilet drainage 12, the siphon effect can be caused in the toilet drainage 12 even by the use of a smaller amount of flush water.

[0064] The on-off valve 25 serving as the delay unit is opened with a delay to initiation of toilet flushing. The water level in the first tank 21 drops in this interim with the result that a large water level difference can be provided between the first and second tanks 21 and 22. Since the water level difference between the first and second tanks 21 and 22 is proportionate to a degree of suction power of the second tank 22, the second tank has such a high suction power as to suck the air in the toilet drainage 12 at a stroke. Consequently, the toilet flushing device 20 can reliably cause a siphon effect in the toilet drainage 12.

[0065] When the pump P is further operated, the second tank 22 continues sucking the air from the toilet drainage 12 with drop of the water level in the second tank 22. In this case, flush water in the second tank 22 flows into the first tank 21 at a high flow rate. However, since the upper region 22U of the second tank 22 has a larger capacity per unit height than the lower region 22D of the second tank 22, the water level in the second tank 22 drops slowly.

[0066] Furthermore, since the lower region 21D of the first tank 21 has a larger capacity than the upper region 21U of the first tank 21, rise in the water level in the first tank 21 due to the flush water flowing from the second tank 22 into the first tank 21 can be reduced. Thus, the water level in the second tank 22 is caused to slowly drop and the rise in the water level in the first tank 21 can be reduced. Consequently, the first and second tanks 21 and 22 can be maintained in the state where a sufficient water level difference is ensured therebetween. In other words, the second tank 22 can suck the air in the toilet drainage 12 with a strong suction power from the beginning for a long time period.

[0067] Thus, the toilet flushing device 20 can long maintain a condition where the suction power of the second tank 22 is stronger than a negative pressure in the

toilet drainage 12 due to the siphon effect caused in the toilet drainage 12. Accordingly, the air can be prevented from counter-flowing from the second tank 22 side into the toilet drainage 12 during the duration of siphon effect. Consequently, the toilet flushing device 20 can continue the siphon effect.

[0068] Furthermore, when the water level difference is reduced between the first and second tanks 21 and 22 in the case where the toilet drainage 12 is substantially full of flush water and the negative pressure in the toilet drainage 12 is maximum, as shown in Fig. 5, the flow rate of flush water pressure-fed by the pump P is increased to q_2 L/min. (t_2 sec. to t_3 sec.). Consequently, since the flow rate of the flush water flowing from the first tank 21 into toilet bowl 11 is increased, the water level in the first tank 21 is prevented from rising by flush water flowing from the second tank 22 into the first tank 21 and the water level difference between the first and second tanks 21 and 22 is prevented from being reduced. As a result, the suction power of the second tank 22 can be maintained so as not to be weaker than the negative pressure in the toilet drainage 12, the siphon effect can be continued in the toilet drainage 12, and sewage or the like in the toilet bowl can desirably be discharged out of the toilet body 10 by making use of the siphon effect.

[0069] Accordingly, the flush toilet according to embodiment 1 can desirably execute toilet flushing.

[0070] The flow rate of flush water pressure-fed by the pump P is reduced in a period from t_3 sec. to t_4 sec., whereby an amount of flush water in the toilet bowl 11 is reduced with the result that the water level in the toilet bowl 11 drops. As a result, air flows from the toilet bowl 11 side into the toilet drainage 12, whereby the siphon effect ends.

[0071] After end of the siphon effect, flush water is supplied into the toilet bowl 11 at a low flow rate q_3 L/min to be stored in the water sealing portion 13 of the toilet body 10 thereby to provide a water seal, and thereafter, the pump P is stopped for end of toilet flushing (a period from t_4 sec. to t_5 sec.). Furthermore, the water-supply valve 26V provided in the tank water-supply passage 26 is opened so that flush water is stored in the first tank 21. Subsequently, the maximum storage water level L is reached in the first tank 21 and the same water level as in the first tank 21 is reached in the second tank 22, with the result that the water-supply valve 26V is closed and the on-off valve 25 provided in the air passage 23 is also closed. Consequently, the flush toilet returns to the standby state before toilet flushing as shown in Fig. 1.

[0072] Although the water level in the first tank 21 drops as the result of execution of toilet flushing by operation of the pump P but does not drop lower than the lower opening 22C of the second tank 22. More specifically, the second tank 22 is disposed so that the lower opening 22C thereof is open to the first tank 21 at a location lower than the minimum storage water level in the first tank 21. Accordingly, the lower opening 22C of the second tank 22 is normally closed by flush water stored in the first

tank 21 and not opened in the interior of the first tank 21. Consequently, the air (foul odor) in the toilet drainage 12 can reliably be prevented from being discharged into the first tank 21.

<Embodiment 2>

[0073] A flush toilet according to embodiment 2 differs from embodiment 1 in that the toilet flushing device 30 includes a third tank 32 and flush water stored in the first tank 31 is supplied into the toilet body 10 by making use of a jet pump 33, as shown in Fig. 7. The other configuration of the flush toilet is the same as that of embodiment 1 and accordingly, an identical or similar structure is labeled by the same reference symbol as that in embodiment 1 and detailed description of such structure will be eliminated.

[0074] The toilet flushing device 30 is located in the rear of the toilet body 10 and a large part of the toilet flushing device 30 is disposed lower than an upper surface of the toilet body 10. Consequently, the flush toilet achieves low silhouette. The toilet flushing device 30 includes a first tank 21, a second tank 22, an air passage 23, a water-supply passage 24, an on-off valve 25 serving as a delay unit, a third tank 32 and a jet pump 33.

[0075] The first tank 31 has an upper end which is upwardly open and includes a vertically extending peripheral wall 31A and a bottom wall 31B closing a lower end of the peripheral wall 31A. The second and third tanks 22 and 32 are accommodated and fixed in the first tank 31.

[0076] The third tank 32 has an inlet 32A open downward in the first tank 31. The third tank 32 further has an upper end formed with an outlet 32B. A diverged water-supply passage 37 is inserted through the top of the third tank 32 into an interior of the third tank 32 in an airtight manner. The diverged water-supply passage 37 is configured to supply flush water to an ejection nozzle 36 which will be described later. The outlet 32B is formed so as to have a larger opening area than an ejection hole 36A of the ejection nozzle 36.

[0077] The water-supply passage 34 communicates between the outlet 32B and the toilet body 10. The water-supply passage 34 extends continuously from an opening edge of the outlet 32B. Accordingly, the water-supply passage 34 has a flow passage area larger than an opening area of the ejection hole 36A of the ejection nozzle 36. The water-supply passage 34 has a rising slope portion which extends obliquely upward to an upper rear end of the toilet body 10. The water-supply passage 34 is disposed so that an outlet 34A on a downstream end thereof ejects flush water along an upper peripheral edge of the toilet bowl 11 of the toilet body 10. As a result, flush water ejected from the outlet 34A of the water-supply passage 34 flows along the surface of the toilet bowl 11 in one direction and can form a swirl flow in the toilet bowl 11.

[0078] Furthermore, since the outlet 32B of the third

tank 32 is formed in an upper end of the third tank 32, the water-supply passage 34 is prevented from being rendered long, and the rising slope of the water-supply passage 34 is not steep. This prevents pressure loss of the flush water flowing through the water-supply passage 34. Consequently, the toilet flushing device 30 can supply flush water to the toilet body 10 at a high flow rate.

[0079] The ejection nozzle 36 of the jet pump 33 is disposed at a position opposed to the outlet 32B of the third tank 32 with a space therebetween in an interior of the third tank 32. The jet pump 33 includes the outlet 32B and the ejection nozzle 36. The ejection nozzle 36 is located on an upper interior of the third tank 32 and directed toward the outlet 32B so that flush water ejected therefrom flows along the water-supply passage 34. Thus, the jet pump 33 is disposed in the upper interior of the third tank 32. Flush water is caused to flow through the diverged water-supply passage 37 which is diverged from the tank water-supply passage 26, into the ejection nozzle 36. The diverged water-supply passage 37 has an ejection nozzle valve 37V in the middle thereof.

[0080] A toilet flushing process executed by thus configured flush toilet will now be described.

[0081] The first tank 31 stores flush water at a maximum storage water level L in a standby state before toilet flushing, as shown in Fig. 7. The second tank 22 also stores flush water at the same water level as the first tank 31. Flush water has reached the interior of the water-supply passage 34, whereby the third tank 32 is full of flush water. In the standby state are closed the on-off valve 25 provided in the air passage 23, the water-supply valve 26V provided in the tank water-supply passage 26 and the ejection nozzle valve 37V provided in the diverged water-supply passage 37. The water sealing portion 13 of the toilet body 10 stores flush water, thereby forming a water seal.

[0082] When a toilet flush button (not shown) is operated, the ejection nozzle valve 37V is opened, whereby toilet flushing is started, as shown in Fig. 8. More specifically, flush water is ejected from the ejection hole 36A of the ejection nozzle 36. The flush water is supplied through the outlet 32B and the water-supply passage 34 to the toilet bowl 11 of the toilet body 10 while drawing the flush water in the third tank 32. In this case, the flush water can be supplied to the toilet bowl 11 at a flow rate about three to four times higher than that of the flush water ejected from the ejection hole 36A.

[0083] Since the upper region 31U of the first tank 31 has a smaller capacity per unit height than the lower region 31D, the water level drops at a stroke in the first tank 31 upon start of toilet flushing, whereby a water level difference is provided between the first and second tanks 31 and 22. The water level in the toilet bowl 11 also rises.

[0084] Subsequently, when toilet flushing is continued, a flow rate of flush water overflowing from the water sealing portion 13 to the downstream side of the toilet drainage 12 is also increased as shown in Fig. 9. The water level in the first tank 31 further drops, whereby the water

level difference between the first and second tanks 31 and 22 is further increased. As a result, the second tank 22 can produce a suction power necessary to suck air from the toilet drainage 12.

[0085] When toilet flushing is further continued, the flush water overflowing from the water sealing portion 13 to the downstream side of the toilet drainage 12 forms a water screen in the downstream portion of the toilet drainage 12, thereby closing the downstream portion of the toilet drainage 12, as shown in Fig. 10. In this state, the on-off valve 25 provided in the air passage 23 is opened. Then, since an air is allowed to flow from the toilet drainage 12 side to the second tank 22 side, the second tank 22 sucks the air in the toilet drainage 12 with drop of the water level in the second tank 22.

[0086] Furthermore, since the second tank 22 starts sucking the air in the toilet drainage 12 with opening of the on-off valve 25, the timing for the second tank 22 to start sucking the air in the toilet drainage 12 can easily be controlled by controlling the opening of the on-off valve 25. Consequently, the toilet flushing device 30 can properly suck the air in the toilet drainage 12 for the purpose of causing the siphon effect in the toilet drainage 12.

[0087] A closed space is defined in the toilet drainage 12 by the water screen formed in the downstream portion of the toilet drainage 12. The second tank 22 draws in the air in the closed space. Consequently, the flush toilet can reliably reduce the air in the toilet drainage 12, with the result that the siphon effect can be caused in the toilet drainage 12 even by the use of a small amount of flush water.

[0088] Furthermore, the on-off valve 25 serving as the delay unit is opened with a delay to the initiation of toilet flushing. In this interim, the water level in the first tank 31 drops with the result that a large water level difference can be provided between the first and second tanks 31 and 22. Since a degree of the water level difference between the first and second tanks 31 and 22 is proportionate to a degree of suction power of the second tank 22, the second tank 22 has such a high suction power as to suck the air in the toilet drainage 12 at a stroke. Consequently, the toilet flushing device 30 can reliably cause a siphon effect in the toilet drainage 12.

[0089] When the toilet flushing is further continued, the water level in the second tank 22 further drops and the second tank 22 continuously sucks the air in the toilet drainage 12. In this case, the flush water in the second tank 22 flows into the first tank 31 at a high flow rate. However, since the upper region 22U of the second tank 22 has a larger capacity per unit height than the lower region 22D of the second tank 22, the water level in the second tank 22 drops slowly.

[0090] Furthermore, since the lower region 31D of the first tank 31 has a larger capacity per unit height than the upper region 31U of the first tank 21, a rise of the water level in the first tank 31 due to the flush water flowing from the second tank 22 into the first tank 31 can be reduced. Thus, the toilet flushing device 30 causes the

water level in the second tank 22 to slowly drop and reduces the rise of the water level in the first tank 31. As a result, the toilet flushing device 30 can maintain a state where a sufficient water level difference is ensured between the first and second tanks 31 and 22. More specifically, the second tank 22 can suck the air in the toilet drainage 12 from the beginning with a strong suction power for a long time period.

[0091] Thus, the toilet flushing device 30 can long maintain a state where the suction power of the second tank 22 is stronger than the negative pressure in the toilet drainage 12 due to the siphon effect caused in the toilet drainage 12. As a result, the air can be prevented from counter-flowing from the second tank 22 side into the toilet drainage 12 during continuation of the siphon effect. Consequently, the toilet flushing device 30 can continue the siphon effect.

[0092] Furthermore, even when the toilet drainage 12 is substantially full of flush water and the negative pressure in the toilet drainage 12 becomes maximum as shown in Fig. 11, the air can be prevented from counter-flowing from the second tank 22 side into the toilet drainage 12 during continuation of the siphon effect since the suction power of the second tank 22 is stronger. Consequently, the toilet flushing device 30 can continue the siphon effect and can discharge sewage or the like in the toilet bowl out of the toilet body 10 using the siphon effect.

[0093] Accordingly, the flush toilet according to embodiment 2 can desirably execute toilet flushing.

[0094] When the toilet flushing is further continued, the water level in the first tank 31 further drops below the inlet 32A of the third tank 32. Air then flows from the first tank 31 through the inlet 32A of the third tank 32 into the interior of the third tank 32, whereupon the water level in the third tank 32 drops at a stroke. Accordingly, the jet pump 33 is exposed in the third tank 32 and cannot thereby draw flush water. This reduces the flow rate of flush water supplied to the toilet bowl 11 with the result that the water level in the toilet bowl 11 drops. Air then flows from the toilet bowl 11 side into the toilet drainage 12, whereby the siphon effect is terminated.

[0095] After termination of siphon effect, flush water is supplied into the toilet bowl 11 to be stored in the water sealing portion 13 of the toilet body 10 thereby to provide a water seal, and thereafter, the ejection nozzle valve 37V is closed thereby completing the toilet flushing. Furthermore, the water-supply valve 26V provided in the tank water-supply passage 26 is opened so that flush water is stored in the first tank 31. Subsequently, the maximum storage water level L is reached in the first tank 31 and the water level in the second tank 22 becomes equal to the water level in the first tank 31. When the third tank 32 becomes full of flush water, the water-supply valve 26V is closed and the on-off valve 25 provided in the air passage is also closed. As a result, the flush toilet returns to the standby state before toilet flushing as shown in Fig. 7.

[0096] Since the lower opening 22C of the second tank

22 is located below the inlet 32A of the third tank 32, the second tank 22 is disposed so that the lower opening 22C is open to the first tank 31 at a location lower than a minimum storage water level in the first tank 31. Accordingly, since the lower opening 22C of the second tank 22 is normally closed by flush water stored in the first tank 31 and is not opened in the first tank 31, the air (foul odor) in the toilet drainage 12 can reliably be prevented from being discharged through the air passage 23 into the first tank 31.

[0097] The flush water in the third tank 32 is drawn by the jet pump 33 such that the flush water is supplied to the toilet body 10 at a large flow rate. At the same time, the flush water in the first tank 31 flows through the inlet 32A of the third tank 32 into the third tank 32. In this case, since the flush water in the third tank 32 is affected by the water pressure of flush water in the first tank 31, the third tank 32 is kept full of flush water. As a result, the jet pump 33 is kept sunk in the flush water in the third tank 32 with the result that the jet pump 33 can continuously draw flush water in the third tank 32. Consequently, flush water can continuously be supplied into the toilet body 10 at a high flow rate.

[0098] The first invention and the second invention should not be limited by the embodiments 1 and 2 described above with reference to the drawings, but the technical scope of the present invention covers the following embodiments.

(1) In embodiments 1 and 2, the second tank includes the outer envelope having the lower part and the upper part enlarged longer in one horizontal direction as compared with the lower part thereof. The second tank is accommodated and fixed in the first tank. As a result, the upper region of the first tank has a smaller capacity per unit height than the lower region of the first tank. However, the capacity of the upper region per unit height may be rendered smaller than that of the lower region by inwardly recessing the upper part of the first tank 41 or 42 without vertical deformation of the outer envelope of the second tank 44, as shown Figs. 12A and 12B. Furthermore, an individual rectangular parallelepiped part 43A may be mounted on an upper part of the inner wall of the first tank 43 to render the capacity of the upper region per unit height smaller than that of the lower region, as shown in Fig. 12C.

[0099] (2) The upper part of the outer envelope of the second tank is enlarged in one horizontal direction as compared with the lower part in embodiments 1 and 2. However, the upper part of the outer envelope of the second tank 45 may be enlarged in a plurality of horizontal directions such as rightward and leftward, as shown in Fig. 12D. Still furthermore, the outer envelope of the second tank 46 may be narrowed gradually downwardly inward so that the upper region has a larger capacity than the lower region, as shown in Fig. 12E.

[0100] (3) Although the on-off valve is used as the delay unit in embodiments 1 and 2, the delay unit may be provided in the second tank 51 as shown in Figs. 13A and

13B. More specifically, in the second tank 51 as shown in Fig. 13A, the interior of the second tank 51 is divided by a partition wall 52 formed with an orifice 53 into an upper water storage chamber 51U and a lower water storage chamber 51D, as shown in Fig. 13A. When toilet flushing starts and flush water in the second tank 51 flows through the lower opening 51A into the first tank 21, the flush water passes through the orifice 53 at an initial stage of the toilet flushing. In this case, since the flush water has a large flow resistance, the water level in the second tank 51 drops slowly. When the water level in the second tank 51 drops below the partition wall 52, air having a smaller flow resistance than the flush water passes through the orifice 53, with the result that the water level in the second tank 51 rapidly drops. Thus, the above-described structure configures a delay unit which can maximize a flow rate of an air flowing from the toilet drainage side to the second tank 51 side with a delay to initiation of toilet flushing.

[0101] Furthermore, the second tank 51 shown in Fig. 13B has an interior divided by a partition wall 52 formed with an orifice 53 into an upper water storage chamber 51U and a lower water storage chamber 51D. A spherical float 54 is accommodated in the lower water storage chamber 51D. The float 54 has a smaller specific gravity than flush water and is capable of closing the orifice 53. When toilet flushing starts and flush water in the second tank 51 flows through the lower opening 51A into the first tank 21, the flush water passing through the orifice 53 is subjected to resistance of the float 54 at an initial stage of the toilet flushing, with the result that the water level in the second tank 51 drops more slowly than in the case where no float 54 is provided. When the water level in the second tank 51 drops below the partition wall 52, the float 54 is lowered thereby to open the orifice 53. Air having a smaller flow resistance than the flush water then passes through the orifice 53, with the result that the water level in the second tank 51 rapidly drops. Thus, the above-described structure configures a delay unit which can maximize a flow rate of an air flowing from the toilet drainage side to the second tank 51 side with a delay to initiation of toilet flushing.

[0102] (4) The toilet flushing device includes the third tank and the jet pump having the ejection nozzle ejecting flush water toward the outlet of the third tank in embodiment 2. However, the toilet flushing device 60 may not be provided with the third tank as shown in Fig. 14. In this case, it is desirable that the jet pump is formed by extending the diverged water-supply passage 37 near the bottom wall 31B of the first tank 31, disposing an ejection hole 61A of the ejection nozzle 61 near the bottom wall 31B and disposing an upstream end opening 62A of the water-supply passage 62 at a location opposed to the ejection hole 61A.

[0103] Next, preferred forms of the third invention will be described.

[0104] The flush water control unit in the third invention may include a pump provided in the water-supply pas-

sage. In this case, supply of flush water from the first tank to the toilet bowl can stably be controlled even when the height of the first tank is low in height.

[0105] In the third invention, the toilet flushing device may further comprise a suction control unit configured to control an air sucking operation of the second tank sucking air from the toilet drainage. In this case, since the air sucking operation of the second tank sucking air from the toilet drainage is controlled by the suction control unit, the air is sucked from the toilet drainage at the right time according to a state of flush water supply from the first tank to the toilet bowl, so that a siphon effect can be caused in the toilet drainage. Consequently, the toilet flushing device can desirably execute toilet flushing using the siphon effect.

[0106] The suction control unit may include an upper water storage chamber and a lower water storage chamber formed by dividing the second tank by a partition wall having an orifice. In this case, upon start of flush water supply from the first tank to the toilet bowl, flush water passes through the orifice at an initial stage of the flush water supply. Since the flush water is liquid, flow resistance of the flush water delays drop of water level in the second tank. When the water level in the second tank drops below the partition wall, an air having a smaller flow resistance passes through the orifice. Then, the water level in the second tank drops faster, so that the flow rate of the air sucked from the toilet drainage is rendered higher. Consequently, the second tank sucks the air from the toilet drainage at a stroke with the result that a siphon effect can be caused.

[0107] The toilet flushing device may further comprise a closing member which is configured to float in the flush water in the lower water storage chamber thereby to close the orifice. In this case, upon start of flush water supply from the first tank to the toilet bowl, the orifice is closed by the closing member at an initial stage of the flush water supply. Accordingly, a flow rate of the flush water passing through the orifice is rendered lower as compared with the case where no closing member is provided. After the water level in the second tank drops and the closing member is accordingly lowered, the air having a lower flow resistance than flush water then passes through the orifice. The water level in the second tank then drops faster. Since the time when the flow rate of the air sucked from the toilet drainage is rendered higher can be delayed as compared with the case where no closing member is provided, the time when a siphon effect is caused in the toilet drainage can also be delayed.

[0108] Next, embodiments 3 to 6 each embodying the flush toilet provided with the toilet flushing device, according to the third invention, will be described with reference to the drawings.

<Embodiment 3>

[0109] The flush toilet according to the third invention includes the toilet body 10 and a toilet flushing device

300 as shown in Fig. 15. The toilet body 10 includes the toilet bowl 11 and the toilet drainage 12 communicating with the downstream side of the toilet bowl 11. The toilet bowl 11 has a rim water passage 14 formed along an opening edge of the upper side. The toilet drainage 12 has an upstream end communicating with a lower end of the toilet bowl 11. The toilet drainage 12 includes a region from a top thereof (a highest part) to the lower end of the toilet bowl 11. The region serves as a water sealing portion 13. The toilet drainage 12 has an air flow hole 15 which is located downstream with respect to the water sealing portion 13 and open above the water sealing portion 13. The toilet drainage 12 further has a narrow portion 16 which is provided in a region extending downward from the air flow hole 15 and has a reduced diameter.

[0110] The toilet flushing device 300 includes a first tank 110, a water-supply passage 114, a second tank 115, an air passage 118, a flush water control unit 119 and a suction control unit 122. The first tank 110 is configured to store flush water supplied from a ball tap 111 provided with a water-supply valve 112. The toilet flushing device 300 is configured to supply flush water stored in the first tank 110 to the toilet bowl 11. The first tank 110 has a lower end formed with a drain outlet 113. The water-supply passage 114 has an upstream end connected to the drain outlet 113. The water-supply passage 114 has a downstream end connected to the rim water passage 14. Flush water stored in the first tank 110 can be supplied through the water-supply passage 114 to the rim water passage 14.

[0111] The second tank 115 is formed into a cylindrical shape and has an upper end that is closed and an underside that is largely open thereby to serve as a communication hole 116. The second tank 115 is fixed in an interior of the first tank 110. The communication hole 116 of the second tank 115 is open at a location lower than a maximum storage water level of the flush water in the first tank 110 before toilet flushing. The second tank 115 has an interior space (a space in which flush water is stored) communicating via the communication hole 116 with an interior space of the first tank 110. The second tank 115 has an upper end formed with an air inlet-outlet 117 which is open at a higher location than the maximum storage water level of flush water in the first tank 110. The air passage 118 has one of two ends connected to the air inlet-outlet 117. The air passage 118 has the other end connected to the air flow hole 15 of the toilet drainage 12. In other words, the air passage 118 communicates between the location in the second tank 115 higher than the maximum storage water level in the first tank 110 and the location in toilet drainage 12 higher than the water sealing portion 13.

[0112] The flush water control unit 119 includes a pump 120 provided in the middle of the water-supply passage 114 and a water-supply electromagnetic on-off valve 121. The pump 120 is configured to pressure-feed flush water stored in the first tank 110 to the toilet bowl 11 (the rim water passage 14) side. The pump 120 has a flow rate

adjusting function of increasing/decreasing the flow rate of flush water to be pressure-fed, irrespective of hydraulic head pressure of the first tank 110. That is, the flow rate of flush water supplied from the first tank 110 to the toilet bowl 11 side can be rendered lower or higher than a flow rate depending upon only the hydraulic head pressure of the first tank 110. Furthermore, flush water supply from the first tank 110 to the toilet bowl 11 side is allowed when the on-off valve 121 is opened. The flush water supply from the first tank 110 to the toilet bowl 11 side is stopped when the on-off valve 121 is closed.

[0113] A suction control unit 122 has an air-flow electromagnetic on-off valve 123 provided in the middle of the air passage 118. Opening of the on-off valve 123 communicates between a space at the downstream side (above) relative to the water sealing portion 13 in the toilet drainage 12 and a space defined over flush water in the second tank 115, whereby air is allowed to flow between the spaces. Furthermore, Closure of the on-off valve 123 cuts off air flow in the air passage 118.

[0114] A toilet flushing process executed by thus configured flush toilet will now be described.

[0115] The on-off valve 121 is closed and the pump 120 is stopped in the standby state of the flush toilet before toilet flushing. The first tank 110 stores flush water at a maximum storage water level L. The second tank 115 also stores flush water at the same water level as the first tank 110. On the other hand, flush water is stored in the water sealing portion 13 of the toilet body 10 thereby to form water seal.

[0116] When a human body detector (not shown) has detected toilet user's having left the toilet bowl 11 or by a manual operation by the user in the above-described state, the on-off valve 121 is switched to an open state and the pump 120 starts up. Flush water supply from the first tank 110 to the toilet bowl 11 (that is, toilet flushing) starts. Flush water pressure-fed from the first tank 110 to the toilet bowl 11 side is supplied through the rim water passage 14 to the toilet bowl 11, sweeping sewage or the like away to the toilet drainage 12 side. The flush water having flowed into the toilet drainage 12 splashes in the narrow portion 16 thereby to form water screen.

[0117] The on-off valve 123 is switched from the closed state to the open state at the same time when flush water starts to flow from the first tank 110 to the toilet bowl 11 or after flush water has started to flow to the toilet bowl 11. Opening of the on-off valve 123 communicates between the space defined over flush water in the second tank 115 and the space defined over the water sealing portion 13 (downstream side) in the toilet drainage 12. Accordingly, the flush water level in the second tank 115 drops and the second tank 115 sucks, through the air passage 118, the air in a space in the toilet drainage 12 at the downstream side (above) relative to the water sealing portion 13. As a result, a siphon effect is caused in the toilet drainage 12, whereupon sewage or the like in the water sealing portion 13 is discharged out of the toilet body 10.

[0118] When a predetermined amount of flush water is supplied into the toilet bowl 11, the on-off valve 121 is closed and the pump 120 is stopped, whereby supply of flush water into the toilet bowl 11 is stopped and toilet flushing is completed. After start of flush water supply from the first tank 110 to the toilet bowl 11, flush water is still continuously supplied from a ball tap 111 to the first tank 110. Accordingly, the water levels in the first and second tanks 110 and 115 rise. When predetermined water levels have been reached in the respective tanks 110 and 115, water supply from the ball tap 111 is stopped, whereby predetermined maximum storage water levels are maintained in the respective first and second tanks 110 and 115. As a result, the flush toilet returns to the standby state before toilet flushing.

[0119] The toilet flushing device 300 includes a pump 120 which is provided in the water-supply passage 114 and serves as a flush water control unit 119 for controlling a flow rate of flush water supplied from the first tank 110 to the toilet bowl 11. Accordingly, a flow rate of flush water supplied from the first tank 110 to the toilet bowl 11 can suitably be set by controlling a flow rate of the flush water pressure-fed by the pump 120 according to the configurations of the toilet bowl 11 and the toilet drainage 12. Consequently, the flush toilet can desirably execute toilet flushing.

[0120] More specifically, when the toilet body 10 has such a configuration as to render the discharge flow rate in the toilet drainage 12 higher, the flow rate of flush water pressure-fed by the pump 120 is set so as to be rendered lower so that the flow rate of flush water supplied to the toilet bowl 11 is reduced. This can prevent sewage or the like from being sucked into the air passage 118. Consequently, the second tank 115 can reliably suck the air in the toilet drainage 12, whereupon the siphon effect can reliably be caused in the toilet drainage 12.

[0121] Furthermore, when the toilet body 10 has such a configuration as to render the discharge flow rate in the toilet drainage 12 lower, the flow rate of flush water pressure-fed by the pump 120 is set so as to be rendered higher so that the flow rate of flush water supplied to the toilet bowl 11 is increased. This can reliably cause the siphon effect in the toilet drainage 12. Consequently, the flush toilet can desirably discharge sewage or the like out of the toilet body 10 by making use of the siphon effect. Furthermore, since the first tank 110 is located substantially at the same level as the toilet bowl 11 is, a water-supply pressure of the flush water cannot be increased by the hydraulic head pressure. However, when the flow rate of flush water pressure-fed by the pump 120 is set so as to be higher, the flush water supply from the first tank 110 to the toilet bowl 11 can stably be executed even in the case where the first tank 110 is low in height.

[0122] Furthermore, the air-flow electromagnetic on-off valve 123 is provided in the air passage 118 as the suction control unit 122 controlling the air suction operation from the toilet drainage 12 to the second tank 115. When the opening/closure (the suction operation from

the toilet drainage 12 to the second tank 115) of the on-off valve 123 is controlled according to opening/closure of the on-off valve 121 and drive of the pump 120, the air can be sucked from the toilet drainage 12 to the second tank 115 at a suitable time according to the state of flush water supply from the first tank 110 to the toilet bowl 11, whereby a siphon effect can be caused in the toilet drainage 12.

[0123] For example, the toilet bowl 11 is flushed by flush water pressure-fed by the pump 120 with the flow rate of the flush water being set to be low at an initial stage and a water screen of the flush water is formed in the narrow portion 16. Subsequently, the flow rate of flush water pressure-fed by the pump 120 is increased so that the suction power of the second tank 115 to suck the air from the toilet drainage 12 is increased. This can cause a strong siphon effect in the toilet drainage 12 with the result that toilet flushing can desirably be executed. When the flow rate of flush water pressure-fed by the pump 120 is reduced, at a final stage of the toilet flushing, the water sealing portion 13 can be rendered full by supply of a requisite smallest amount of flush water.

<Embodiment 4>

[0124] A flush toilet according to embodiment 4 differs from embodiment 3 in the suction control unit 124 of the toilet flushing device 310, as shown in Fig. 16. The other configuration of the flush toilet is the same as that of embodiment 3 and accordingly, an identical or similar structure is labeled by the same reference symbol as that in embodiment 3 and detailed description of such structure will be eliminated.

[0125] The suction control unit 124 includes a partition wall 125 dividing the interior of the second tank 115 into an upper water storage chamber 127 and a lower water storage chamber 128 located lower than the upper storage chamber 127. The partition wall 125 has an orifice 126 vertically formed therethrough. The partition wall 125 is installed at a location lower than the maximum storage water level in the second tank 115 in the standby state of the flush toilet. The upper storage chamber 127 has an upper end formed with an air inlet-outlet 117. The lower storage chamber 128 has a lower end formed with a communication hole 116. Furthermore, the air passage 118 is formed with no air flow electromagnetic on-off valve. Accordingly, a space located over the flush water in the second tank 115 normally communicates with a space located over (downstream side) the water sealing portion 13 in the toilet drainage 12.

[0126] Upon start of flush water supply from the first tank 110 to the toilet bowl 11, flush water in the first tank 110 is caused to swiftly flow to the toilet bowl 11 side, so that the water level of the flush water promptly drops in a region other than the second tank 115 in the first tank 110. On the other hand, in the second tank 115, the flush water passing through the orifice at an initial stage of flush water supply (that is, until flush water forms a water

screen in the narrow portion 16) has a relatively higher flow resistance. Accordingly, the water level drops slowly in the second tank (the upper storage chamber 127). Accordingly, a flow rate of the air the second tank 115 sucks from the toilet drainage 12 is low. The suction control unit 124 is configured so that the water therein drops below the partition wall 125 in the second tank 115 substantially in synchronism with the forming of a water screen of flush water in the narrow portion 16. When the water level drops below the partition wall 125 in the second tank 115, the air having a lower flow resistance than the flush water passes through the orifice 126. Accordingly, the water level drops faster in the second tank 115 (the lower storage chamber 128). In other words, the flow rate of the air sucked from the toilet drainage 12 by the second tank 115 is rendered higher such that the air in the toilet drainage 12 can be sucked at once. As a result, the siphon effect can be caused in the toilet drainage 12.

[0127] When the drop of the water level in the second tank 115 is rendered slower than the drop of the water level in the first tank 110, the flow rate of flush water flowing from the second tank 115 into the first tank 110 sometimes becomes higher than the flow rate of flush water flowing out of the first tank 110 in the case where the water level in the first tank 110 drops and the flow rate of flush water flowing out of the first tank 110 is rendered lower. Consequently, since the water level difference between the first and second tanks 110 and 115 becomes smaller, a speed at which the water level in the second tank 115 drops is reduced, with the result that the suction power of the second tank 115 is lowered. As a result, there is a possibility that the air may counter-flow from the second tank 115 to the toilet drainage 12 side and the siphon effect would terminate.

[0128] In the flush toilet, however, the flow rate of flush water flowing from the first tank 110 to the toilet bowl 11 side can be increased by the pump 120. This can avoid the reduction in the water level difference between the first and second tanks 110 and 115 with the result that the speed at which the water level in the second tank 115 drops can be increased. Consequently, the suction power of the second tank 115 can be prevented from reduction and the siphon effect can be continued.

[0129] Furthermore, an inner diameter of the orifice 126 may be rendered smaller in order that the water level in the second tank 115 may drop more slowly at the initial stage and a time period may be prolonged from start of toilet flushing to the time when the flow rate of the air sucked from the toilet drainage 12 by the second tank 115 becomes higher. However, when the inner diameter of the orifice 126 is reduced, there is a possibility that foreign matter in the flush water would clog the orifice 126. In this regard, the flush water in the upper storage chamber 127 is forcibly sucked to the lower storage chamber 128 side by the pump 12 in the flush toilet of the embodiment. Accordingly, there is no possibility of clogging of the orifice 126.

<Embodiment 5>

[0130] A flush toilet according to embodiment 5 differs from embodiment 4 in the suction control unit 129 of the toilet flushing device 320, as shown in Fig. 17. The other configuration of the flush toilet is the same as that of embodiment 4 and accordingly, an identical or similar structure is labeled by the same reference symbol as that in embodiment 4 and detailed description of such structure will be eliminated.

[0131] The suction control unit 129 includes a closing member 130 which is accommodated in the lower storage chamber 128 of the second tank 115 and is capable of closing the orifice 126. The closing member 130 has a lower specific weight than the flush water. Accordingly, the closing member 130 floats on the flush water in the second tank 115. Consequently, the closing member 130 closes the orifice 126 from below by buoyancy when the water level of flush water in the second tank 115 is not less than a predetermined level.

[0132] Upon start of flush water supply from the first tank 110 to the toilet bowl 11, the closing member 130 is located close to the orifice 126 from below by buoyancy at an initial stage of flush water supply. Accordingly, the flow rate of flush water passing through the orifice 126 is lower than in the case where no closing member 130 is provided. The flow rate of flush water passing through the orifice 126 in this case is affected by the buoyancy acting on the closing member 130 and varied by the water level difference between the flush water in the first tank 110 and the flush water in the second tank 115.

[0133] When the water level in the second tank 115 becomes lower than the underside of the partition wall 125, air having a smaller flow resistance than the flush water then passes through the orifice 126. This drops the water level in the second tank 115 faster such that the siphon effect can be caused in the toilet drainage 12. Since the opening of the orifice 126 can be reduced by the closing member 130 during pass of flush water through the orifice in the flush toilet of the embodiment, the time when the siphon effect in the toilet bowl 12 is caused can be delayed as compared with the case where no closing member 130 is provided. Furthermore, when the flow rate of flush water pressure-fed by the pump 120 is reduced before the air starts to pass through the orifice 126, the water level difference is rendered smaller between the first and second tanks 110 and 115. Consequently, the flow rate of flush water passing through the orifice 126 can be reduced and the production of siphon effect in the toilet drainage 12 can be delayed.

<Embodiment 6>

[0134] A flush toilet according to embodiment 6 differs from embodiment 3 in a flush water control unit 131 of the toilet flushing device 330, as shown in Fig. 18. The other configuration of the flush toilet is the same as that of embodiment 3 and accordingly, an identical or similar

structure is labeled by the same reference symbol as that in embodiment 3 and detailed description of such structure will be eliminated.

[0135] The first tank 110 is located higher than the toilet bowl 11 in the flush toilet. Accordingly, the maximum storage water levels in the first and second tanks 110 and 115 are sufficiently higher than the toilet bowl 11. The toilet flushing device 330 includes water-supply electromagnetic on-off valve 121 provided in the middle of the water-supply passage 114 and a water-supply flow rate control valve 132 disposed at the downstream side (toilet bowl 11 side) with respect to the on-off valve 121. Thus, the flush water control unit 131 includes a configuration of raising the hydraulic head pressure in the first tank 110 located higher than the toilet bowl 11 and a configuration of providing the water-supply electromagnetic on-off valve 121 and the water-supply flow rate control valve 132.

[0136] When the on-off valve 121 is opened, the hydraulic head pressure of flush water in the first tank 110 starts supply of flush water from the first tank 110 to the toilet bowl 11 side (that is, toilet flushing). Flush water supplied to the toilet bowl 11 washes out sewage or the like in the toilet bowl 11 to the toilet drainage 12 side. Furthermore, the flush water having flowed into the toilet drainage 12 splashes in the narrow portion 16 thereby to form water screen. An air in the space at the downstream side (over) with respect to the water sealing portion 13 in the toilet drainage 12 is sucked through the air passage 118 into the second tank 115. As a result, the siphon effect is caused in the toilet drainage 12. In this case, when the water-supply flow rate control valve 132 is adjusted so that the flow rate of flush water supplied to the toilet bowl 11 is increased, the siphon effect can reliably be caused in the toilet drainage 12 and sewage or the like can desirably be discharged out of the toilet body. Furthermore, when the water-supply flow rate control valve 132 is adjusted so that the flow rate of flush water supplied to the toilet bowl 11 is reduced, sewage or the like can be prevented from being sucked into the air passage 118. Furthermore, the on-off valve 123 is switched to an open state at the same time flush water starts to flow to the toilet bowl 11 side or after flush water has started to flow to the toilet bowl 11 side. Accordingly, air in the toilet drainage 12 is sucked through the air passage 118 into the second tank 115 with drop of water level in the second tank 115, whereby the siphon effect is caused in the toilet drainage 12. As a result, sewage or the like in the water sealing portion 13 is discharged out of the toilet body 10.

[0137] The third invention should not be limited by the embodiments 3 to 6 described above with reference to the drawings, but the technical scope of the present invention also covers the following embodiments.

[0138]

(1) Although the second tank is disposed in the first tank in embodiments 3 to 6, the second tank may be

disposed outside the first tank.

(2) Although the first tank is disposed substantially at the same level with the toilet bowl in embodiments 3 to 5, the first tank may be disposed higher than the toilet bowl.

(3) Although the pump capable of adjusting the flow rate of pressure-fed flush water is employed as the flush water control unit, a flow rate control valve may be used as the flush water control unit, instead of the pump and a flush water control unit may be constituted by the pump which cannot adjust the flow rate of the pressure-fed flush water and the flow rate control valve provided at the downstream side of the pump.

(4) Although the air flow electromagnetic on-off valve is provided in the air passage as the suction control unit controlling a suction operation from the toilet drainage to the second tank in embodiments 3 and 6, a flow rate control valve may be provided instead of the air flow electromagnetic on-off valve or both the air flow electromagnetic on-off valve and the flow rate control valve may be provided. Furthermore, the suction control unit may be or may not be provided.

(5) In each of embodiments 4 and 5, an electromagnetic on-off valve, a flow rate control valve or both electromagnetic on-off valve and flow rate control valve may be provided in the air passage as the suction control unit controlling a suction operation from the toilet drainage to the second tank.

(6) The suction control unit employed in each one of embodiments 4 and 5 may be applied to embodiment 6.

(7) In embodiment 6, the first tank is installed higher than the toilet bowl as the flush water control unit so that the hydraulic head pressure in the first tank is rendered high, and the electromagnetic on-off valve and the flow rate control valve are provided in the water-supply passage. A pump and an electromagnetic on-off valve may be provided in the water-supply passage as in embodiments 3 to 5, instead.

[0139] Next, preferred forms of the fourth invention will be described.

[0140] The outlet in the fourth invention may be formed so as to extend through an upper part of the third tank, and the nozzle may be provided in an upper interior of the third tank. In this case, even when the toilet flushing device is disposed at a position lower than the upper surface of the toilet body, flush water can be supplied to the toilet body at a high flow rate by a jet pump. Consequently, the flush toilet can achieve low silhouette.

[0141] The nozzle may eject flush water until air flows from the first tank through the inlet into the third tank with a result that the water level in the third tank drops. In this case, when air flows from the first tank through the inlet into the third tank, the water level in the third tank rapidly drops with the result that the jet pump cannot draw flush water in the third tank thereby to stop ejection of flush

water. The flow rate of flush water ejected varies when the pressure of flush water supplied to the nozzle fluctuates. Accordingly, the flow rate of flush water stored in the third tank and drawn by the jet pump also fluctuates. Thus, the flow rate of flush water supplied to the toilet body fluctuates with fluctuation of pressure of flush water supplied to the nozzle. However, the toilet flushing device can maintain a substantially constant amount of flush water supplied to the toilet body.

[0142] More specifically, an amount of flush water drawn by the jet pump until the water level in the third tank drops equals an amount of flush water stored outside the third tank in the first tank and is substantially constant. In the case where the jet pump draws a constant amount of flush water, a flush water ejecting time is longer when the flow rate of flush water ejected from the nozzle is low, and the flush water ejecting time is shorter when the flow rate of flush water ejected from the nozzle is high. Thus, in order that the jet pump may draw a constant amount of flush water, a substantially constant amount of flush water is ejected from the nozzle. Accordingly, even when the flow rate of flush water ejected from the nozzle fluctuates and the flow rate of flush water stored in the third tank and drawn by the pump also fluctuates, and consequently, the flow rate of flush water supplied to the toilet body fluctuates, the toilet flushing device can render an amount of flush water supplied to the toilet body substantially constant.

[0143] In the fourth invention, the water level in the first tank, at which air starts to flow from the first tank through the inlet into the third tank may be changeable. In this case, an amount of flush water supplied to the toilet body can be changed by changing the water level in the first tank, at which air starts to flow from the first tank through the inlet to the third tank. More specifically, when the water level in the first tank, at which air starts to flow from the first tank through the inlet to the third tank is reduced, the time when the water level of flush water in the third tank drops is delayed, whereby the jet pump can draw flush water in the third tank for a longer period of time. This can increase an amount of flush water supplied to the toilet body. On the other hand, when the water level in the first tank, at which air starts to flow from the first tank through the inlet to the third tank is increased, the water level in the third tank drops faster with the result that the jet pump cannot draw flush water in the third tank early. Accordingly, an amount of flush water the toilet flushing device supplies to the toilet body can be rendered smaller. Consequently, since the toilet flushing device can easily change an amount of flush water supplied to the toilet body, the toilet flushing device can easily be applied to a plurality of types of toilet bodies differing from each other in an amount of flush water for use in flushing.

[0144] In the fourth invention, the toilet flushing device may further comprise a communication passage which communicates between a lower part of the first tank and the nozzle and a water feed unit which is provided in the communication passage for feeding flush water stored

in the first tank to the nozzle. In this case, since flush water can be fed to the nozzle by using a water feed unit, flush water of stable high pressure can be fed to the nozzle. Consequently, the jet pump can strongly draw flush water in the third tank and flush water can stably be supplied at a high flow rate through the water-supply passage 114 to the toilet body.

[0145] Next, embodiments 7 to 10 each embodying the flush toilet provided with the toilet flushing device, according to the fourth invention, will be described with reference to the drawings.

<Embodiment 7>

[0146] The flush toilet according to embodiment 7 includes the toilet body 10 and a toilet flushing device 220 supplying flush water to the toilet body 10 as shown in Fig. 19. The toilet body 10 has the toilet bowl 11 and the toilet drainage 12 communicating with the downstream side of the toilet bowl.

[0147] The toilet flushing device 220 is located in the rear of the toilet body 10 and disposed at a lower position than an upper surface of the toilet body 10. Consequently, the flush toilet achieves low silhouette. The toilet flushing device 220 includes a first tank 221, a second tank 222, a jet pump 223 and a water-supply passage 224. Flush water is adapted to flow through the tank water-supply passage 225 to the first tank 221. The tank water-supply passage 225 communicates with a water pipe serving as a water supply source. The tank water-supply passage 225 has a downstream end provided with a tank water-supply valve 225V. The first tank 221 is configured to store flush water flowing through the tank water-supply passage 225 thereinto.

[0148] The second tank 222 is disposed in the first tank 221. The second tank 222 has an inlet 222A which is located near a lower interior of the first tank 221 and is open downward. The second tank 222 also has an upper end formed with an outlet 222B. A diverged water-supply passage 227 is inserted through the top of the second tank 222 into an interior of the second tank 222 in an airtight manner. The diverged water-supply passage 227 is configured to supply flush water to an ejection nozzle 226 which will be described later. The outlet 222B is formed so as to have a larger opening area than an ejection hole 226A of the ejection nozzle 226.

[0149] The water-supply passage 224 communicates between the outlet 222B and the toilet body 10. The water-supply passage 224 extends continuously from an opening edge of the outlet 222B. Accordingly, the water-supply passage 224 has a flow passage area larger than an opening area of the ejection hole 226A of the ejection nozzle 226. The water-supply passage 224 has a rising slope portion which extends obliquely upward to an upper rear end of the toilet body 10. The water-supply passage 224 is disposed so that an ejection outlet 224A in a downstream end thereof ejects flush water along an upper peripheral edge of the toilet bowl 11 of the toilet body 10.

As a result, flush water ejected from the ejection outlet 224A of the water-supply passage 224 flows along the surface of the toilet bowl 11 in one direction and can form a swirl flow in the toilet bowl 11.

[0150] Furthermore, since the outlet 222B of the second tank 222 is formed in an upper end of the second tank 222, the water-supply passage 224 is prevented from being rendered long, and the rising slope of the water-supply passage 224 is not steep. This can reduce pressure loss of the flush water flowing through the water-supply passage 224.

[0151] The ejection nozzle 226 of the jet pump 223 is disposed at a position opposed to the outlet 222B of the second tank 222 with a space therebetween in an interior of the second tank 222. The jet pump 223 includes the outlet 222B and the ejection nozzle 226. The ejection nozzle 226 is located on an upper interior of the second tank 222 and directed toward the outlet 222B so that flush water ejected therefrom flows along the water-supply passage 224. Thus, the jet pump 223 is disposed in the upper interior of the second tank 222. Flush water is caused to flow through the diverged water-supply passage 227 which is diverged from the tank water-supply passage 225, into the ejection nozzle 226. The diverged water-supply passage 227 has an ejection nozzle valve 227V in the middle thereof.

[0152] A toilet flushing process executed by thus configured flush toilet will now be described.

[0153] Flush water having flowed from the tank water-supply passage 225 further flows into the first tank 221 in a standby state before toilet flushing, as shown in Fig. 19. The flush water further flows from a lower interior of the first tank 221 through the inlet 222A of the second tank 222 into the second tank 222. In other words, the first and second tanks 221 and 222 are full of flush water in the standby state before toilet flushing. In the standby state, the tank water-supply valve 225V and the ejection nozzle valve 227V are closed.

[0154] Furthermore, an opening area of the downstream end of the water-supply passage 224 is smaller than the opening area of the upwardly open first tank 221 in the standby state before toilet flushing. Accordingly, the pressure of flush water in the first tank 221 causes flush water to flow from the second tank 222 into water-supply passage 224 communicating with the downstream side. More specifically, the second tank 222 is full of flush water and the water level of flush water in the water-supply passage 224 rises up to a location higher than a water level of flush water outside the second tank 222 in the first tank 221.

[0155] Subsequently, upon start of toilet flushing, the ejection nozzle valve 227 V is opened as shown in Fig. 20. Flush water is then ejected from the ejection hole 226A and the flush water in the second tank 222 is drawn into the ejected flush water. The first flush water ejected from the ejection nozzle 226A and the second flush water in the second tank 222 drawn by the first flush water join together thereby to be supplied through the water-supply

passage 224 to the toilet body 10. In this case, the flush water can be supplied to the toilet body 10 at a flow rate about three to four times higher than the flow rate at which the flush water is ejected from the ejection hole 226A of the ejection nozzle 226.

[0156] Since the jet pump 223 is disposed in the upper interior of the second tank 222, the length of the water-supply passage 224 can be prevented from being increased and the rising slope of the water-supply passage 224 can be prevented from becoming steep. This can reduce pressure loss of the flush water passing through the water-supply passage 224. Consequently, the toilet flushing device 220 can supply flush water to the toilet body 10 at a high flow rate.

[0157] The flush water thus starts to be supplied to the toilet body 10 with the flush water in the second tank 222 being drawn by the jet pump 223. At the same time, the flush water in the lower interior of the first tank 221 flows through the inlet 222A into the second tank 222. As a result, the water level in the first tank 221 drops. In this case, the flush water in the second tank 222 is affected by the pressure of flush water in the first tank 221, whereupon the second tank 222 is maintained in a full state. Accordingly, the jet pump 223 can remain under flush water in the second tank 222. Consequently, the jet pump 223 can continuously draw flush water in the second tank 222 with the result that the flush water can continuously be supplied to the toilet body 10 at the high flow rate.

[0158] When the toilet flushing further continues, the water level in the first tank 221 further drops below the inlet 222A of the second tank 222, as shown in Fig. 21. Air then flows from the first tank 221 through the inlet 222A into the second tank 222, whereby the water level in the second tank 222 drops at once. Accordingly, the jet pump 223 is exposed in the second tank 222 and cannot accordingly draw flush water in the second tank 222.

[0159] The toilet flushing device 220 includes a water level sensor (not shown) such as a float sensor for detecting a water level in the second tank 222. The ejection nozzle valve 227V is closed when the water level sensor has detected drop in the water level in the second tank 222. Thus, the supply of flush water to the toilet body 10 is completed. In other words, the ejection nozzle 226 continues to eject flush water until air flows from the first tank 221 through the inlet 222A into the second tank 222 and the water level in the second tank 222 drops.

[0160] When the pressure of flush water supplied to the ejection nozzle 226 fluctuates, the flow rate at which flush water is ejected from the ejection nozzle 226 also fluctuates. This also fluctuates the flow rate of flush water which is stored in the second tank 222 and is drawn by the jet pump 223. When the pressure of flush water supplied to the ejection nozzle 226 fluctuates, the flow rate at which flush water is supplied to the toilet body 10 also fluctuates. However, the toilet flushing device 220 of the flush toilet can render an amount of water supplied to the toilet body 10 substantially constant.

[0161] In other words, an amount of flush water drawn by the jet pump 223 until the water level in the second tank 222 drops is substantially equal to an amount of flush water stored outside the second tank 222 in the first tank 221 and is substantially constant. In the case where the jet pump 223 draws a constant amount of flush water, a ejecting time is rendered longer when the flow rate at which flush water is ejected from the ejection hole 226A is low. On the contrary, the ejecting time is rendered shorter when the flow rate at which flush water is ejected from the ejection hole 226A is high. Thus, in order that the constant amount of flush water may be drawn by the jet pump 223 from the second tank 222, a substantially constant amount of flush water is ejected from the ejection hole 226A of the ejection nozzle 226. Accordingly, even when the flow rate of flush water ejected from the ejection hole 226A fluctuates and the flow rate of flush water that is stored in the second tank 222 and drawn by the jet pump 223 fluctuates, and consequently, the flow rate of flush water supplied to the toilet body 10 fluctuates, an amount of flush water the toilet flushing device 220 supplies to the toilet body 10 can be rendered substantially constant.

[0162] Subsequently, the tank water-supply valve 225V is opened so that flush water is caused to flow from the tank water-supply passage 225 to the first tank 221, as shown in Fig. 22. As a result, flush water is stored in both first and second tanks 221 and 222, whereby the flush toilet returns to the standby state before toilet flushing, as shown in Fig. 19. One cycle of the toilet flushing step is thus completed.

[0163] The toilet flushing device 220 is located in the rear of the toilet body 10 and disposed at the lower position than the upper surface of the toilet body 10. Consequently, the flush toilet achieves low silhouette. Furthermore, since the jet pump 223 is disposed in the upper interior of the second tank 222, the length of the water-supply passage 224 can be prevented from being increased and the rising slope of the water-supply passage 224 can be prevented from becoming steep. This can reduce pressure loss of the flush water passing through the water-supply passage 224. Consequently, the toilet flushing device 220 can supply flush water to the toilet body 10 at a high flow rate. The jet pump 223 can draw flush water in the second tank 222 until almost all the flush water in the first tank 221 flows into the second tank 222. As a result, flush water can be supplied to the toilet body 10 at a high flow rate for a long period of time. In other words, the flush toilet can use almost all the flush water stored in both first and second tanks 221 and 222.

[0164] Consequently, the flush toilet of embodiment 7 has a certain degree of freedom in the installation position of the toilet flushing device 220 and can desirably execute toilet flushing.

<Embodiment 8>

[0165] A flush toilet of embodiment 8, as shown in Fig.

23, differs from embodiment 7 in that the second tank 231 of the toilet flushing device 230 has a side surface 231B formed into an accordion shape, whereby the water level in the first tank when air is caused to flow from the first tank 221 through the inlet 231A into the second tank 231 can be changed. The other configuration of the flush toilet is the same as that of embodiment 7 and accordingly, an identical or similar structure is labeled by the same reference symbol as that in embodiment 7 and detailed description of such structure will be eliminated.

[0166] When air starts to flow from the first tank 221 through the inlet 231A into the second tank 231, the water level in the first tank 221 can be changed by expanding and contracting the accordion portion of the side surface 231B of the second tank 231. Accordingly, an amount of flush water supplied to the toilet body 10 can be changed.

[0167] That is, as shown in Fig. 23A, the accordion portion of the side surface 231B of the second tank 231 is expanded and the inlet 231A of the second tank 231 is disposed in the lower interior of the first tank 221. This can decrease the water level of the first tank 221 at which air starts to flow from the first tank 221 through the inlet 231A into the second tank 231. Consequently, since the time when the water level in the second tank 231 drops after start of toilet flushing can be delayed, the jet pump 223 can draw flush water in the second tank 231 for a long period of time, with the result that an amount of flush water the toilet flushing device 230 supplies to the toilet body 10 can be increased. That is, the toilet body 10 can be supplied with an amount of flush water substantially equal to an amount of flush water stored above the inlet 231A outside the second tank 231 in the first tank 221 (part X in Fig. 23A).

[0168] On the other hand, as shown in Fig. 23B, the accordion portion of the side surface 231B of the second tank 231 is contracted and the inlet 231A of the second tank 231 is disposed in the higher interior of the first tank 221. This can increase the water level of the first tank 221 at which air starts to flow from the first tank 221 through the inlet 231A into the second tank 231. Consequently, since the water level in the second tank 231 drops earlier after start of toilet flushing, the jet pump 223 cannot early draw flush water in the second tank 231. This can reduce an amount of flush water the toilet flushing device 230 supplies to the toilet body 10. That is, the toilet body 10 can be supplied with an amount of flush water substantially equal to an amount of flush water stored above the inlet 231A outside the second tank 231 in the first tank 221 (part Y in Fig. 23B). This amount of flush water supplied in the case where the accordion portion is contract is smaller than the amount of flush water in the case where the accordion portion is expanded.

[0169] Thus, since the toilet flushing device 230 of the flush toilet of embodiment 8 can easily change an amount of flush water supplied to the toilet body 10, the flush toilet of embodiment 8 can easily be applied to a plurality of types of toilet bodies 10 differing in an amount of flush water required in toilet flushing.

<Embodiment 9>

[0170] A flush toilet of embodiment 9, as shown in Fig. 24, differs from embodiment 7 in that a plurality of second tanks 241 and 242 differing in the longitudinal dimension of the side are replaceably usable in the toilet flushing device 240. The other configuration of the flush toilet is the same as that of embodiment 7 and accordingly, an identical or similar structure is labeled by the same reference symbol as that in embodiment 7 and detailed description of such structure will be eliminated.

[0171] In the toilet flushing device 240 of the flush toilet, the water level in the first tank 221, at which air starts to flow from the first tank 221 through the inlet 241A or 242A into the second tank 241 or 242, can be changed by replacing the second tank by one of the second tanks 241 and 242 differing in the longitudinal dimension of the side. Consequently, an amount of flush water supplied to the toilet body 10 can be changed.

[0172] In other words, as shown in Fig. 24A, the second tank 241 with the side having a longer longitudinal dimension is mounted in the first tank 221 and the inlet 241A of the second tank 241 is located in the lower interior of the first tank 221. This can decrease the water level in the first tank 221, at which air starts to flow from the first tank 221 through the inlet 241A into the second tank 241. Thus, since the time when the water level in the second tank 241 drops is delayed, the jet pump 223 can draw the flush water in the second tank 241 for a longer time. Consequently, an amount of flush water the toilet flushing device 240 supplies to the toilet body 10 can be increased. That is, the toilet body 10 can be supplied with an amount of flush water substantially equal to an amount of flush water stored above the inlet 241A outside the second tank 241 in the first tank 221 (part X in Fig. 24A).

[0173] On the other hand, as shown in Fig. 24B, the second tank 242 with the side having a shorter longitudinal dimension is mounted in the first tank 221 and the inlet 242A of the second tank 242 is located in the higher interior of the first tank 221. This can increase the water level in the first tank 221, at which air starts to flow from the first tank 221 through the inlet 242A into the second tank 242. Consequently, since the water level in the second tank 241 drops earlier after start of toilet flushing, the jet pump 223 cannot early draw flush water in the second tank 242. This can reduce an amount of water the toilet flushing device 240 supplies to the toilet body 10. That is, the toilet body 10 can be supplied with an amount of flush water substantially equal to an amount of flush water stored above the inlet 242A outside the second tank 242 in the first tank 221 (part Y in Fig. 24B). This amount of flush water supplied in the case where the second tank 242 with the side having a shorter longitudinal dimension is mounted is smaller than the amount of flush water in the case where the second tank 241 with the side having a longer longitudinal dimension is mounted.

[0174] Thus, since the toilet flushing device 240 of the

flush toilet of embodiment 9 can easily change an amount of flush water supplied to the toilet body 10, the flush toilet of embodiment 9 can easily be applied to a plurality of types of toilet bodies 10 differing in an amount of flush water required in toilet flushing.

<Embodiment 10>

[0175] A flush toilet of embodiment 10, as shown in Fig. 25, differs from embodiment 7 in that the toilet flushing device 250 includes a communication passage 228 communicating between the lower interior of the first tank 221 and the ejection nozzle 226 and a pump P provided in the communication passage 228 and serving as a water feed unit which feeds to the ejection nozzle 226 flush water stored in the first tank 221. The other configuration of the flush toilet is the same as that of embodiment 7 and accordingly, an identical or similar structure is labeled by the same reference symbol as that in embodiment 7 and detailed description of such structure will be eliminated.

[0176] Upon start of toilet flushing in the toilet flushing step, the pump P is driven to eject flush water stored in the first tank 221 from the ejection hole 226A of the ejection nozzle 226, with the result that the flush water in the second tank 222 can be drawn into the flush water to be ejected. Since the pump P is used to feed the flush water to the ejection nozzle 226, flush water of high pressure can stably be fed to the ejection nozzle 226. Consequently, the jet pump 223 can strongly draw flush water in the second tank 222 and flush water can stably be supplied through the water-supply passage 224 to the toilet body 10 at a high flow rate.

[0177] The fourth invention should not be limited by the embodiments 7 to 10 described above with reference to the drawings, but the technical scope of the present invention also covers the following embodiments.

(1) Although the second tank is disposed in the first tank in each one of embodiments 7 to 10, the first and second tanks may be disposed side-by-side with each other and a connecting passage may be provided for connecting lower interiors of the tanks.

(2) Although the second tank has a larger flow passage area than the water-supply passage in each one of embodiments 7 to 10, the flow passage area of the second tank may be equal to that of the water-supply passage.

(3) Although the outlet is provided in the upper end of the second tank and the water-supply passage is connected to the outlet in each one of embodiments 7 to 10, the outlet may be located at any higher position than the inlet.

(4) Although the water-supply passage communicates with the upper interior of the toilet bowl and flush water is ejected onto the surface of the toilet bowl in each one of embodiments 7 to 10, the ejection outlet in the downstream end of the water-supply

passage may be provided in a lower end of the toilet bowl or an upstream end of the toilet drainage so that flush water is ejected along the toilet drainage. (5) Although the supply of flush water to the ejection nozzle ends when the water level in the first tank drops below the inlet of the second tank and the water level in the second tank drop, the supply of flush water to the ejection nozzle may end when the water level in the first tank is higher than the inlet of the second tank.

Explanation of Reference Symbols

[0178] 10 ... toilet body

11 toilet bowl
12 toilet drainage
13 water sealing portion
20, 30 60 toilet flushing device
21, 31 first tank
21D lower region (of first tank)
21U upper region (of first tank)
22 second tank
22C lower opening (of second tank)
22D lower region (of second tank)
22U upper region (of second tank)
23 air passage
24, 34 water-supply passage
25 on-off valve (delay unit)
L maximum storage water level
300, 310, 320, 330 toilet flushing device
110 first tank
115 second tank
114 water-supply passage
118 air passage
119, 131 flush water control unit
120 pump
122, 124, 129 suction control unit
125 partition wall
126 orifice
127 upper storage chamber
128 lower storage chamber
130 closing member
220, 230, 240, 250 toilet flushing device
221 first tank
222, 231, 241, 242 second tank
222A, 231A, 241A, 242A inlet
222B outlet
223 jet pump mechanism
224 water-supply passage
226 ejection nozzle
228 communication passage
P pump (water-feed mechanism)

Claims

1. A toilet flushing device which supplies flush water to

a toilet body including a toilet bowl and a toilet drainage communicating with a downstream side of the toilet bowl, the toilet flushing device comprising:

5 a first tank which stores flush water;
a second tank having a lower opening communicating with the first tank and an interior including a lower region and an upper region having a larger capacity per unit height than the lower region;
10 an air passage communicating between the second tank and the toilet drainage via a position located higher than a maximum storage water level in the first tank;
15 a water-supply passage communicating between the first tank and the toilet bowl; and
a delay unit which maximizes a flow rate of an air in the air passage with a delay to initiation of supply of flush water stored in the first tank through the water-supply passage into the toilet bowl, the air flowing from the toilet drainage side to the second tank side.

2. The toilet flushing device according to claim 1, wherein the first tank has an interior including a lower region and an upper region having a smaller capacity per unit height than the lower region.

3. A toilet flushing device which supplies flush water to a toilet body including a toilet bowl and a toilet drainage communicating with a downstream side of the toilet bowl, the toilet flushing device comprising:

35 a first tank configured to store flush water and having an interior including a lower region and an upper region having a smaller capacity per unit height than the lower region;
a second tank having a lower opening communicating with the first tank;
40 an air passage communicating between the second tank and the toilet drainage via a position located higher than a maximum storage water level in the first tank;
a water-supply passage communicating between the first tank and the toilet bowl; and
45 a delay unit which maximizes a flow rate of an air in the air passage with a delay to initiation of supply of flush water stored in the first tank through the water-supply passage into the toilet bowl, the air flowing from the toilet drainage side to the second tank side.

50 4. The toilet flushing device according to any one of claims 1 to 3, wherein the lower opening of the second tank communicates with the first tank at a location lower than a minimum storage water level of the first tank.

5. The toilet flushing device according to any one of claims 1 to 3, wherein the delay unit is an on-off valve which is provided in the air passage so as to open and close the air passage. 5
6. The toilet flushing device according to any one of claims 1 to 3, wherein the second tank is accommodated in the first tank. 10
7. A toilet flushing device which supplies flush water to a toilet body including a toilet bowl and a toilet drainage communicating with a downstream side of the toilet bowl, the toilet flushing device comprising:
 - a first tank into which flush water flows and which stores the flush water; 15
 - a second tank communicating with a lower part of the first tank;
 - an air passage communicating between the second tank and the toilet drainage; 20
 - a water-supply passage communicating between the first tank and the toilet bowl; and
 - a flush water control unit configured to control a flow rate of the flush water supplied from the first tank to the toilet bowl. 25
8. The toilet flushing device according to claim 7, wherein the flush water control unit includes a pump provided in the water-supply passage. 30
9. The toilet flushing device according to claim 7 or 8, further comprising a suction control unit configured to control an air sucking operation of the second tank sucking an air from the toilet drainage. 35
10. The toilet flushing device according to claim 9, wherein the suction control unit includes an upper water storage chamber and a lower water storage chamber formed by dividing the second tank by a partition wall having an orifice. 40
11. The toilet flushing device according to claim 10, further comprising a closing member which is configured to float in the flush water in the lower water storage chamber thereby to close the orifice. 45
12. A flush toilet comprising a toilet body having a toilet bowl and a toilet drainage communicating with a downstream side of the toilet bowl, and the toilet flushing device defined in claim 1 or 7. 50
13. A toilet flushing device which supplies flush water to a toilet body, the device comprising:
 - a first tank into which flush water flows and which stores the flush water; 55
 - a third tank having an inlet through which flush water flows from a lower part of the first tank
- thereinto and an outlet provided above the inlet and communicating with the toilet body, the third tank being maintained in a state full of flush water under an influence of pressure of flush water in the first tank when air is prevented from flowing through the inlet from the first tank in a case where flush water is supplied to the toilet body; a jet pump disposed at a position where the jet pump is opposed to the outlet in the third tank with a space therebetween, the jet pump having a nozzle ejecting flush water toward the outlet; and
- a water-supply passage communicating between the outlet and the toilet body.
14. The toilet flushing device according to claim 13, wherein the outlet is formed so as to extend through an upper part of the third tank, and the nozzle is provided in an upper interior of the third tank.
15. The toilet flushing device according to claim 13 or 14, wherein the nozzle ejects flush water until air flows from the first tank through the inlet into the third tank with a result that the water level in the third tank drops.
16. The toilet flushing device according to claim 15, wherein the water level in the first tank, at which air starts to flow from the first tank through the inlet into the third tank is changeable.
17. The toilet flushing device according to claim 13 or 14, further comprising a communication passage which communicates between a lower part of the first tank and the nozzle and a water feed unit which is provided in the communication passage for feeding flush water stored in the first tank to the nozzle.
18. A flush toilet comprising a toilet body and the toilet flushing device defined in claim 13 or 14.

Fig. 1

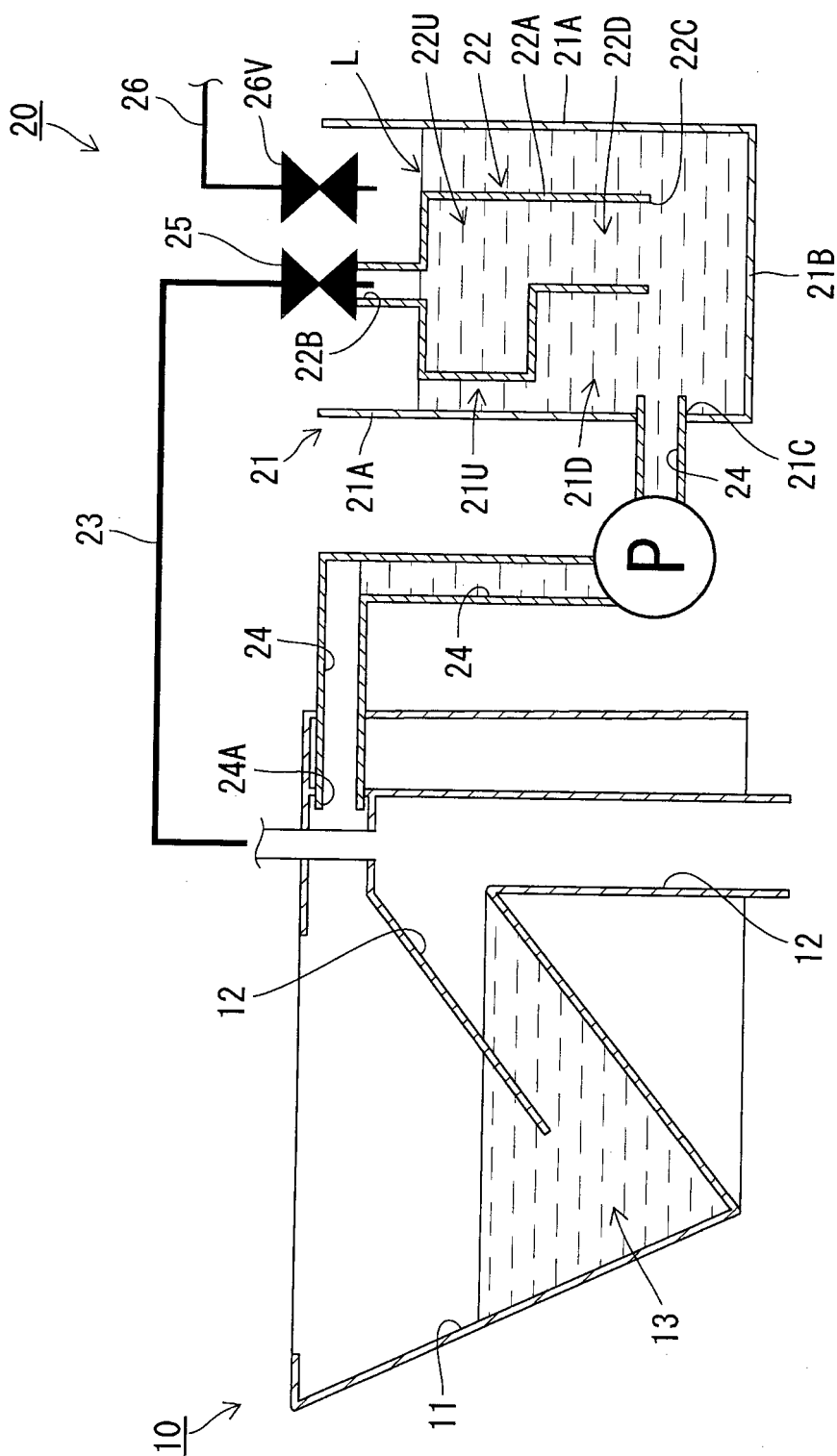


Fig. 2

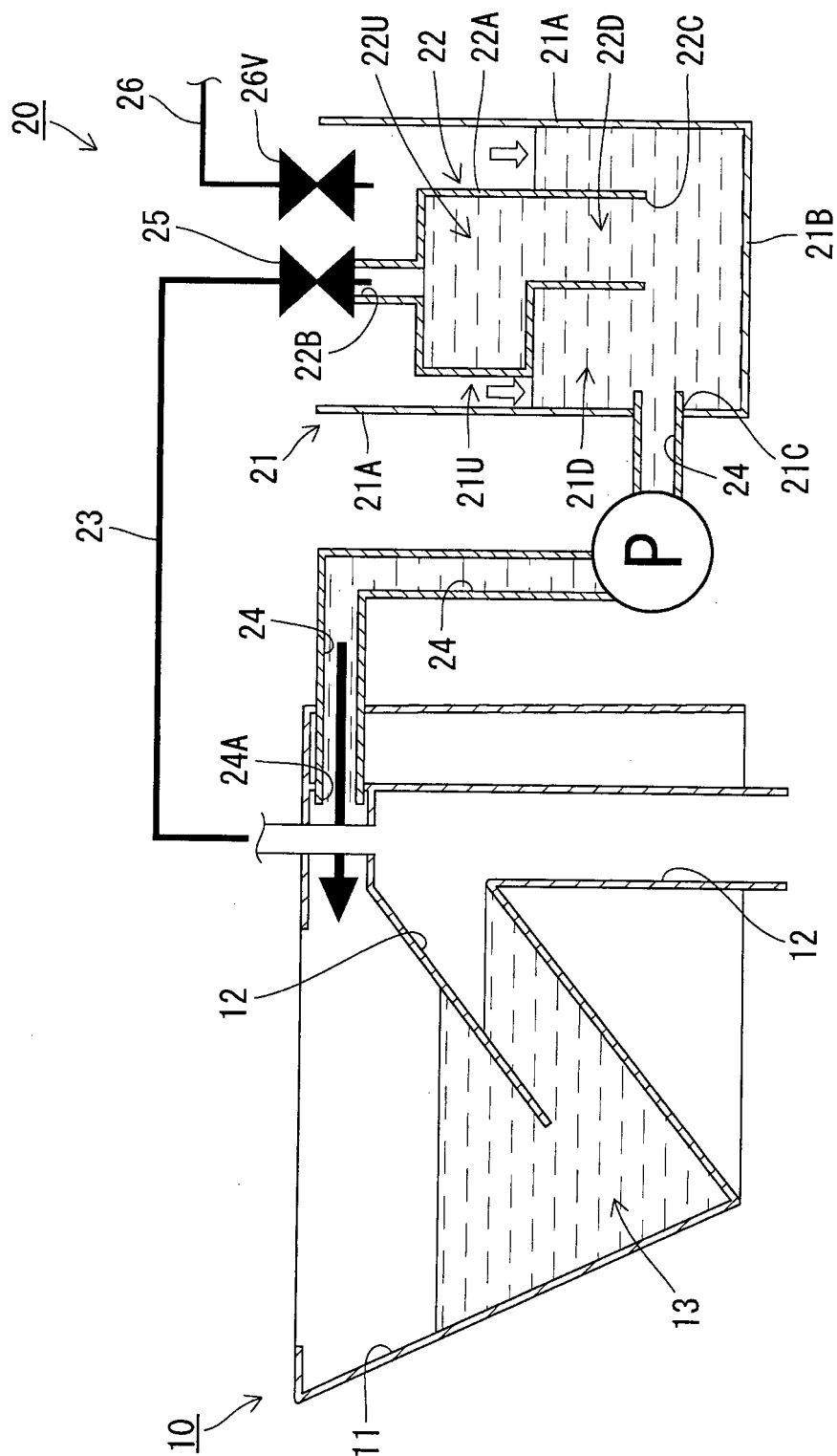


Fig. 3

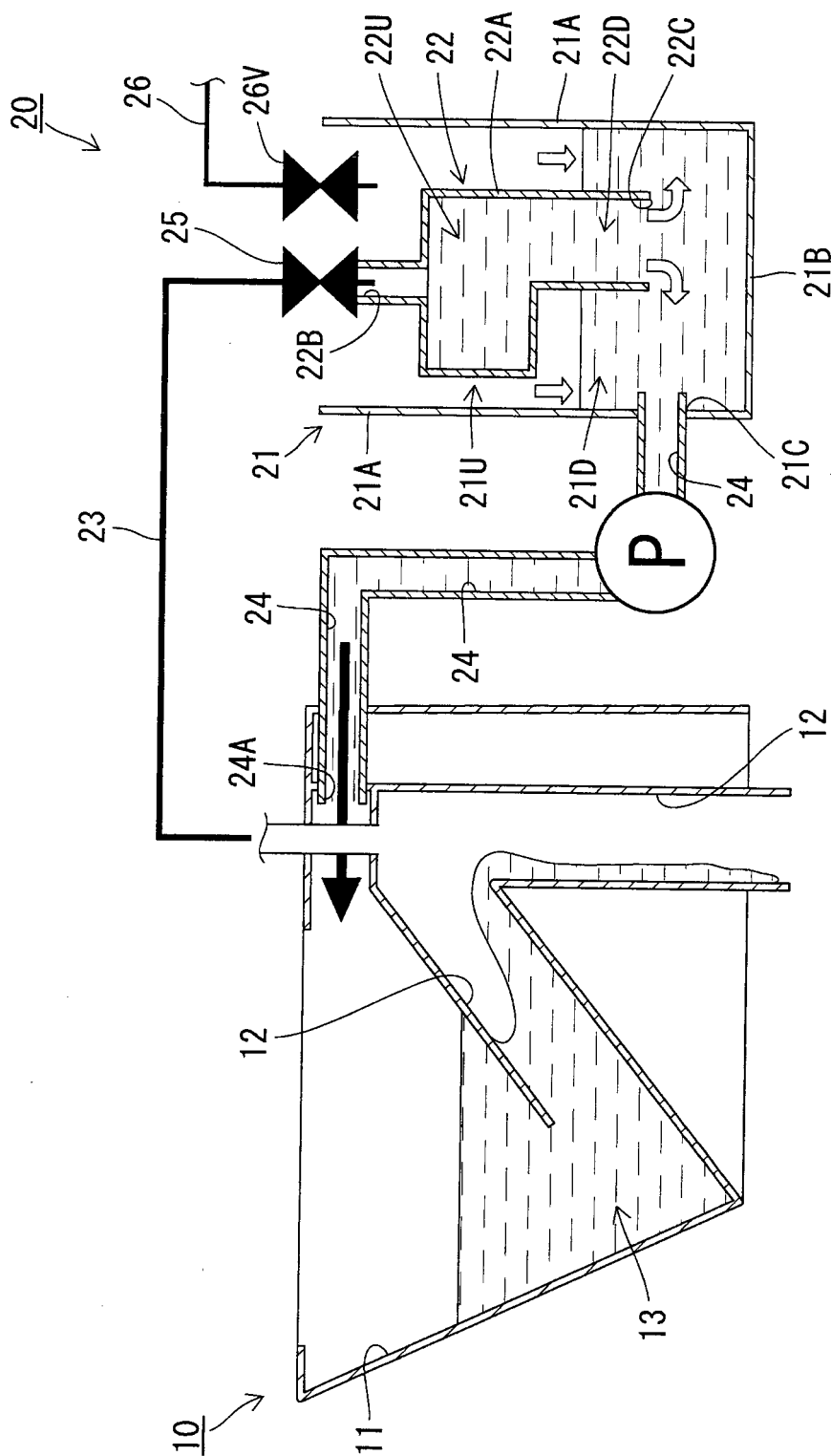


Fig. 4

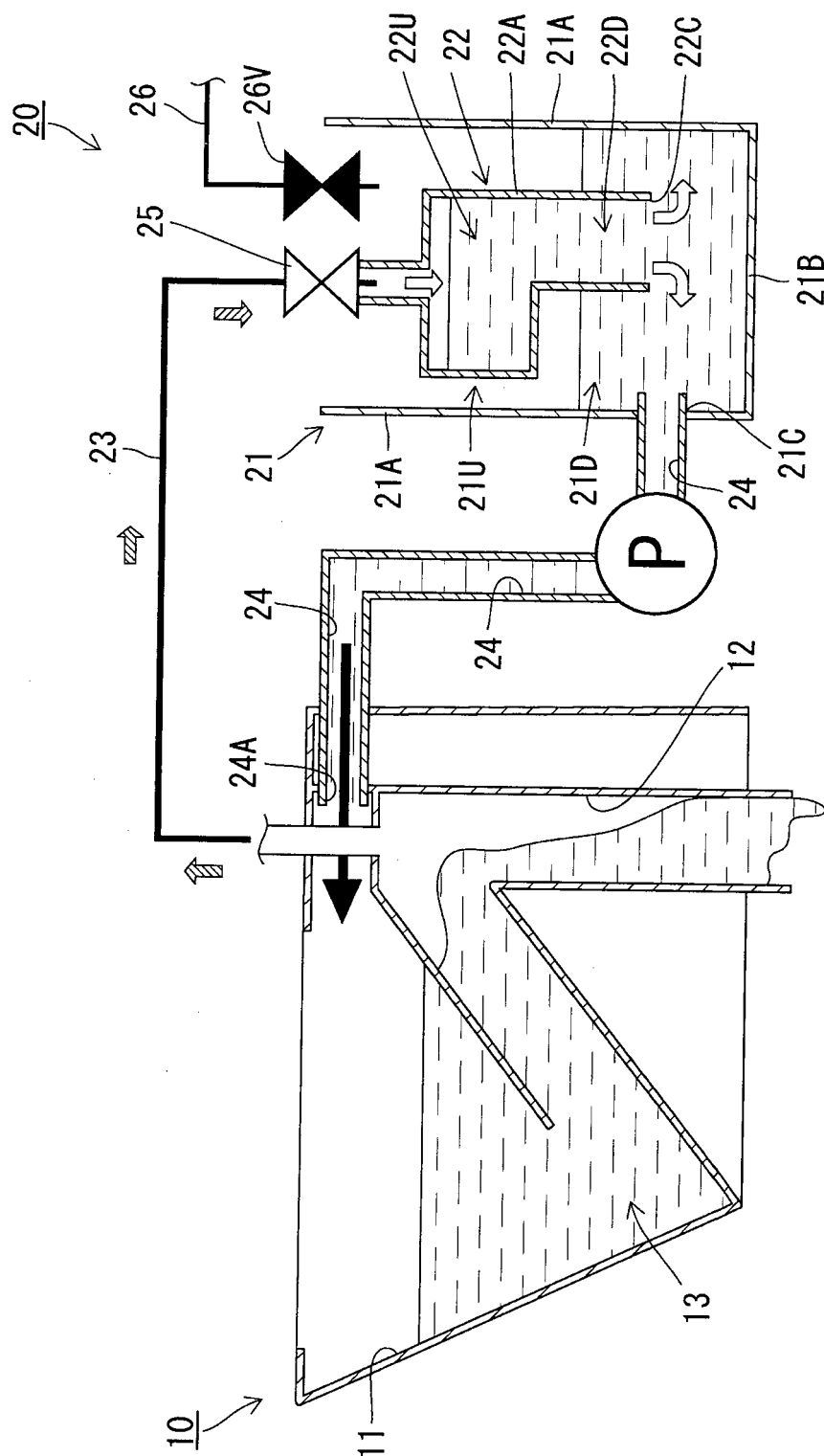


Fig. 5

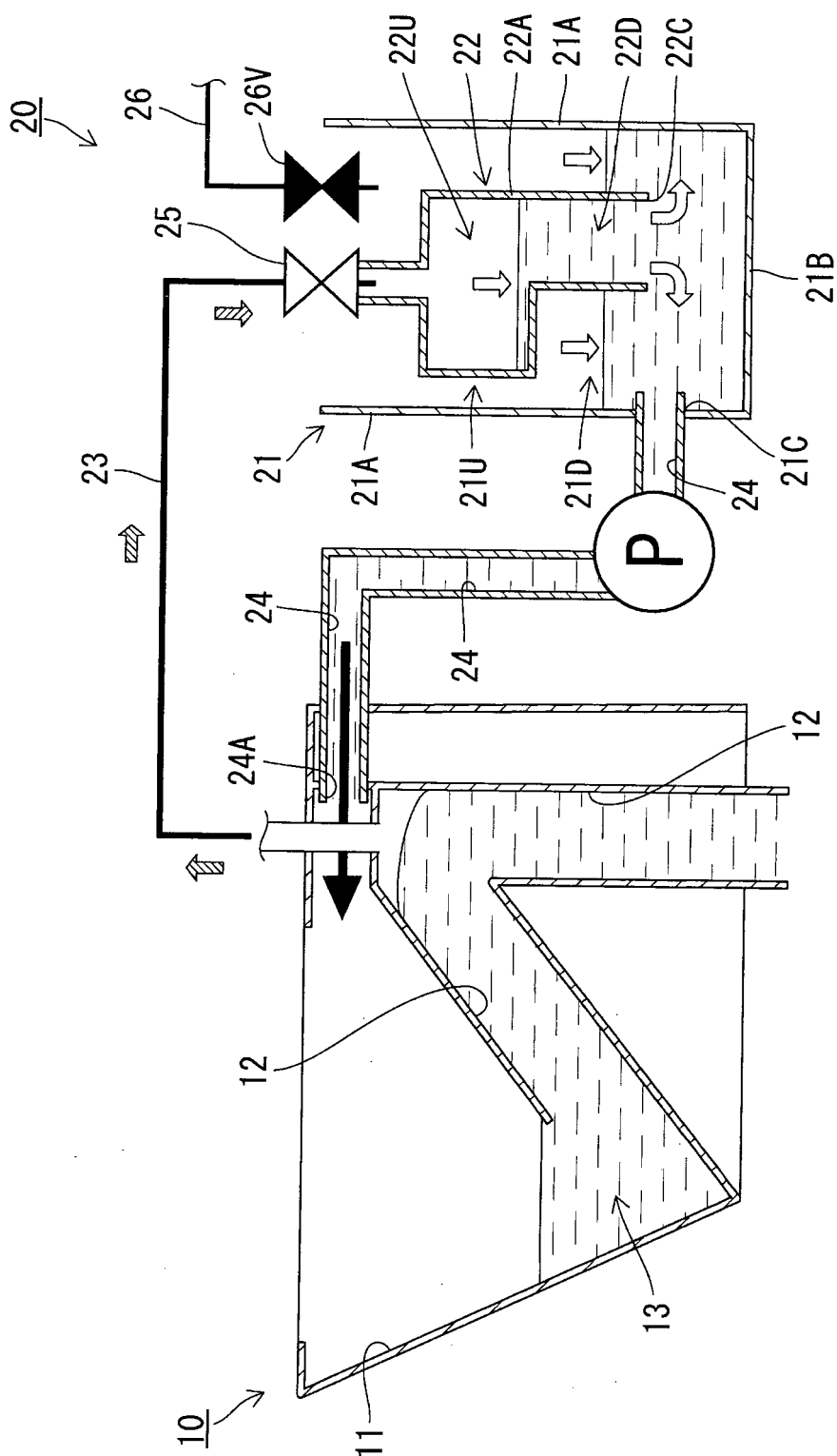


Fig. 6

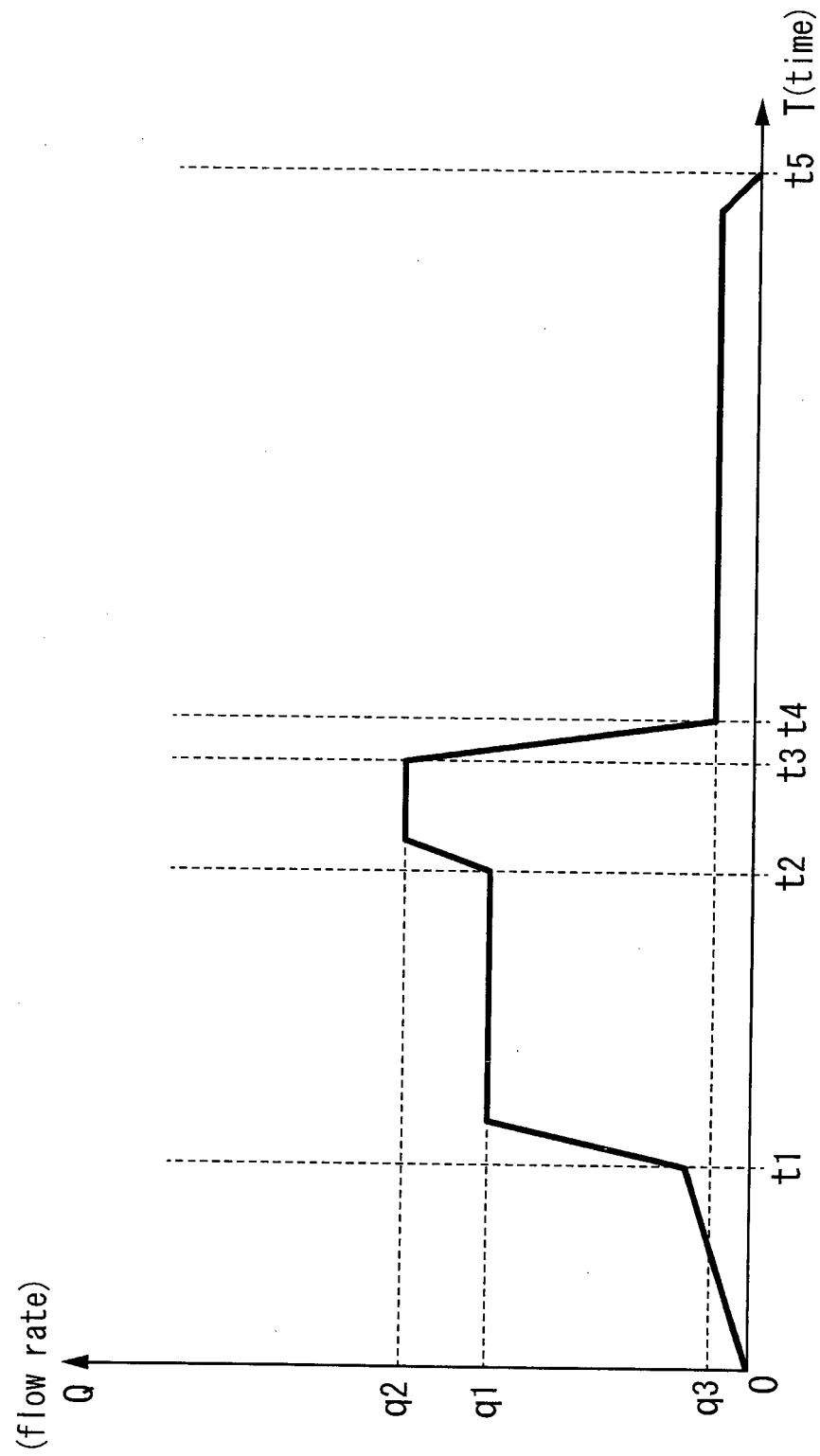


Fig. 7

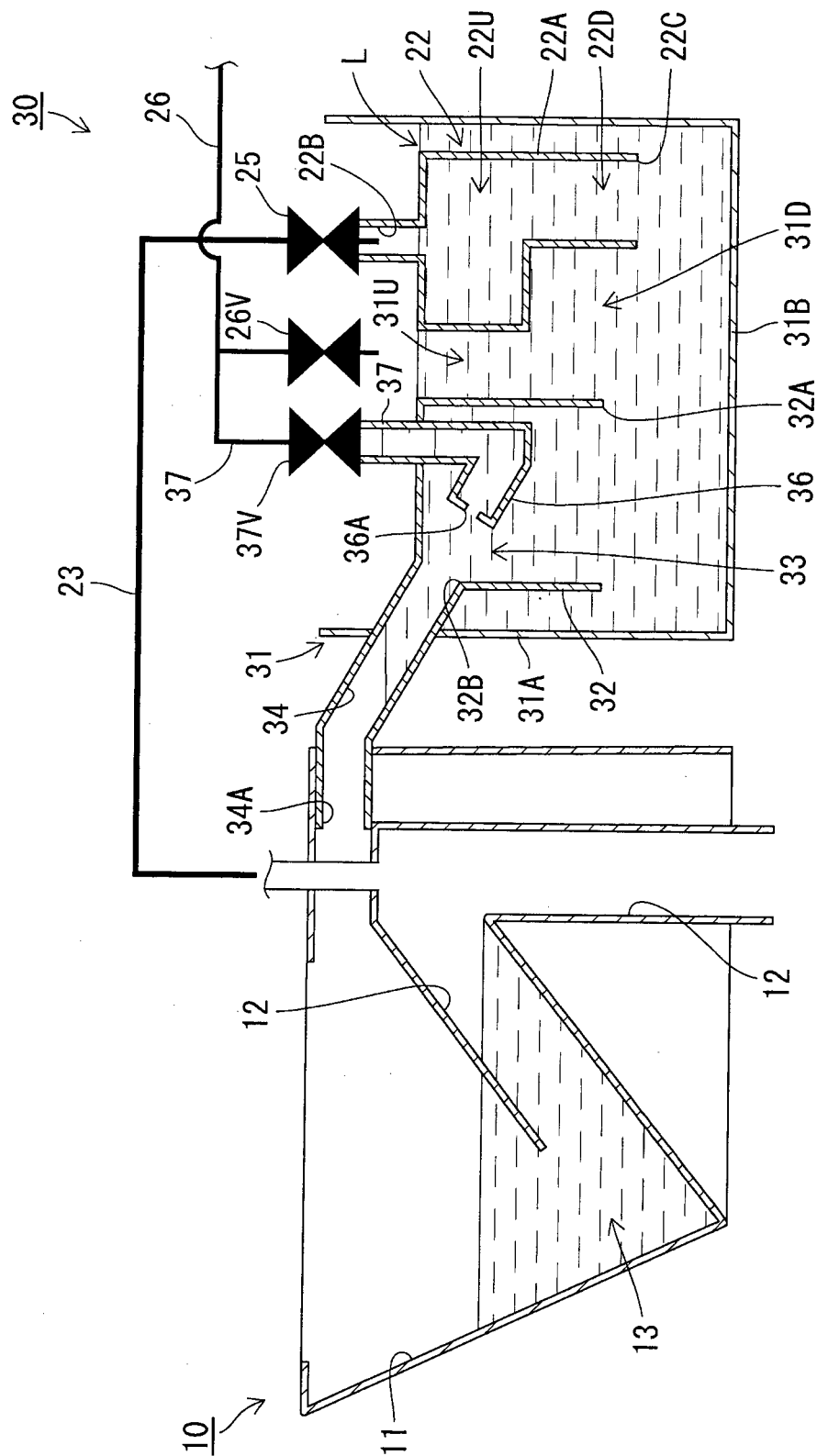


Fig. 8

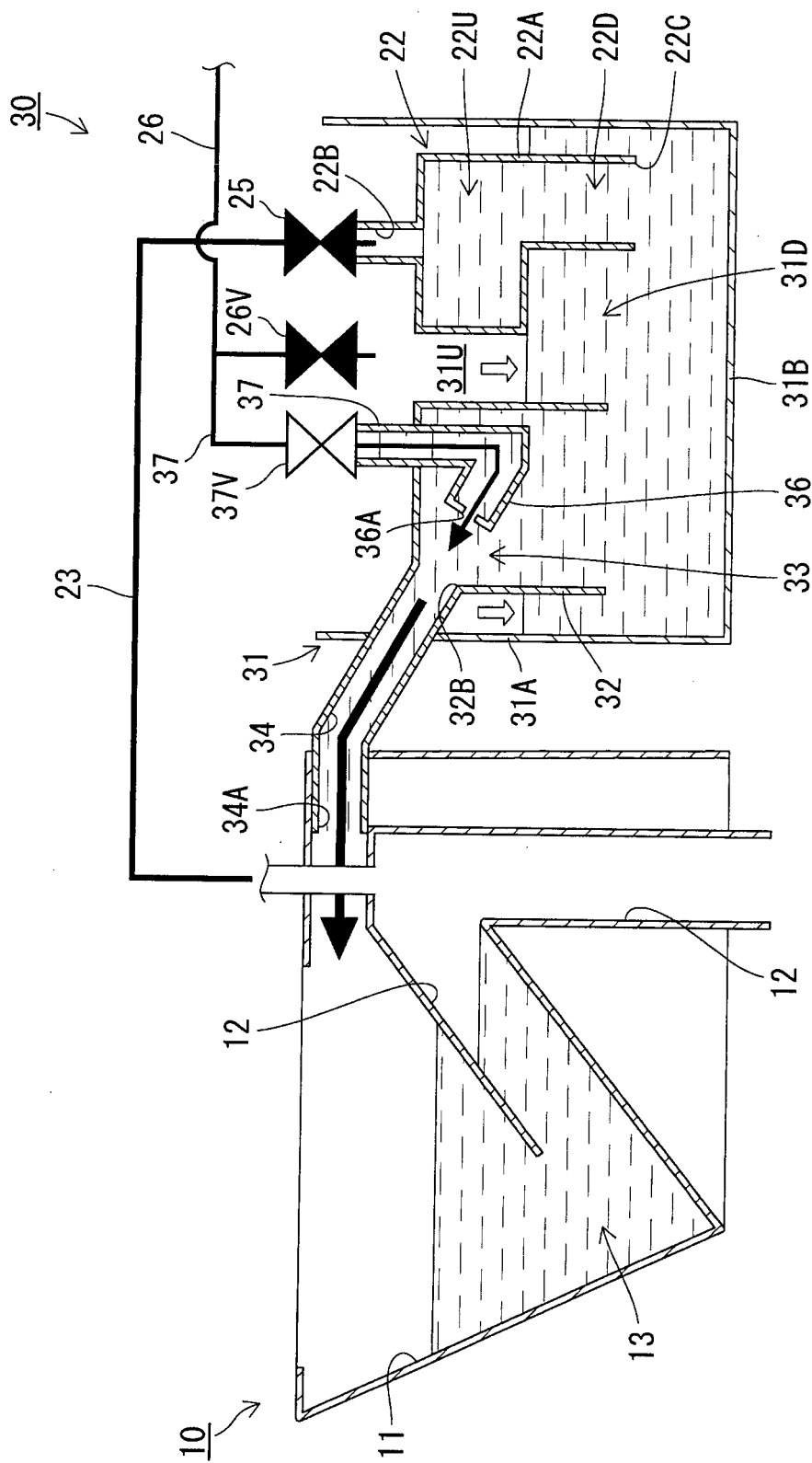


Fig. 9

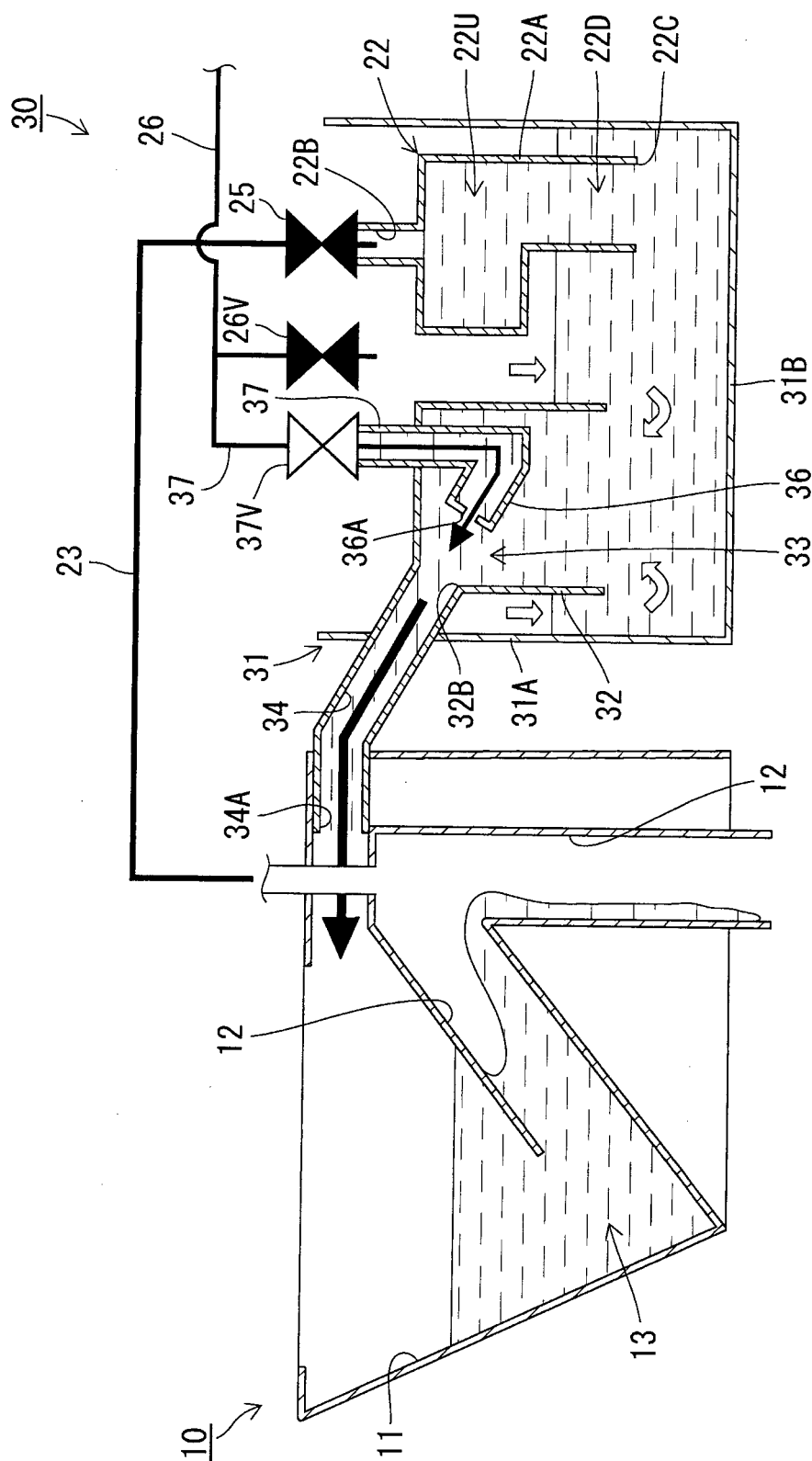


Fig.10

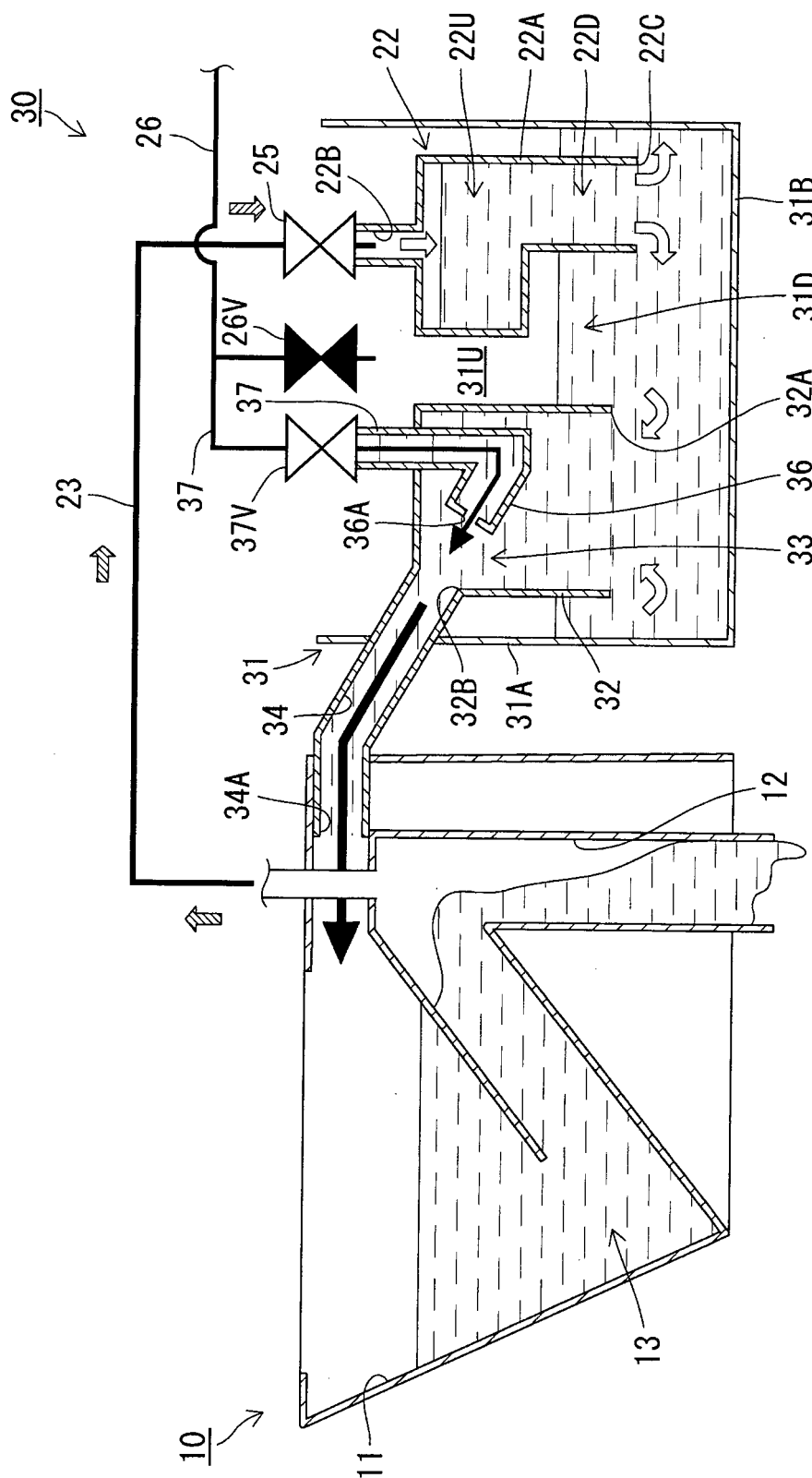


Fig.11

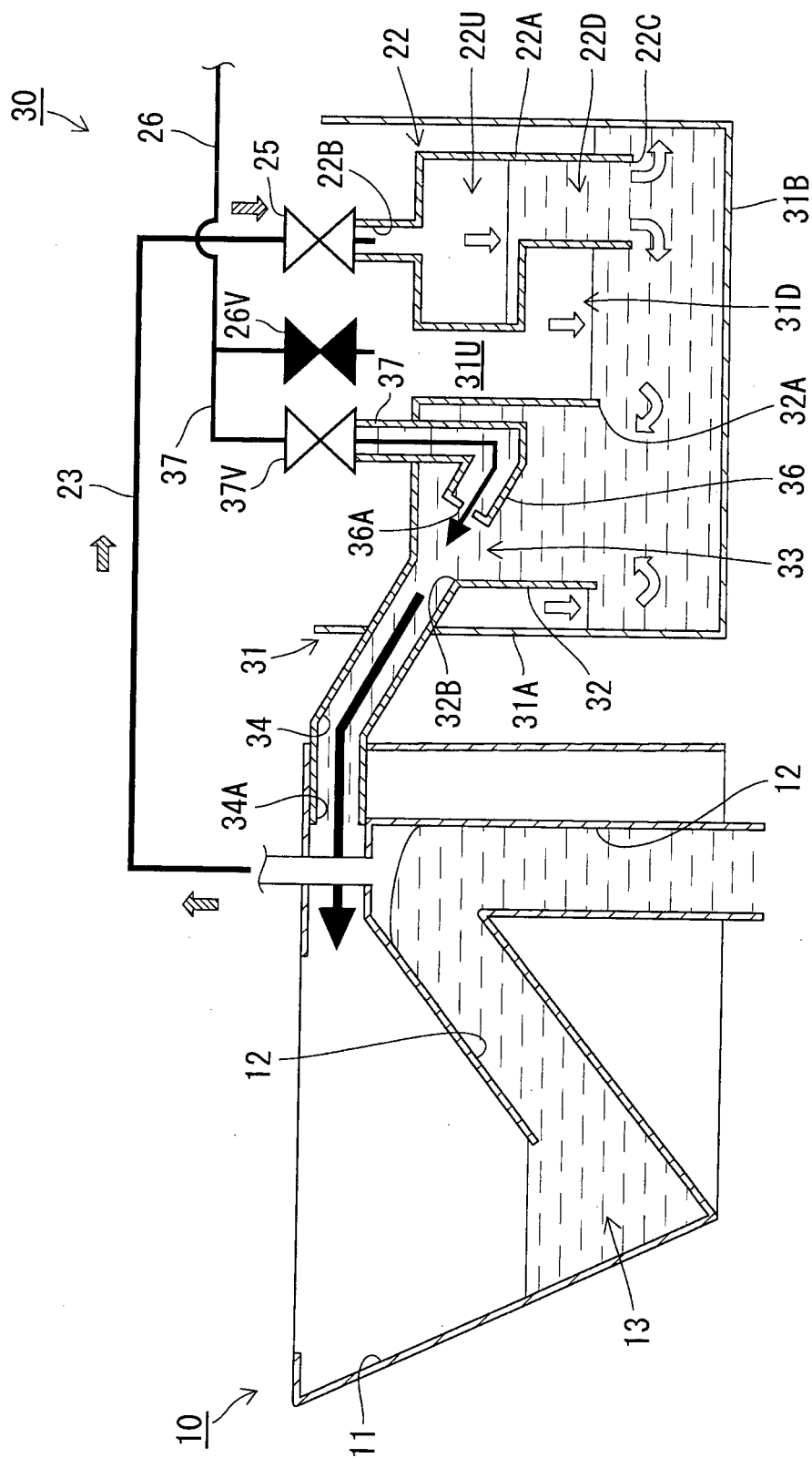


Fig.12

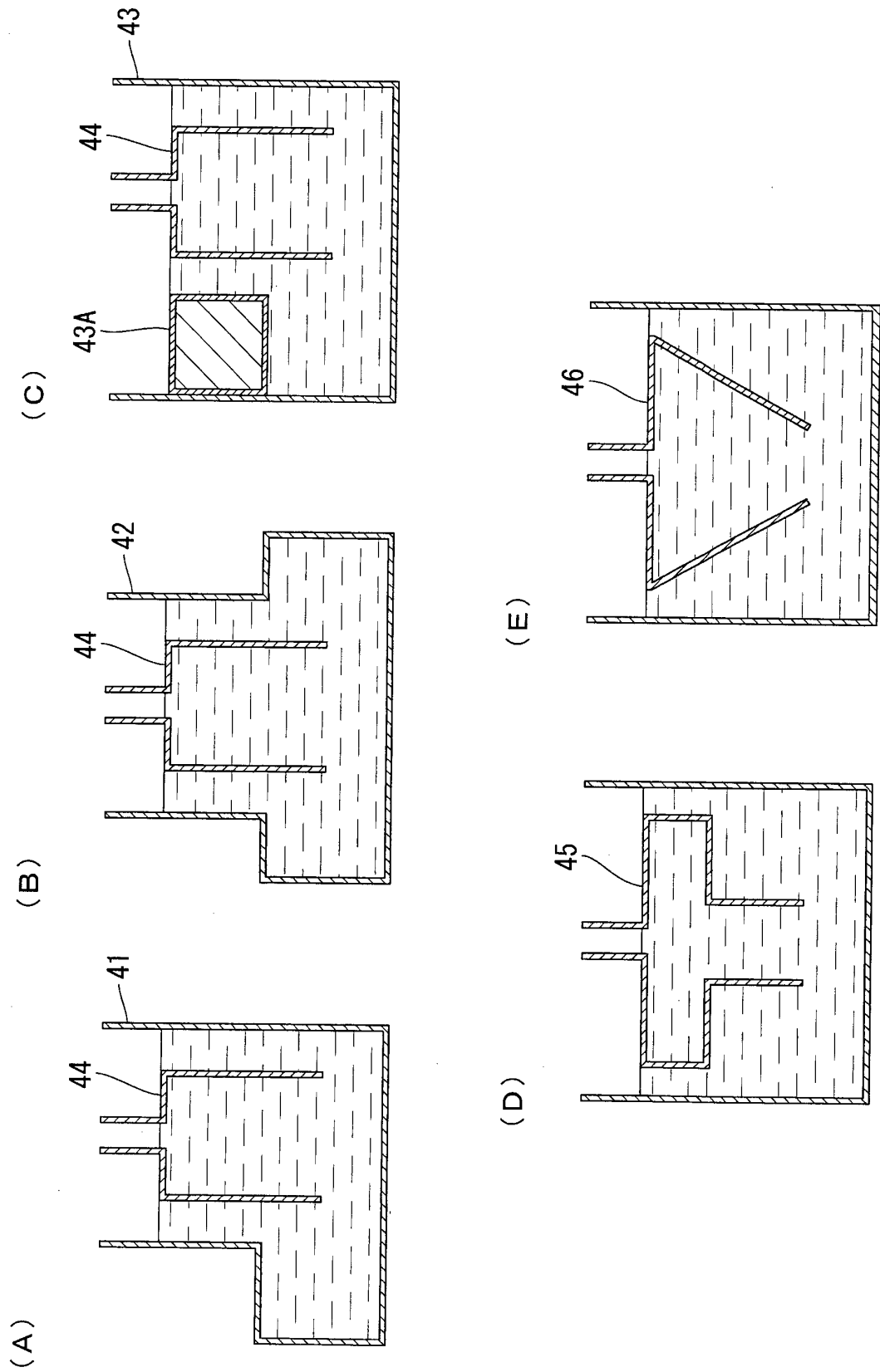


Fig.13

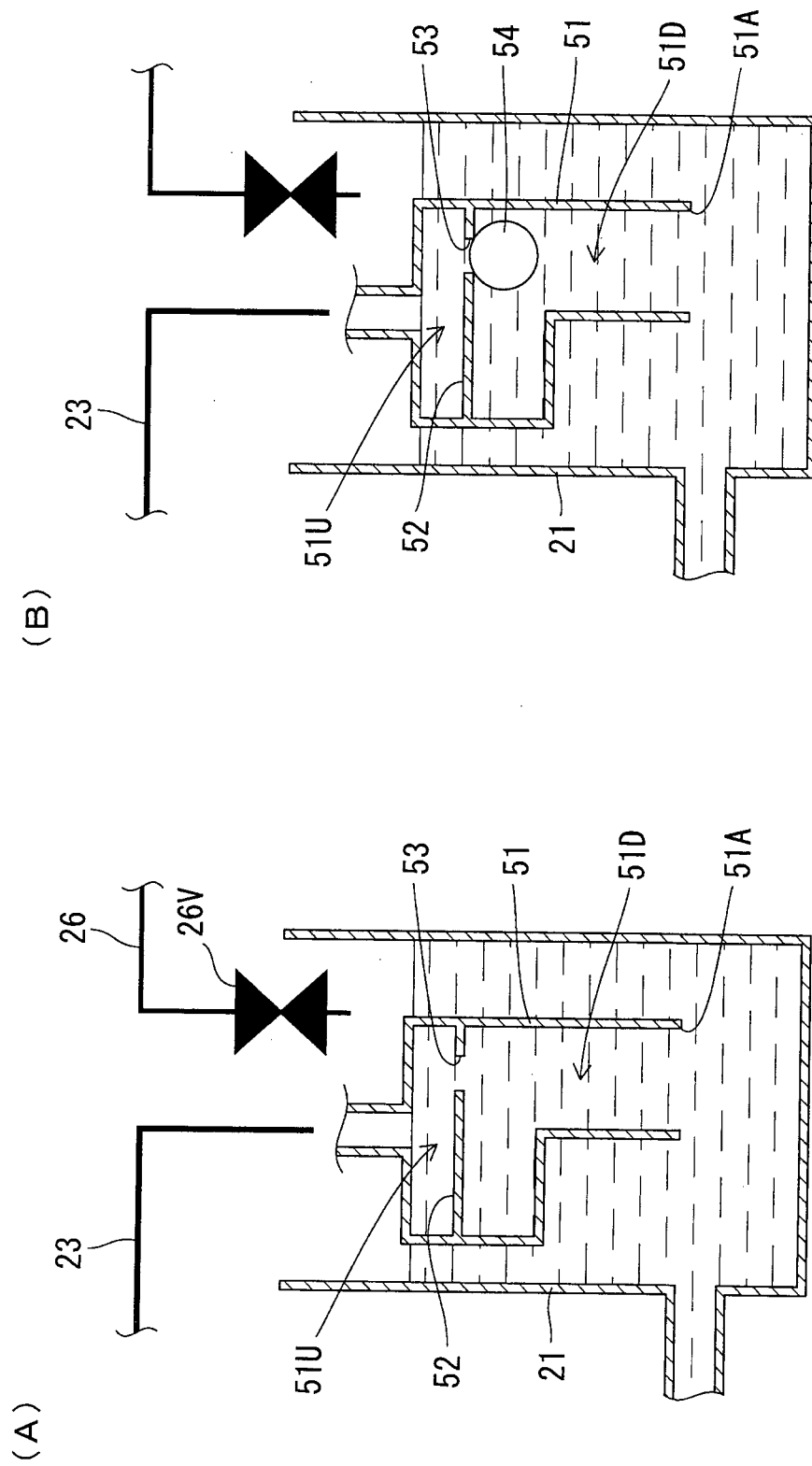


Fig.14

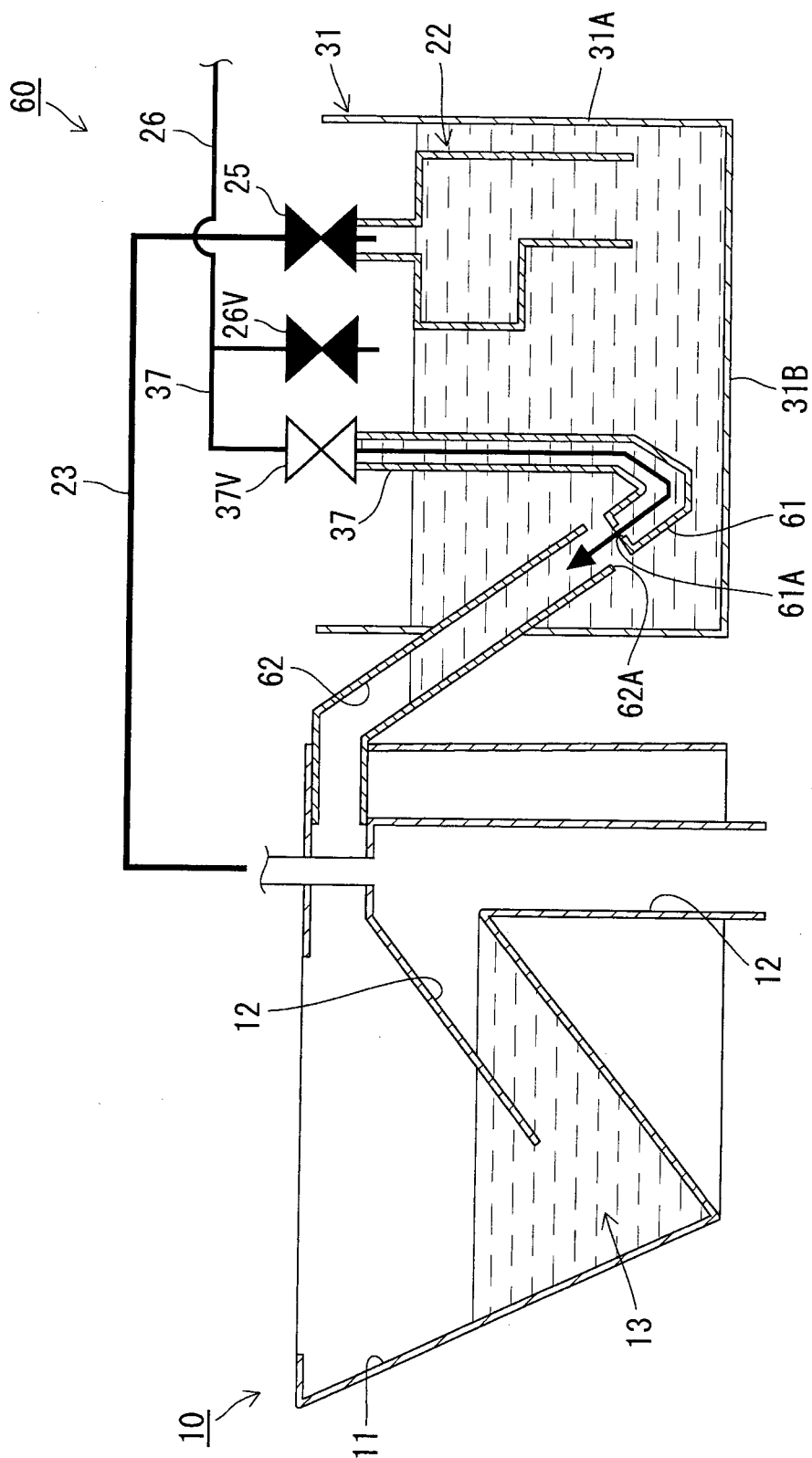


Fig.15

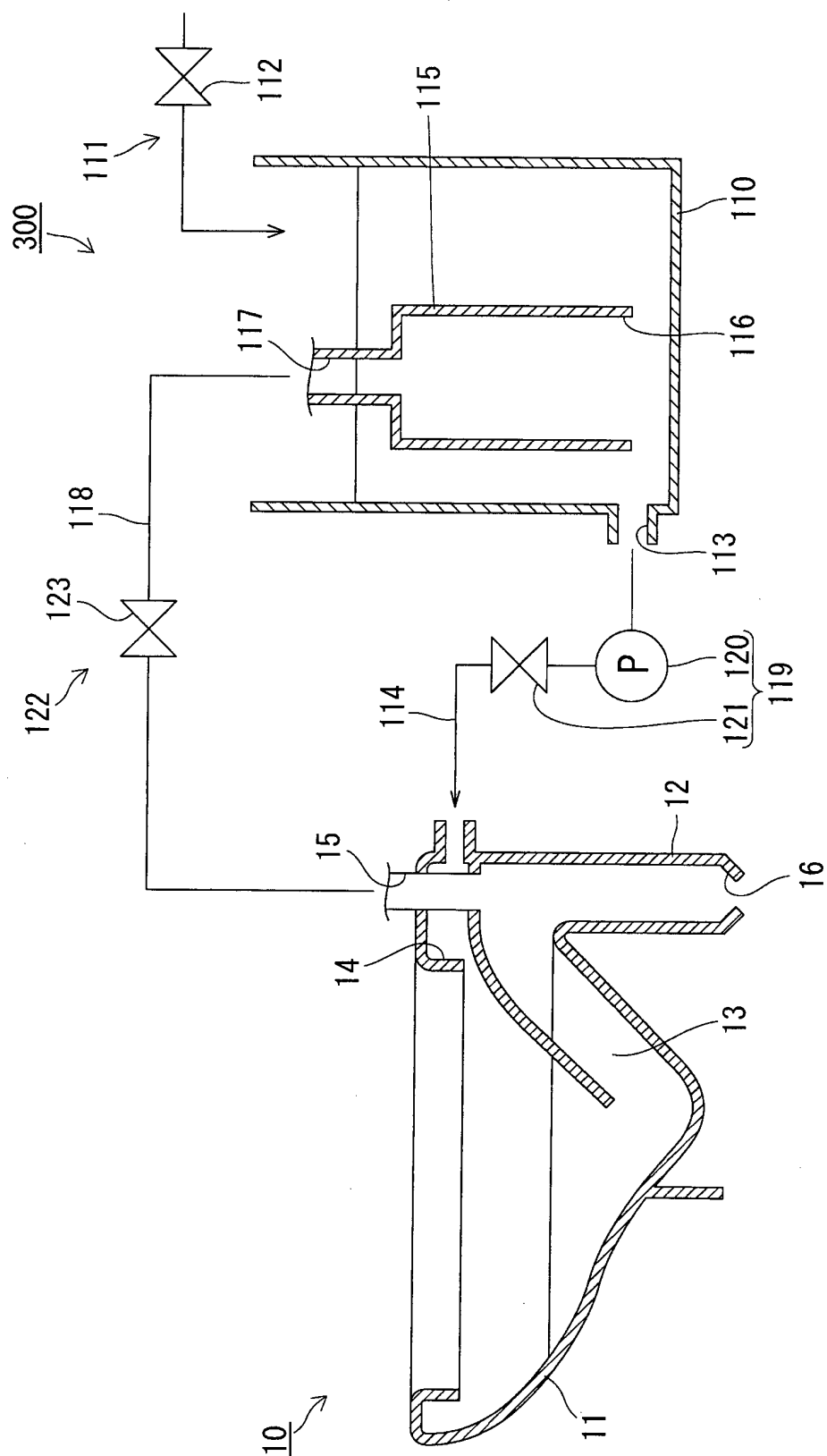


Fig.16

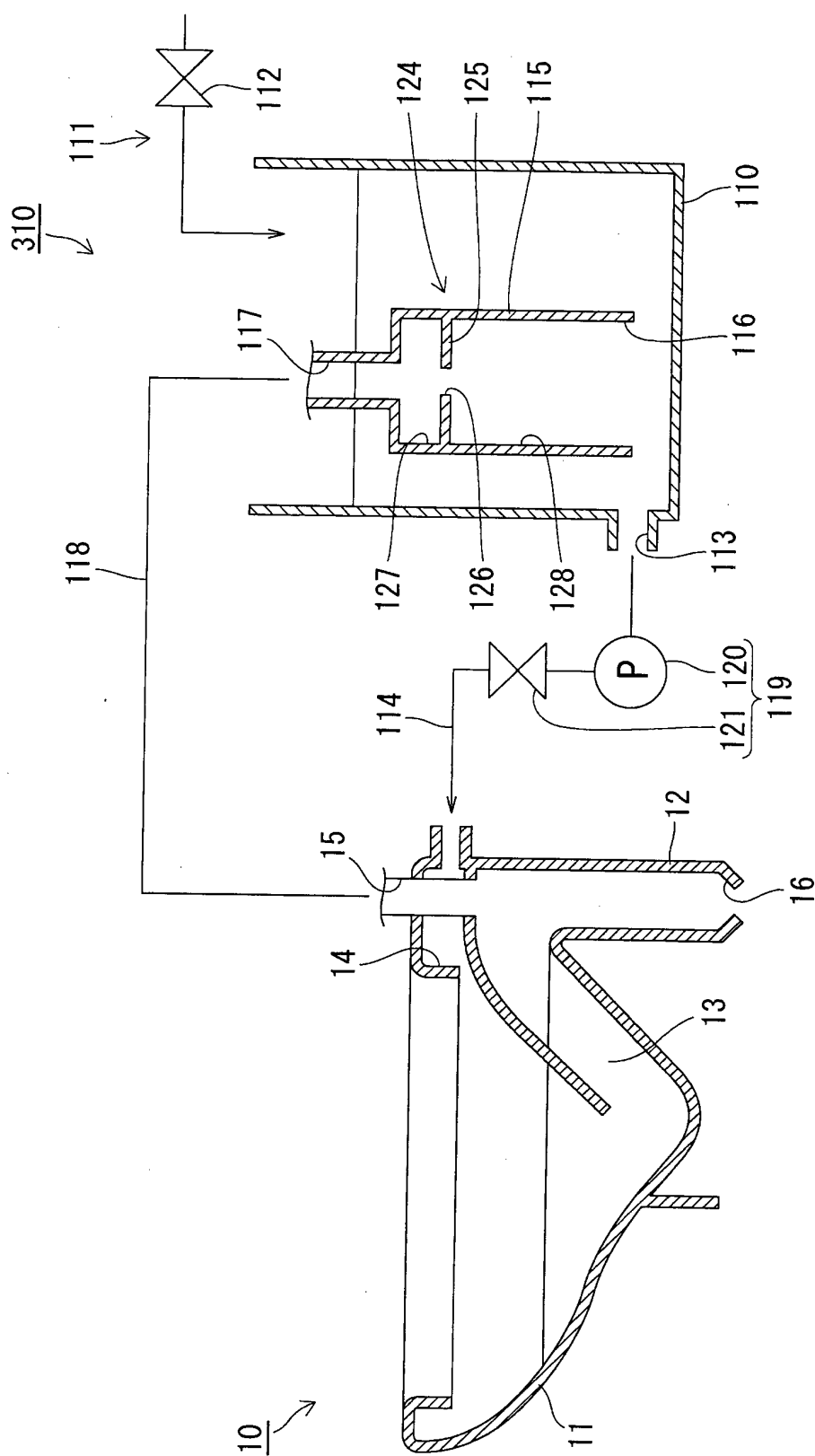


Fig.17

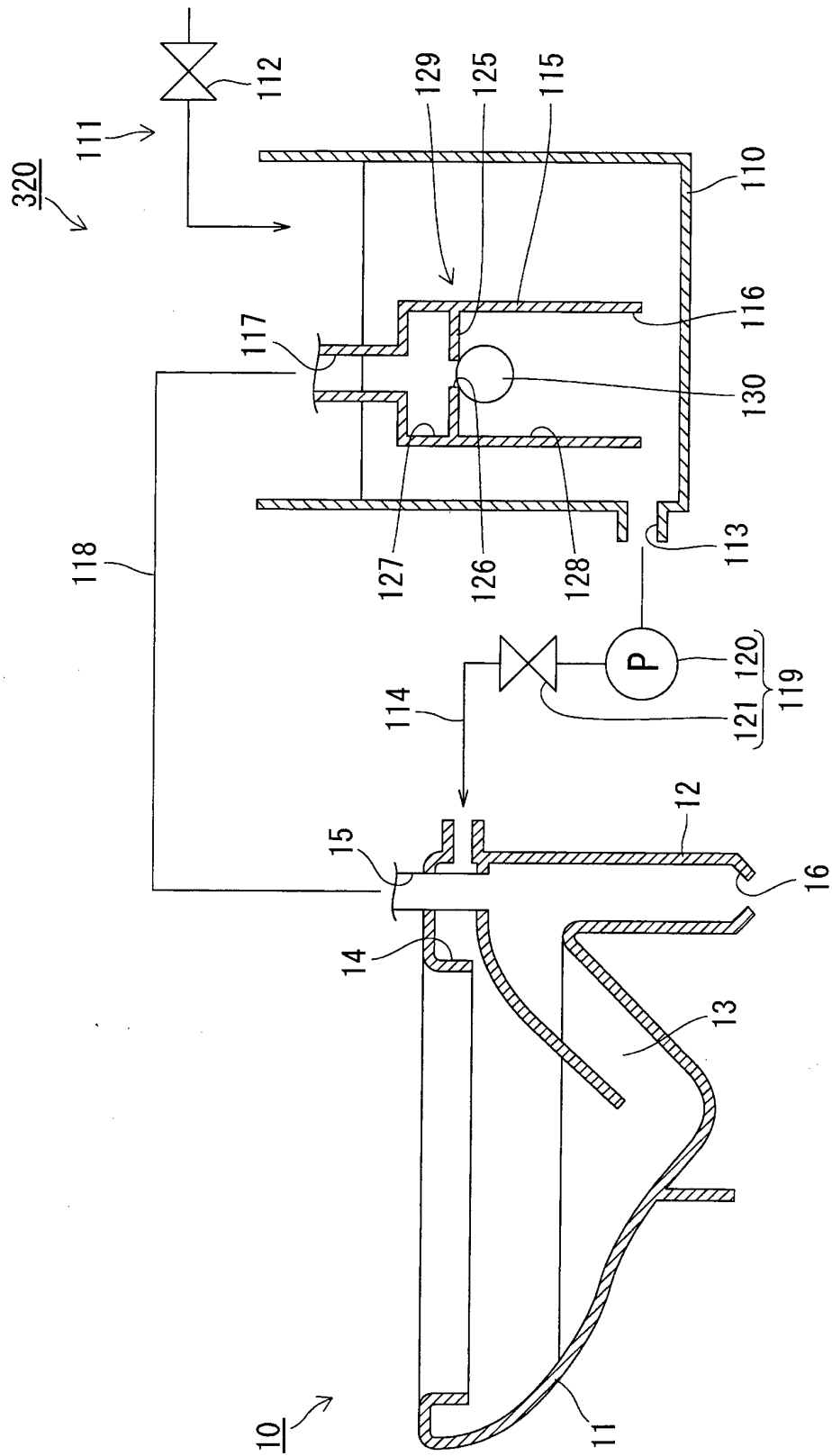


Fig.18

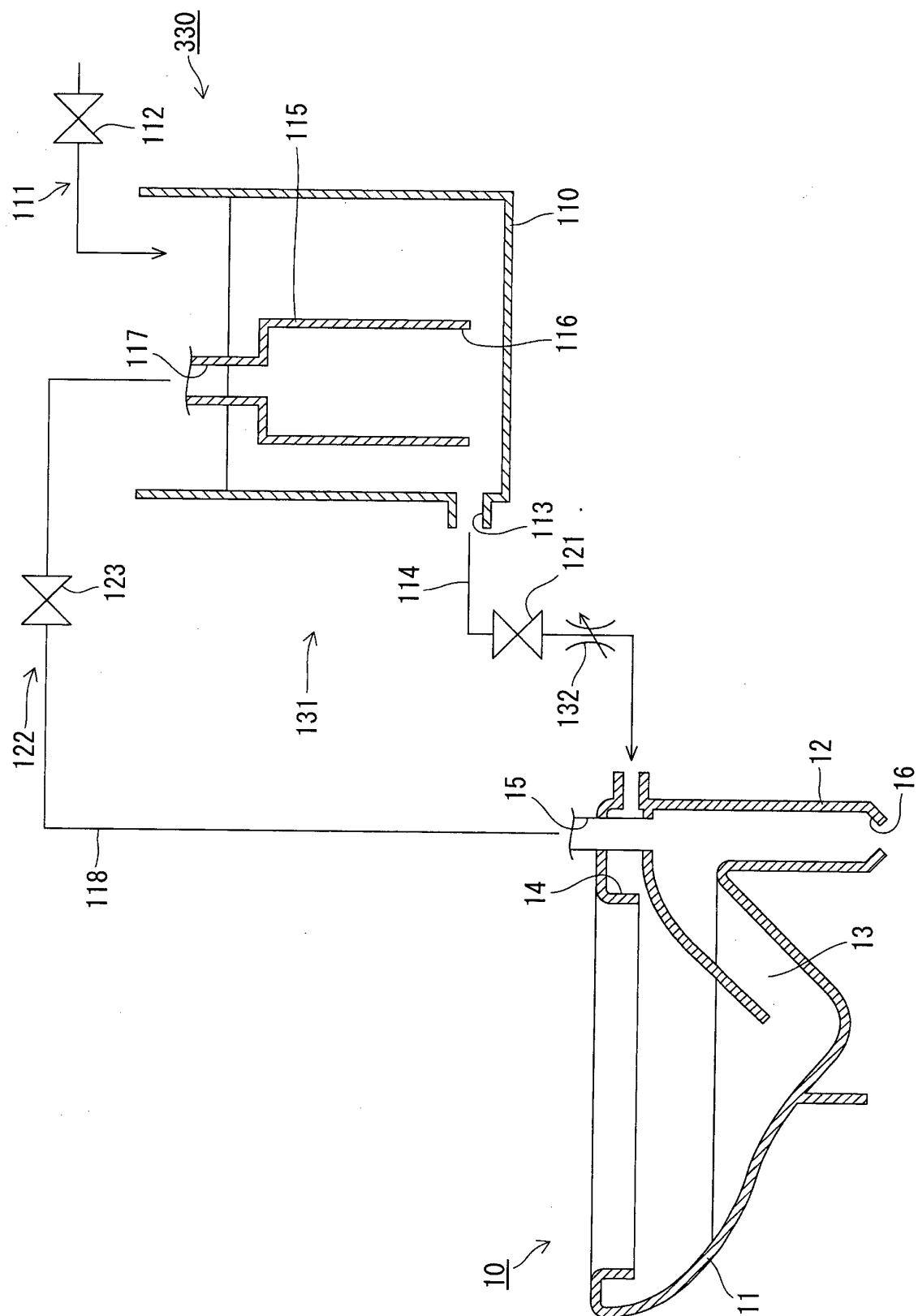


Fig.19

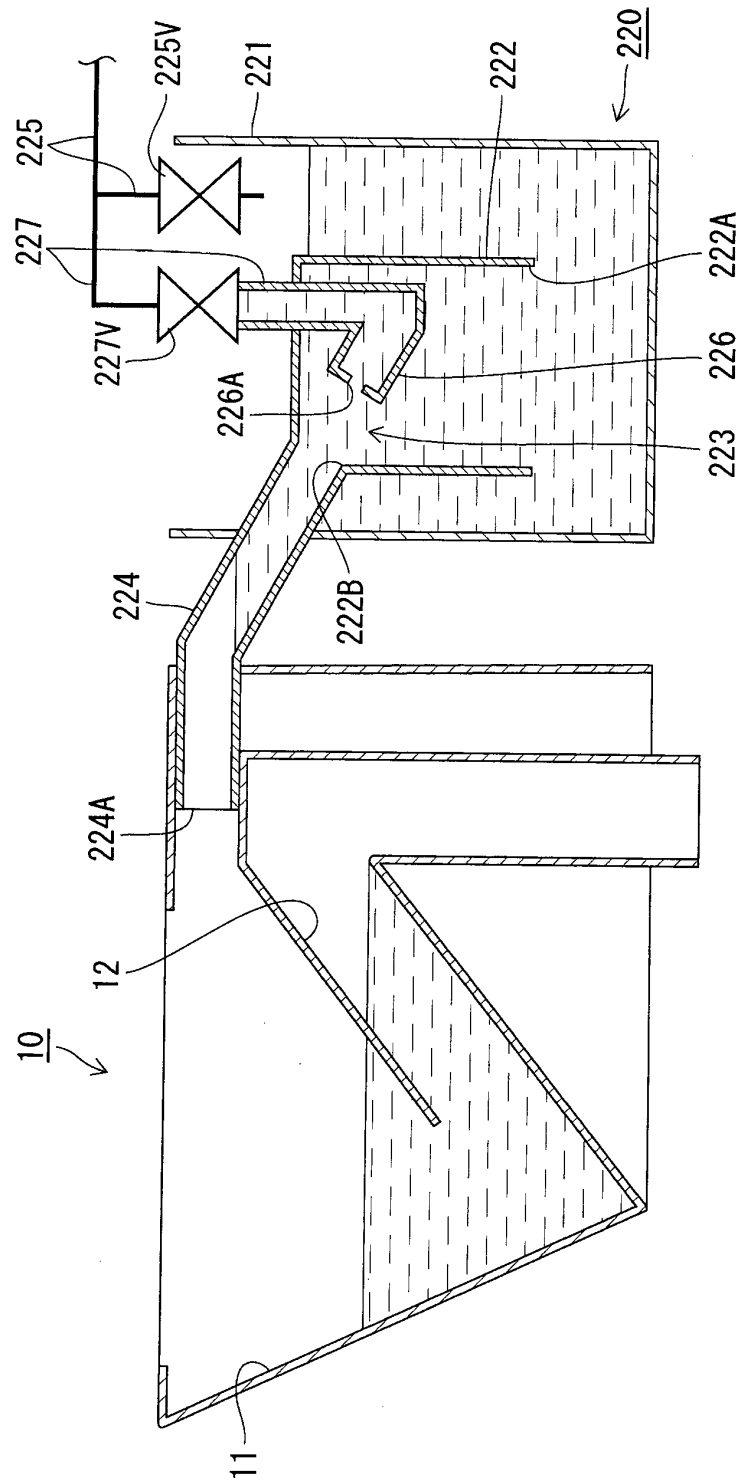


Fig.20

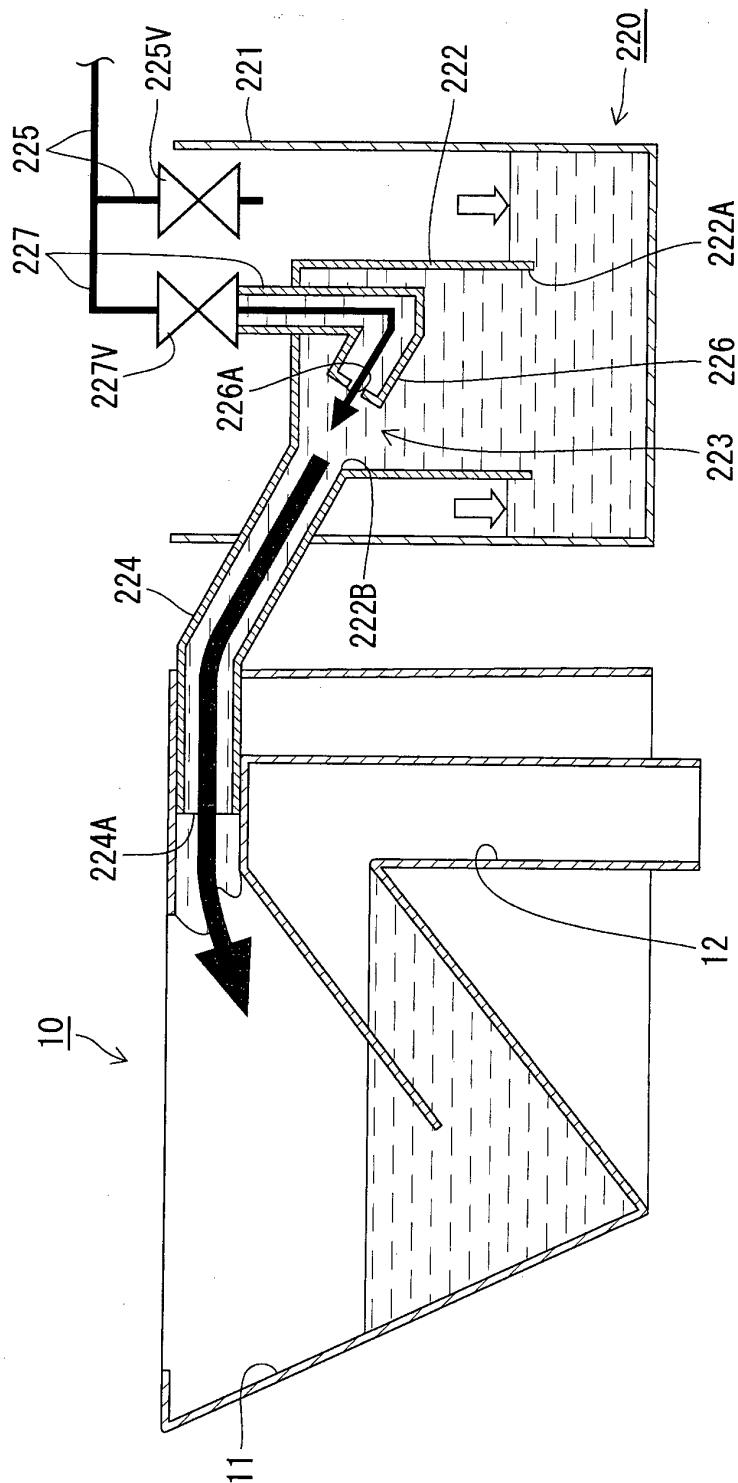


Fig.21

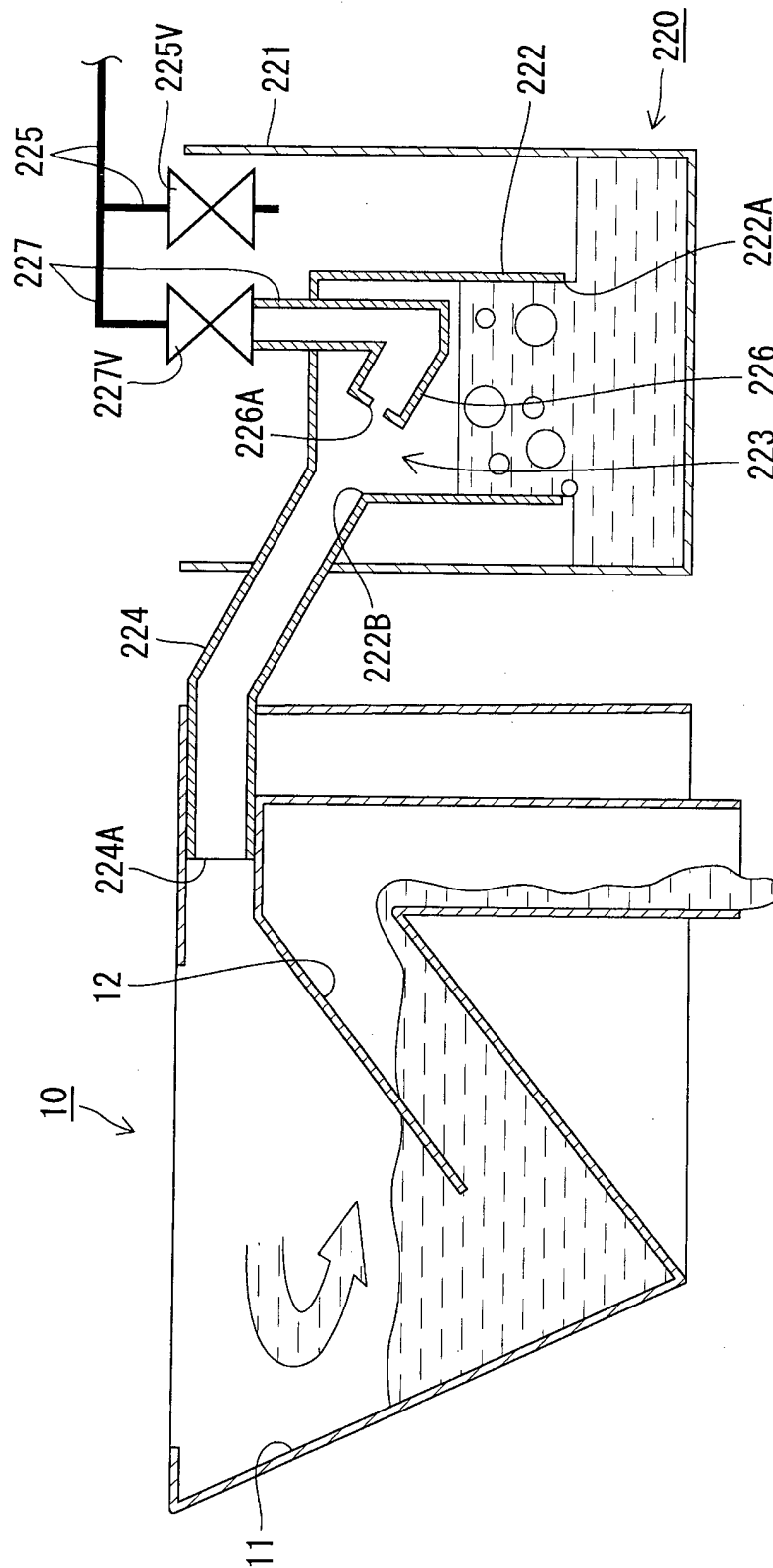


Fig.22

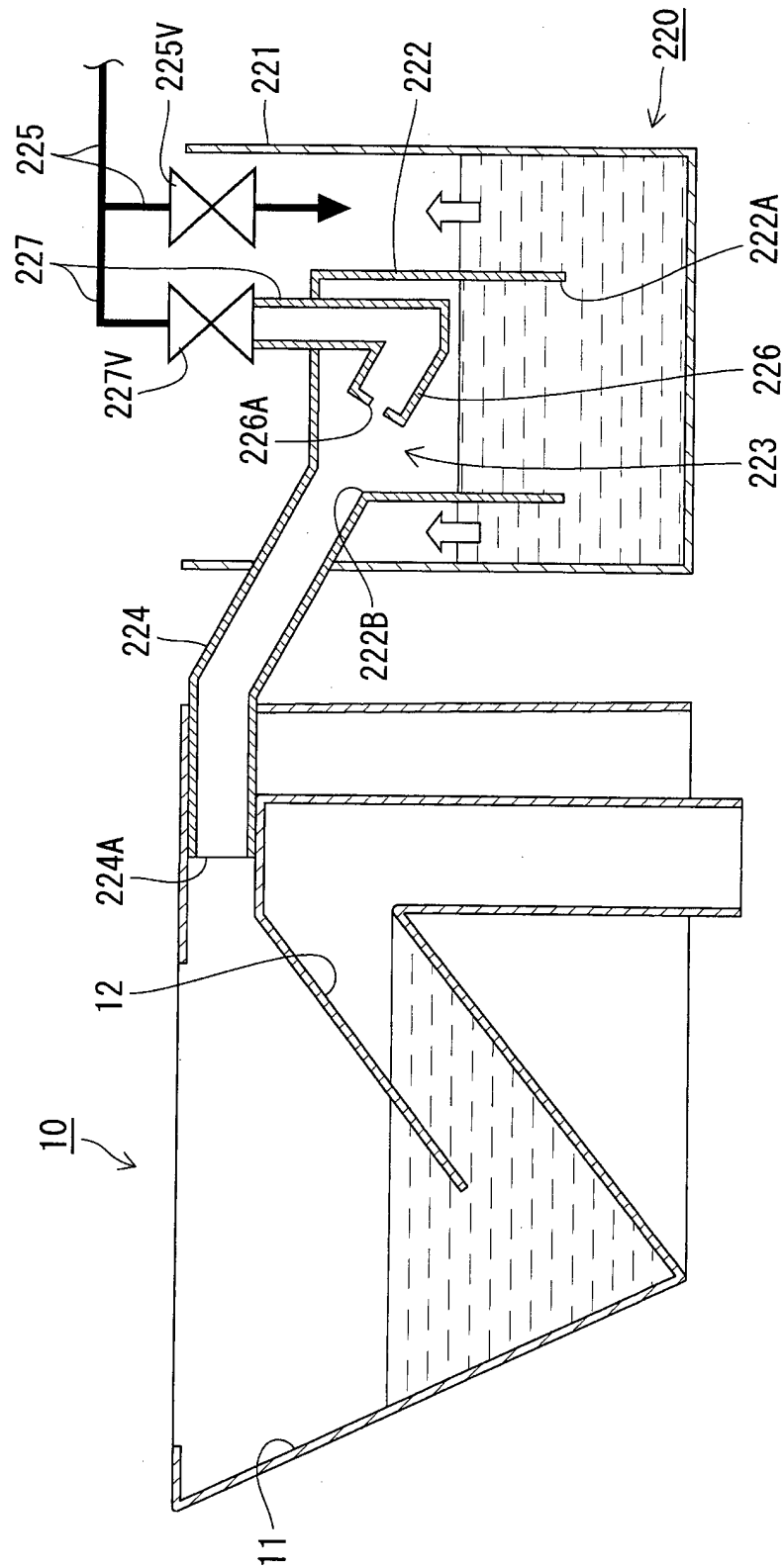


Fig.23

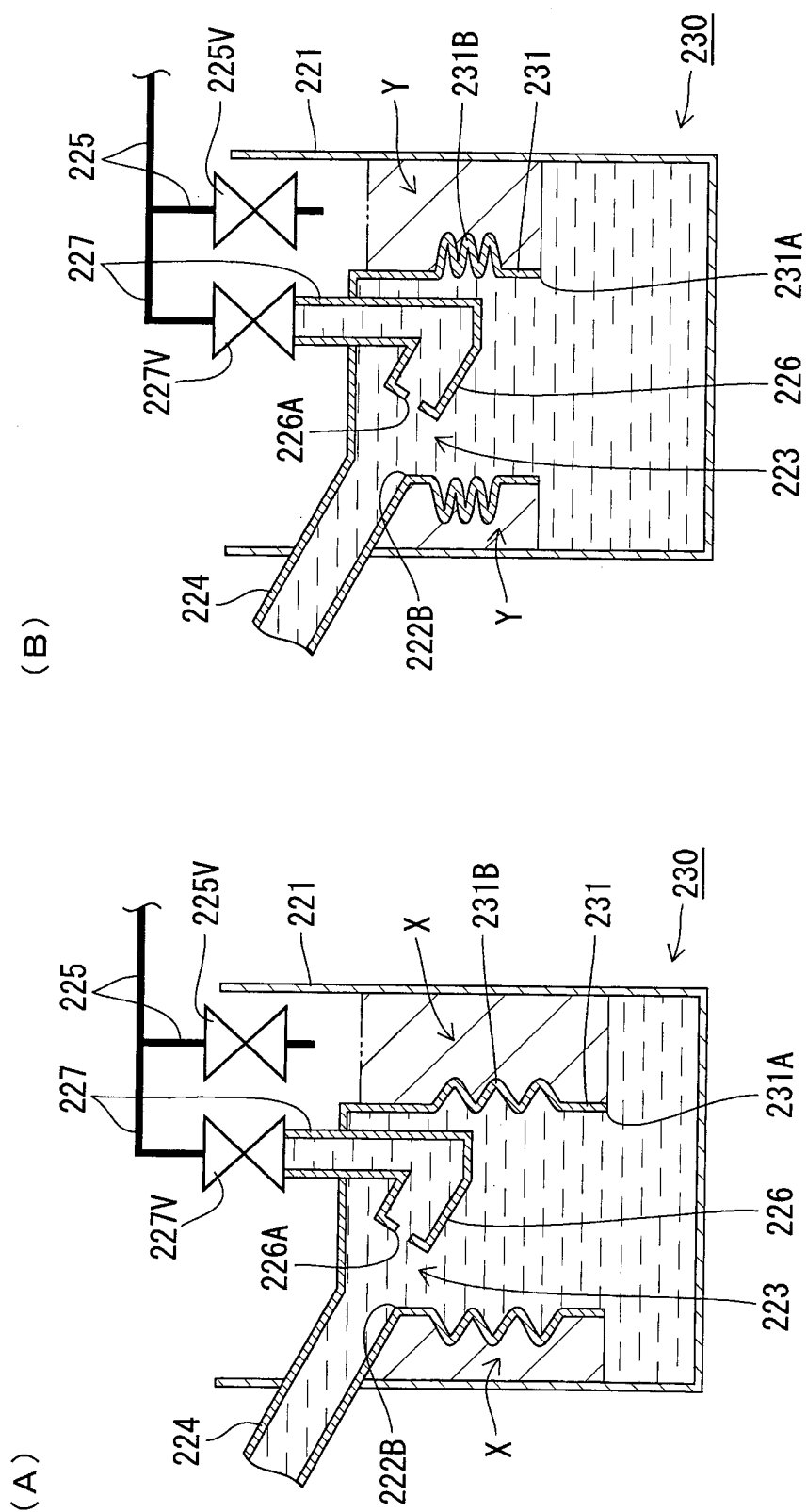


Fig.24

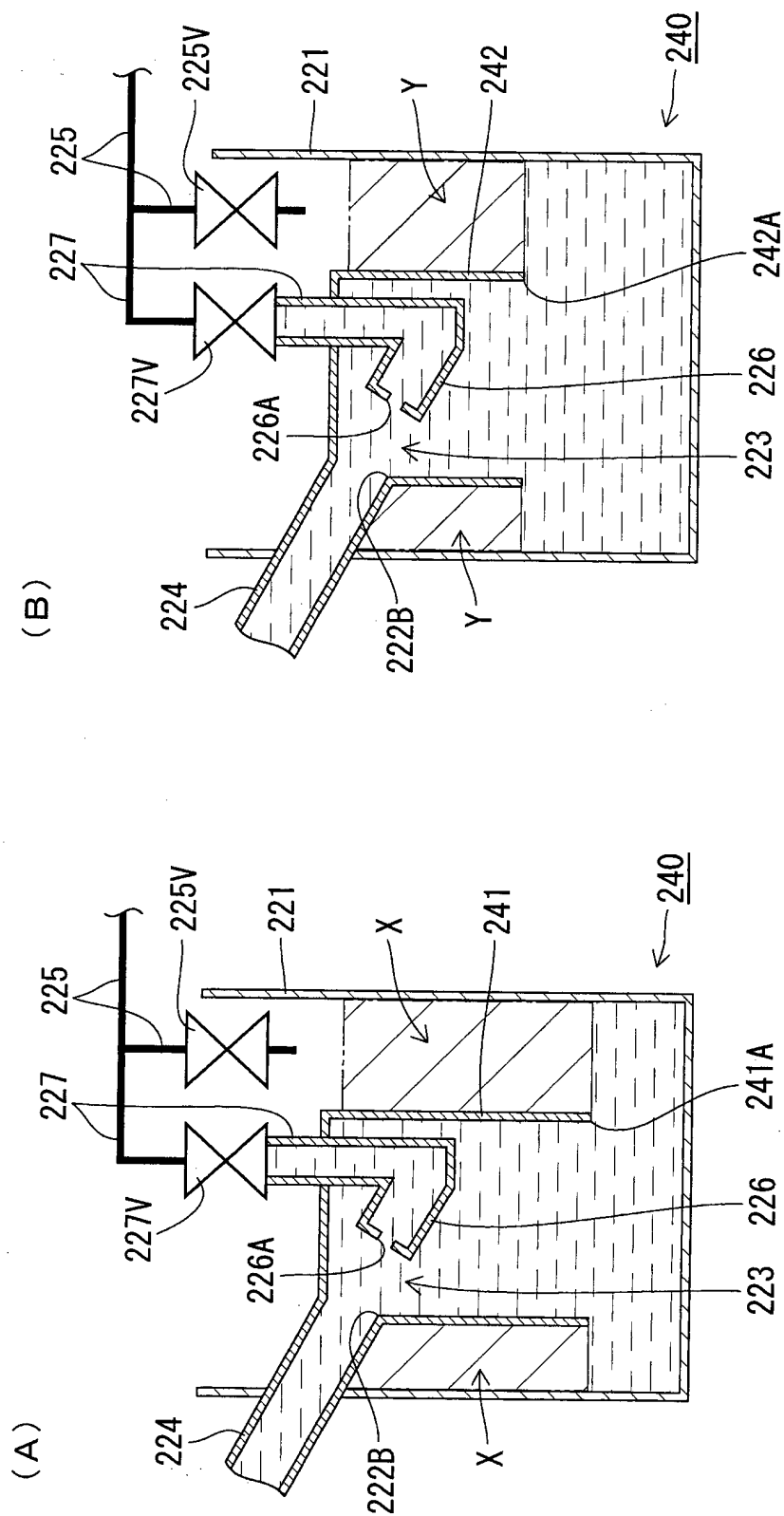
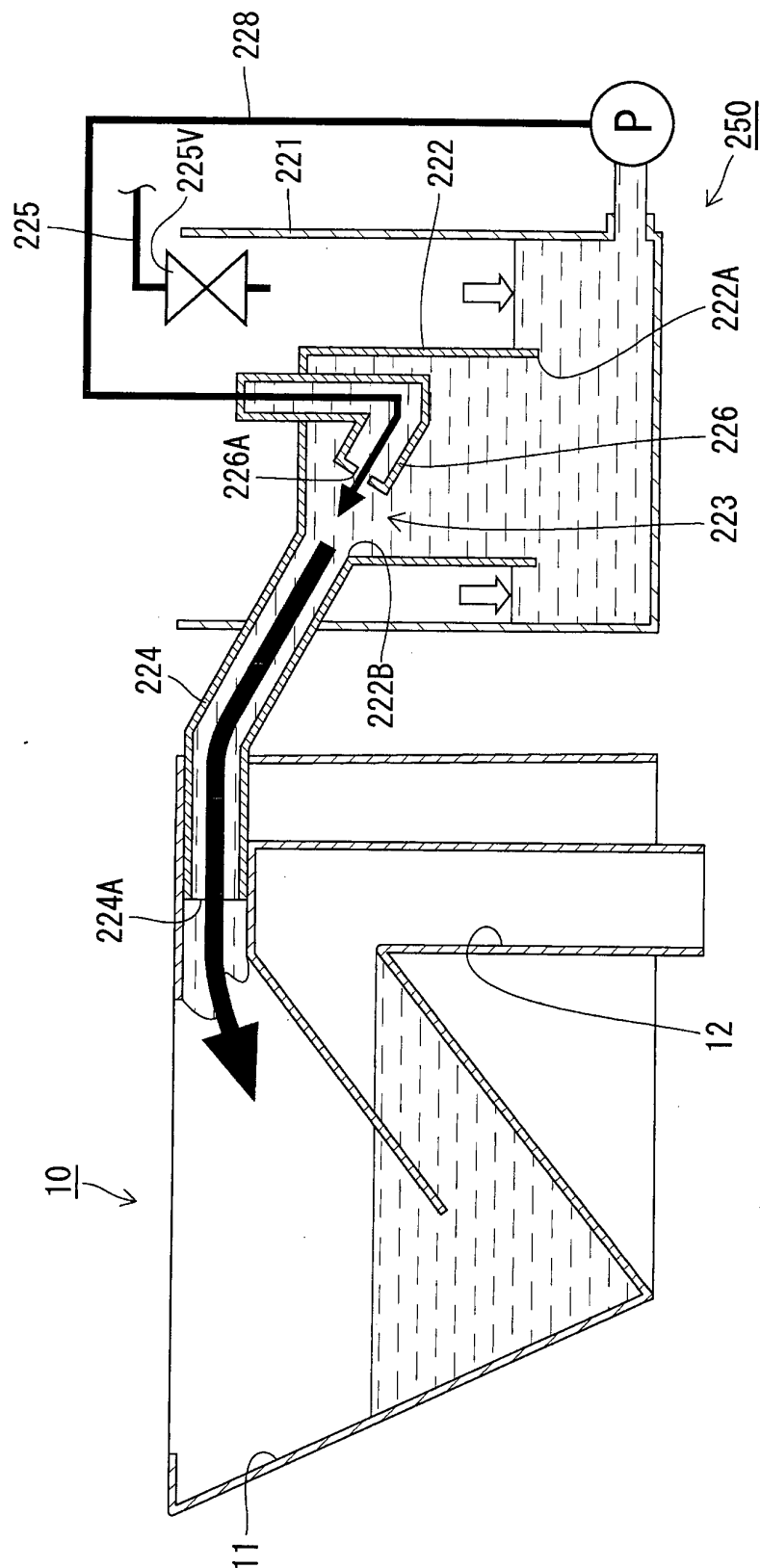


Fig.25



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2012/051631

A. CLASSIFICATION OF SUBJECT MATTER

E03D11/02 (2006.01) i, E03D11/18 (2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

E03D11/02, E03D11/18

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2012
Kokai Jitsuyo Shinan Koho	1971-2012	Toroku Jitsuyo Shinan Koho	1994-2012

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	JP 2009-275364 A (Inax Corp.), 26 November 2009 (26.11.2009), paragraphs [0036] to [0048]; fig. 6 to 8 & WO 2009/136549 A1	3, 6 4, 7-12 1, 2, 5, 13-18
Y A	JP 7-42217 A (Toto Ltd.), 10 February 1995 (10.02.1995), paragraphs [0133] to [0137]; fig. 21 (Family: none)	4 1-3, 5-18
Y A	JP 56-93935 A (Toto Ltd.), 29 July 1981 (29.07.1981), page 2, upper right column, lines 11 to 20; fig. 1 (Family: none)	7-12 1-6, 13-18



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search
06 March, 2012 (06.03.12)Date of mailing of the international search report
13 March, 2012 (13.03.12)Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

Facsimile No.

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2012/051631

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2004-156382 A (Toto Ltd.), 03 June 2004 (03.06.2004), paragraph [0025]; fig. 2 (Family: none)	1-18

Form PCT/ISA/210 (continuation of second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2012/051631

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

The inventions of claims 1, 3, 7 and 13 have a common technical feature which is relevant to "toilet bowl washing device which supplies washing water to the main body of a toilet bowl and is equipped with a first tank into which Washing water is flown and which stores flown-in washing water". However, said technical feature is not considered to be a special technical feature, since the technical feature does not make a contribution over the prior art in the light of the contents disclosed in the document 1 (JP 2009-275364 A (Inax Corp.), 26 November 2009 (26.11.2009), paragraphs [0036]-[0048], fig. 6-8). Further, there is no other same or corresponding special technical feature among these inventions.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☒ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet (2)) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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

Patent documents cited in the description

- JP H0557080 U [0010]
- JP 2004156382 A [0010]