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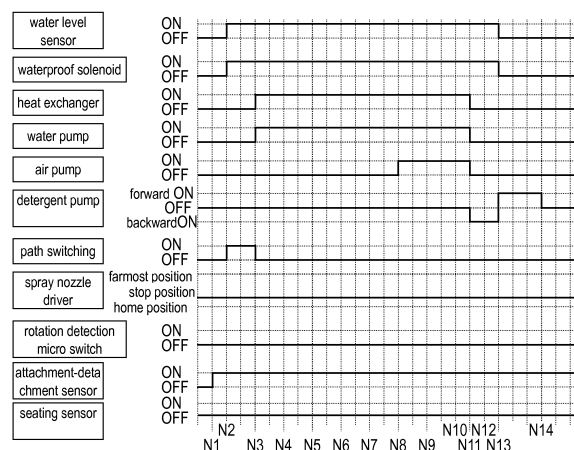
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(54) **SANITARY WASHING DEVICE**

(57) A sanitary washing apparatus includes the following: a body to be placed on a toilet bowl; a foam generator (560) for generating washing foam; a spray nozzle (550) for spraying at least one of washing water and the washing foam onto the inner surface of the toilet bowl; a spray nozzle driver (550a) for rotating the orientation of the outlet orifice of the spray nozzle (550); and a control unit (130) for controlling at least the operation of the spray

nozzle driver (550a). The control unit (130) has the following modes: a rotary foam-spraying mode in which the washing foam is sprayed into the toilet bowl while the orientation of the outlet orifice of the spray nozzle (550) is being rotated; and a rinse mode in which the washing water passes through the foam generator and then is sprayed from the spray nozzle.

FIG. 46



Description

TECHNICAL FIELD

[0001] The present disclosure relates to a sanitary washing apparatus for washing human privates.

BACKGROUND ART

[0002] Some well-known sanitary washing apparatuses of this type operate as follows. The cleaning nozzle is advanced from the stored position either to the anal cleaning position or to the bidet cleaning position, and then washing water is jetted from the outlet orifice of the nozzle to wash human privates.

[0003] Other types of sanitary washing apparatuses include, in addition to the cleaning nozzle for washing human privates, a spray nozzle for spraying foam onto the inner surface of the toilet bowl before defecation, thereby coating the surface with foam film (e.g., Patent Literature 1).

[0004] In these sanitary washing apparatuses known in the art, the spray nozzle sprays foam onto the inner surface of the toilet bowl automatically when the detector detects that the user is seated. The sprayed foam is formed into foam film and coats the toilet bowl before defecation, thereby preventing stain adsorption on the bowl inner surface.

[0005] However, the prevention of stain is not enough partly because the sprayed foam does not thoroughly cover the inner surface of the toilet bowl.

Citation List

Patent Literature

[0006] PTL 1: Japanese Unexamined Patent Application Publication No. 2000-104319

SUMMARY

[0007] An object of the present disclosure is to provide a sanitary washing apparatus that can form foam film onto the inner surface of a toilet bowl from the front to the back of the surface, thereby preventing stain adsorption.

[0008] The sanitary washing apparatus includes the following components: a body to be placed on a toilet bowl; a foam generator for generating washing foam; a spray nozzle for spraying at least one of washing water and the washing foam onto the inner surface of the bowl; a spray nozzle driver for rotating the orientation of the outlet orifice of the spray nozzle; and a control unit for controlling at least the operation of the spray nozzle driver. The control unit has the following modes: a rotary foam-spraying mode in which the washing foam is sprayed into the bowl while the orientation of the outlet orifice of the spray nozzle is being rotated; and a rinse

mode in which the washing water passes through the foam generator and the is sprayed from the spray nozzle.

[0009] With this structure, when the spray nozzle sprays foam (hereinafter, washing foam) onto the toilet bowl, the orientation of the outlet orifice of the nozzle is rotated in such a manner that the washing foam can reach every part inside the bowl. The rinse mode makes the washing water pass through the foam generator and is sprayed from the spray nozzle. In this mode, the washing water removes residual detergent from the foam generator and the spray nozzle so as to prevent their clogging, thereby achieving a stable spray of the washing foam.

[0010] The sanitary washing apparatus according to the present disclosure can form foam film onto the bowl inner surface from the front to the back of the surface so as to prevent stain adsorption. Furthermore, the rinsing process can achieve a stable spray of the washing foam.

BRIEF DESCRIPTION OF DRAWINGS

[0011]

FIG. 1 is an external perspective view of the sanitary washing apparatus according to a first exemplary embodiment of the present disclosure when the apparatus is installed on a toilet bowl.

FIG. 2 is a perspective view of the sanitary washing apparatus according to the first exemplary embodiment of the present disclosure when the front-body case is detached from the body of the apparatus.

FIG. 3 is a perspective view of the sanitary washing apparatus according to the first exemplary embodiment of the present disclosure when the front-body case and the control unit are detached from the body of the apparatus.

FIG. 4 is a perspective view of the top face of the operation unit in the sanitary washing apparatus according to the first exemplary embodiment of the present disclosure.

FIG. 5 is an external perspective view of remote controller 400 in the first exemplary embodiment of the present disclosure.

FIG. 6 is a schematic configuration view of the water circuit in the sanitary washing apparatus according to the first exemplary embodiment of the present disclosure.

FIG. 7 is an exploded perspective view of the water circuit in the sanitary washing apparatus according to the first exemplary embodiment of the present disclosure.

FIG. 8 is an assembled perspective view of the water circuit of the sanitary washing apparatus in the first exemplary embodiment of the present disclosure.

FIG. 9 is an external perspective view of the sub tank in the first exemplary embodiment of the present disclosure.

FIG. 10 is a cross sectional view of the sub tank in the first exemplary embodiment of the present disclosure.

closure.

FIG. 11 is a front-back cross sectional view of the sub tank in the first exemplary embodiment of the present disclosure.

FIG. 12 is an external perspective view of the heat exchanger in the first exemplary embodiment of the present disclosure.

FIG. 13 is a sectional view of the heat exchanger in the first exemplary embodiment of the present disclosure.

FIG. 14 is an external perspective view of the water pump, which is the discharge water amount variable unit, in the first exemplary embodiment of the present disclosure.

FIG. 15 is a sectional view of the water pump, which is the discharge water amount variable unit, in the first exemplary embodiment of the present disclosure.

FIG. 16 is an external perspective view of the nozzle device in the first exemplary embodiment of the present disclosure when the nozzle device is stored.

FIG. 17 is a sectional view of the nozzle device taken along the line 17-17 of FIG. 16.

FIG. 18 is a longitudinal sectional view of the nozzle device in the first exemplary embodiment of the present disclosure when the nozzle device is stored.

FIG. 19 is an enlarged sectional view of the nozzle device corresponding to Part B of FIG. 18.

FIG. 20 is a sectional view of the nozzle device taken along line 20-20 of FIG. 19.

FIG. 21 is a cross sectional view of the nozzle device in the first exemplary embodiment of the present disclosure when the nozzle device is stored.

FIG. 22 is an enlarged sectional view of the nozzle device corresponding to Part C of FIG. 21.

FIG. 23 is a longitudinal sectional view of the nozzle device in the first exemplary embodiment of the present disclosure at the time of using the anal cleaning nozzle.

FIG. 24 is an enlarged sectional view of the nozzle device corresponding to Part D of FIG. 23.

FIG. 25 is a longitudinal sectional view of the nozzle device in the first exemplary embodiment of the present disclosure at the time of using the bidet nozzle.

FIG. 26 is an enlarged sectional view of the nozzle device corresponding to Part E of FIG. 25.

FIG. 27 is a cross sectional view of the nozzle part of the nozzle device in the first exemplary embodiment of the present disclosure at the time of using the bidet nozzle.

FIG. 28 is an enlarged sectional view of the nozzle device corresponding to Part G of FIG. 27.

FIG. 29 is a time chart of the washing part in the initial use in the sanitary washing apparatus according to the first exemplary embodiment of the present disclosure.

FIG. 30 is a time chart of the washing part in the

ordinary use in the sanitary washing apparatus according to the first exemplary embodiment of the present disclosure.

FIG. 31 is an external perspective view of the spray nozzle in the first exemplary embodiment of the present disclosure.

FIG. 32 is a longitudinal sectional view of the spray nozzle in the first exemplary embodiment of the present disclosure.

FIG. 33 is a longitudinal sectional view of the spray nozzle installed in the sanitary washing apparatus according to the first exemplary embodiment of the present disclosure.

FIG. 34 is a front view of the spray nozzle installed in the sanitary washing apparatus according to the first exemplary embodiment of the present disclosure.

FIG. 35 is a plan view of the spray nozzle installed in the sanitary washing apparatus and the rotation angles of the outlet orifice of the spray nozzle in the first exemplary embodiment of the present disclosure.

FIG. 36 is a chart showing the pump output at different rotation angles of the outlet orifice of the spray nozzle in the first exemplary embodiment of the present disclosure.

FIG. 37 is a diagram showing the spraying of the spray nozzle onto the inner surface of the toilet bowl in the first exemplary embodiment of the present disclosure.

FIG. 38 is a transparent perspective view of the sleeve case in the sanitary washing apparatus according to the first exemplary embodiment of the present disclosure.

FIG. 39 is a perspective view of the sleeve case from which the sleeve lid is detached in the sanitary washing apparatus according to the first exemplary embodiment of the present disclosure.

FIG. 40 is a sectional view of the spray nozzle installed in the rear-body case in the sanitary washing apparatus according to the first exemplary embodiment of the present disclosure when the central part of the spray nozzle is cut in the front-back direction.

FIG. 41 is a front view of the body of the sanitary washing apparatus according to the first exemplary embodiment of the present disclosure.

FIG. 42 is a side view of the body of the sanitary washing apparatus according to the first exemplary embodiment of the present disclosure.

FIG. 43 is a perspective view of the body fixing plate and the rear-body case of the body of the sanitary washing apparatus according to the first exemplary embodiment of the present disclosure.

FIG. 44 is a partial sectional view of the body fixed to the body fixing plate in the sanitary washing apparatus according to the first exemplary embodiment of the present disclosure.

FIG. 45 is a time chart when the washing foam is

sprayed while the orientation of the outlet orifice of the spray nozzle is being rotated in the sanitary washing apparatus according to the first exemplary embodiment of the present disclosure.

FIG. 46 is a time chart of the rinsing process in the sanitary washing apparatus according to the first exemplary embodiment of the present disclosure.

FIG. 47 is a time chart when the washing foam is sprayed while the orientation of the outlet orifice of the spray nozzle is not being rotated in the sanitary washing apparatus according to the first exemplary embodiment of the present disclosure.

FIG. 48 is an explanatory diagram of the automatic operation selection between foam-spraying processes in the sanitary washing apparatus according to the first exemplary embodiment of the present disclosure.

FIG. 49 is an explanatory diagram showing the effect of splash reduction by foam-spraying in the sanitary washing apparatus according to the first exemplary embodiment of the present disclosure.

FIG. 50 is a partial sectional view of the foam tank in the sanitary washing apparatus according to the first exemplary embodiment of the present disclosure.

FIG. 51 is a perspective view of the sanitary washing apparatus according to a second exemplary embodiment of the present disclosure.

DESCRIPTION OF EMBODIMENTS

[0012] A sanitary washing apparatus of a first aspect of the present disclosure includes the following components: a body to be placed on a toilet bowl; a foam generator for generating washing foam; a spray nozzle for spraying at least one of washing water and the washing foam onto the inner surface of the bowl; a spray nozzle driver for rotating the orientation of the outlet orifice of the spray nozzle; and a control unit for controlling at least the operation of the spray nozzle driver. The control unit has the following modes: a rotary foam-spraying mode in which the washing foam is sprayed into the bowl while the orientation of the outlet orifice of the spray nozzle is being rotated; and a rinse mode in which the washing water passes through the foam generator and the is sprayed from the spray nozzle.

[0013] With this structure, when the spray nozzle sprays foam (hereinafter, washing foam) onto the toilet bowl, the orientation of the outlet orifice of the nozzle is rotated in such a manner that the washing foam can reach every part inside the bowl. As a result, the inner surface of bowl is coated with foam film from the front to the back of the surface, thereby preventing stain adsorption. The rinse mode makes the washing water pass through the foam generator and sprayed from the spray nozzle. In this mode, the washing water removes residual detergent from the foam generator and the spray nozzle to prevent their clogging, achieving a stable spray of the washing

foam.

[0014] In a second aspect based on the first aspect, the spray nozzle may be installed in the body in such a manner that the rotation axis of the outlet orifice of the spray nozzle can be inclined back and forth and side to side when the orientation of the outlet orifice of the spray nozzle is rotate. When the rotation axis is inclined back and forth, the bottom of the rotation axis may be inclined toward the front of the toilet bowl. Meanwhile, when the rotation axis is inclined side to side, the bottom of the rotation axis may be inclined toward a cleaning nozzle for cleaning a human body.

[0015] With this structure, at the time of spraying the washing foam into the toilet bowl from the spray nozzle, when the outlet orifice faces the front of the bowl to make the distance slightly large between the outlet orifice and the position to be sprayed, the outlet orifice is inclined higher. Meanwhile, when the outlet orifice faces the back of the bowl to make the distance short between the outlet orifice and the position to be sprayed, the outlet orifice is inclined lower. Thus, the washing foam can be sprayed while changing the height of the outlet orifice depending on the distance between the outlet orifice and the bowl inner surface. As a result, the foam film can be formed from the front to the back of the bowl inner surface, thereby reducing stain adsorption.

[0016] In a third aspect based on either the first aspect or the second aspect, when the washing foam is sprayed from the spray nozzle into the toilet bowl with the orientation of the outlet orifice of the spray nozzle being rotated, the control unit may rotate the orientation of the outlet orifice of the spray nozzle at least two rounds. The two rounds consists of the following rotations: making the spray nozzle driver rotate the orientation of the outlet orifice of the spray nozzle forward from the back of the bowl to the front of the bowl, and then return to the back of the bowl, and making the spray nozzle driver rotate the orientation of the outlet orifice of the spray nozzle backward from the back of the bowl to the front of the bowl, and then return to the back of the bowl.

[0017] With this structure, when the washing form is sprayed from the spray nozzle while the rotation of the orientation of the outlet orifice is being rotated, the control unit makes the spray nozzle driver rotate the orientation of the outlet orifice forward from the back to the front of the bowl, and then returns to the back of the bowl. After this, the control unit makes the spray nozzle driver rotate the orientation of the outlet orifice backward from the back to the front of the bowl, and then returns to the back of the bowl. In this manner, at least two rounds of rotation is performed. As a result, the output of the discharge water amount variable unit is controlled so that the washing foam can reach the vicinity of the rim of the bowl. Thus, the washing foam can be sprayed almost the entire periphery of the bowl inner surface and formed into foam film covering from the front to the back of the inner surface of the bowl, thereby reducing stain adsorption.

[0018] In a fourth aspect based on any one of the first

to third aspects, the sanitary washing apparatus may further include a human body detection sensor for detecting that the user enters or leaves the toilet room. When the human body detection sensor detects that the user enters the toilet room, the control unit may make the washing foam sprayed into the bowl while the outlet orifice of the spray nozzle is being rotated.

[0019] With this structure, when the human body detection sensor detects that the user enters the toilet room, the washing foam is sprayed onto the bowl inner surface while the orientation of the outlet orifice is being rotated at least two rounds. This ensures the formation of foam film onto the bowl inner surface before the user uses the toilet, thereby reducing stain adsorption.

[0020] In a fifth aspect based on any one of the first to fourth aspects, the sanitary washing apparatus may further include a discharge water amount variable unit and a valve both controlled by the control unit. The foam generator may include the following components: a foam tank to be supplied with the washing water by the discharge water amount variable unit when the control unit opens the valve; a detergent tank; a detergent pump to supply the detergent in the detergent tank to the foam tank; and an air pump configured to supply air to the foam tank. At least one of the washing water and the washing foam in the foam tank may be sprayed from the spray nozzle.

[0021] With this structure, the surface of the cleaning nozzle or the bowl inner surface is sprayed with not just (hot) water but detergent foam. This improves the effect of cleaning, and hence, the effect of reducing stain adsorption. Moreover, the detergent foam can reduce odor and visually create a hygienic impression.

[0022] In a sixth aspect based on the fifth aspect, in the rinse mode, the control unit may open the valve while keeping the detergent pump of the foam generator in the stopped state, so that the washing water is supplied to the foam tank by the discharge water amount variable unit and is sprayed from the spray nozzle.

[0023] With this structure, the washing water rinses the passage leading from the foam tank to the spray nozzle, thereby preventing residual detergent from clogging the passage and the spray nozzle, and also from causing improper rotation of the spray nozzle. The washing water can also rinse the bowl inner surface.

[0024] Exemplary embodiments of the present disclosure will be described as follows with reference to the accompanying drawings. Note that the present disclosure is not limited to these exemplary embodiments.

FIRST EXEMPLARY EMBODIMENT

[0025] FIG. 1 is an external perspective view of sanitary washing apparatus 100 according to a first exemplary embodiment of the present disclosure when apparatus 100 is installed on toilet bowl 110. FIG. 2 is a perspective view of apparatus 100 when the front-body case is detached from of body 200 of apparatus 100. FIG. 3

is a perspective view of apparatus 100 when the front-body case and control unit 130 are detached from body 200. FIG. 4 is a perspective view of the top face of operation unit 210 in apparatus 100. FIG. 5 is an external perspective view of remote controller 400 in the first exemplary embodiment of the present disclosure.

1. The Overall Structure of the Sanitary Washing Apparatus

[0026] As shown in FIG. 1, sanitary washing apparatus 100 includes body 200, toilet seat 300, toilet lid 320, remote controller 400, and human body detection sensor 450 as primary components. Body 200, toilet seat 300, and toilet lid 320 are integrated together and installed on the top surface of toilet bowl 110.

[0027] In the following description of each component of apparatus 100, body 200 is defined to be located at the back of apparatus 100, and toilet seat 300 is defined to be located at the front of apparatus 100. When seen from behind apparatus 100, the right-hand side is defined as right, and the left-hand side is defined as left.

[0028] Operation unit 210 is integrated with body 200 and projects along a side of body 200. Toilet seat 300 and toilet lid 320 are openably and closably attached to the front of body 200 via seat/seat-lid rotary mechanism 360 (see FIG. 2). Mechanism 360 is composed of a DC motor and a plurality of gears to open and close seat 300 and lid 320 either separately or simultaneously.

[0029] As shown in FIG. 1, when opened, lid 320 stands at the rear end of apparatus 100. Meanwhile, when closed, lid 320 covers the top surface of seat 300.

[0030] Toilet seat 300 includes a toilet seat heater (not shown) for heating the seating surface to a comfortable temperature.

[0031] Body 200 further includes seating sensor 330 at a bearing that supports the rotary shaft of seat 300. Sensor 330 is a seating detector for detecting a human body seated on seat 300, and is a gravimetric seating sensor. Sensor 330 opens or closes the switch in response to a weight change when the user is seated on seat 300, thereby detecting whether the user is seated on the surface of seat 300.

[0032] Body 200 includes sub tank 600, heat exchanger 700, and nozzle device 800 (see FIG. 3). Body 200 further includes anal cleaning nozzle 831, which is a nozzle for cleaning the anal area; spray nozzle 550 for spraying washing water or washing foam onto the bowl inner surface; deodorization equipment 120 (see FIG. 2) for deodorizing the smell of defecation; and control unit 130 for controlling each function of apparatus 100 (see FIG. 2).

[0033] As shown in FIG. 2, body 200 includes washing part 500, which includes nozzle device 800 as its main component at the internal center of body 200. Spray nozzle 550 is located on the right of nozzle device 800 and also in front of body 200, which is fixedly mounted on toilet bowl 110. Deodorization equipment 120 is located

on the left of nozzle device 800. Seat/seat-lid rotary mechanism 360 is located at the left of body 200 so as to drive the opening and closing of seat 300 and lid 320.

[0034] As shown in FIG. 3, body 200 further includes waterproof solenoid valve 514 of washing part 500, sub tank 600, and other components at the front on the right of nozzle device 800. Body 200 further includes heat exchanger 700 at the back on the right of nozzle device 800. Body 200 further includes, behind heat exchanger 700, water pump 516, which is a discharge water amount variable unit. As shown in FIG. 2, control unit 130 is located above washing part 500.

[0035] Body 200 further includes sleeve case 250, which projects ahead along the right side of body 200. Sleeve case 250 includes operation unit 210 at its top. As shown in FIG. 4, operation unit 210 includes a plurality of switches and lamps to operate and set the functions of apparatus 100.

[0036] Operation unit 210 includes an operation board (not shown) mounted with a plurality of tact switches and LEDs. The tact switches can be pushed and the LEDs can be visible via switch nameplates pasted on the top face of operation unit 210.

[0037] Operation unit 210 further includes, at the back of its top face, infrared receiver 211 (FIG. 4) for receiving an infrared signal from remote controller 400, which includes human body detection sensor 450.

[0038] The switches in operation unit 210 include a plurality of operation switches 220 for operating the cleaning processes, and a plurality of setting switches 230 for setting various functions. The lamps in operation unit 210 include a plurality of LEDs for displaying the settings.

[0039] One of operation switches 220 is anal cleaning switch 221 used auxiliary when remote controller 400 has a dead battery, failure, or other troubles. Another of operation switches 220 is rinse switch 223 used for rinsing, with the washing water, the passage leading from foam tank 532 (see FIG. 6) to outlet orifice 550u (see FIG. 31) of spray nozzle 550, which will be described later.

[0040] Setting switches 230 include the following switches; water temperature switch 231 for setting the temperature of the washing water; a seat temperature switch for setting the temperature of the toilet seat; an 8-hour stop switch for stopping the heating of seat 300 for eight hours after the setting, and a power-saving switch for automatically learning the time period during which apparatus 100 is not used and for maintaining the temperature of seat 300 low during this time period to save electricity. Still another of setting switches 230 is automatic seat-lid opening/closing switch for setting the automatic opening and closing of seat 300 and lid 320.

[0041] Still another of setting switches 230 is automatic process selection switch 236 for selecting between a foam coating process, a splash reduction process, and a periodic foaming process, which will be described later. The foam coating process is automatically performed as follows. When human body detection sensor 450 detects

a human body, the washing foam is sprayed to a large area in the periphery of the bowl while spray nozzle 550 is being rotated. This can prevent stain adsorption on the bowl. The splash reduction process is performed as follows. When the user operates manual urine splash reduction switch 434 of remote controller 400, the orientation of outlet orifice 550u is rotated to the back of the bowl, and a large amount of the washing foam is sprayed quickly in this direction. As a result, foam film is formed onto the water surface in the bowl, thereby preventing urine splash. The periodic foaming process enables washing foam to be sprayed automatically and periodically to the bowl even in the time period during which apparatus 100 is not used. This can make the washing foam remain on the water surface in the bowl, thereby reducing waterline stain.

[0042] As shown in FIG. 38, sleeve case 250, which has operation unit 210 at its top, includes foam generator 560 (FIG. 6) for generating the washing foam. Foam generator 560 includes foam tank 532, detergent tank 533, detergent pump 534, and air pump 535.

[0043] Detergent tank 533 has, at its top, detergent inlet port 537 with a filter. Tank 533 is located ahead of operation unit 210, or in other words, at the front part of sleeve case 250. Sleeve case 250 has, on its front face, window 216 for detergent level observation, allowing the user to observe the level of the detergent in detergent tank 533.

[0044] FIG. 39 is a perspective view of sleeve case 250 from which sleeve lid 217 is detached. Lid 217 is opened or closed when detergent is injected into detergent tank 533 shown in FIG. 38 or when detergent tank 533 is attached or detached.

[0045] Many operations of apparatus 100 are performed by remote controller 400, which is separate from body 200. Controller 400 is attached on the toilet wall so that the user sitting on seat 300 can easily operate.

[0046] As shown in FIG. 5, remote controller 400 is a thin cuboid as a whole and includes box-shaped remote controller body 401 made of resin. The top and front faces of body 401 are equipped with a plurality of switches and lamps. Controller body 401 further includes, at its top corner, transmitter 402 for transmitting the operation signal of controller 400 to body 200 via infrared radiation.

[0047] Remote controller body 401 includes a control board (not shown) having the control function of controller 400, and a battery (not shown) as a power supply of controller 400.

[0048] Human body detection sensor 450 is located at the top center of the front face of remote controller body 401. Under human body detection sensor 450, controller body 401 includes seat-lid switch 418 and seat switch 419 which open and close lid 320 and seat 300, respectively, by electricity. Operating these switches allows the user to open and close seat 300 and lid 320 when necessary.

[0049] Note that when seat 300 is open, seat 300 stands nearly vertically as when a man urinates. Mean-

while, when it is closed, seat 300 is substantially parallel with the top surface of bowl 110. Whether seat 300 is open or closed can be detected by the signal from seat lid opening/closing sensor 331 (FIG. 1), which is a seat lid opening/closing detector.

[0050] Remote controller body 401 includes, on the right-hand side of its front face, the following switches: anal cleaning switch 410 for starting the anal cleaning; moving cleaning switch 413 for periodically moving the cleaning position back and forth during the anal cleaning and the bidet cleaning so as to expand the body area of the user that can be cleaned; and pulsating cleaning switch 414 for periodically changing the water pressure during the anal cleaning. Remote controller body 401 further includes, on the right-hand side of its front face, the following switches: a pair of water pressure switches 415 for adjusting the water pressure during the anal cleaning and the bidet cleaning; a pair of cleaning position switches 416 for adjusting the cleaning position during the anal cleaning and the bidet cleaning; anal blow-dry switch 431; and powerful deodorization switch 432.

[0051] Remote controller body 401 includes, on the left-hand side of its front face, the following switches: bidet switch 411 for starting the bidet cleaning to clean women's privates; stopping switch 412 for stopping the anal cleaning and the bidet cleaning; manual foam coating switch 433 for spraying the washing foam to a large area in the periphery of the bowl by rotating spray nozzle 550; and manual urine splash reduction switch 434 for spraying the washing foam with spray nozzle 550 fixed in a specific direction. Remote controller body 401 further includes, on the left-hand side of its front face, the following switches: water temperature switch 435 for setting the temperature of the washing water; seat temperature switch 436 for setting the temperature of the toilet seat; and 8-hour stop switch 437 for stopping the heating of seat 300 for eight hours after the setting. Remote controller body 401 further includes, on the left-side of its front face, the following switches: power-saving switch 438 for automatically leaning the time period during which apparatus 100 is not used and for maintaining the temperature of seat 300 low during this time period to save electricity; automatic seat-lid opening/closing switch 439 for setting the automatic opening and closing of seat 300 and lid 320; and nozzle cleaning switch 430 for cleaning anal cleaning nozzle 831 and bidet nozzle 832, which are cleaning nozzles.

[0052] Remote controller body 401 further includes LED lamp 421 for showing the water pressure in five levels between two water pressure switches 415, and position lamp 422 for showing the cleaning position in five levels between two cleaning position switches 416.

[0053] Note that when seat 300 is open, seat 300 stands nearly vertically as when a man urinates. Meanwhile, when it is closed, seat 300 is substantially parallel with the top surface of bowl 110. Whether the seat is open or closed can be detected by the signal from seat lid opening/closing sensor 331 (FIG. 1), which is a seat

lid opening/closing detector.

2. The Water Circuit Configuration of the Sanitary Washing Apparatus

[0054] FIG. 6 is a schematic configuration view of the water circuit in apparatus 100 according to the first exemplary embodiment of the present disclosure.

[0055] Body 200 includes washing part 500 for cleaning the user's privates. Washing part 500 is composed of nozzle device 800 for jetting the washing water, and washing water supply path 690 for supplying the washing water from water supply connection unit 510 to nozzle device 800.

[0056] As shown in FIG. 6, washing water supply path 690 is equipped with the following members: water supply connection unit 510, strainer 511, check valve 512, constant flow valve 513, waterproof solenoid valve 514, relief valve 515, sub tank 600, heat exchanger 700, buffer tank 750, water pump 516, and flow control valve 517 located in this order. Path 690 is connected to nozzle device 800.

[0057] Water supply connection unit 510 is located at the lower right of body 200 and is connected to the water service pipe. Unit 510 includes strainer 511 for preventing the entry of dust in tap water and check valve 512 for preventing the backflow of the water in sub tank 600 into the water service pipe.

[0058] In the downstream of check valve 512, the following valves are integrated together: constant flow valve 513 for maintaining a constant amount of the washing water flowing through the path; waterproof solenoid valve 514 for opening and closing the path by electricity, and relief valve 515.

[0059] In the downstream of waterproof solenoid valve 514, the following components are interconnected: sub tank 600 with an air releasing port; heat exchanger 700 for instantaneously heating the washing water; and buffer tank 750 for homogenizing the temperature heated by heat exchanger 700.

[0060] Water pump 516 is connected to the downstream of the buffer tank 750. Nozzle device 800 is connected to the downstream of water pump 516 via flow control valve 517. Three ports of flow control valve 517 are connected to anal cleaning nozzle 831, bidet nozzle 832, and nozzle cleaning unit 833 of nozzle device 800.

[0061] Washing water supply path 690 includes branch path 530 connected between water pump 516 and flow control valve 517. Branch path 530 is connected to foam tank 532 via check valve 531 so that the washing water can be supplied to foam tank 532. The downstream of foam tank 532 is connected to spray nozzle 550, which is rotated by spray nozzle driver 550a. Foam tank 532 is further connected to detergent tank 533 and detergent pump 534, which supply detergent. Foam tank 532 includes air pump 535, which supplies air to foam tank 532 to generate the washing foam.

[0062] Foam generator 560 includes air pump 535, de-

tergent pump 534, detergent tank 533, foam tank 532, and check valve 531.

[0063] In FIG. 6, branch path 530, which is connected between water pump 516 and flow control valve 517, includes only one check valve 531. In reality, however, another check valve 531b (duckbill valve) made of rubber is formed in foam-tank water inlet 532a (see FIG. 50) through which the washing water is carried through branch path 530 into foam tank 532. Providing the plurality of check valves in the upstream of foam tank 532 can ensure the prevention of backflow of liquid and the washing foam in detergent-containing foam tank 532 toward the water service pipe.

[0064] Note that the broken lines in FIG. 6 indicate electric connection between each unit and control unit 130.

[0065] As shown in FIGS. 7 and 8, of all the components of washing part 500, the components mentioned below are integrated into chassis 501 molded from resin and assembled into rear-body case 201 (FIG. 2) of body 200. The integrated components are as follows: water supply connection unit 510, strainer 511, check valve 512, constant flow valve 513, waterproof solenoid valve 514, relief valve 515, sub tank 600, heat exchanger 700, buffer tank 750, and water pump 516.

[0066] As shown in FIG. 7, strainer 511 and check valve 512 are integrated into water supply connection unit 510. Constant flow valve 513 and relief valve 515 are integrated into waterproof solenoid valve 514. Buffer tank 750 is integrated with heat exchanger 700.

[0067] Water supply connection unit 510 and waterproof solenoid valve 514 are directly connected together via an O ring, which is a packing attached to their connection ports instead of using a connection tube or the like. Waterproof solenoid valve 514 and sub tank 600 are directly connected together in the same manner. Sub tank 600 and heat exchanger 700 are also directly connected together in the same manner. These components of the water circuit are fixed in predetermined positions of chassis 501.

[0068] This configuration improves the water tightness of washing part 500 and the position accuracy of each member. In particular, improving the position accuracy of sub tank 600 and heat exchanger 700 improves the control accuracy of the washing water flow, thereby enhancing the performance and control accuracy of washing part 500.

[0069] Water pump 516 is a piston pump, which is a positive displacement pump. As shown in FIGS. 14 and 15, when seen from the front, water pump 516 is roughly L-shaped. Water pump 516 is composed of (roughly) cylindrical motor 516a, link mechanism unit 516b for converting the rotating motion of the motor into a reciprocating motion, and piston 516c driven by the reciprocating motion of link mechanism unit 516b. Piston 516c includes, on its outer surface, water inlet 516d and outlet orifice 516e as connection ports.

[0070] In this configuration, when water pump 516 is driven, motor 516a creating a rotating motion causes less

vibration than link mechanism unit 516b and piston 516c, which perform a reciprocating motion.

[0071] Driving motor 516a enables piston 516c to start a reciprocating motion, so that the washing water is drawn through water inlet 516d and is sprayed from outlet orifice 516e. The sprayed washing water is formed into a pulsating water flow by the reciprocating motion of piston 516c.

[0072] In this configuration, the outer periphery of the roughly cylindrical motor 516a of water pump 516 is surrounded by an elastic cushioning material (not shown) made of foamed resin. Motor 516a is then inserted into roughly cylindrical water pump installation part 501a (FIG. 7) located at the back of chassis 501. This configuration supports water pump 516, from which link mechanism unit 516b and piston 516c hang.

[0073] Water pump installation part 501a shown in FIG. 7 is thin thick and located at the top of leg part 501b standing like a rib from the bottom surface of chassis 501. Water pump installation part 501a with the thin thickness can absorb the vibration of water pump 516 by the elasticity of the resin.

[0074] As shown in FIGS. 12 and 13, heated-water discharge port 712, which is the connection port of heat exchanger 700 integrated with buffer tank 750, is connected to water inlet 516d (FIG. 14), which is the connection port of water pump 516, via a connection tube made of flexible resin.

[0075] As described above, motor 516a with less vibration is located in the thin-thick water pump installation part 501a of chassis 501 via the cushioning material. Meanwhile, link mechanism unit 516b and piston 516c with more vibration hang freely from pump 516. Buffer tank 750 and water pump 516 are connected via connection tube 502 (see FIG. 8) made of flexible resin. With this configuration, the vibration caused by water pump 516 can be prevented from propagating to chassis 501, body 200, and other components. As a result, apparatus 100 has better comfort and durability.

[0076] In particular, water pump 516 is supported by two different materials: the cushioning material made of foamed resin and the elastic resin of water pump installation part 501a. As a result, vibration in a wide range of frequencies can be absorbed to effectively reduce the propagation of vibration to the body.

3. The Structure of the Sub Tank

[0077] FIG. 9 is an external perspective view of sub tank 600 in the first exemplary embodiment of the present disclosure. FIG. 10 is a cross sectional view of sub tank 600, and FIG. 11 is a front-back cross sectional view of sub tank 600.

[0078] As shown in FIG. 9, sub tank 600 is composed of tank body 610 molded from resin, water level sensor 620 (FIG. 6) for detecting the water level of the washing water in tank body 610, and supplied-water temperature sensor 630, which is a thermistor for detecting the tem-

perature of the washing water supplied to tank body 610.

[0079] Tank body 610 is composed of the following three components: tank front 611 composing the front wall, side walls, bottom surface, and top surface of the tank; tank rear 612 composing the rear wall of the tank; and air releasing unit 613 located on the top surface of tank body 610. Tank body 610 is, as a whole, composed of a plurality of planar surfaces; front wall; rear wall; side walls; bottom surface; and top surface. Tank body 610 is roughly square when seen two dimensionally. The front wall includes an inclined part which is inclined, from the middle of the front wall upward, toward the rear wall. When seen from its side, the front wall is roughly trapezoidal (the upper part is thinner than the lower part). Tank body 610 has a smaller cross sectional area in the lower part than in the upper part.

[0080] Tank body 610 has water supply port 601 at the bottom of one of the side walls, and water discharge port 602 at the bottom of the rear wall. Air releasing unit 613, which is located on the top surface of tank body 610, has air releasing port 603 for communication between the inside and outside of tank body 610. Providing air releasing port 603 can release the air trapped in tank body 610 to the outside, so that the internal pressure of tank body 610 can be kept at atmospheric pressure.

[0081] Maintaining the inside of sub tank 600 at atmospheric pressure allows the path leading from the downstream of sub tank 600 to water inlet 516d of water pump 516 to be kept at atmospheric pressure. As a result, water pump 516 can supply water without the influence of variation in water pressure, thereby performing stable pumping.

[0082] The path leading to air releasing port 603 of air releasing unit 613 includes buffer unit 613a (FIG. 10) with a large cross sectional area. Buffer unit 613a can temporarily trap the washing water that is going to accidentally escape with air bubbles from air releasing port 603, thereby preventing the escape of the washing water from port 603.

[0083] Tank body 610 includes partition wall 614, which partitions the inside of tank body 610 into water-receiving tub 615 and storage tub 616. Water-receiving tub 615 has water supply port 601 near the bottom surface of its side. Storage tub 616 has water discharge port 602 near the bottom surface of its rear wall.

[0084] When partition wall 614 is provided to form water-receiving tub 615 and storage tub 616, even if the washing water drawn in from water supply port 601 contains air, the air can be released from the top of water-receiving tub 615 to the outside via air releasing port 603. As a result, storage tub 616 can receive air-free washing water.

[0085] Tank body 610 further includes, above water-receiving tub 615, barrier wall 617 (FIG. 10), which is located between upper surface opening 615a of water-receiving tub 615 and air releasing unit 613. Barrier wall 617 projects (substantially) horizontally from the side wall of tank body 610. Barrier wall 617 is large enough to

entirely cover the upper surface opening of water-receiving tub 615.

[0086] Water-receiving tub 615 includes a plurality of rectifying ribs 618 formed on the side wall of tank body 610 and on the surface of partition wall 614, which opposes the side wall of tank body 610. Ribs 618 project alternately from the two sides in the (substantially) horizontal direction.

[0087] The washing water from water supply port 601 flows into the bottom part of water-receiving tub 615 first, and then rises inside water-receiving tub 615 while its flow direction is changed by rectifying ribs 618. Assume that the washing water drawn in from water supply port 601 has a high pressure or contains so much air that its flow is significantly disturbed. In this case, the flow can be properly rectified by rectifying ribs 618, and the air in the washing water can be removed by the eddy generated in the downstream of rectifying ribs 618.

[0088] After rising inside water-receiving tub 615 and being separated from the air, the washing water gets over the upper edge of partition wall 614 and is drawn into storage tub 616 and is trapped there.

[0089] In this case, even if the washing water drawn in from water supply port 601 has a high pressure or contains so much air that its flow is significantly disturbed, the washing water is prevented from flowing upward by barrier wall 617 and is blocked by air releasing unit 613. Thus, the washing water is prevented from flowing through air releasing port 603 to the outside of sub tank 600.

[0090] As described above, the washing water drawn in from water supply port 601 is separated from air in it while rising inside water-receiving tub 615. The removed air is released through air releasing port 603 to the outside of tank body 610. As a result, the air-free washing water is trapped in storage tub 616, and supplied to heat exchanger 700 through water discharge port 602.

[0091] If the washing water supplied from sub tank 600 to heat exchanger 700 contained air, heat exchanger 700 would have air bubbles inside, which might cause an abnormal increase in the internal temperature, possibly damaging heat exchanger 700. However, in the present exemplary embodiment, partition wall 614 is provided to block the entry of air, thereby preventing heat exchanger 700 from being damaged.

[0092] As shown in FIG. 11, water level sensor 620 is composed of common electrode 621 and a plurality of water level electrodes 622 placed at each water level. In the present exemplary embodiment, water level sensor 620 is composed of one common electrode 621 and two water level electrodes 622.

[0093] Common electrode 621 is located on the inner surface of the front wall bottom of tank body 610. Water level electrodes 622 is located on the inner surface of the rear wall of tank body 610. Water level electrodes 622 are composed of upper limit electrode 623 located in the upper part and lower limit electrode 624 located in the lower part. Common electrode 621 is located lower

than lower limit electrode 624, and is always kept in water during normal use.

[0094] Common electrode 621 is located on the different surface from upper and lower limit electrodes 623 and 624, which are water level electrodes 622. This configuration prevents water remaining on the inner surface of tank body 610 from being mistakenly detected as stored water.

[0095] The water level is detected by applying a DC voltage between common electrode 621 and water level electrodes 622. This detection is based on the fact that the voltage changes depending on whether water level electrodes 622 are submerged. To be more specific, assume that the washing water is drawn into storage tub 616 and that the water level rises, making lower limit electrode 624 and upper limit electrode 623 (or lower limit electrode 624 alone) submerged. This causes a decrease in the voltage between common electrode 621 and upper and lower limit electrodes 623 and 624. Consequently, control unit 130 detects the water level.

[0096] Upper limit electrode 623 is used to detect that the water has reached the upper limit, whereas lower limit electrode 624 is used to detect that the water has reached the lower limit. Upper limit electrode 623 is located lower than air releasing port 603 so as to prevent the release of the washing water from air releasing port 603. Lower limit electrode 624 is located higher than water discharge port 602 so as to prevent the air from flowing into heat exchanger 700.

4. The Configuration of the Heat Exchanger

[0097] FIG. 12 is an external perspective view of heat exchanger 700 in the first exemplary embodiment of the present disclosure. FIG. 13 is a sectional view of heat exchanger 700.

[0098] Heat exchanger 700 in the present exemplary embodiment is integrally formed with buffer tank 750, which is located at the top of heat exchanger 700.

[0099] As shown in FIG. 12, heat exchanger 700 is roughly rectangular when seen from the front. Heat exchanger 700 is mainly composed of casing 701 molded from reinforced ABS resin compounded with glass fiber, ceramic flat heater 702 (FIG. 13), and heated-water discharge member 703.

[0100] Casing 701 is composed of front face member 710 composing the front part and rear face member 720 composing the rear part. Flat heater 702 is located in the space between front face member 710 and rear face member 720. Casing 701 further includes heated-water paths 715 formed in the space between front face member 710 and flat heater 702 and between rear face member 720 and flat heater 702. The washing water flowing through heated-water paths 715 is instantaneously heated by flat heater 702.

[0101] Heat exchanger 700 has water supply port 711 as the connection port at the right bottom of the front face of front face member 710. Heated-water discharge port

712 as the connection port is located in heated-water discharge member 703 at the top of the right end of front face member 710.

[0102] As shown in FIG. 13, casing 701 further includes supply water path 713 leading to water supply port 711. Path 713 extends substantially throughout the bottom width of casing 701. Supply water path 713 has a plurality of slits 714 throughout the width of its top surface. The washing water drawn into supply water path 713 passes through slits 714 into heated-water paths 715. Slits 714 allow the washing water to be drawn into heated-water paths 715 equally throughout the path width.

[0103] Heated-water paths 715 each include partition rib 716 at their top end. Buffer tank 750 is located above partition rib 716. Partition rib 716 has a plurality of water-through-holes 717 substantially throughout the path width. The washing water heated through heated-water paths 715 passes through water-through-holes 717 and drawn into buffer tank 750.

[0104] Buffer tank 750 has projections 718 with a (roughly) semicircular cross section through substantially the entire width at intervals. The washing water flowing inside buffer tank 750 toward heated-water discharge port 712 is disturbed by projections 718 and is mixed to eliminate its temperature unevenness. As a result, the washing water of even temperature is discharged through heated-water discharge port 712.

[0105] Heated-water discharge member 703 includes two thermistors: one is heated-water temperature sensor 730 for detecting the temperature of the heated washing water, and the other is over-temperature sensor 731 for detecting the over-temperature of heat exchanger 700.

5. The Configuration of the Nozzle Device

[0106] FIG. 16 is a perspective view of nozzle device 800 when it is stored. FIG. 17 is a sectional view of nozzle device 800 taken along the line 17-17 of FIG. 16. FIG. 18 is a longitudinal sectional view of nozzle device 800 when it is stored. FIG. 19 is an enlarged sectional view of nozzle device 800 corresponding to Part B of FIG. 18. FIG. 20 is a sectional view of nozzle device 800 taken along the line 20-20 of FIG. 19. FIG. 21 is a cross sectional view of nozzle device 800 when it is stored. FIG. 22 is an enlarged sectional view of nozzle device 800 corresponding to Part C of FIG. 21. FIG. 23 is a longitudinal sectional view of nozzle device 800 at the time of using the anal cleaning nozzle.

[0107] FIG. 24 is an enlarged sectional view of nozzle device 800 corresponding to Part D of FIG. 23. FIG. 25 is a longitudinal sectional view of nozzle device 800 at the time of using the bidet nozzle. FIG. 26 is an enlarged sectional view of nozzle device 800 corresponding to Part E of FIG. 25. FIG. 27 is a cross sectional view of nozzle part 820 of nozzle device 800 at the time of using the bidet nozzle. FIG. 28 is an enlarged sectional view of nozzle device 800 corresponding to Part G of FIG. 27.

[0108] As shown in FIG. 16, nozzle device 800 is com-

posed of the following components: roughly triangular frame-like support unit 810 molded from resin, nozzle part 820 for reciprocating along support unit 810, cleaning nozzle driver 860 for driving the reciprocating motion of nozzle part 820, and flow control valve 517 for switching the supply of the washing water to nozzle part 820.

[0109] In the following description, the position of each component is defined as follows. The direction to retract nozzle part 820 is defined as the back, and the direction to advance nozzle part 820 is defined as the front. When seen from behind nozzle part 820, the right-hand side is defined as right, and the left-hand side is defined as left.

[0110] Support unit 810 includes the following parts: roughly horizontal bottom part 811, which is roughly triangular frame-like when seen from its side; inclined part 812 lowered forward; and vertical part 813 (FIG. 18) joining bottom part 811 and the rear end of inclined part 812.

[0111] Inclined part 812 includes, substantially throughout its length, guide rail 814 for guiding the reciprocation motion of nozzle part 820, and rack guide 815 (FIG. 17) for guiding flexible rack 861 (FIG. 23) of cleaning nozzle driver 860. Inclined part 812 is integrally formed with roughly cylindrical holding part 816 located at the front end bottom of part 812. Holding part 816 supports nozzle part 820 by holding it.

[0112] As shown in FIGS. 16 and 17, guide rail 814 for guiding nozzle part 820 has a roughly T-shaped cross section. Rack guide 815 for guiding flexible rack 861 has a cross section like a square with one side open. Rack guide 815 guides flexible rack 861 by controlling the top and bottom sides and the closed side of the square.

[0113] Rack guide 815 is extended to inclined part 812, and also to vertical part 813 at the back of support unit 810, and to bottom part 811. The corner of inclined part 812 and the corner of vertical part 813 are connected in the shape of an arc, whereas the corner of vertical part 813 and the corner of bottom part 811 are also connected in the shape of an arc. Rack guide 815 formed in vertical part 813 and in bottom part 811 also has a cross section like a square with one side open. The open side is on the left-hand side in inclined part 812, but is on the right-hand side in vertical part 813 and bottom part 811. The open surfaces of rack guides 815 of vertical part 813 and bottom part 811 are closed by the support unit lid of a different member.

[0114] Nozzle part 820 is advanced and retracted along guide rail 814 by cleaning nozzle driver 860. Driver 860 is composed of flexible rack 861 joined with nozzle part 820, pinion gear 862 (FIG. 17) engaged with flexible rack 861, and drive motor 863 (FIG. 16) for rotating pinion gear 862.

[0115] Drive motor 863 is a stepping motor whose rotation angle is controlled by a pulse signal. Drive motor 863 is rotated to drive flexible rack 861 via pinion gear 862.

[0116] The inner circumferential surface of holding part 816 of support unit 810 is spaced from the outer circumferential surface of nozzle part 820. This allows the wash-

ing water jetted from nozzle part 820 to flow into the space, thereby cleaning the outer circumferential surface of nozzle part 820.

[0117] Nozzle device 800 includes nozzle lid 801 ahead of holding part 816. Nozzle lid 801 opens and closes as nozzle part 820 is advanced and retracted. When retracted to the stored position, nozzle part 820 is covered with nozzle lid 801 so as to be kept away from feces and other dirty materials.

[0118] Support unit 810 includes water supply joint 817 at bottom part 811. Water supply joint 817 joins a water supply tube (not shown) connected to the washing water supply part with connection tube 802 for carrying the washing water from support unit 810 to flow control valve 517.

[0119] Nozzle part 820 is composed of the following members: bar-like nozzle body 830 molded from resin; cylindrical nozzle cover 840 covering nozzle body 830 roughly entirely; and coupling part 850 (FIG. 21) for pulling nozzle cover 840 with nozzle body 830.

[0120] Nozzle body 830 includes the following members: anal cleaning nozzle 831 for cleaning the anal area; bidet nozzle 832 for cleaning women's privates; and nozzle cleaning unit 833 for cleaning snozzle part 820.

[0121] Anal cleaning nozzle 831 is composed of anal-cleaning-water jet orifice 834 located at the tip of nozzle body 830 and upward oriented, and anal cleaning water path 835 communicated with anal-cleaning-water jet orifice 834 from the rear end of nozzle body 830. Anal cleaning water path 835 is located at the bottom of nozzle body 830 and is bent upward under anal-cleaning-water jet orifice 834. At this bent part, anal cleaning water path 835 is equipped with rectifying plate 835a for rectifying the flow of the washing water (FIG. 24). The washing water from anal-cleaning-water jet orifice 834 passes through jet opening 844 of nozzle cover 840 and is jetted upward.

[0122] Bidet nozzle 832 is composed of bidet water jet orifice 836 located behind anal-cleaning-water jet orifice 834, and bidet water path 837 communicated with bidet water jet orifice 836 from the rear end of nozzle body 830. The washing water from bidet water jet orifice 836 passes through jet opening 844 of nozzle cover 840 and is jetted upward (FIG. 26).

[0123] Nozzle cleaning unit 833 is composed of nozzle-cleaning-water jet port 838 located in a side surface of nozzle body 830, and nozzle-cleaning path 839 (FIG. 21) communicated with nozzle-cleaning-water jet port 838 from the rear end of nozzle body 830. The washing water from nozzle-cleaning-water jet port 838 is jetted inside nozzle cover 840 and is released to the outside of nozzle cover 840 through drain 845 of nozzle cover 840. The washing water jetted from nozzle-cleaning-water jet port 838 is used to clean nozzle part 820 and its vicinity.

[0124] The front part of nozzle part 820 is inserted and held in holding part 816 of support unit 810, whereas the back part slidably hangs from guide rail 814.

[0125] Nozzle part 820 can be advanced and retracted

between the following three positions: the stored position where nozzle part 820 is stored behind holding part 816 as shown in FIG. 16; the anal cleaning position where nozzle part 820 projects over holding part 816 as shown in FIG. 23; and the bidet cleaning position shown in FIG. 25.

[0126] Nozzle cover 840 is composed of nozzle cover body 841 and coupling member 842 (FIG. 21). Nozzle cover body 841 is a cylindrical stainless steel with a closed tip and an open rear end. Coupling member 842 is a (roughly) cylindrical member made from resin. Coupling member 842 is equipped, on each side, with coupling piece 843 to be engaged with nozzle body 830 (FIG. 22).

[0127] Coupling member 842 is integrated with a nozzle cover stopper located on its right rear end. The nozzle cover stopper restricts the sliding range of nozzle cover 840 when coming into contact with a front stopper receiver and a rear stopper receiver provided in support unit 810.

[0128] Coupling member 842 is partially inserted into nozzle cover body 841 from the rear end opening of body 841 and is integrally fixed to body 841. Nozzle cover body 841 is equipped, at its front top surface, with jet opening 844, which can be aligned with anal-cleaning-water jet orifice 834 and bidet water jet orifice 836 of nozzle body 830. Nozzle cover body 841 is equipped, at its front bottom surface, with drain 845, which drains the washing water from nozzle cover body 841.

[0129] The inner diameter of nozzle cover 840 is slightly larger than the outer diameter of nozzle body 830. As a result, nozzle body 830 and nozzle cover 840 can be smoothly slid against each other when nozzle body 830 is inserted into nozzle cover 840.

[0130] Nozzle body 830 includes, on its rear end surface, with flow control valve 517. Valve 517 is composed of a disc valve body and a stepping motor for driving the switching process. Flow control valve 517 supplies the washing water selectively to one of anal cleaning water path 835, bidet water path 837 and nozzle-cleaning path 839.

[0131] The body of flow control valve 517 is equipped, on its outer surface, with a feed-water inlet through which the washing water is supplied to flow control valve 517. The feed-water inlet is joined to connection tube 802 communicated with water supply joint 817 of support unit 810 (FIG. 16).

[0132] The following description is about coupling part 850, which is composed of coupling member 842 of nozzle cover 840 and coupling receiving part 851 of nozzle body 830.

[0133] As shown in FIGS. 22 and 28, nozzle body 830 is equipped, on the right side of the rear end outer periphery, with coupling receiving part 851. Coupling receiving part 851 has two roughly V-shaped grooves, which are front recess 851a and rear recess 851b formed with a space in-between in the back-and-forth direction. The space between these recesses 851a and 851b is

equal to the space between anal-cleaning-water jet orifice 834 and bidet water jet orifice 836.

[0134] Meanwhile, coupling member 842 of nozzle cover 840 is a roughly cylindrical member molded from resin. Coupling member 842 is equipped, on both of its rear sides, with coupling piece 843 projecting rearward. Coupling piece 843 is equipped, on its rear end, with coupling projection 843a, which is roughly V-shaped and projecting inward.

[0135] When nozzle body 830 is inserted in nozzle cover 840, the elasticity of coupling member 842 of nozzle cover 840 allows coupling projection 843a to be constantly pushed against coupling receiving part 851 of nozzle body 830.

[0136] When coupling projection 843a is engaged with either front recess 851a or rear recess 851b, nozzle body 830 and nozzle cover 840 are coupled together. As a result, nozzle cover 840 can be moved by being pulled by nozzle body 83.

[0137] As shown in FIG. 22, when coupling projection 843a is inside front recess 851a, bidet water jet orifice 836 of nozzle body 830 is aligned with jet opening 844 of nozzle cover 840 as shown in FIG. 26.

[0138] As shown in FIG. 28, when coupling projection 843a is inside rear recess 851b, anal-cleaning-water jet orifice 834 is aligned with jet opening 844 as shown in FIGS. 19 and 24.

6. The Control and Operation of the Washing Part

[0139] FIG. 29 is a time chart of washing part 500 in the initial use in the first exemplary embodiment of the present disclosure. FIG. 30 is a time chart of washing part 500 in the ordinary use.

[0140] Washing part 500 has the following basic operations. The tap water in the water service pipe is supplied as the washing water to water supply connection unit 510. Waterproof solenoid valve 514 is opened to supply the washing water into sub tank 600. The flow of the washing water through the path is kept constant by constant flow valve 513. Waterproof solenoid valve 514 is driven in response to the user's operation through at least one of remote controller 400 and operation unit 210 under the control of control unit 130.

[0141] The washing water supplied into sub tank 600 is trapped there and is then supplied to heat exchanger 700 and water pump 516. When water pump 516 is driven, the washing water passes through flow control valve 517 and is supplied to nozzle device 800.

[0142] Water pump 516 is driven in response to the user's operation through at least one of remote controller 400 and operation unit 210 under the control of control unit 130. Control unit 130 drives water pump 516 and turns on flat heater 702 of heat exchanger 700 so as to start to heat the washing water.

[0143] Control unit 130 receives detection information from supplied-water temperature sensor 630 and heated-water temperature sensor 730 and controls the cur-

rent to flat heater 702. As a result, the washing water is maintained at the temperature set through water temperature switch 231 of operation unit 210.

[0144] Control unit 130 then controls flow control valve 517 based on the operation information of at least one of operation unit 210 and remote controller 400, so that the washing water can be supplied to one of anal cleaning nozzle 831, bidet nozzle 832, and nozzle cleaning unit 833 of nozzle device 800. As a result, the washing water is jetted from one of anal-cleaning-water jet orifice 834, bidet water jet orifice 836, and nozzle-cleaning-water jet port 838.

[0145] The following is a detailed description of the control (especially water level detection and flow detection) of sub tank 600, which is a characteristic feature of the present exemplary embodiment.

[0146] FIG. 29 is a time chart of each function of washing part 500 when washing part 500 contains no water because it is used for the first time either after the installation of apparatus 100 or after water drainage to prevent freezing.

[0147] Assume that a cleaning switch (e.g., anal cleaning switch 221 or 410) is operated through operation unit 210 or remote controller 400 at time point P1. In this case, control unit 130 turns on waterproof solenoid valve 514 so as to start to supply the washing water. At the same time, control unit 130 activates water level sensor 620. Sensor 620 continues to operate until the anal cleaning is stopped at time point P14.

[0148] When water level sensor 620 detects that the water has reached the upper limit at time point P2, control unit 130 starts to count time. When a predetermined time has passed at time point P3, control unit 130 turns off waterproof solenoid valve 514 to stop supplying the washing water. In the present exemplary embodiment, the power supply is stopped two seconds after it is detected that the water has reached the upper limit.

[0149] At time point P2 when it is detected that the water has reached the upper limit, sub tank 600 and heat exchanger 700 are basically filled with the washing water. However, continuing the water supply for two more seconds can ensure that heat exchanger 700 and water pump 516 are filled with the washing water.

[0150] This ensures heat exchanger 700 to contain no air and to be filled with the washing water. This certainly prevents heat exchanger 700 from being heated without water, thereby improving safety and durability. Furthermore, when filled with the washing water, water pump 516 can start its water supply function without fail.

[0151] At time point P3 when waterproof solenoid valve 514 is turned off, control unit 130 activates water pump 516 and turns on flow control valve 517 to start to supply the washing water to anal cleaning water path 835 of nozzle part 820.

[0152] Driving water pump 516 decreases the water level of sub tank 600. At time point P4 when water level sensor 620 detects that the water is below the upper limit, control unit 130 activates heat exchanger 700. The de-

tection of a decrease in the water level indicates that water pump 516 is operating properly. This prevents heat exchanger 700 from, for example, being heated to an abnormally high temperature.

[0153] The washing water supplied to anal cleaning water path 835 is jetted from anal-cleaning-water jet orifice 834. The jetted washing water passes through jet opening 844 and is reflected by the inner surface of holding part 816 provided at the tip of support unit 810, thereby cleaning the outer surface of nozzle cover 840. This cleaning process is referred to as a pre-cleaning process. The pre-cleaning process is continued until time point P5, which is two seconds after the water heated by heat exchanger 700 reaches 25°C.

[0154] When the pre-cleaning process is finished at time point P5, control unit 130 activates cleaning nozzle driver 860 of nozzle device 800, so that nozzle part 820 can be advanced from the stored position to the anal cleaning position. During this travel of nozzle part 820, flow control valve 517 is switched so that the washing water can be supplied to nozzle-cleaning path 839. The washing water supplied to path 839 is jetted from nozzle-cleaning-water jet port 838 into nozzle cover 840. The jetted washing water cleans the inner surface of nozzle cover 840 and is discharged from drain 845 to the outside of nozzle cover 840. In the meantime, nozzle part 820 is warmed by the washing water and avoids jetting cold water at the subsequent anal cleaning process, which would make the user feel uncomfortable.

[0155] At time point P6 when nozzle part 820 reaches the anal cleaning position, control unit 130 switches flow control valve 517 and starts to supply the washing water to anal cleaning water path 835. The washing water supplied to path 835 is jetted from anal-cleaning-water jet orifice 834, passes through jet opening 844, and cleans the user's privates. The anal cleaning process is continued until time point P11 when the cleaning process is stopped.

[0156] While heat exchanger 700 is in operation, control unit 130 maintains the washing water at a temperature determined based on detection data received from supplied-water temperature sensor 630 and heated-water temperature sensor 730.

[0157] Continuing to drive water pump 516 decreases the water level of sub tank 600. At time point P7 when water level sensor 620 detects that the water has reached the lower limit, control unit 130 turns on waterproof solenoid valve 514. Valve 514 is powered until time point P8 when water level sensor 620 detects that the water has reached the upper limit.

[0158] At time point P8 when it is detected that the water has reached the upper limit, control unit 130 turns off waterproof solenoid valve 514 and starts to count time. Control unit 130 counts the time elapsed until time point P9 when water level sensor 620 detects that the water has reached the lower limit. At time point P9, control unit 130 calculates the flow based on the counted elapsed time and the amount of water (65 cc) contained between

the upper limit and the lower limit. At time point P10 when the calculation is finished, if there is a difference between the flow set at each water pressure and the calculated flow, control unit 130 adjusts the output of water pump 516 so as to adjust the flow of the washing water.

[0159] At time point P11 when the cleaning process is stopped via operation unit 210 or remote controller 400, the power supply to water pump 516 and heat exchanger 700 is stopped. At the same time, cleaning nozzle driver 860 of nozzle device 800 starts to retract nozzle part 820 from the anal cleaning position to the stored position.

[0160] At time point P12 when nozzle part 820 has been retracted to the stored position, cleaning nozzle driver 860 of nozzle device 800 is stopped. At the same time, water pump 516 and heat exchanger 700 are activated again to perform a post-cleaning process for cleaning nozzle part 820. When a predetermined time has elapsed after this, water pump 516 and heat exchanger 700 are stopped to terminate the post-cleaning process at time point P13.

[0161] At time point P13 when the post-cleaning process for nozzle part 820 has been terminated, waterproof solenoid valve 514 is turned on again to supply the washing water to sub tank 600. At time point P14 when it is detected that the water has reached the upper limit, waterproof solenoid valve 514 is turned off. Thus, the series of controls for the anal cleaning process is terminated, and the washing part enters the standby state with the water filled to the upper limit in sub tank 600.

[0162] FIG. 30 is a time chart of washing part 500 in the ordinary use in the first exemplary embodiment of the present disclosure when apparatus 100 placed in the standby state performs a cleaning process.

[0163] The operation in the ordinary use is significantly different from that in the initial use shown in FIG. 29 as follows. At time point P20 when the cleaning process is performed, sub tank 600 is already filled with water, and control unit 130 remembers that apparatus 100 has gone through the initial use.

[0164] As shown in FIG. 30, at time point P20 when sub tank 600 is in the standby state and filled with water, and a cleaning switch (e.g., anal cleaning switch 221, 410) of operation unit 210 or remote controller 400 is operated, control unit 130 turns on the water pump 516 to supply the washing water. At the same time, control unit 130 also turns on heat exchanger 700 based on the stored data containing the control data in the initial use. Also, at the same time, the pre-cleaning process of nozzle device 800 and water level sensor 620 are started.

[0165] The control in the ordinary use differs from that in the previously described initial use after the time point when the cleaning process is performed until the time point when heat exchanger 700 is turned on. At and after time point P5 when nozzle device 800 is activated, the control and operation are identical to those in the initial use.

[0166] As described so far, washing part 500 of apparatus 100 does not have a flow sensor dedicated to de-

tecting the flow. Instead, the water level sensor in sub tank 600 detects the water level from which the flow is calculated. As a result, washing part 500 has a simplified configuration and is cost effective.

[0167] To detect the water level, a change in the output voltage between the electrodes is determined by a threshold. The threshold can be adjusted depending on the temperature. This configuration improves the detection accuracy of the water level and the flow, allowing water with a wide range of electrical conductivities to be used as the washing water in the sanitary washing apparatus. This enables apparatus 100 to have a wider range of application and to be easier to use.

[0168] Furthermore, heat exchanger 700 can be prevented from being heated without water as follows. In the initial use of apparatus 100, after sub tank 600 is detected to be filled with water, more water is supplied for a predetermined time. After the water pump is turned on and then the water level sensor detects that the water is below the upper limit, heat exchanger 700 is turned on. This ensures safety and reliability with a simpler configuration and lower cost than the widely-used approach to the prevention of heat exchanger 700 from being heated without water by using the flow sensor.

7. The Control and Spraying Operation of the Spray Nozzle into the Inner Surface of the Toilet Bowl

[0169] FIG. 31 is an external perspective view of spray nozzle 550 in the first exemplary embodiment of the present disclosure. FIG. 32 is a sectional view of nozzle 550. FIG. 33 is a longitudinal sectional view of installed nozzle 550. FIG. 34 is a front view of installed nozzle 550. FIG. 35 is a plan view of installed nozzle 550 and the rotation angles of the outlet orifice of nozzle 550. FIG. 36 is a chart showing the pump output at different rotation angles of outlet orifice 550u of nozzle 550.

[0170] As shown in FIG. 32, in spray nozzle 550, rotary nozzle 550d is sealed with O rings 550e and 550f into body 550c including inlet path 550b. Rotary nozzle 550d can be rotated by spray nozzle driver 550a, which is a motor. O ring 550f can be replaced by an X ring to reduce the torque necessary for rotation and to prevent adhesion between body 550c and rotary nozzle 550d, thereby allowing spray nozzle driver 550a to have a low torque. Spray nozzle driver 550a has shaft 550n fitted into rotary nozzle 550d.

[0171] The washing water or washing foam supplied through inlet path 550b of body 550c passes through a plurality of inlet holes 550h around rotary nozzle 550d and is sprayed from outlet orifice 550u.

[0172] As shown in FIGS. 34 and 35, spray nozzle 550 is located on the right side of the center of body 200. The reason for this is that the cleaning nozzle for cleaning human privates such as anal cleaning nozzle 831 is preferentially located at the center, thereby forcing spray nozzle 550 to be located either on the right or left side of the cleaning nozzle.

[0173] When the user enters the toilet room, control unit 130 of apparatus 100 operates as follows. Control unit 130 makes human body detection sensor 450 detect the user's entry. Control unit 130 then goes into a rotary foam-spraying (foam coating) mode. In this mode, control unit 130 sprays the washing foam into bowl 110 while rotating the orientation of outlet orifice 550u. Control unit 130 also turns on water pump 516 and opens opening/closing valve 530a.

[0174] In this case, flow control valve 517, which switches between anal cleaning nozzle 831, bidet nozzle 832, and nozzle cleaning unit 833, is in the closed state. As a result, the washing water coming from heat exchanger 700 passes through branch path 530, check valve 531, and foam tank 532, and is sprayed from spray nozzle 550 onto the inner surface of bowl 110.

[0175] At this moment, control unit 130 makes spray nozzle driver 550a rotate the orientation of outlet orifice 550u of spray nozzle 550. The washing water or washing foam sprayed from outlet orifice 550u is formed into water film or foam film over the entire periphery of the inner surface of bowl 110.

[0176] As shown in FIG. 35, the distance between spray nozzle 550 and the inner surface of bowl 110 differs depending on the rotation angle and orientation of outlet orifice 550u of spray nozzle 550. As shown in FIG. 36, control unit 130 changes the output of water pump 516 according to the rotation angle of outlet orifice 550u.

[0177] In apparatus 100, the distance from outlet orifice 550u to the bowl inner surface is longest when orifice 550u is at a rotation angle of 160 degrees, and is the shortest when orifice 550u is at a rotation angle of 340 degrees.

[0178] When human body detection sensor 450 detects that the user enters the toilet room, control unit 130 changes the output of water pump 516 according to the rotation angle of orifice 550u as shown in the chart of FIG. 36.

[0179] Thus the amount (and speed) of the washing water or washing foam sprayed from orifice 550u is controlled as follows. The pump output is largest when the rotation angle is around 160 degrees where the distance from orifice 550u to the bowl inner surface is longest. Meanwhile, the pump output is smallest when the rotation angle is around 340 degrees where the distance from orifice 550u to the bowl inner surface is shortest.

[0180] Hence, when sprayed to the front of the bowl, which is farthest from orifice 550u, the washing water is sprayed at the highest pressure to reach there. Meanwhile, when sprayed to the back of bowl 110, which is nearest from orifice 550u, the washing water is sprayed at the smallest pressure to prevent water splash or other problems. At the smallest pressure, the washing water or washing foam can be sprayed to reach the entire inner surface of the bowl and be formed into water film or foam film over the entire inner surface so as to reduce stain adsorption.

[0181] In this manner, the washing foam is sprayed

into bowl 110 when human body detection sensor 450 detects that the user enters the toilet room or when spray switch 417 is operated through operation unit 210 or remote controller 400.

[0182] When the washing foam is sprayed into the bowl in response to the above-mentioned signal for spraying the washing foam into the bowl, control unit 130 controls at least two rounds of rotation as a foam spraying process as follows, while changing the output of discharge water amount variable unit 516. As shown in FIG. 36, control unit 130 first makes spray nozzle driver 550a rotate the orientation of outlet orifice 550u of the spray nozzle forward from the back to the front of the bowl, and then returns to the back of the bowl. After this, control unit 130 makes spray nozzle driver 550a rotate the orientation of outlet orifice 550u backward from the back to the front of the bowl, and then returns to the back of the bowl.

[0183] Thus, the output of the discharge water amount variable unit is controlled so that the washing foam can reach the vicinity of the rim of bowl 110. As a result, the washing foam can be sprayed onto almost the entire periphery of the bowl inner surface and can be formed into foam film covering from the front to the back of the bowl inner surface, thereby reducing stain adsorption.

[0184] In this case, as shown in FIG. 36, control unit 130 may control the spray of the washing foam in such a manner that the output of the discharge water amount variable unit can be lower when spray nozzle driver 550a is rotated forward than it is rotated backward.

[0185] When the output of the discharge water amount variable unit is increased, the washing foam can be sprayed at a higher pressure, and hence, farther from spray nozzle 550. Meanwhile, when the output of the discharge water amount variable unit is decreased, the washing foam can be sprayed at a lower pressure, and hence, nearer from spray nozzle 550.

[0186] Consequently, when the orientation of outlet orifice 550u is rotated forward as shown by the dotted line in FIG. 35 representing a spray trajectory, the washing foam is sprayed onto the water surface inside the rim of bowl 110. When the orientation of outlet orifice 550u is rotated backward as shown by the broken line in FIG. 35 representing another spray trajectory, the washing foam is sprayed to the vicinity of the rim of bowl 110.

[0187] This enables the water surface of the outlet hole of bowl 110 to be coated with the washing foam at an early stage of the spraying process. Furthermore, the washing foam can be sprayed onto almost the entire periphery of the bowl inner surface up to the rim. As a result, foam film can be formed from the front to the back of the bowl inner surface, thereby reducing stain adsorption.

[0188] Spray nozzle 550 is located ahead of body 200 mounted on bowl 110 as shown in FIGS. 2, 33, 34, and 35. In addition, spray nozzle 550 is located far more ahead of the front end of cleaning nozzle 831 stored in nozzle device 800. Consequently, the orientation of outlet orifice 550u of the spray nozzle can be rotated to spray the washing foam as far as the back of the bowl. The

washing foam is formed into foam film covering from the front to the back of the bowl inner surface, thereby reducing stain adsorption.

[0189] In the above description, the forward rotation is a clockwise rotation whereas the backward rotation is a counterclockwise rotation when seen from above in FIG. 35. Alternatively, the forward rotation may be a counterclockwise rotation whereas the backward rotation may be a clockwise rotation. In short, the direction in which the orientation of outlet orifice 550u starts to rotate at the time of spraying is defined as the forward direction whereas the direction in which the orientation of outlet orifice 550u returns is defined as the backward direction.

[0190] In the above description, the output of water pump 516 is changed when the washing foam is sprayed into bowl 110 while the orientation of outlet orifice 550u of spray nozzle 550 is being rotated. However, the present disclosure is not limited to this. Instead of changing the output of water pump 516, spray nozzle 550 can be structured as follows in order to form foam film covering from the front to the back of the bowl inner surface to reduce stain adsorption.

[0191] As shown in FIGS. 33 and 34, spray nozzle 550 is installed in body 200 in such a manner that the rotation axis Ax of outlet orifice 550u can be inclined back and forth and side to side while spray nozzle 550 is being rotated. When inclined back and forth, the rotation axis Ax is inclined with its bottom toward the front of bowl 110. When inclined side to side, the rotation axis Ax is inclined with its bottom toward cleaning nozzle 831. With this configuration, when orifice 550u faces the front of bowl 110 and the distance is large between orifice 550u and the position to be sprayed, orifice 550u is inclined high. This allows the washing foam to be sprayed to the vicinity of the front rim of bowl 110. Meanwhile, when orifice 550u faces the back of bowl 110 and the distance is short between orifice 550u and the position to be sprayed, orifice 550u is inclined low.

[0192] When orifice 550u faces the left of bowl 110 and the distance is slightly large between orifice 550u and the position to be sprayed, orifice 550u is inclined slightly high. This allows the washing foam to be sprayed to the vicinity of the left-hand rim of bowl 110. Meanwhile, when orifice 550u faces the right of bowl 110 and the distance is slightly short between orifice 550u and the position to be sprayed, orifice 550u is inclined slightly low.

[0193] In this manner, when the washing foam is sprayed into bowl 110 while spray nozzle 550 is being rotated, spray nozzle driver 550a rotates the orientation of outlet orifice 550u around the rotation axis Ax. Along with the rotation of spray nozzle 550, the distance from outlet orifice 550u to the bowl inner surface is changed, and in addition, the height of outlet orifice 550u spraying the washing foam is also changed. This enables the formation of foam film from the front of the bowl as far as the back rim of the inner surface, with the spray trajectory shown by the backward broken line in FIG. 35. This can reduce stain adsorption from the front to the back of the

bowl inner surface.

[0194] The rotary foam-spraying is performed with the output of water pump 516 kept constant. Hence, when the rotary foam-spraying is performed forward, the same spray trajectory as that shown by the backward broken line of FIG. 35 is tracked in the opposite direction.

[0195] In the present exemplary embodiment, the rotation axis Ax of outlet orifice 550u can be inclined back and forth within an angle β of 20 degrees (with respect to the vertical direction) as shown in FIG. 33, and can be inclined side to side within an angle γ of 10 degrees (with respect to the perpendicular direction) as shown in FIG. 34. The height of outlet orifice 550u is lower than the upper edge of bowl 110 wherever outlet orifice 550u is located during the rotation.

[0196] As described above, control unit 130 changes the pump output according to the rotation angle of outlet orifice 550u of spray nozzle 550. In this configuration, regardless of the distance between orifice 550u and each of the front, side, and back of the bowl, the washing water or washing foam can be sprayed to a large area of the bowl inner surface. As a result, water film or foam film can be formed in a large area of the bowl inner surface to reduce stain adsorption.

[0197] It is possible to provide a level selector switch for increasing or decreasing the above-mentioned pump output level (average level) in at least one of operation unit 210 and remote controller 400. With the level selector switch, the washing water or washing foam can be sprayed throughout the bowl inner surface regardless of the size of bowl 110. As a result, water film or foam film can be formed from the front to the back of the bowl inner surface, thereby reducing stain adsorption.

[0198] As described above, control unit 130 can change the pump output according to the rotation angle of outlet orifice 550u of spray nozzle 550. In addition to this, control unit 130 may change the speed of spray nozzle driver 550a according to the rotation angle of outlet orifice 550u. When the output of water pump 516 can be changed, the water pressure can be changed so that the washing water can reach farther on the bowl inner surface and can be prevented from splashing at the area of the bowl inner surface that is near outlet orifice 550u. Furthermore, when the speed of spray nozzle driver 550a can be changed according to the rotation angle of outlet orifice 550u, spraying is performed more evenly.

[0199] In other words, when the orientation of outlet orifice 550u is rotated at a constant speed, spraying density is thin when the distance is large between outlet orifice 550u and the position to be sprayed on the bowl inner surface, and is thick when the distance is small.

[0200] Thus, changing the output of water pump 516 can make spray distribution uniform. Meanwhile, changing the speed of spray nozzle driver 550a according to the rotation angle can achieve uniform spraying to the bowl inner surface.

[0201] This will be explained based on the rotation angle shown in FIG. 35. Assume that the washing water or

washing foam is sprayed to the front of the bowl at around a rotation angle of 160 degrees, which is farthest from the outlet orifice 550u. In this case, the spraying density is thin because the washing water or foam is scattered; however, spray nozzle 550 can be rotated at the lowest speed, to increase the spraying density. Meanwhile, assume that the washing water or washing foam is sprayed to the back of the toilet bowl at around a rotation angle of 340 degrees, which is nearest from outlet orifice 550u. In this case, spray nozzle 550 can be rotated at the highest speed to decrease the spraying density. Thus, the washing water or washing foam can be sprayed more evenly onto the bowl inner surface so as to reduce stain adsorption.

[0202] Thus, control unit 130 changes the speed of spray nozzle driver 550a according to the rotation angle of outlet orifice 550u. To be more specific, when outlet orifice 550u is at a rotation angle at which it faces the front of the bowl and is distant from the bowl inner surface, spray nozzle driver 550a can be rotated at low speed. Meanwhile, when outlet orifice 550u is at a rotation angle at which it faces the back of the bowl and is near from the bowl inner surface, spray nozzle driver 550a can be driven at high speed. In this configuration, regardless of the distance between outlet orifice 550u and each of the front, side, and back of the bowl, the washing water or washing foam can be sprayed evenly throughout the bowl inner surface. As a result, water film or foam film can be formed evenly as far as the front of the bowl inner surface so as to reduce stain adsorption.

[0203] When human body detection sensor 450 detects that the user enters the toilet room, control unit 130 allows the washing foam to be sprayed onto the bowl inner surface while making spray nozzle driver 550a rotate rotary nozzle 550d at least two rounds. Control unit 130 then stops the spraying process.

[0204] As a result, when the user enters the toilet room, foam film can be formed on the bowl inner surface before the user uses the toilet, thereby reducing stain adsorption. The number of rotation of outlet orifice 550u to spray the washing water or washing foam onto the bowl inner surface is not limited to the two rounds as long as the washing water or washing foam can be sufficiently spread out. The number of rounds can be chosen by the user through at least one of operation unit 210 and remote controller 400.

[0205] When the washing water or washing foam is sprayed onto the bowl inner surface, rotary nozzle 550d of spray nozzle 550 is rotated a plurality of rounds as shown in FIG. 36 in different directions. If rotary nozzle 550d were rotated either forward or backward, the washing water or washing foam would be sprayed in the same direction each time. In contrast, when rotary nozzle 550d is rotated both forward and backward, the washing water or washing foam can be sprayed in opposite directions. The spraying in the two opposite directions can sufficiently spread out the washing water or washing foam, thereby reducing the area that remains unsprayed. Consequent-

ly, stain adsorption can be reduced by a fewer number of rounds (in a shorter time) of spraying.

[0206] The chart of FIG. 36 shows that the orientation of outlet orifice 550u is rotated forward from 0 degrees, which corresponds to the back of the bowl, to 340 degrees first, and then backward from 340 degrees to 0 degrees.

[0207] Rotary nozzle 550d of spray nozzle 550 includes a rotation restrictor (not shown), which restricts the rotation range between 0 degrees and 340 degrees using a mechanical stopper.

[0208] The rotation restrictor (not shown) functions as follows. Rotary nozzle 550d has a projection on its outer periphery, and the projection rotates with rotary nozzle 550d. When the projection comes into contact with the rotation restriction wall of body 550c, the motor (spray nozzle driver 550a) rotating rotary nozzle 550d slips and runs idle because rotary nozzle 550d is in mechanical contact with the rotation restriction wall. As a result, rotary nozzle 550d is prevented from rotation.

[0209] Thus, spray nozzle 550 is rotated in opposite directions outside the range restricted by the rotation restrictor. The spraying in the forward and backward directions can sufficiently spread out the washing water or washing foam, thereby reducing the area that remains unsprayed. Consequently, stain adsorption can be reduced by a fewer number of rounds (in a shorter time) of spraying.

[0210] Furthermore, spray nozzle driver 550a, which is composed of a motor, can recognize the home position of rotation where the rotation restrictor comes into contact with the rotation restriction wall of body 550c. This improves the accuracy of the angle and speed of rotation, thereby providing significantly stable spray.

[0211] As described in the water circuit configuration with reference to FIG. 6, branch path 530 connected between water pump 516 and flow control valve 517 in washing water supply path 690 is connected to foam tank 532 so that the washing water can be supplied there via opening/closing valve 530a and check valve 531. Spray nozzle 550 is connected to the downstream of foam tank 532. Foam tank 532, which is connected to detergent tank 533 and detergent pump 534 for supplying detergent, contains air pump 535 for supplying air to foam tank 532 to generate the washing foam.

[0212] When control unit 130 opens opening/closing valve 530a, the washing water coming from heat exchanger 700 is supplied to spray nozzle 550 by water pump 516. As a result, the washing water or washing foam is sprayed from spray nozzle 550. In this case, the outputs of water pump 516 and air pump 535 are increased or decreased so as to increase or decrease the amount and force (speed and pressure) of the washing water or washing foam sprayed from spray nozzle 550.

[0213] The configuration with opening/closing valve 530a in branch path 530 may be replaced by the configuration with a path switching valve at the branch point between branch path 530 and washing water supply path

690.

[0214] Which of the washing water and washing foam should be sprayed from spray nozzle 550 can be chosen by the user through at least one of operation unit 210 on body 200 and remote controller 400.

[0215] Foam tank 532 for generating the washing foam from the supplied detergent is provided between opening/closing valve 530a and spray nozzle 550. The washing foam is sprayed from outlet orifice 550u onto the bowl inner surface. With this configuration, the bowl inner surface is coated with water film made of not just (hot) water, but detergent foam. This further improves the effect of reducing stain adsorption.

[0216] Moreover, the foam film made of the detergent foam can reduce odor and visually create a hygienic impression.

[0217] In apparatus 100 of the present exemplary embodiment, the washing water or washing foam can be sprayed from spray nozzle 550 onto the bowl inner surface not only when human body detection sensor 450 detects the user's entry, but also when operation unit 210 or spray switch 417 of remote controller 400 is operated.

[0218] Consequently, whenever the user is concerned about stain, foam film made of the detergent foam can be sprayed to keep bowl 110 clean.

[0219] Which of the washing water and washing foam should be sprayed from spray nozzle 550 onto the bowl inner surface can be freely chosen by the user by previously selecting the spray selection switch (not shown) of at least one of operation unit 210 and remote controller 400.

[0220] Control unit 130 has a rinse mode, which can be selected using a switch button of at least one of operation unit 210 and remote controller 400. In the rinse mode, control unit 130 may open opening/closing valve 530a while detergent pump 534, which supplies the detergent in detergent tank 533 of foam generator 560 to foam tank 532, is in the stopped state. This allows the washing water to be supplied by discharge water amount variable unit 516 into foam tank 532 and be sprayed from spray nozzle 550.

[0221] With this configuration, the washing water can rinse the passage leading from foam tank 532 to spray nozzle 550. This prevents residual detergent from clogging the passage and spray nozzle 550 and also from causing improper rotation of spray nozzle 550. The washing water can further rinse the bowl inner surface.

[0222] Thus, the rinsing process is performed with detergent pump 534 stopped, allowing foam tank 532 to be supplied with the washing water without detergent. As a result, the washing water can rinse the passage leading from foam tank 532 to spray nozzle 550, and can further rinse the bowl inner surface.

[0223] This rinsing process can be performed using temperature-uncontrolled washing water, but can provide better performance by setting the temperature of the washing water from heat exchanger 700 at about 40°C.

[0224] The user can set the rinse mode by operating

rinse switch 223 of operation unit 210 to perform the rinsing process whenever desired.

[0225] To set the rinse mode, it is possible to provide rinse lamp 223a (FIG. 4) such as an LED near rinse switch 223 of operation unit 210. In this case, rinse lamp 223a may be automatically flashed by control unit 130 when a predetermined time (e.g., 20 days) has passed after the last rinsing process. This can prevent the rinsing process from being forgotten.

[0226] Alternatively, when the washing foam is sprayed from spray nozzle 550 onto the bowl inner surface, control unit 130 may change the output of air pump 535 according to the rotation angle of outlet orifice 550u in the same manner as the above-described pump output shown in FIG. 36. In this configuration, regardless of the distance between outlet orifice 550u and each of the front, side, and back of the bowl, the washing foam can be sprayed throughout the bowl inner surface. As a result, foam film can be formed to the front of the bowl inner surface to reduce stain adsorption.

[0227] Thus, the output of air pump 535 is largest when outlet orifice 550u is at a rotation angle of about 160 degrees, where the distance from orifice 550u to the bowl inner surface is longest. In this case, air pump 535 has high pressure, allowing the washing foam to be sprayed at high pressure to reach an area far from orifice 550u. Meanwhile, the output of air pump 535 is smallest when orifice 550u is at a rotation angle of about 340 degrees, where the distance from orifice 550u to the bowl inner surface is shortest. In this case, air pump 535 has low pressure, allowing the washing foam to be sprayed at low pressure to reach an area near from orifice 550u. Thus, the washing foam can be sprayed evenly to the bowl inner surface.

[0228] It is also possible to provide a stain detector (not shown) for detecting stain on bowl 110 using, for example, an image sensor. In this case, control unit 130 makes spray nozzle 550 move back and forth through the stained area for intensive spraying to achieve effective stain reduction. Instead of making spray nozzle 550 move back and forth through the stained area, it is possible to reduce the rotation speed of outlet orifice 550u or to increase the pump output in the stained area.

8. The Control and Operation of the Spray Nozzle when the Toilet Seat is Open with Nobody Sat on the Seat

[0229] The following is a description of a case in which the spray switch of operation unit 210 or remote controller 400 is operated when toilet seat 300 is open nearly vertically as when a man urinates.

[0230] In this case, the user is standing and seat 300 is open. Hence, the signal of seat lid opening/closing detector 331 indicates that the seat is open, and the signal of seating detector 330 indicates that nobody is sat on the seat.

[0231] When the user presses spray switch 417, as shown in FIG. 37, control unit 130 makes spray nozzle

driver 550a rotate the orientation of outlet orifice 550u of spray nozzle 550 until orifice 550u faces outlet hole 115 of the toilet. In the present exemplary embodiment, this position is where orifice 550u is at around 20 degrees as shown in the chart of FIG. 37. After this, discharge water amount variable unit 516 is controlled with an intermediate output, and the washing foam is sprayed into outlet hole 115 of the bowl as shown by the arrow of FIG. 37 for a predetermined time (eight seconds in the present exemplary embodiment). The sprayed washing foam covers the water surface in outlet hole 115 of bowl 110.

[0232] In the rotary foam-spraying (foam coating) mode of control unit 130 describe in the above section 7, the washing foam is sprayed onto the bowl while the orientation of outlet orifice 550u of spray nozzle 550 is being rotated. In contrast, in the present section 8, control unit 130 is placed in a fixed foam-spraying (splash reduction) mode. In this mode, the washing foam is sprayed into bowl 110, with the orientation of outlet orifice 550u of spray nozzle 550 fixed in a direction.

[0233] Assume that when the user is not seated on seat 300 as when a man urinates, and seat 300 is opened nearly vertically, manual urine splash reduction switch 434, which is a spray switch of operation unit 210 or remote controller 400, is operated. In this case, as shown in FIG. 37, control unit 130 makes spray nozzle driver 550a rotate the orientation of outlet orifice 550u until orifice 550u faces the back of the bowl. In the present exemplary embodiment, this position is where orifice 550u is at around 20 degrees as shown in the chart of FIG. 37. After this, discharge water amount variable unit 516 is controlled with a high output, and the washing foam is sprayed onto the back of the bowl as shown by the arrow of FIG. 37 for a predetermined time (eight seconds in the present exemplary embodiment).

[0234] In this case, outlet orifice 550u faces an angle α rearward with respect to the rotation axis Ax of spray nozzle 550 as shown in the sectional view of FIG. 33. As a result, the washing foam is sprayed with outlet orifice 550u fixed in the orientation of outlet orifice Ac (b) of FIG. 33.

[0235] Thus, the orientation of orifice 550u is rotated until orifice 550u faces the back of the bowl, and then discharge water amount variable unit 516 is controlled with a high output. As a result, the washing foam can quickly cover the water surface and the waterline in outlet hole 115 of the bowl. This allows the washing foam to reduce odor and stain adsorption around the water surface of the bowl. In addition, the washing foam covering the water surface serves as a cushion to reduce the splashing of urine falling onto the water surface of the bowl. Thus, a large amount of the washing foam is quickly sprayed onto the water surface of bowl 110 in the direction in which spray nozzle 550 is fixed so as to reduce urine splash.

[0236] In the present exemplary embodiment, when the user operates manual urine splash reduction switch 434 of remote controller 400 before urination, control unit

130 goes into the fixed foam-spraying (splash reduction) mode. In this mode, spray nozzle driver 550a rotates the orientation of outlet orifice 550u until orifice 550u faces outlet hole 115 of the toilet. After this, discharge water amount variable unit 516 is controlled with a high output so as to spray the washing foam toward the back of the bowl. Alternatively, however, the washing foam may be exclusively sprayed to any of the front, center, and back of outlet hole 115 of the bowl.

[0237] Thus, the washing foam can cover the water surface and the waterline in the bowl within as short a time as several seconds so as to reduce urine splash. This can also reduce stain adsorption around and over the waterline in bowl 110.

[0238] In the above-described fixed foam-spraying (splash reduction) mode, the washing foam is sprayed into bowl 110 with the orientation of outlet orifice 550u fixed in the predetermined direction. In this case, as shown in FIG. 37, discharge water amount variable unit 516 is controlled with a high output so that the washing foam can be sprayed to reach outlet hole 115 of bowl 110. Alternatively, however, water pump 516 may have a constant output in the same manner as the rotary foam-spraying described in the section 7 above.

[0239] Thus, the sanitary washing apparatus according to the present exemplary embodiment includes the following: body 200 placed on bowl 110; cleaning nozzle 831 for cleaning a human body; foam generator 560 for generating washing foam; spray nozzle 550 for spraying washing water or the washing foam onto the inner surface of the toilet bowl; a discharge water amount variable unit (water pump 516) capable of changing the flow of the washing water supplied to the spray nozzle; and spray nozzle driver 550a for rotating the orientation of outlet orifice 550u of the spray nozzle. The apparatus further includes the following: opening/closing valve 530a for opening and closing the water path to spray nozzle 550; control unit 130 for controlling the operations of these components; and operation unit 210 (or remote controller 400) for giving instructions to control unit 130.

[0240] Control unit 130 has the two modes: the rotary foam-spraying (foam coating) mode in which the washing foam is sprayed into bowl 110 while the orientation of outlet orifice 550u of spray nozzle 550 is being rotated, and the fixed foam-spraying (splash reduction) mode in which the washing foam is sprayed into the bowl while the orientation of orifice 550u is fixed in a direction.

[0241] With this configuration, when the washing foam is sprayed into bowl 110 from spray nozzle 550, the orientation of outlet orifice 550u is rotated so that the washing foam can reach every part inside the bowl. As a result, foam film can be formed from the front to the back of the bowl inner surface, thereby preventing stain adsorption on the bowl inner surface and around the waterline. Furthermore, in the fixed foam-spraying mode in which the washing foam is sprayed into the bowl with the orientation of orifice 550u fixed in a direction, the washing foam can quickly cover the water surface in outlet hole 115 of bowl

110. This allows the washing foam to reduce urine odor and urine splash.

[0242] Verification experiment results of urine splash prevention when a man urinates are shown in FIG. 49. As the results show, foam with a height (thickness) of about 5 mm is effective compared with the case of spraying no foam. Foam with a height (thickness) of about 10 mm has a significant effect. In short, the thickness of the foam sprayed onto the water surface of bowl 110 is preferably in the range of 5 mm to 50 mm, inclusive. When the foam thickness is 50 mm or less, the user's hips on the toilet seat can be prevented from touching the sprayed foam.

[0243] In apparatus 100 according to the present exemplary embodiment, spray nozzle 550 is installed in body 200 in such a manner that the rotation axis Ax of outlet orifice 550u can be inclined back and forth and side to side while spray nozzle 550 is being rotated. When inclined back and forth, the rotation axis Ax is inclined with its bottom toward the front of bowl 110. When inclined side to side, the rotation axis Ax is inclined with its bottom toward cleaning nozzle 831.

[0244] With this configuration, the washing foam is sprayed into bowl 110 from spray nozzle 550 as follows. When outlet orifice 550u faces the front of bowl 110 and the distance is large between orifice 550u and the position to be sprayed, orifice 550u is inclined high. Meanwhile, when orifice 550u faces the back of the bowl and the distance is short between orifice 550u and the position to be sprayed, orifice 550u is inclined low.

[0245] In this manner, the washing foam can be sprayed while the height of outlet orifice 550u is being changed according to the distance from orifice 550u to the inner surface of bowl 110. As a result, during the rotary foam-spraying, the sprayed foam can be formed into foam film covering from the front to the back of the bowl inner surface, without the need to change the output of water pump 516. This reduces stain adsorption.

[0246] In apparatus 100 according to the present exemplary embodiment, when the washing foam is sprayed into bowl 110 from spray nozzle 550 while spray nozzle 550 is being rotated, control unit 130 first makes spray nozzle driver 550a rotate the orientation of outlet orifice 550u forward from the back to the front of the bowl, and then returns to the back of the bowl. After this, control unit 130 makes spray nozzle driver 550a rotate the orientation of outlet orifice 550u backward from the back to the front of the bowl, and then returns to the back of the bowl. Thus, at least two rounds of rotation is performed as the rotary foam-spraying process.

[0247] Thus, when the washing foam is sprayed into bowl 110 while spray nozzle 550 is being rotated, control unit 130 makes spray nozzle driver 550a rotate the orientation of orifice 550u forward from the back to the front of the bowl, and then returns to the back of the bowl. After this, control unit 130 makes spray nozzle driver 550a rotate the orientation of orifice 550u backward from the back to the front of the bowl, and then returns to the back

of the bowl. In short, at least two rounds of rotation is performed. Thus, the output of the discharge water amount variable unit is controlled so that the washing foam can reach the vicinity of the rim of bowl 110. As a result, the washing foam can be sprayed to almost the entire periphery of the bowl inner surface and formed into foam film covering from the front to the back of the bowl inner surface, thereby reducing stain adsorption.

[0248] Apparatus 100 according to the present exemplary embodiment further includes human body detection sensor 450 for detecting that the user enters the toilet room. When sensor 450 detects the user's entry, control unit 130 allows the washing foam to be sprayed into bowl 110 by rotating the orientation of outlet orifice 550u at least two rounds as mentioned above.

[0249] With this configuration, when human body detection sensor 450 detects that the user enters the toilet room, the orientation of outlet orifice 550u is rotated at least two rounds while the washing foam is sprayed onto the inner surface of bowl 110. This ensures the formation of foam film onto the bowl inner surface before the user uses the toilet, thereby reducing stain adsorption.

[0250] Apparatus 100 according to the present exemplary embodiment further includes the following components: foam tank 532 into which the washing water is supplied by discharge water amount variable unit 516 when control unit 130 opens opening/closing valve 530a; detergent pump 534 for supplying the detergent of detergent tank 533 to foam tank 532; and air pump 535 for supplying air to the foam tank. This allows the washing water or washing foam of foam tank 532 to be sprayed from spray nozzle 550.

[0251] With this configuration, the surface of cleaning nozzle 831 or the bowl inner surface is sprayed with not just (hot) water but detergent foam. This improves the effect of cleaning, and hence, the effect of reducing stain adsorption. Moreover, the detergent foam can reduce odor and visually create a hygienic impression.

[0252] In apparatus 100 of the present exemplary embodiment, control unit 130 has the rinse mode. In the rinse mode, opening/closing valve 530a is opened while detergent pump 534, which supplies the detergent contained in detergent tank 533 of foam generator 560 to foam tank 532, is in the stopped state. This allows the washing water to be supplied to foam tank 532 by discharge water amount variable unit 516 and to be sprayed from spray nozzle 550.

[0253] With this configuration, the washing water can rinse the passage leading from foam tank 532 to spray nozzle 550. This prevents residual detergent from clogging the passage and spray nozzle 550, and also from causing improper rotation of spray nozzle 550. The washing water can further rinse the bowl inner surface.

[0254] In the present exemplary embodiment, spray nozzle driver 550a is a motor; however other driving sources may be used. For example, spray nozzle 550 may be rotated by the force produced when the washing foam is sprayed from outlet orifice 550u of spray nozzle

550.

[0255] Alternatively, it is possible to provide a plurality of spray nozzles 550 for spraying the washing foam: one near the rim of bowl 110 and another rear outlet hole 115 of bowl 110. These spray nozzles 550 can be rotated both separately and in conjunction with each other.

[0256] Still alternatively, spray nozzle 550 may have a plurality of outlet orifices 550u for spraying the washing foam: one near the rim of bowl 110 and another near outlet hole 115 of bowl 110.

[0257] Spray nozzle 550 in the present exemplary embodiment sprays the washing foam to two positions: near the rim of bowl 110 and near outlet hole 115 of bowl 110, but may further spray to another position.

[0258] As shown in FIGS. 34, 38, and 39, in apparatus 100 of the present exemplary embodiment, sleeve case 250 is integrally formed with body 200 and projects ahead along the right side of body 200. Sleeve case 250 includes sleeve lid 217, which is located ahead of operation unit 210 located at the top of sleeve case 250. Under sleeve lid 217, transparent or translucent detergent tank 533 of foam generator 560 is located at the front part of sleeve case 250. Sleeve case 250 has, on its front face, window 216 for detergent level observation, allowing the user to observe the level of the detergent in detergent tank 533.

[0259] With this configuration, the user can visually check the residual amount of the detergent and can refill it before running out.

[0260] Detergent tank 533, which has detergent inlet port 537 and detergent tank lid 536, is located at the front part of sleeve case 250, or in other words, ahead of operation unit 210. Thus, detergent tank 533 is located nearest to the front of the bowl and therefore is easy to refill the detergent. Furthermore, the detergent can be prevented from dropping onto operation unit 210 when sleeve lid 217 is opened to refill the detergent through detergent inlet port 537 into detergent tank 533.

[0261] As shown in FIGS. 38 and 39, detergent inlet port 537 is lower in height than operation unit 210. This can further prevent the detergent from dropping onto operation unit 210 when the detergent is refilled into detergent tank 533.

[0262] Apparatus 100 of the present exemplary embodiment further includes detergent pump hose 561 shown in FIGS. 6 and 38. Hose 561 is a cylindrical hollow tube for carrying the detergent from the outlet of detergent pump 534 to the inlet of foam tank 532. The tube is coated with another tube and is formed into a double hose. Detergent pump hose 561 has a smaller inner diameter than foam tank hose 562 for carrying the washing foam from foam tank 532 to spray nozzle 550.

[0263] With this configuration, even if high pressure is applied by detergent pump 534, detergent pump hose 561 is prevented from swelling and bursting. This allows spray nozzle 550 to stably spray the washing foam.

[0264] In apparatus 100 of the present exemplary embodiment, detergent pump hose 561 is a double hose

composed of an elastomer resin tube and a heat-shrink tube coating the resin tube, but the material is not limited to this. Double hoses made of other materials could be prevented from swelling and bursting, allowing spray nozzle 550 to stably spray the washing foam.

[0265] As known from FIGS. 2, 39, and 40, in apparatus 100 of the present exemplary embodiment, body 200, which includes control unit 130, spray nozzle 550, and nozzle device 800, has rear-body case 201 whose front face is covered with body case 202.

[0266] Spray nozzle 550 is located ahead of rear-body case 201. The front and top of spray nozzle 550 are covered with body case 202, and outlet orifice 516e at the bottom of spray nozzle 550 is open to the bowl inner surface (FIG. 40).

[0267] FIG. 40 is a sectional view of spray nozzle 550 installed in rear-body case 201 in the first exemplary embodiment of the present disclosure when the central part of spray nozzle 550 is cut in the back-and-forth direction.

[0268] The washing foam sprayed from outlet orifice 516e of spray nozzle 550 is generally sprayed onto the bowl inner surface as shown by dot lines T of FIG. 40. However, when the washing water not containing detergent is sprayed from outlet orifice 516e as in the above-described rinse mode, the sprayed water may be spattered outside the bowl as shown by the two-dot chain lines of FIG. 40 and wet the floor.

[0269] In contrast, in apparatus 100 of the present exemplary embodiment, body case 202 includes spatter guard 550z as shown in FIG. 40. Spatter guard 550z blocks the water sprayed beyond the upper limit from outlet orifice 516e to make the water fall into bowl 110. Thus, spatter guard 550z can prevent the washing foam and washing water sprayed from spray nozzle 550 from being spattered outside bowl 110.

[0270] To be more specific, the portion of body case 202 of body 200 that covers the front and top of spray nozzle 550 is provided with spatter guard 550z, which blocks the water sprayed beyond the upper limit from outlet orifice 550u to make the water fall into the bowl. As a result, the washing foam or washing water sprayed from spray nozzle 550 can be prevented from being spattered outside bowl 110.

[0271] The function of spatter guard 550z of body case 202 is not just to prevent the washing foam and washing water sprayed from spray nozzle 550 from being spattered outside bowl 110. Another function of spatter guard 550z will be described as follows. In apparatus 100, body 200 can be attached to bowl 110 via body fixing plate 240 (FIG. 43). When the contractor or the user installs apparatus 100 to bowl 110, or when the user wants to detach body 200 from bowl 110 to clean the bottom end of body 200, the detached body 200 is often placed temporarily on a table or the floor.

[0272] Even if body 200 is placed casually like this, spatter guard 550z can keep outlet orifice 516e of spray nozzle 550, which is located below the mounting face of body 200, out of contact with the table or floor. Thus,

spray nozzle 550 is prevented from being damaging. The two-dot chain lines in FIG. 41, which is the front view of body 200 and the two-dot chain line in FIG. 42, which is the side view of body 200, represent the surface of the table on which body 200 is placed. As shown in FIGS. 41 and 42, spatter guard 550z keeps orifice 516e out of contact with the table surface.

[0273] In apparatus 100 of the present exemplary embodiment, spatter guard 550z is provided in body case 202, but may alternatively be provided, for example, in body 550c of spray nozzle 550.

[0274] FIG. 43 is a perspective view of body fixing plate 240 and rear-body case 201 of body 200 in the first exemplary embodiment of the present disclosure.

[0275] Note that the perspective view of rear-body case 201 does not illustrate control unit 130, spray nozzle 550, nozzle device 800, or other components for convenience of explanation.

[0276] Body fixing plate 240 is fixed to bowl 110 by inserting a mounting bolt (not shown) into positioning long hole 241. Next, body fixing plate 240 and body 200 are aligned at their centers. While the back of body fixing plate 240 is being slightly raised, body 200 is pushed inside through the bowl surface until it clicks. As a result, the ratchet mechanism allows body 200 to be fixed with bowl 110.

[0277] Meanwhile, to detach body 200 from bowl 110, the user can pull body 200 forward while pushing body detachment button 242 besides body 200 deep with a finger.

[0278] As shown in FIG. 43, resin body fixing plate 240 includes magnet 243 buried inside. Rear-body case 201 includes attachment-detachment sensor 244, which detects whether body 200 is fixed to bowl 110 or detached from it.

[0279] Attachment-detachment sensor 244 is composed of a reed switch. As shown in the partial sectional view of FIG. 44, when body 200 is fixed to bowl 110, this can be detected from the positional relationship in which magnet 243 of body fixing plate 240 faces attachment-detachment sensor 244 of rear-body case 201. Meanwhile, when body 200 is detached from bowl 110, this can be detected because attachment-detachment sensor 244 is apart from magnet 243.

[0280] When attachment-detachment sensor 244 detects that body 200 is detached from bowl 110, control unit 130 does not allow spray nozzle 550 to perform spraying. To be more specific, spray nozzle 550 does not perform spraying when body 200 is detached from bowl 110, even if a button for allowing spray nozzle 550 to perform spraying is pushed, such as manual foam coating switch 433 of remote controller body 401 or manual urine splash reduction switch 434. This prevents the washing foam from being inadvertently sprayed onto the user or the floor.

[0281] Even if attachment-detachment sensor 244 detects that body 200 is detached from bowl 110, control unit 130 does not prevent anal cleaning nozzle 831 or

bidet nozzle 832 from performing spraying. As a result, even if attachment-detachment sensor 244 is at fault and falsely recognizes that body 200 is detached from bowl 110, the anal cleaning and bidet cleaning are guaranteed because they are basic functions of apparatus 100 and are important to the user.

[0282] FIG. 45 is a time chart showing the rotary foam-spraying in apparatus 100 of the first exemplary embodiment of the present disclosure.

[0283] When manual foam coating switch 433 of remote controller body 401 is pushed, detergent pump 534 is rotated backward for two seconds at time N2 shown in FIG. 45, and then starts to be rotated forward at time N3. At the same time, water pump 516 and air pump 535 start to supply foam tank 532 with detergent, water, and air so as to generate the washing foam. The generated washing foam is sprayed from outlet orifice 550u of spray nozzle 550 onto the inner surface of bowl 110. The rotary foam-spraying enables the bowl inner surface to be hard to be stained and easy to be cleaned.

[0284] In this case, the orientation of outlet orifice 550u is rotated by spray nozzle driver 550a, which is a stepping motor. In the time chart of FIG. 45, the orientation of orifice 550u is rotated forward while the washing foam is sprayed from the stop position at time N3 to the farthest position at time N6. Next, the orientation of orifice 550u is rotated backward while the washing foam is sprayed from the farthest position at time N6 to the stop position at time N9. At time N11, water pump 516 and air pump 535 are automatically stopped to automatically stop the rotary foam-spraying.

[0285] From time N3 to time N11 during which the rotary foam-spraying is performed, control unit 130 continues to operate water pump 516 and air pump 535. Meanwhile, detergent pump 534 is rotated forward intermittently in the following periods: from time N3 to N4, from time N6 to N7, and from time N9 to N10.

[0286] An experiment has revealed that detergent pump 534 can generate more stable washing foam by being rotated intermittently than continuously during the rotary foam-spraying because the detergent, the water, and the air can be mixed more effectively. Thus, the intermittent rotation of detergent pump 534 during the rotary foam-spraying can generate stable washing foam, eliminate waste of detergent, and save the trouble of refilling the detergent.

[0287] In apparatus 100 of the present exemplary embodiment, detergent pump 534 is operated for two seconds in a six-second cycle when operated intermittently.

[0288] In the time chart of FIG. 45 showing the rotary foam-spraying, the operation of heat exchanger 700 is shown in a broken line. The results indicate that when the washing water coming from water pump 516 is lower than 20°C, it is heated to about 20°C by heat exchanger 700 before being supplied to foam tank 532. The detergent does not lather well in cold water, but can produce better washing foam in foam tank 532 by heating the water to about 20°C by heat exchanger 700.

[0289] In the time chart of FIG. 45 showing the rotary foam-spraying, detergent pump 534 is rotated backward from time N2 to time N3. Time N3 is when the rotary foam-spraying is started. The purpose of the backward rotation is as follows. Detergent pump 534 is a tube pump. The preceding backward rotation allows the detergent liquid near the outlet of the tube to flow back to the portion of the tube that has been crushed by the roller. The forward rotation is started after the crushed portion is restored to the cylindrical shape. This achieves supplying a stable amount of detergent.

[0290] In the time chart of FIG. 45 showing the rotary foam-spraying, control unit 130 controls spray nozzle driver 550a as follows from time N11, in which the rotary foam-spraying is ended, to time N14. Spray nozzle driver 550a is moved from the stop position to the home position where driver 550a pushes the rotation detection micro switch. When recognizing the home position, spray nozzle driver 550a as a stepping motor returns to the stop position.

[0291] The resetting of spray nozzle driver 550a to the home position has the following effect. Assume that the stepping motor of spray nozzle driver 550a slips due, for example, to an increase in some rotational load and fails to rotate the given number of steps. In this case, the stop position, which is the start position of the rotary foam-spraying, can be reset to the start rotation. As a result, the washing foam can be sprayed to the same position each time.

[0292] The rotation detection micro switch is pushed by spray nozzle driver 550a being reset to the home position. The rotation detection micro switch detects that the detergent adheres around outlet orifice 550u for some reason, making rotation impossible unless the switch is pushed. Thus, when the signal to push this switch cannot be obtained after the rotary foam-spraying, rinse lamp 223a is lit to urge the user to push the above-mentioned rinse switch 223 to perform the rinsing process.

[0293] In apparatus 100 of the present exemplary embodiment, the time period from time N3 to time N12 during which the rotary foam-spraying is performed is set to about 15 seconds. The period of about 15 seconds can be changed to for example, about 10 or 25 seconds depending on the size of bowl 110 and the amount of the washing foam to be held.

[0294] Assume that the time period until the rotation detection micro switch is pushed is delayed by about 10% or more with respect to the set time for the rotary foam-spraying. In this case, rinse lamp 223a blinks once, urging the user to push rinse switch 223 to perform the rinsing process. The rinsing process continues for about three minutes with running water heated to about 40°C by heat exchanger 700. In this rinsing process, foam generator 560, spray nozzle 550, and other members are rinsed with the washing water and prevented from being clogged with residual detergent. This stabilizes the foam spraying.

[0295] Assume that detergent spray nozzle 550 is

clogged with detergent and does not move properly, causing the time period until the rotation detection micro switch is pushed is delayed by about 20% or more with respect to the set time for the rotary foam-spraying. In this case, rinse lamp 223a blinks twice, urging the user to push rinse switch 223 and to clean outlet orifice 550u of spray nozzle 550 with a toothbrush or the like.

[0296] In the time chart of FIG. 45 showing the rotary foam-spraying, the supply destination of the washing water from discharge water amount variable unit 516 in the water circuit of FIG. 6 is switched from nozzle device 800 to foam generator 560 between time N2 and time N3, and from foam generator 560 to nozzle device 800 between time N11 and time N13.

[0297] In other words, control unit 130 closes flow control valve 517 and opens opening/closing valve 530a from time N2 to time N3, and closes valve 530a and opens valve 517 from time N11 to time N13. Instead of valve 530a, a path switching valve may be provided at a branch point at which branch path 530 is branched from washing water supply path 690.

[0298] FIG. 46 is a time chart of the rinsing process in apparatus 100 of the first exemplary embodiment of the present disclosure.

[0299] Assume that rinse switch 223 of operation unit 210 is pushed to make control unit 130 go into the rinse mode. Between time N2 and time N3, the supply destination of the washing water is switched from nozzle device 800 to foam generator 560. For about two minutes from time N3 to time N8, the washing water heated to about 40°C by heat exchanger 700 is supplied from discharge water amount variable unit 516 to foam tank 532 and is sprayed from spray nozzle 550 while detergent pump 534 remains stopped.

[0300] For about one minute from time N8 to time N10, air pump 535 is operated to supply air to foam tank 532 in addition to the washing water heated to about 40°C so as to rinse foam tank 532.

[0301] In this manner, in the rinsing process, the washing water alone is supplied first, and then later, air is added by operating air pump 535. As a result, most of the detergent remaining in foam tank 532 and the path is sprayed efficiently together with the washing water from spray nozzle 550. After this, the pressure of the air bubbles produced by air pump 535 helps to rinse small amounts of residual detergent, and hence to perform effective rinsing in a short time.

[0302] After the completion of the about three-minute rinse from time N3 to N10, detergent pump 534 is rotated backward first and then forward from time N10 to N14 and is placed in a standby state for both the rotary foam-spraying and the fixed foam-spraying. Then, the rinsing process is automatically ended.

[0303] FIG. 47 is a time chart when the washing foam is sprayed while the spray nozzle is not being rotated in apparatus 100 of the first exemplary embodiment of the present disclosure.

[0304] When manual urine splash reduction switch 434

of remote controller body 401 is pushed, detergent pump 534 is rotated backward for two seconds at time N2 of FIG. 47, and starts to be rotated forward at time N3. At the same time, water pump 516 and air pump 535 start to supply foam tank 532 with the detergent, the water,

[0305] The generated washing foam is sprayed from outlet orifice 550u onto the inner surface of bowl 110. When the washing foam is sprayed to the bowl inner surface while the orientation of outlet orifice 550u is not being rotated, the washing foam is kept on the water surface of bowl 110. This prevents urine splash when the user urinates standing up.

[0306] The time chart of the fixed foam-spraying shown in FIG. 47 differs from the time chart of the rotary foam-spraying shown in FIG. 45 as follows. In the rotary foam-spraying, spray nozzle driver 550a rotates the orientation of outlet orifice 550u, whereas in the fixed foam-spraying, spray nozzle driver 550a fixes the orientation of outlet orifice 550u in a direction. The time chart of FIG. 47 is identical (except the above features) to the time chart of FIG. 45, and the description common to both will be omitted.

[0307] FIGS. 45 to 47 each show the home position, the stop position, and the farthest position of spray nozzle driver 550a. In FIG. 37, the home position is at 0 degrees (the back), the stop position is at 20 degrees (forward), and the farthest position is at 340 degrees (forward). However, the present disclosure is not limited to this configuration. Alternatively, for example, the home position may be at 5 degrees (forward), the stop position may be at 60 degrees (forward from the back), and the farthest position may be at 300 degrees (forward).

[0308] In the fixed foam-spraying shown in FIG. 47, upon receiving the instruction for the fixed foam-spraying, spray nozzle driver 550a starts the fixed foam-spraying, while keeping the orientation of outlet orifice 550u at the stop position, which is about 60 degrees forward from the back. In this manner, spray nozzle driver 550a places the orientation of outlet orifice 550u in a standby state at about 60 degrees, which is the stop position. As a result, spray nozzle 550 can start to spray the washing foam onto the bowl inner surface without moving to any position, immediately after the fixed foam-spraying is ordered. This enables the water surface of the bowl to be quickly coated with the washing foam thick enough to prevent urine splash before the user urinates.

[0309] The water surface can be coated with the washing foam particularly quickly by the following configuration. The orientation of outlet orifice 550u in the stop position is placed at 50 to 70 (about 60) degrees, at which the washing foam hit the inclined surface of the bowl inner surface can roll down the inclined surface of the bowl and fall onto the water surface.

[0310] In apparatus 100 of the present exemplary embodiment, the rotary foam-spraying shown in FIG. 45 can be set to be performed automatically every time the user uses the toilet in addition to when manual foam coating

switch 433 of remote controller body 401 is pushed. Alternatively, the rotary foam-spraying can be set to be performed automatically at specified time intervals. Performing the rotary foam-spraying automatically either after the use of the toilet or at specified time intervals enables the bowl inner surface to be hard to be stained and easy to be cleaned.

[0311] Automatically performing the rotary foam-spraying at specified time intervals can reduce stain around the waterline of bowl 110, particularly, reduce ring-shaped stain.

[0312] In apparatus 100 of the present exemplary embodiment, in the case that the rotary foam-spraying is set to be performed automatically after the use of the toilet, the following operations are performed. As soon as the user leaves toilet seat 300, seating sensor 330 detects this. About 60 seconds after the detection, the rotary foam-spraying is performed for about 15 seconds. Meanwhile, in the case that the user urinates standing up, as soon as seat 300 is closed, seat lid opening/closing sensor 331 detects this. About 60 seconds after the detection, the rotary foam-spraying is performed for about 15 seconds.

[0313] The about 60 seconds can be changed to, for example, about 10 or 25 seconds using the switch of remote controller body 401. With this configuration, the time after the user leaves the seat until the rotary foam-spraying is started can be changed according to the user's preference.

[0314] The about 15 seconds of the rotary foam-spraying can be changed to, for example, 10 or 25 seconds using the switch of remote controller body 401. As a result, the amount of the washing foam to be held can be changed depending on the size of bowl 110.

[0315] In apparatus 100 of the present exemplary embodiment, the fixed foam-spraying shown in FIG. 47 can be set to be performed automatically every time seat 300 is opened, in addition to when manual urine splash reduction switch 434 of remote controller body 401 is pushed. Automatically performing the fixed foam-spraying every time seat 300 is opened can reduce urine splash.

[0316] In apparatus 100 of the present exemplary embodiment, in the case that the fixed foam-spraying is set to be performed automatically every time seat 300 is opened, the fixed foam-spraying is performed for about 15 seconds immediately after seat 300 is opened.

[0317] The about 15 seconds of the fixed foam-spraying can be changed to, for example, 10 or 25 seconds using the switch of remote controller body 401. As a result, the amount of the washing foam to be held can be changed depending on the size of bowl 110.

[0318] FIG. 48 is an explanatory diagram of automatic operation selection between the fixed foam-spraying and the rotary foam-spraying in the first exemplary embodiment of the present disclosure.

[0319] The user can select desired settings by pushing automatic process selection switch 236 of operation unit

210. The following lamps are located beside switch 236: lamp 236a for after-use automatic rotary spraying; lamp 236b for automatic periodic rotary spraying; and lamp 236c for automatic fixed foam-spraying with the seat open. Every time automatic process selection switch 236 of operation unit 210 is pushed, the settings of the three automatic operations can be changed in the direction shown by the arrows of FIG. 48.

[0320] When all of lamps 236a, 236b, and 236c are OFF as shown by H0, all of three automatic operations are OFF. When automatic process selection switch 236 is pushed once in this state, lamp 236a alone is turned on as shown by H1.

[0321] In this manner, every time switch 236 is pushed once, the setting changes as shown by H2, H3 ... H6. The setting shown by H7 indicates that all the three automatic operations can be turned on. In the lamps of FIG. 48, the symbol ○ indicates that the setting is OFF, and the symbol ● indicates that the setting is ON.

[0322] Assume that in FIG. 48, one of H2, H4, H6, and H7 is set to perform the rotary foam-spraying automatically at specified time intervals. In this case, the rotary foam-spraying shown in the time chart of FIG. 45 is performed automatically about every three hours so as to reduce stain around the waterline of bowl 110, particularly, reduce ring-shaped stain.

[0323] The interval of the rotary foam-spraying can be changed to, for example, about 6, 12, or 24 hours using the switch of remote controller body 401. This allows the user to reduce the number of times of the automatic operation as desired during the user's long absence.

SECOND EXEMPLARY EMBODIMENT

[0324] FIG. 51 is a perspective view of sanitary washing apparatus 1000 according to a second exemplary embodiment of the present disclosure.

[0325] Apparatus 1000 is an integrated sanitary washing apparatus composed of toilet bowl 110 and body 200.

[0326] Apparatus 100 of the first exemplary embodiment is independent of toilet bowl 110 and is installed on it afterwards.

[0327] Apparatus 1000 of the second exemplary embodiment performs foam spraying similarly to apparatus 100 of the first exemplary embodiment.

[0328] Apparatus 1000 differs apparatus 100 in including a flush valve (not shown). With this valve, the user can flush the toilet bowl after urination or defecation by pushing either after-urination flush switch 910 or after-defecation flush switch 920 on remote controller 400 as the operation unit.

[0329] Assume that the automatic foam spraying shown in FIG. 45 is set to be performed when the predetermined time has passed after use as shown in H1, H4, H5, and H7 of FIG. 48. In this case, the amount of the washing foam to be sprayed onto the bowl inner surface can be made larger when after-defecation flush switch 920 is pushed than when after-urination flush

switch 910 is pushed. This enables the bowl to be harder to be stained and easier to be cleaned after defecation, which is stained more easily than after-urination.

[0330] In the case that body 200 is installed afterwards on bowl 110 as apparatus 100 of the first exemplary embodiment, control unit 130 cannot receive the signal to flush bowl 110, and hence, cannot receive information whether it is after urination or after defecation. This makes it impossible to change the amount of the washing foam to be sprayed automatically after use depending on whether it is urination or defecation.

[0331] In contrast, in apparatus 1000 of the second exemplary embodiment, remote controller 400 as the operation unit includes after-urination flush switch 910 and after-defecation flush switch 920. This enables control unit 130 to change the amount of the washing foam to be sprayed automatically after use based on the signal. Control unit 130 allows the amount of the washing foam to be sprayed onto the bowl inner surface to be larger when after-defecation flush switch 920 is pushed than when after-urination flush switch 910 is pushed. This enables the bowl to be harder to be stained and easier to be cleaned after defecation, which is stained more easily than after-urination. This eliminates waste of detergent and performs appropriate foam spraying depending on the user's situation. Hence, apparatus 1000 has bowl 110 whose inner surface is hard to be stained.

INDUSTRIAL APPLICABILITY

[0332] As described so far, the present disclosure provides a sanitary washing apparatus that can prevent stain adsorption on the bowl inner surface by forming foam film from the front to the back on the surface. Therefore, such a sanitary washing apparatus of the present disclosure is applicable to a sanitary washing apparatus for cleaning human privates and to other apparatuses with a spray nozzle.

REFERENCE MARKS IN THE DRAWINGS

[0333]

100,1000	sanitary washing apparatus
110	toilet bowl
115	outlet hole
120	deodorization equipment
130	control unit
200	body
201	rear-body case
202	body case
210	operation unit
211	infrared receiver
216	liquid detergent level audit window
217	sleeve lid
220	operation switch
221	anal cleaning switch
223	rinse switch

223a	rinse lamp			able unit)
230	setting switch		516a	motor
231	water temperature switch		516b	link mechanism unit
236	automatic process selection switch		516c	piston
236a	lamp for after-use automatic rotary spraying	5	516d	water inlet
236b	lamp for automatic periodic rotary spraying		516e	outlet orifice
236c	lamp for automatic fixed foam-spraying with the seat open		517	flow control valve
			530	branch path
240	body fixing plate		530a	opening/closing valve
241	positioning long hole	10	531	check valve
242	body detachment button		531b	check valve
243	magnet		532	foam tank
244	attachment-detachment sensor		532a	foam-tank water inlet
250	sleeve case		533	detergent tank
300	toilet seat	15	534	detergent pump
320	toilet lid		535	air pump
330	seating sensor (seating detector)		536	detergent tank lid
331	seat lid opening/closing sensor (seat lid opening/closing detector)		537	detergent inlet port
			550	spray nozzle
360	seat/seat-lid rotary mechanism	20	550a	spray nozzle driver
400	remote controller		550b	inlet path
401	remote controller body		550c	body
402	transmitter		550d	rotary nozzle
410	anal cleaning switch		550e	O ring
411	bidet switch	25	550f	O ring
412	stopping switch		550h	inlet hole
413	moving cleaning switch		550n	shaft
414	pulsating cleaning switch		550u	outlet orifice
415	water pressure switch		550z	spatter guard
416	cleaning position switch	30	560	foam generator
417	spray switch		561	detergent pump hose
418	seat-lid switch		562	foam tank hose
419	seat switch		600	sub tank
421	display lamp		601	water supply port
422	position lamp	35	602	water discharge port
430	nozzle cleaning switch		603	air releasing port
431	anal blow-dry switch		610	tank body
432	powerful deodorization switch		611	tank front
433	manual foam coating switch		612	tank rear
434	manual urine splash reduction switch	40	613	air releasing unit
435	water temperature switch		613a	buffer unit
436	seat temperature switch		614	partition wall
437	8-hour stop switch		615	water-receiving tub
438	power-saving switch		615a	upper surface opening
439	automatic seat-lid opening/closing switch	45	616	storage tub
450	human body detection sensor		617	barrier wall
500	washing part		618	rectifying rib
501	chassis		620	water level sensor
501a	water pump installation part		621	common electrode
501b	leg part	50	622	water level electrode
502	connection tube		623	upper limit electrode
510	water supply connection unit		624	lower limit electrode
511	strainer		630	supplied-water temperature sensor
512	check valve		690	washing water supply path
513	constant flow valve	55	700	heat exchanger
514	waterproof solenoid valve		701	casing
515	relief valve		702	flat heater
516	water pump (discharge water amount vari-		703	heated-water discharge member

710	front face member			a body configured to be placed on a toilet bowl;
711	water supply port			a foam generator configured to generate washing foam;
712	heated-water discharge port			a spray nozzle configured to spray at least one
713	supply water path			of washing water and the washing foam onto an
714	slit	5		inner surface of the toilet bowl;
715	heated-water path			a spray nozzle driver configured to rotate an orientation of an outlet orifice of the spray nozzle;
716	partition rib			and
717	water-through-hole			a control unit configured to control at least an operation of the spray nozzle driver, the control unit having following modes:
718	projection			
720	rear face member	10		
730	heated-water temperature sensor			
731	over-temperature sensor			
750	buffer tank			
800	nozzle device			a rotary foam-spraying mode in which the
801	nozzle lid	15		washing foam is sprayed into the toilet bowl while the orientation of the outlet orifice of the spray nozzle is being rotated; and
802	connection tube			a rinse mode in which the washing water passes through the foam generator and then is sprayed from the spray nozzle.
810	support unit			
811	bottom part			
812	inclined part			
813	vertical part	20		
814	guide rail			
815	rack guide			
816	holding part			
817	water supply joint			
820	nozzle part	25		
830	nozzle body			
831	anal cleaning nozzle (cleaning nozzle)			
832	bidet nozzle			
833	nozzle cleaning unit			
834	anal-cleaning-water jet orifice	30		
835	anal cleaning water path			
835a	rectifying plate			
836	bidet water jet orifice			
837	bidet water path			
838	nozzle-cleaning-water jet port	35		
839	nozzle-cleaning path			
840	nozzle cover			
841	nozzle cover body			
842	coupling member			
843	coupling piece	40		
843a	coupling projection			
844	jet opening			
845	drain			
850	coupling part			
851	coupling receiving part	45		
851a	front recess			
851b	rear recess			
860	cleaning nozzle driver			
861	flexible rack			
862	pinion gear	50		
863	drive motor			
910	after-urination flush switch			
920	after-defecation flush switch			

Claims

1. A sanitary washing apparatus comprising:

- a body configured to be placed on a toilet bowl;

a foam generator configured to generate washing foam;

a spray nozzle configured to spray at least one of washing water and the washing foam onto an inner surface of the toilet bowl;

a spray nozzle driver configured to rotate an orientation of an outlet orifice of the spray nozzle; and

a control unit configured to control at least an operation of the spray nozzle driver, the control unit having following modes:

 - a rotary foam-spraying mode in which the washing foam is sprayed into the toilet bowl while the orientation of the outlet orifice of the spray nozzle is being rotated; and
 - a rinse mode in which the washing water passes through the foam generator and then is sprayed from the spray nozzle.
2. The sanitary washing apparatus according to claim 1, wherein

the spray nozzle is installed in the body in such a manner that a rotation axis of the outlet orifice of the spray nozzle can be inclined back and forth and side to side when the orientation of the outlet orifice of the spray nozzle is rotated,

when the rotation axis is inclined back and forth, a bottom of the rotation axis is inclined toward a front of the toilet bowl, and

when the rotation axis is inclined side to side, the bottom of the rotation axis is inclined toward a cleaning nozzle for cleaning a human body.
3. The sanitary washing apparatus according to claim 1 or 2, wherein when the washing foam is sprayed from the spray nozzle into the toilet bowl with the orientation of the outlet orifice of the spray nozzle being rotated, the control unit rotates the orientation of the outlet orifice of the spray nozzle at least two rounds, the two rounds consisting of:
 - making the spray nozzle driver rotate the orientation of the outlet orifice of the spray nozzle forward from a back of the toilet bowl to a front of the toilet bowl, and then return to the back of the toilet bowl, and
 - making the spray nozzle driver rotate the orientation of the outlet orifice of the spray nozzle backward from the back of the toilet bowl to the front of the toilet bowl, and then return to the back of the toilet bowl.
4. The sanitary washing apparatus according to any of claims 1 to 3, further comprising a human body detection sensor configured to detect that a user enters or leaves a toilet room,

wherein when the human body detection sensor detects that the user enters the toilet room, the control unit makes the washing foam sprayed into the toilet bowl while the outlet orifice of the spray nozzle is being rotated.

5

5. The sanitary washing apparatus according to any of claims 1 to 4, further comprising a discharge water amount variable unit and a valve both configured to be controlled by the control unit,

10

wherein the foam generator comprises:

a foam tank configured to be supplied with the washing water by the discharge water amount variable unit when the control unit opens the valve;

15

a detergent tank;

a detergent pump configured to supply detergent in the detergent tank to the foam tank; and

an air pump configured to supply air to the foam tank,

20

wherein at least one of the washing water and the washing foam in the foam tank is sprayed from the spray nozzle.

25

6. The sanitary washing apparatus according to claim 5, wherein in the rinse mode, the control unit is configured to open the valve while keeping the detergent pump of the foam generator in a stopped state, so that the washing water is supplied to the foam tank by the discharge water amount variable unit and is sprayed from the spray nozzle.

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FIG. 1

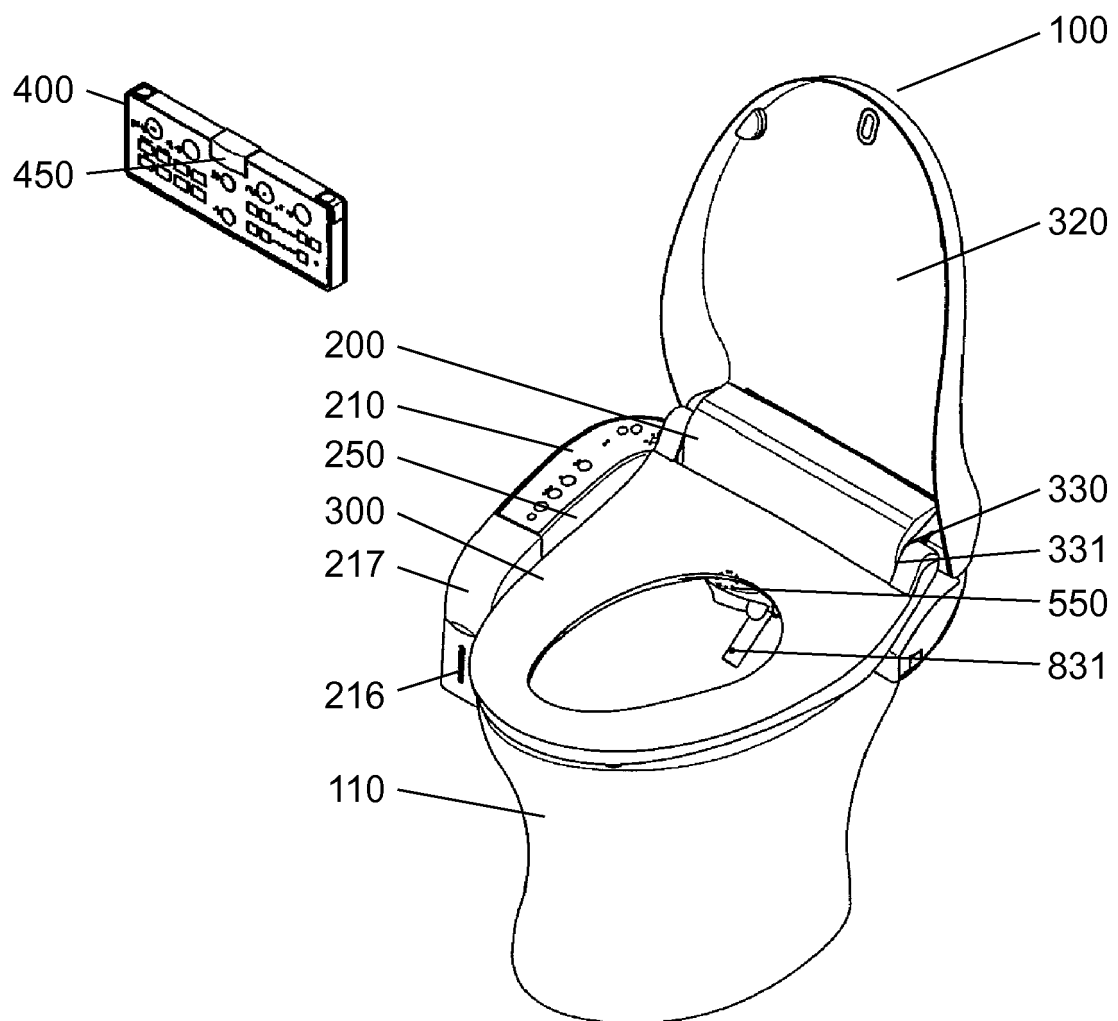


FIG. 2

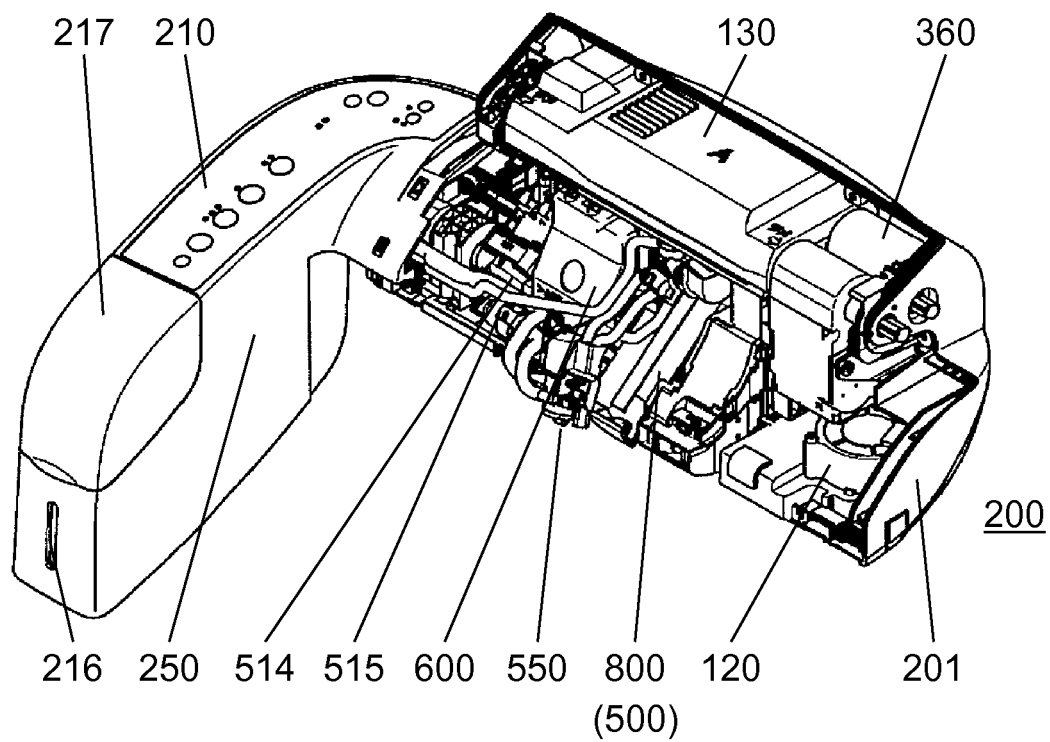


FIG. 3

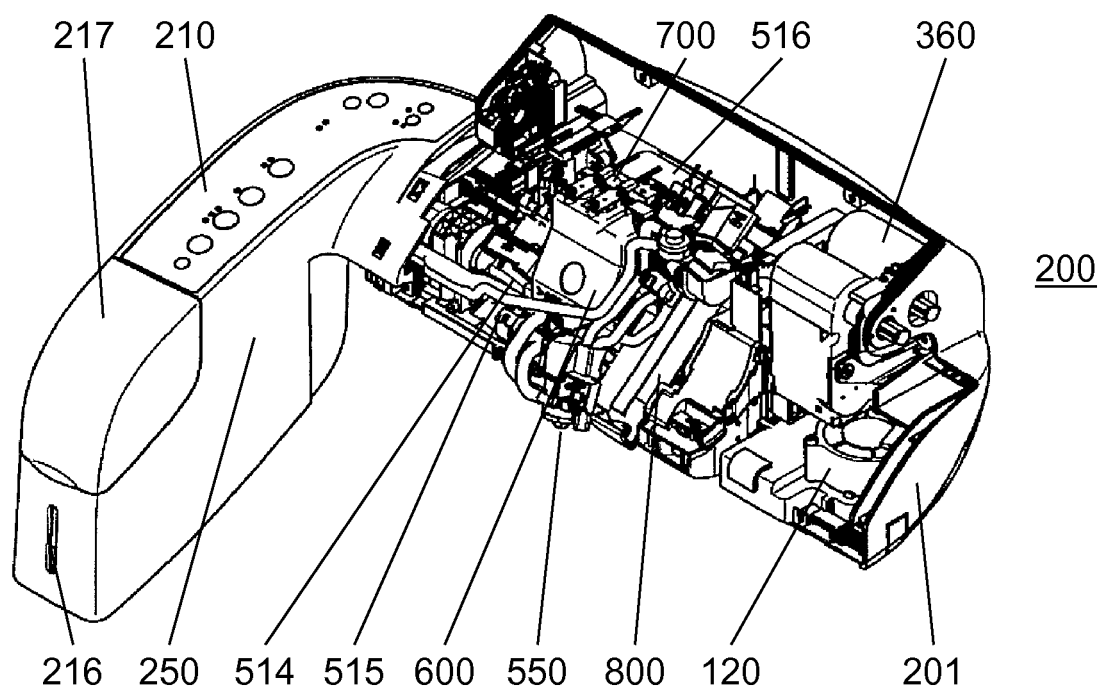


FIG. 4

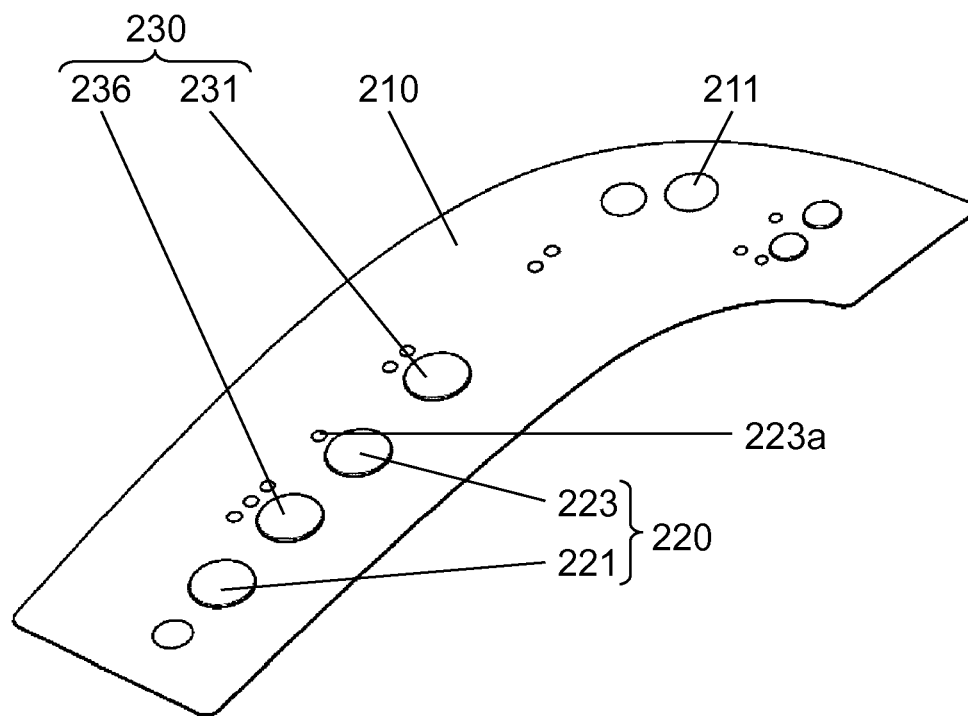


FIG. 5

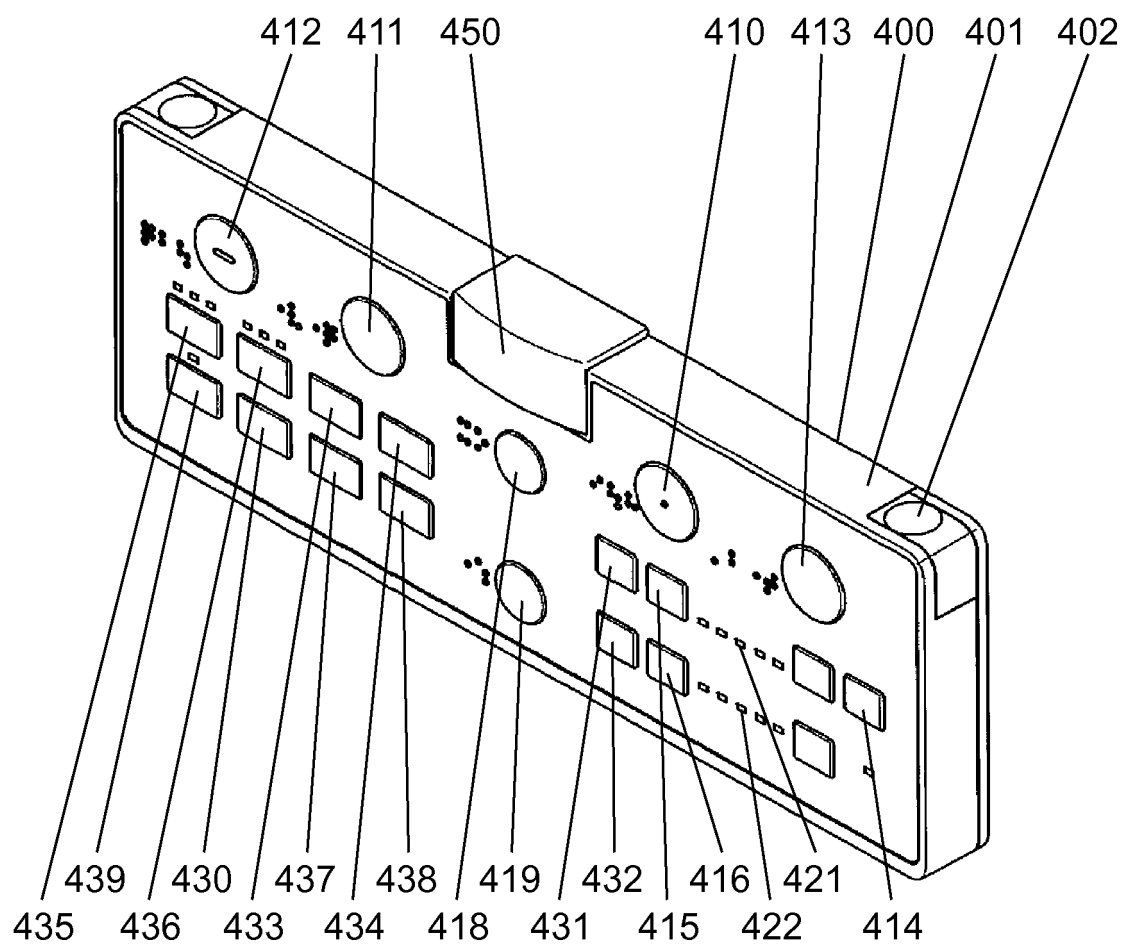


FIG. 6

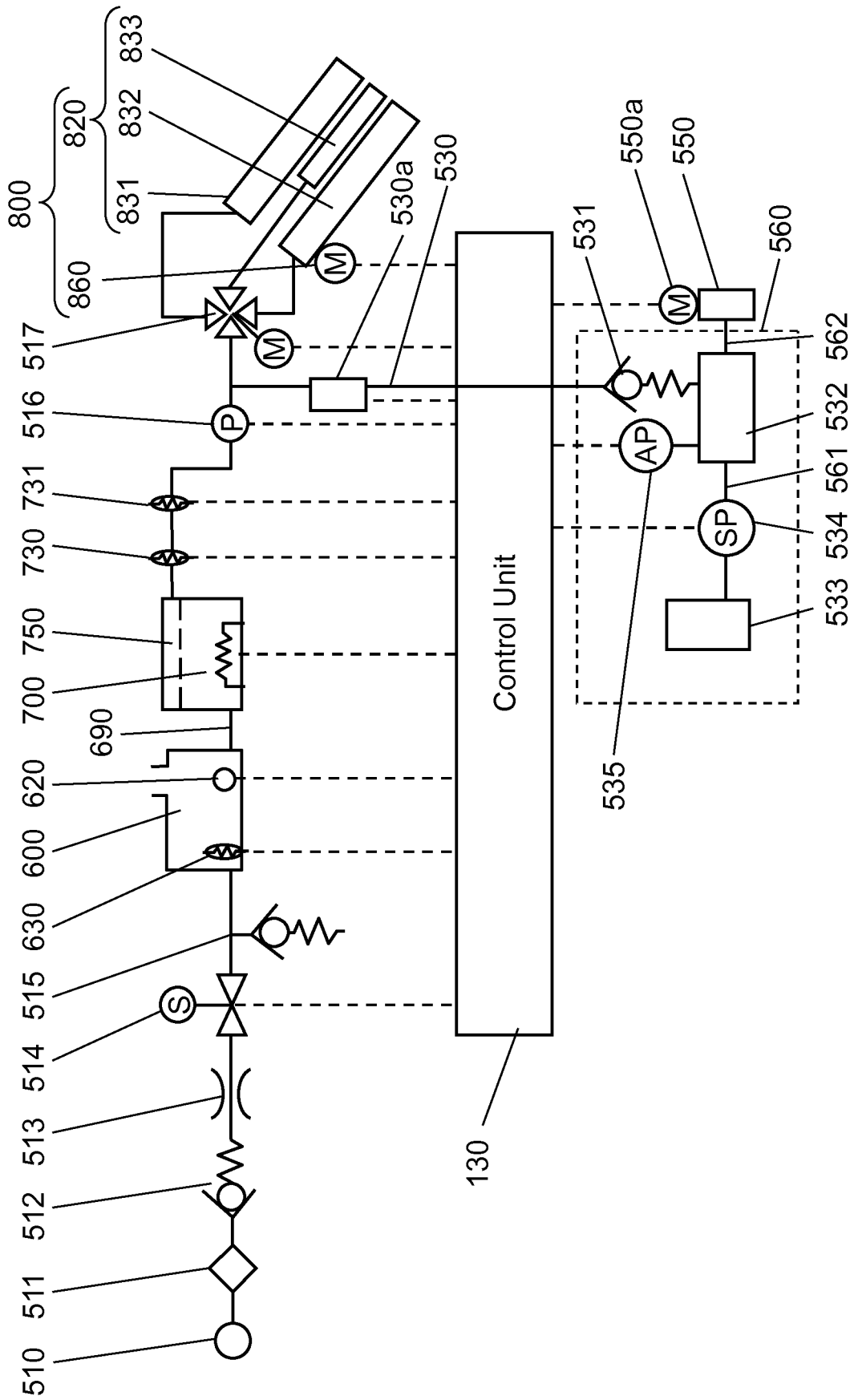


FIG. 7

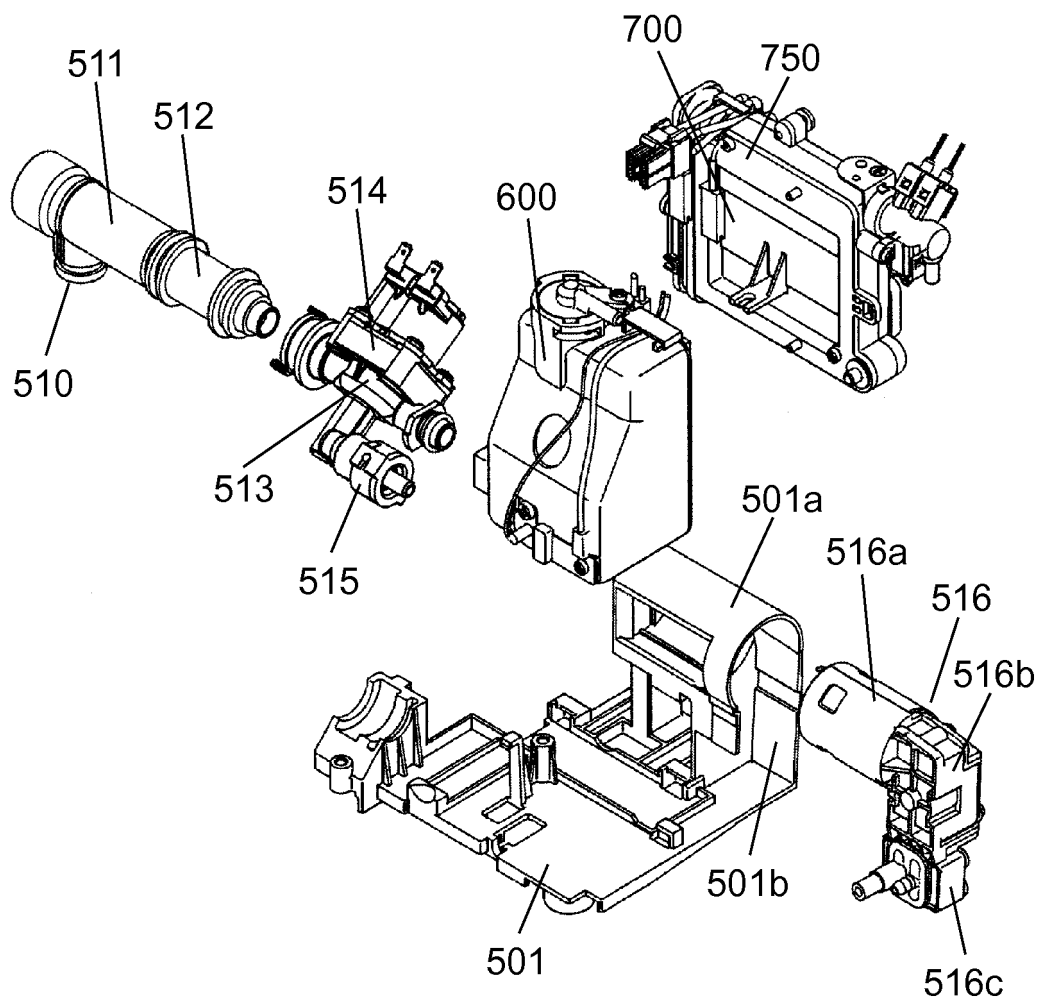


FIG. 8

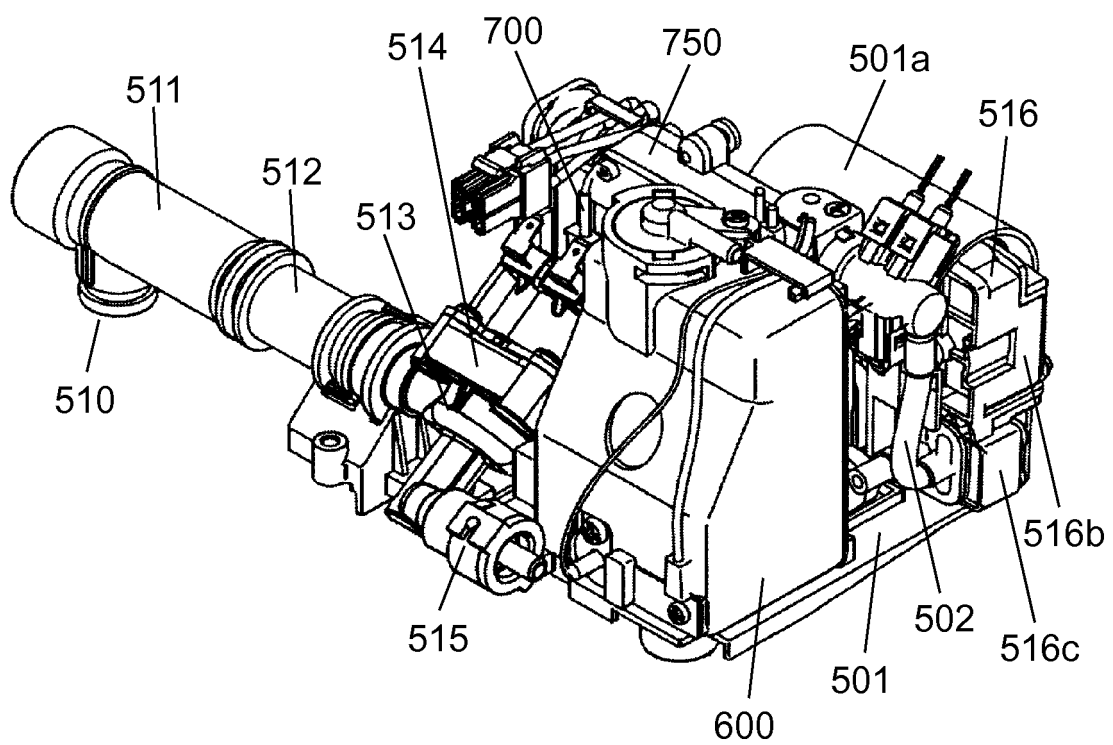


FIG. 9

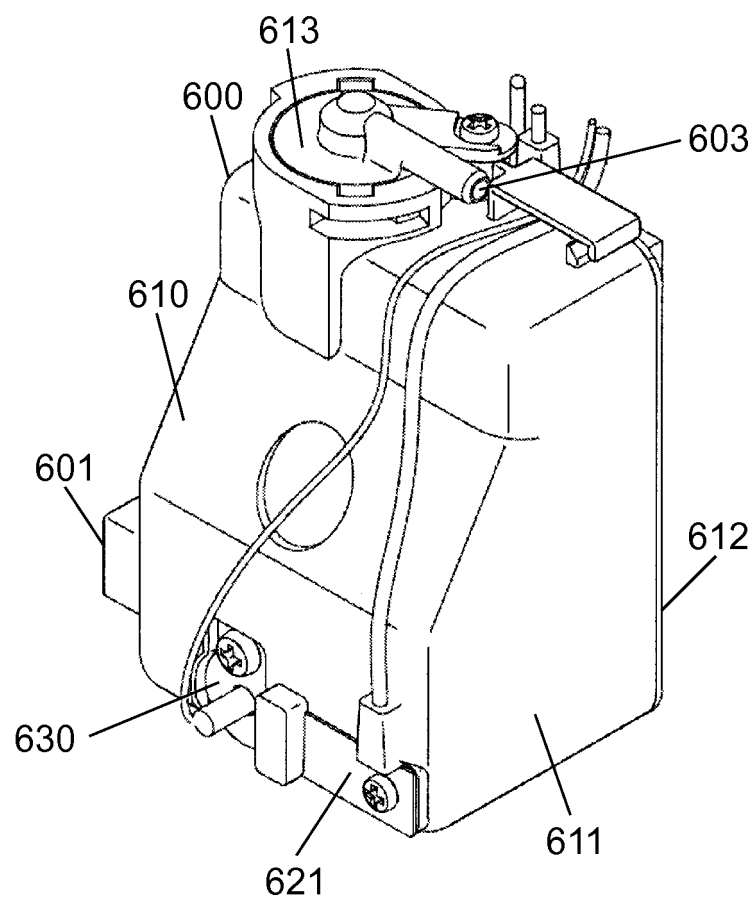


FIG. 10

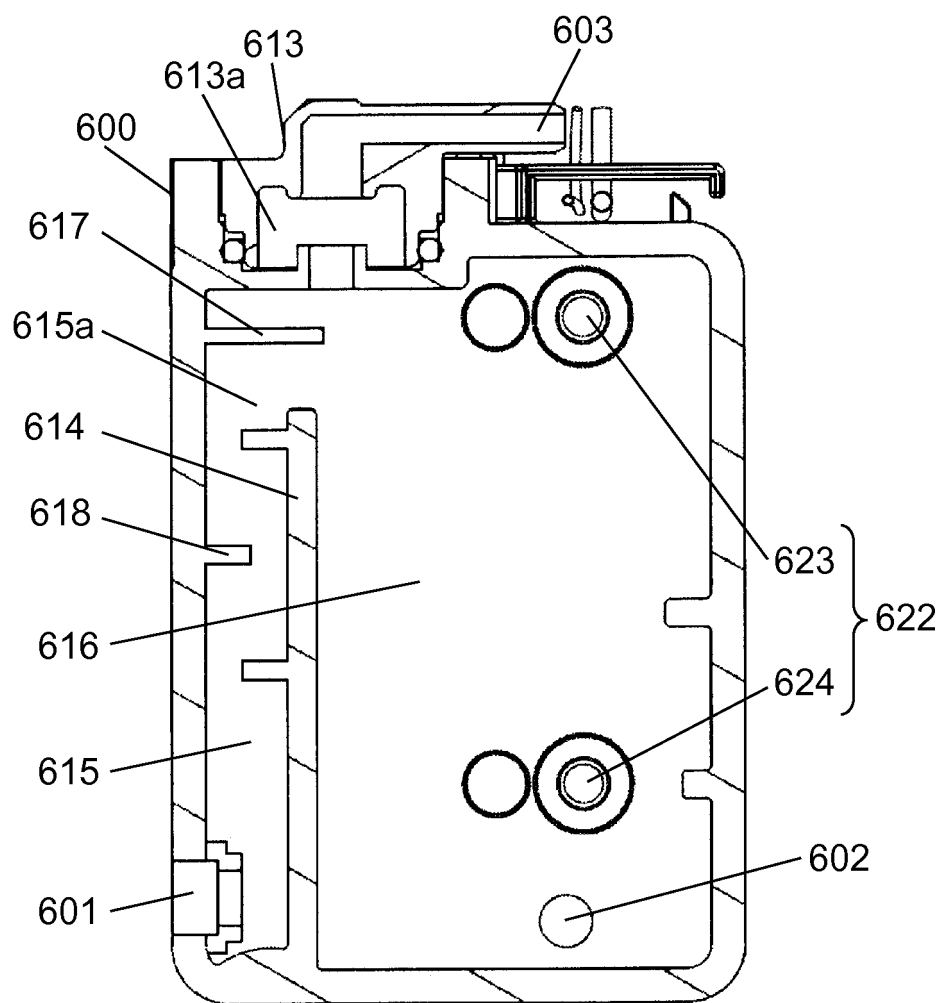


FIG. 11

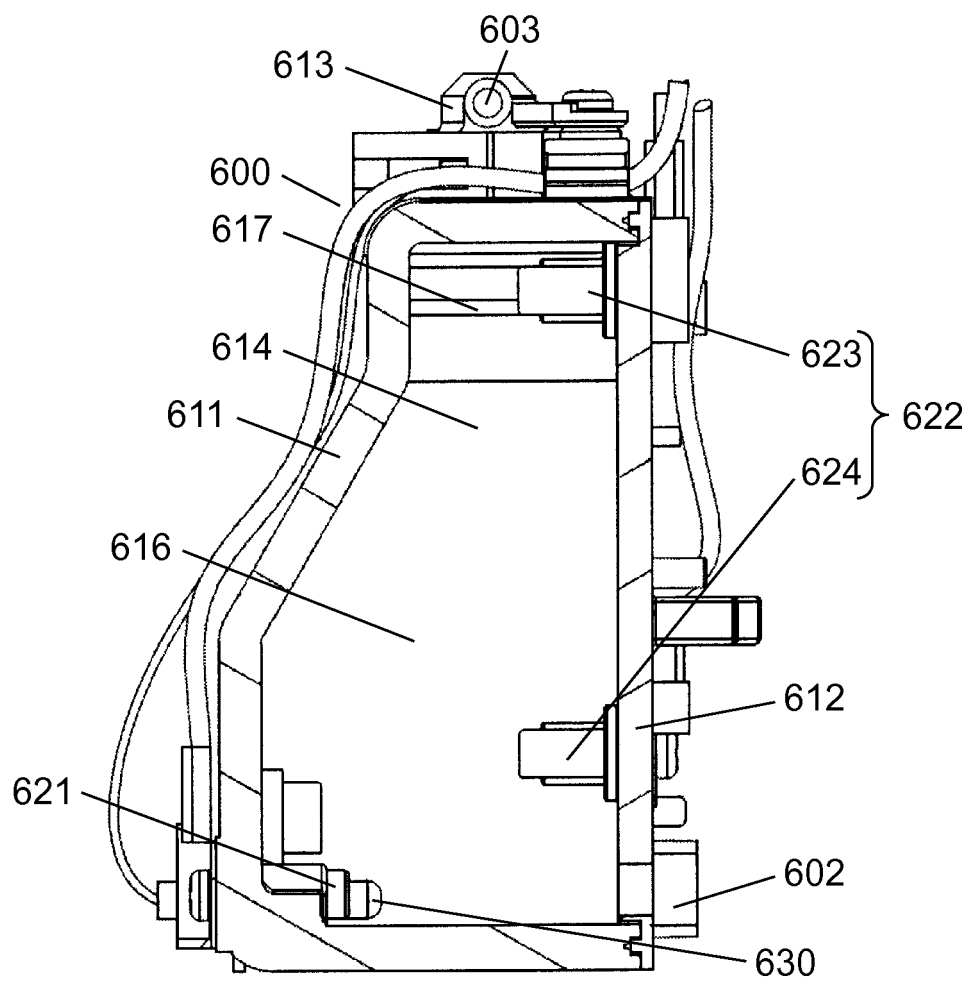


FIG. 12

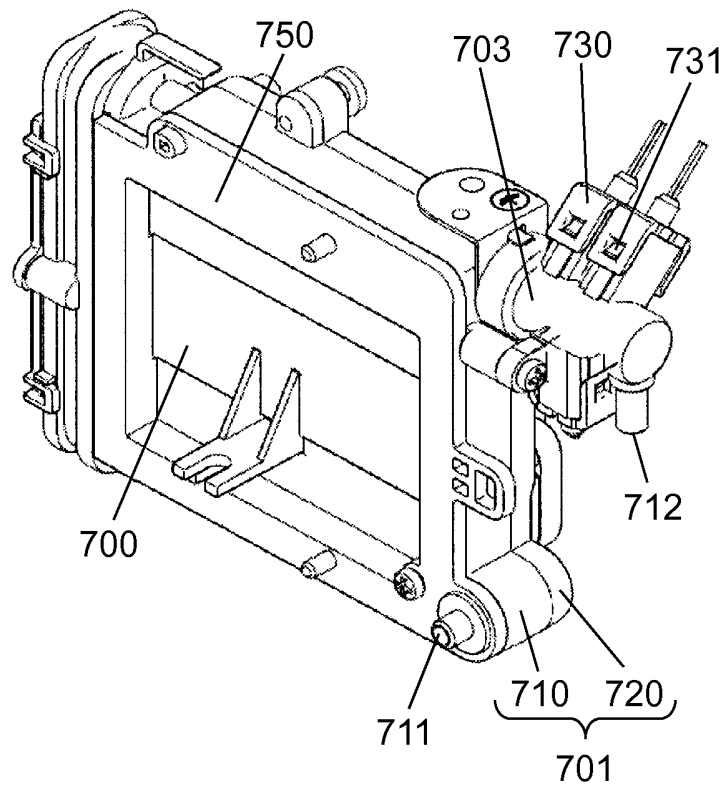


FIG. 13

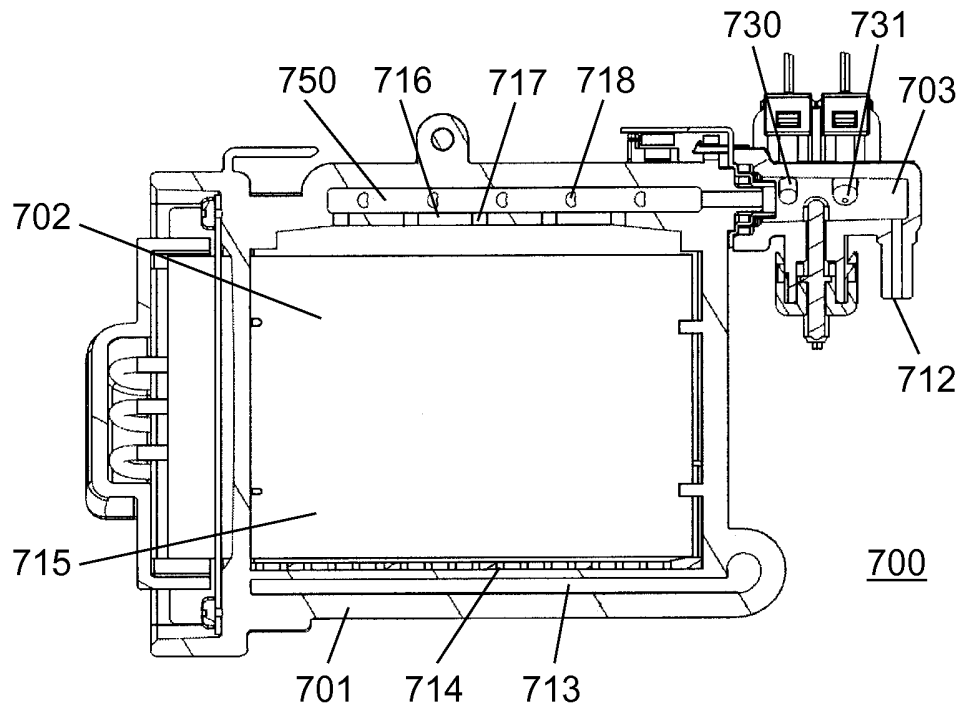


FIG. 14

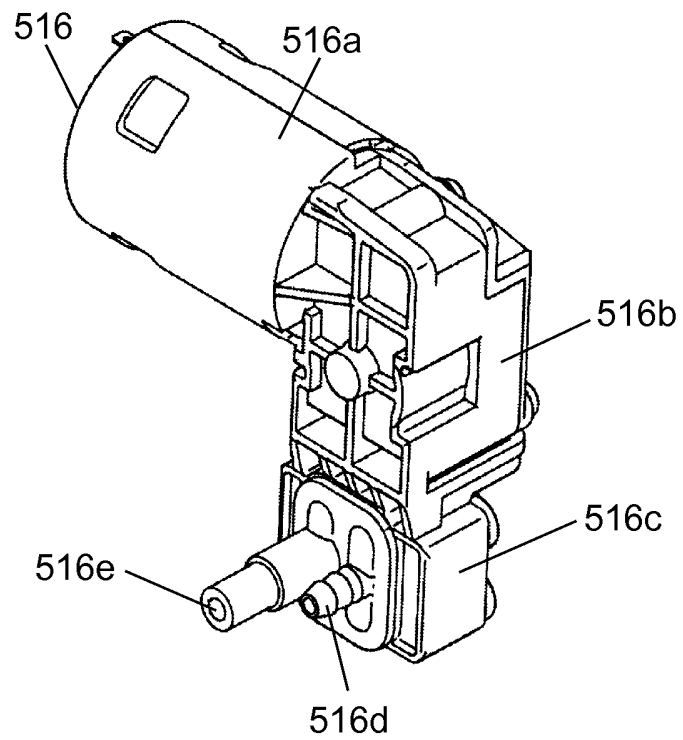


FIG. 15

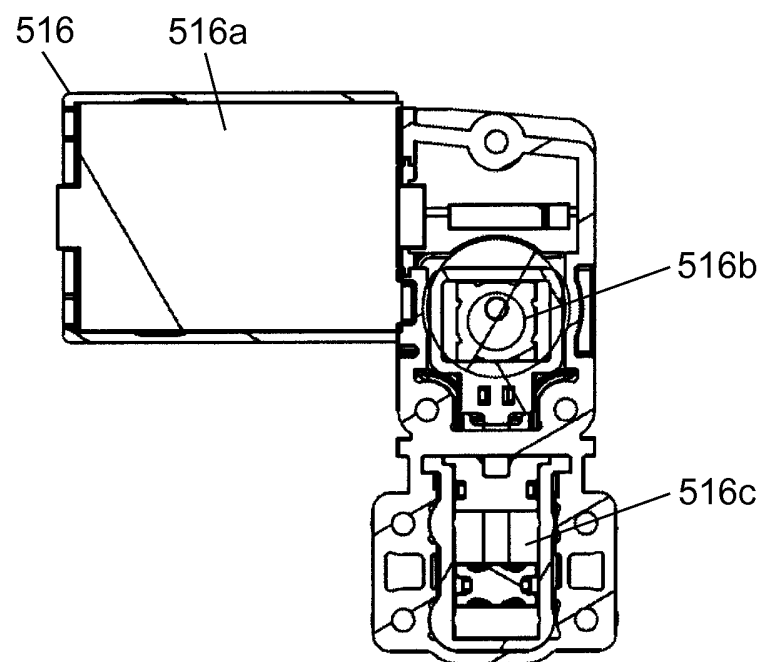


FIG. 16

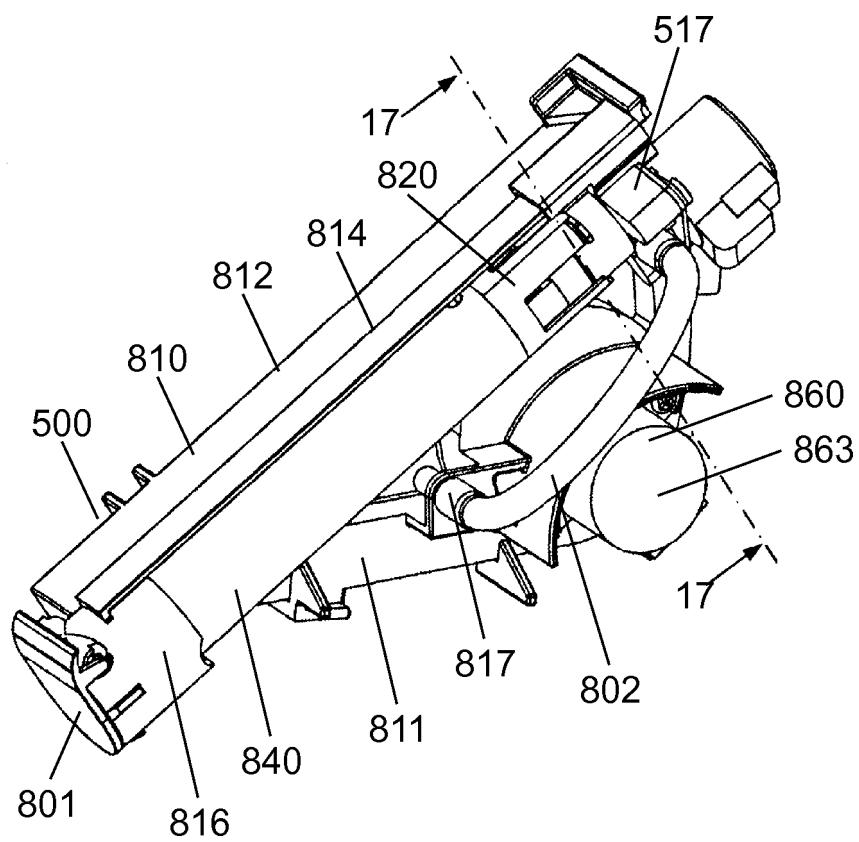


FIG. 17

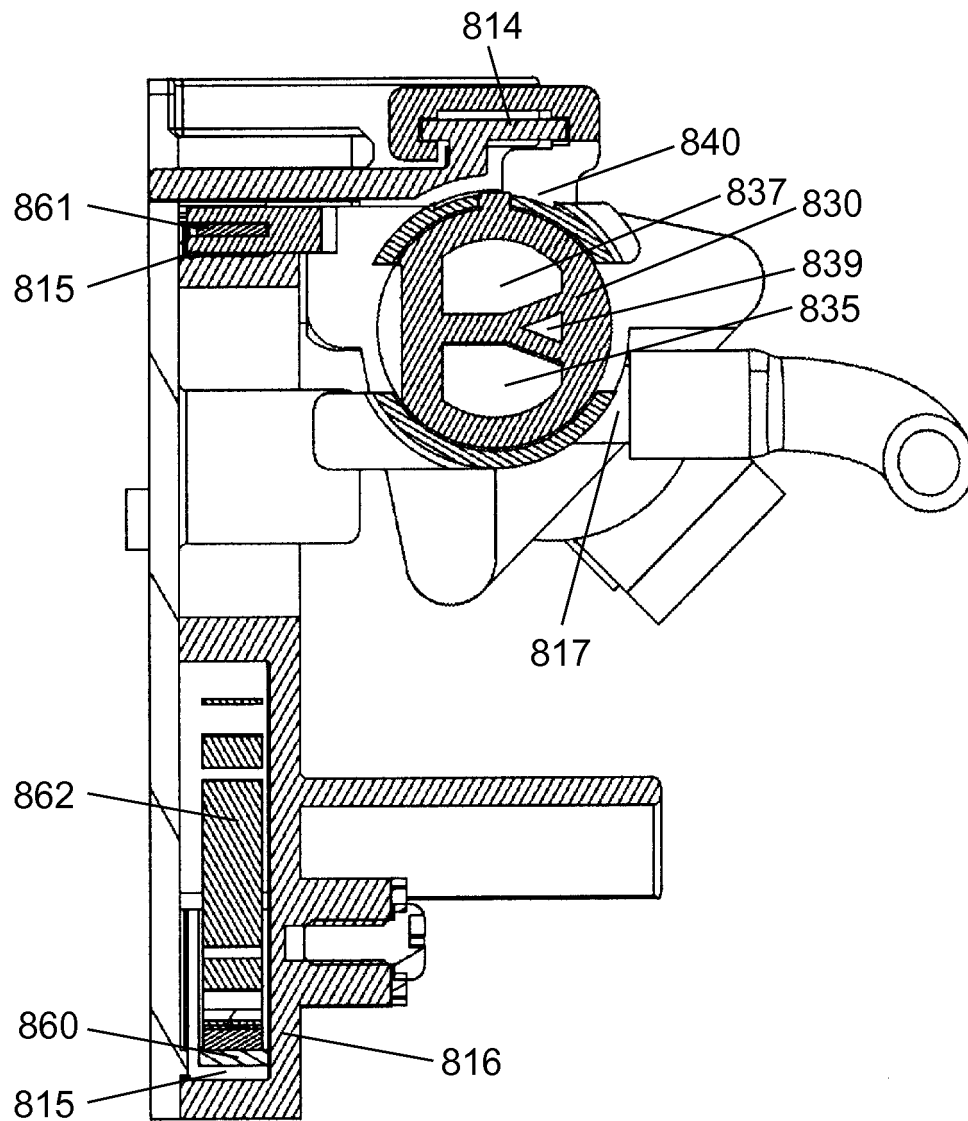


FIG. 18

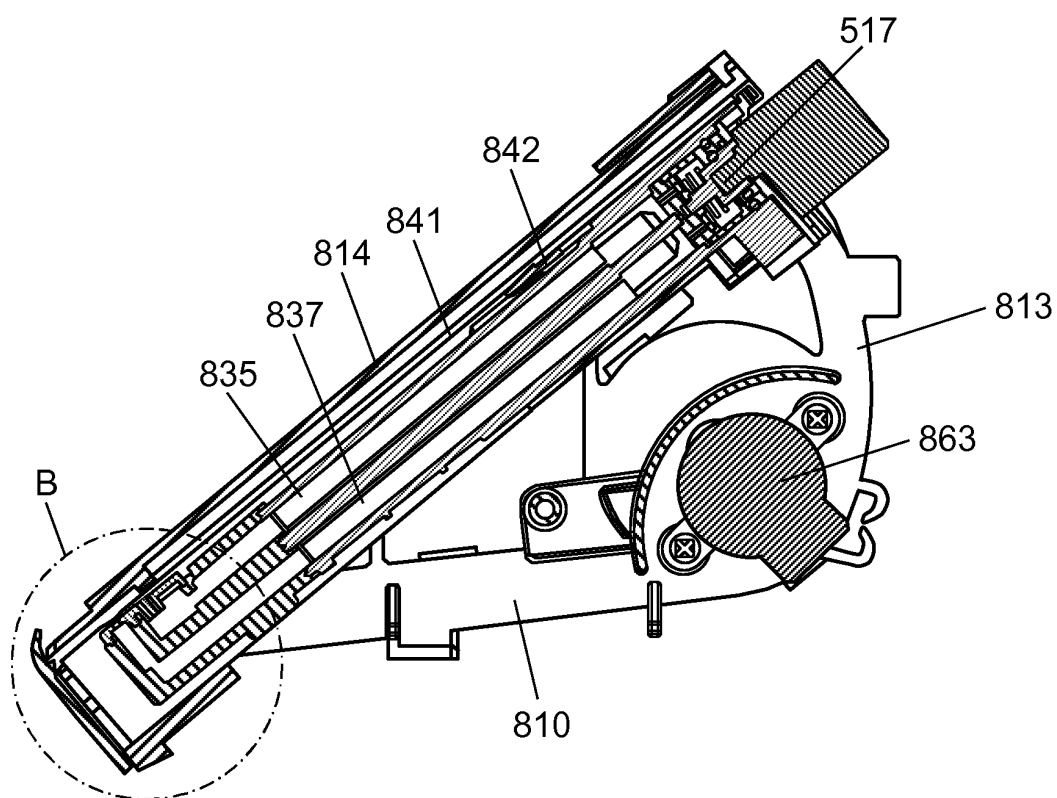


FIG. 19

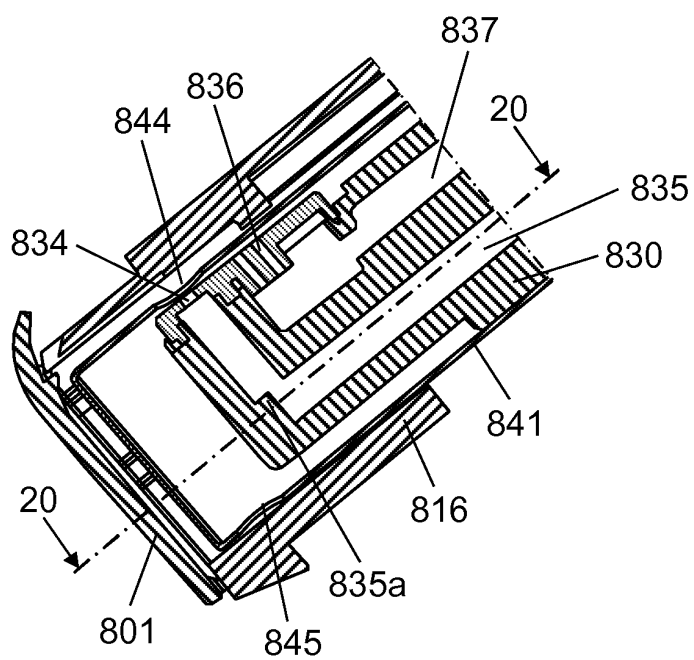


FIG. 20

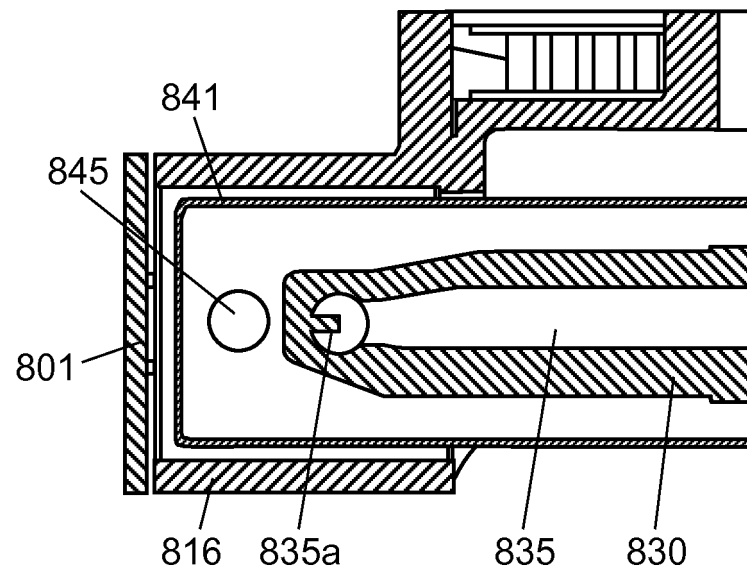


FIG. 21

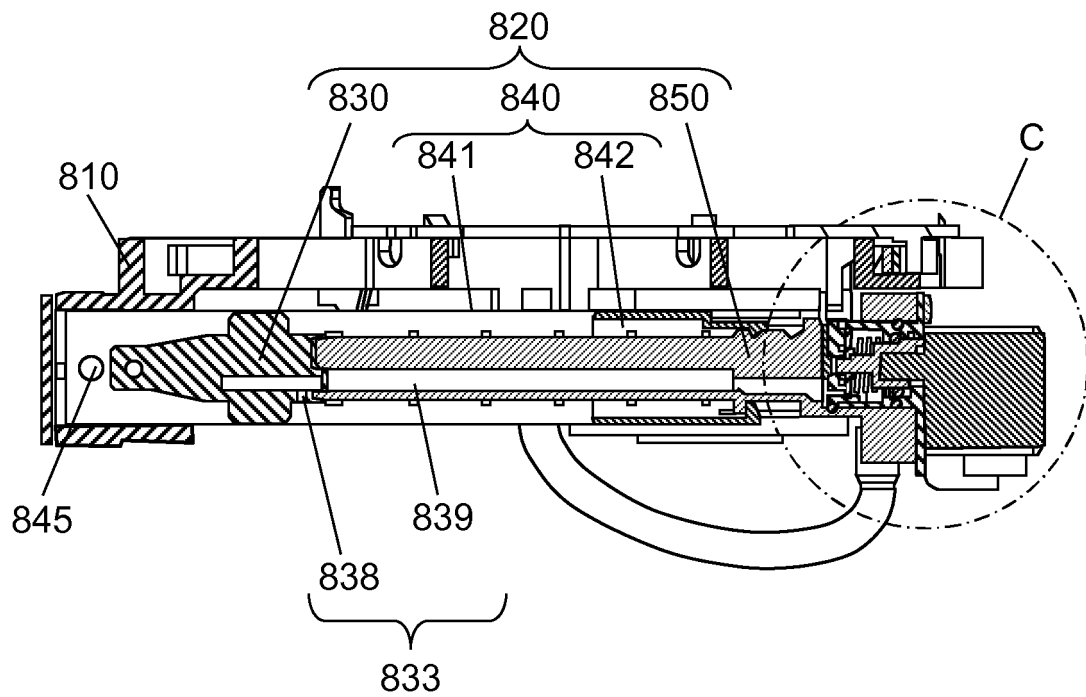


FIG. 22

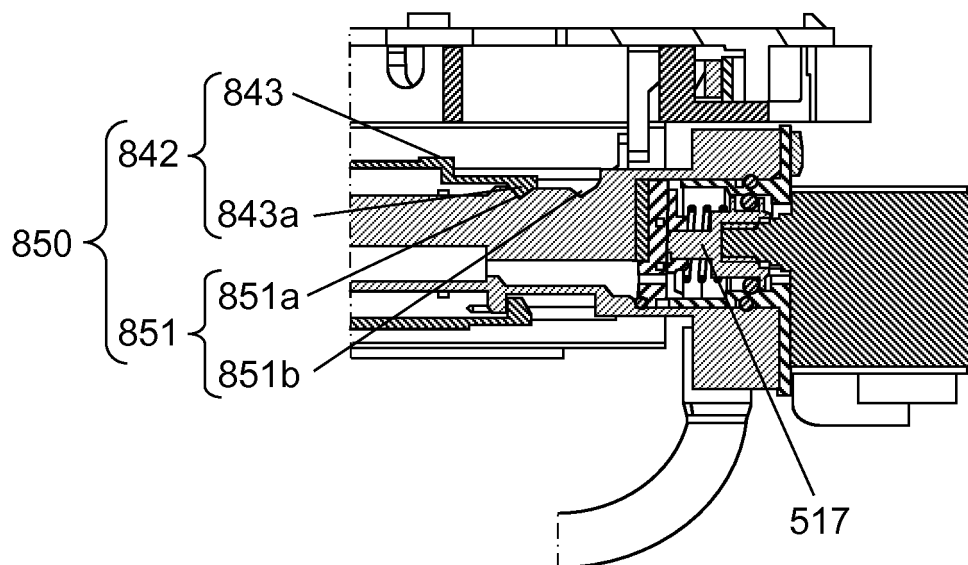


FIG. 23

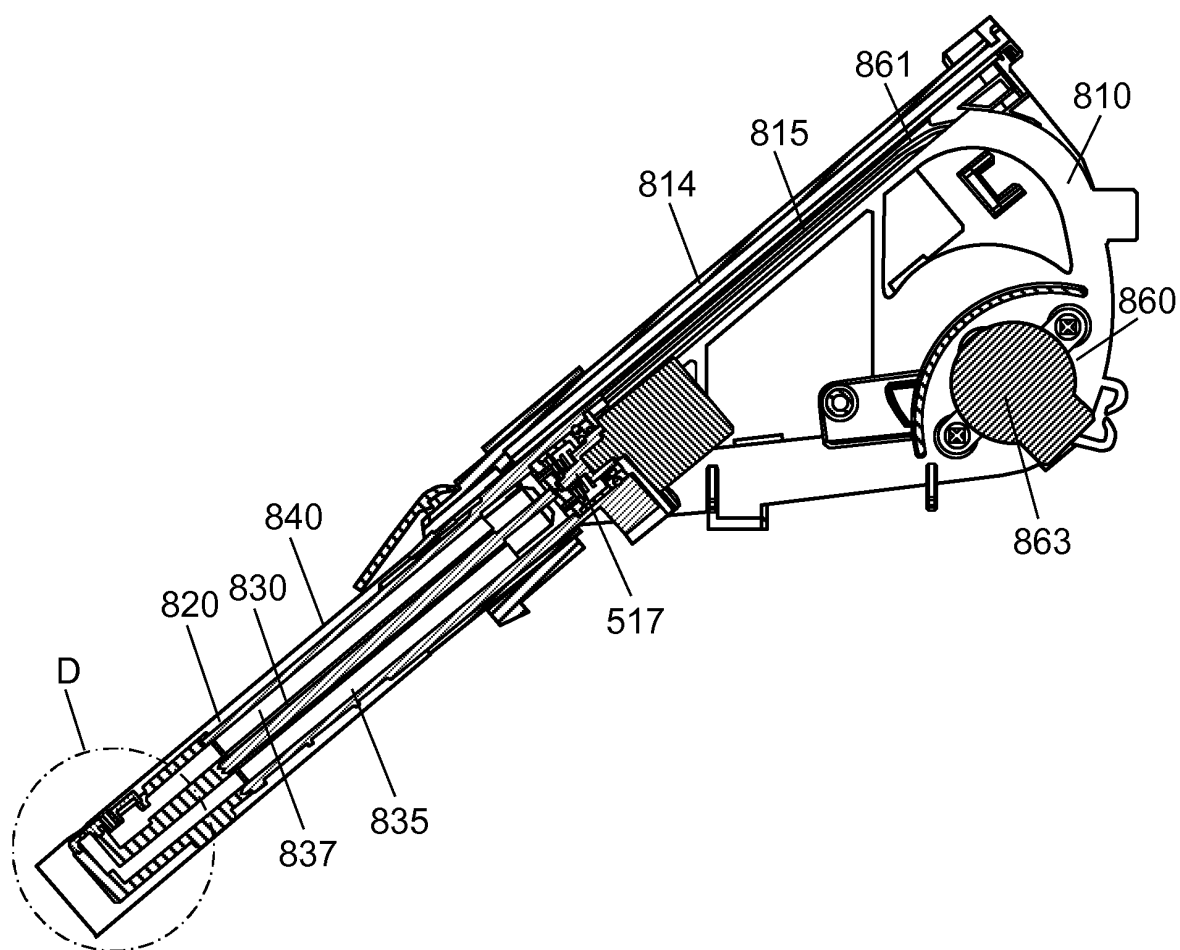


FIG. 24

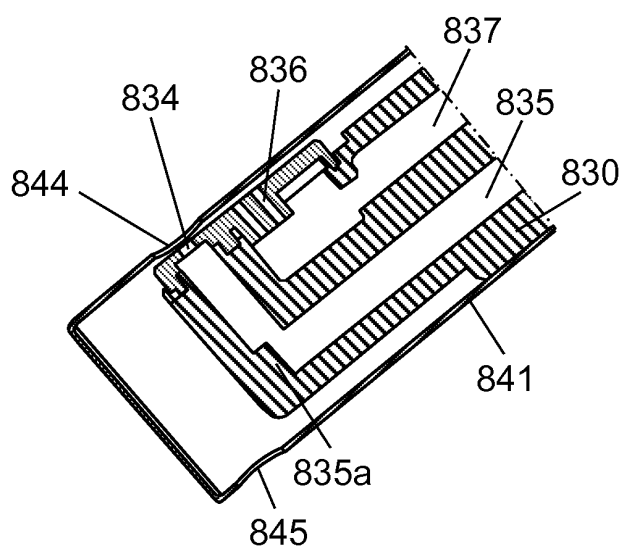


FIG. 25

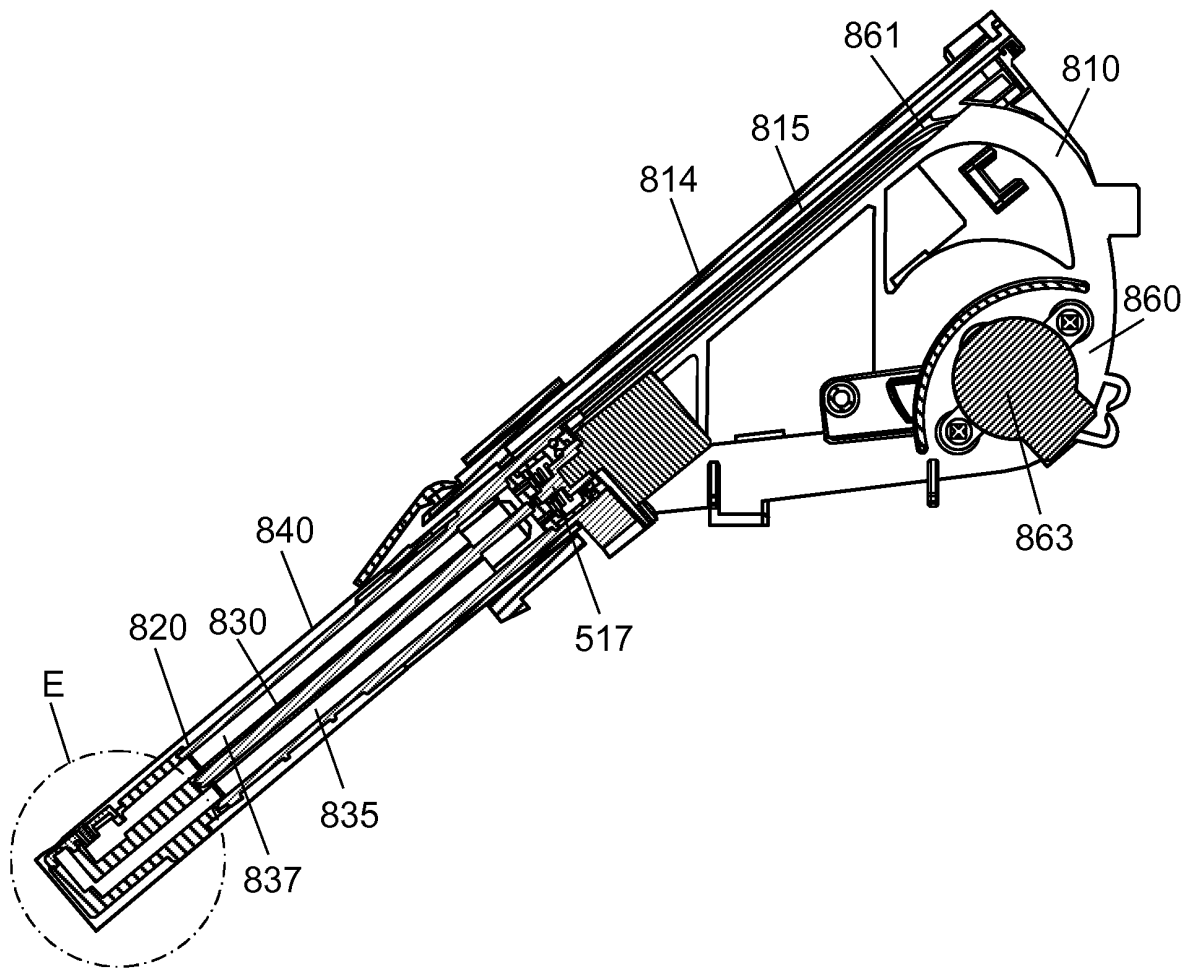


FIG. 26

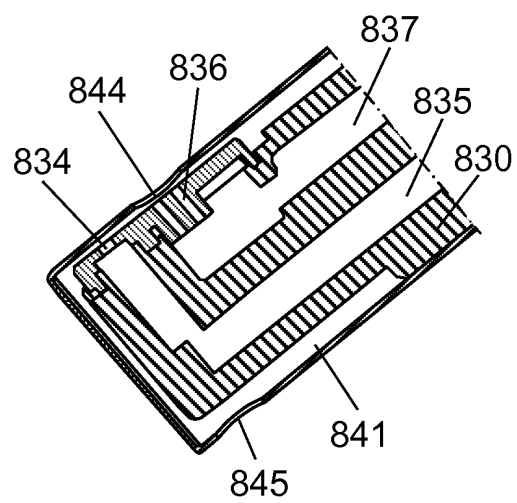


FIG. 27

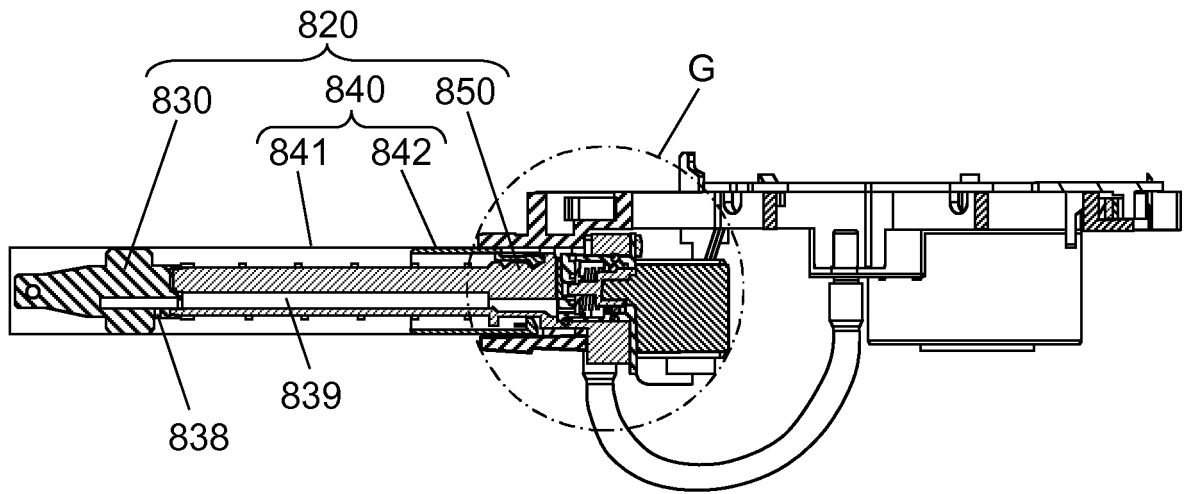


FIG. 28

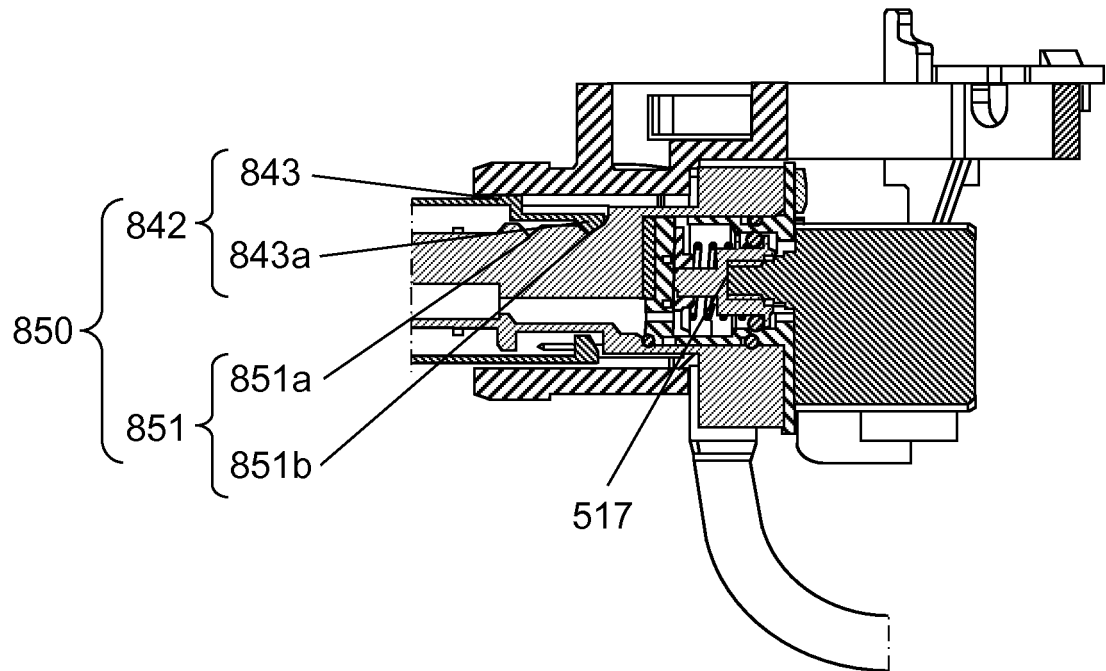


FIG. 29

the time chart of the washing part in the initial use

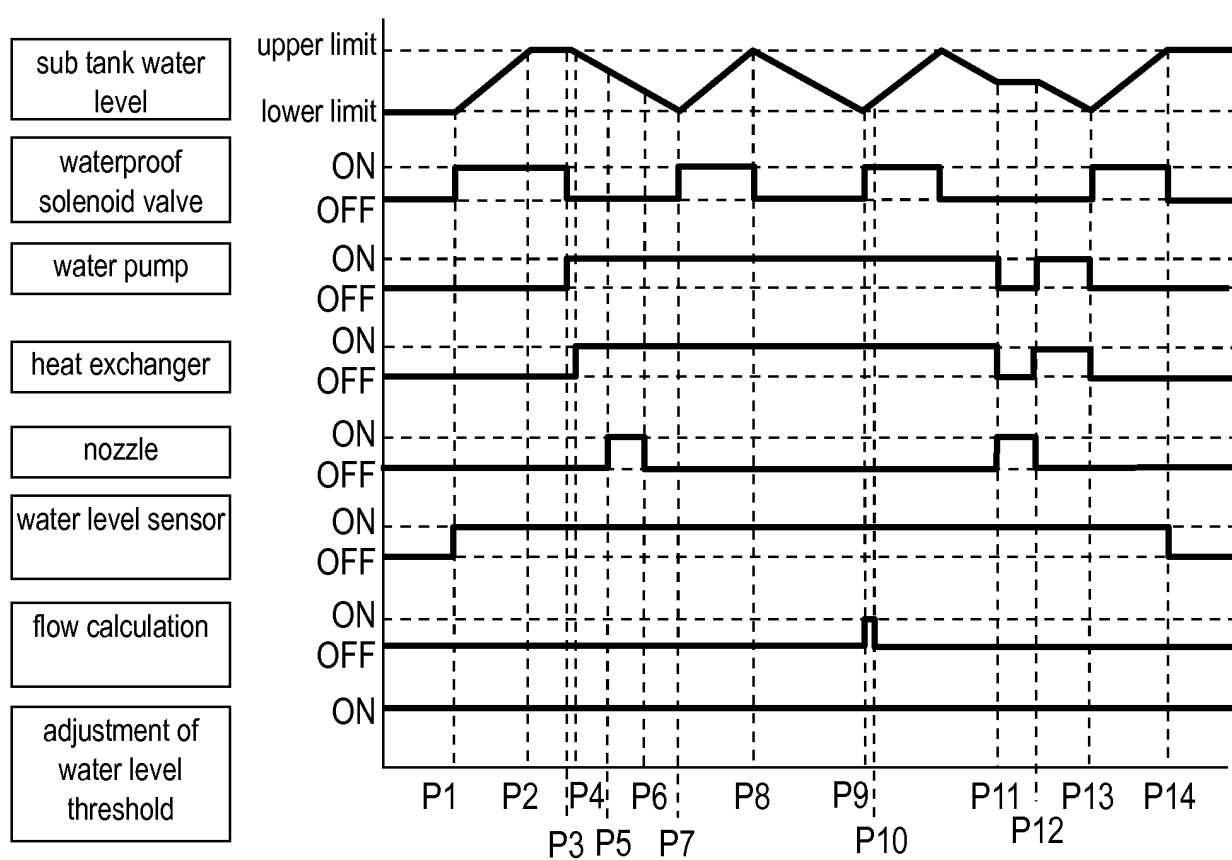


FIG. 30

the time chart of the washing part in the ordinary use

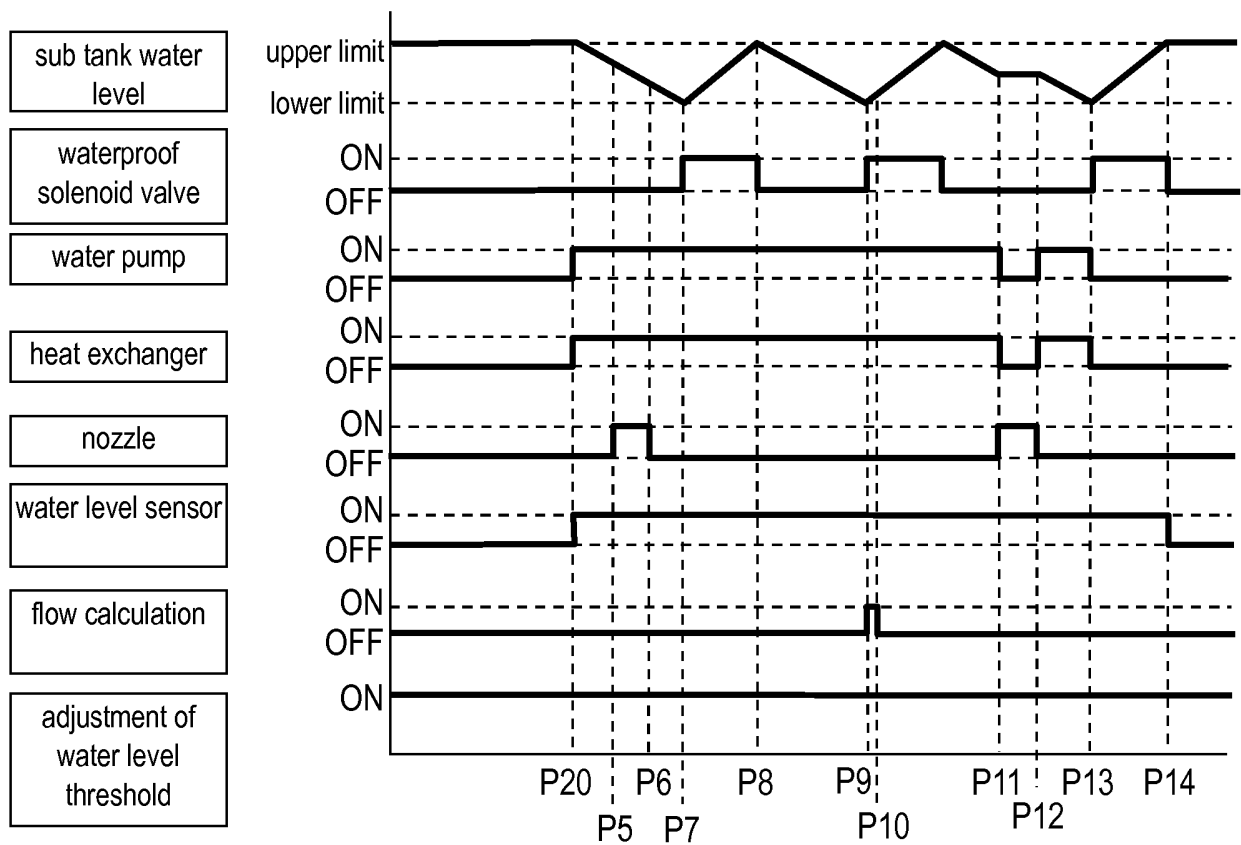


FIG. 31

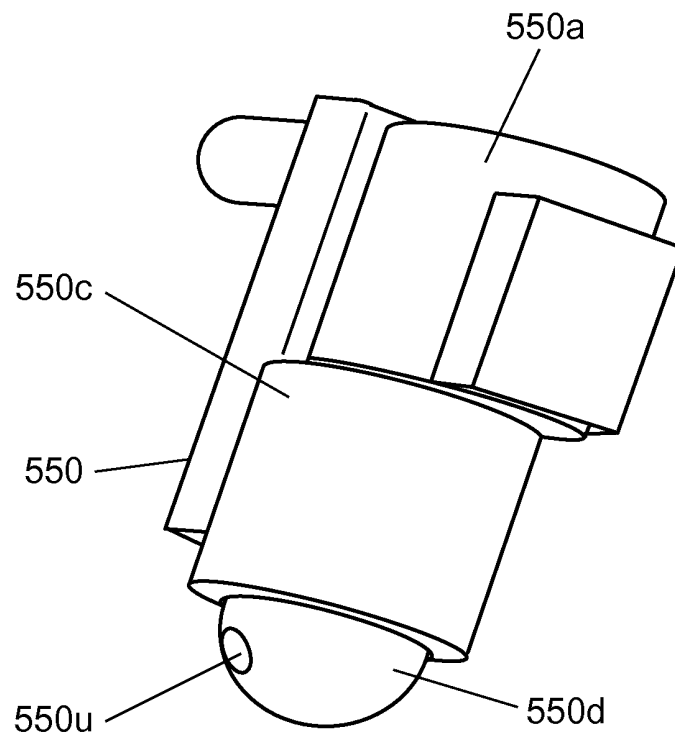


FIG. 32

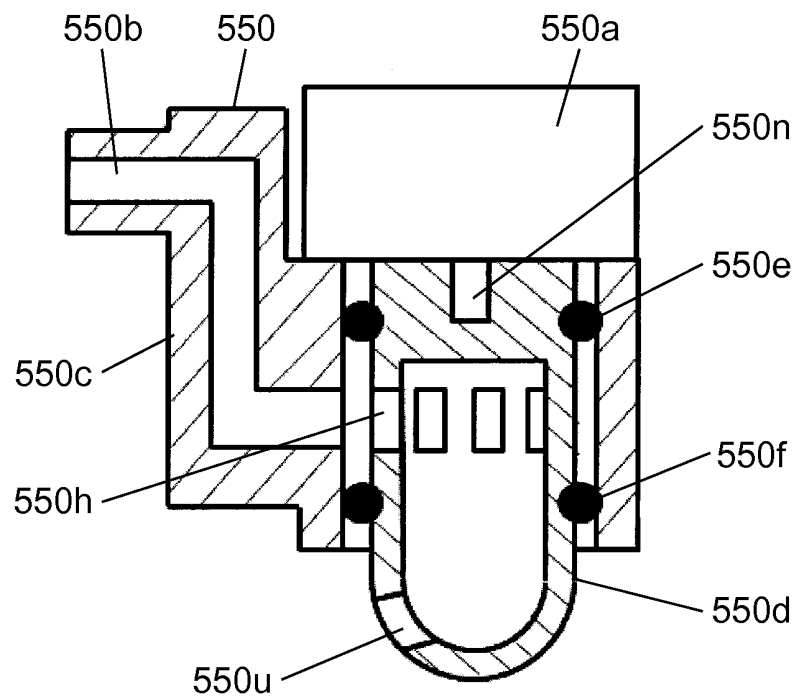


FIG. 33

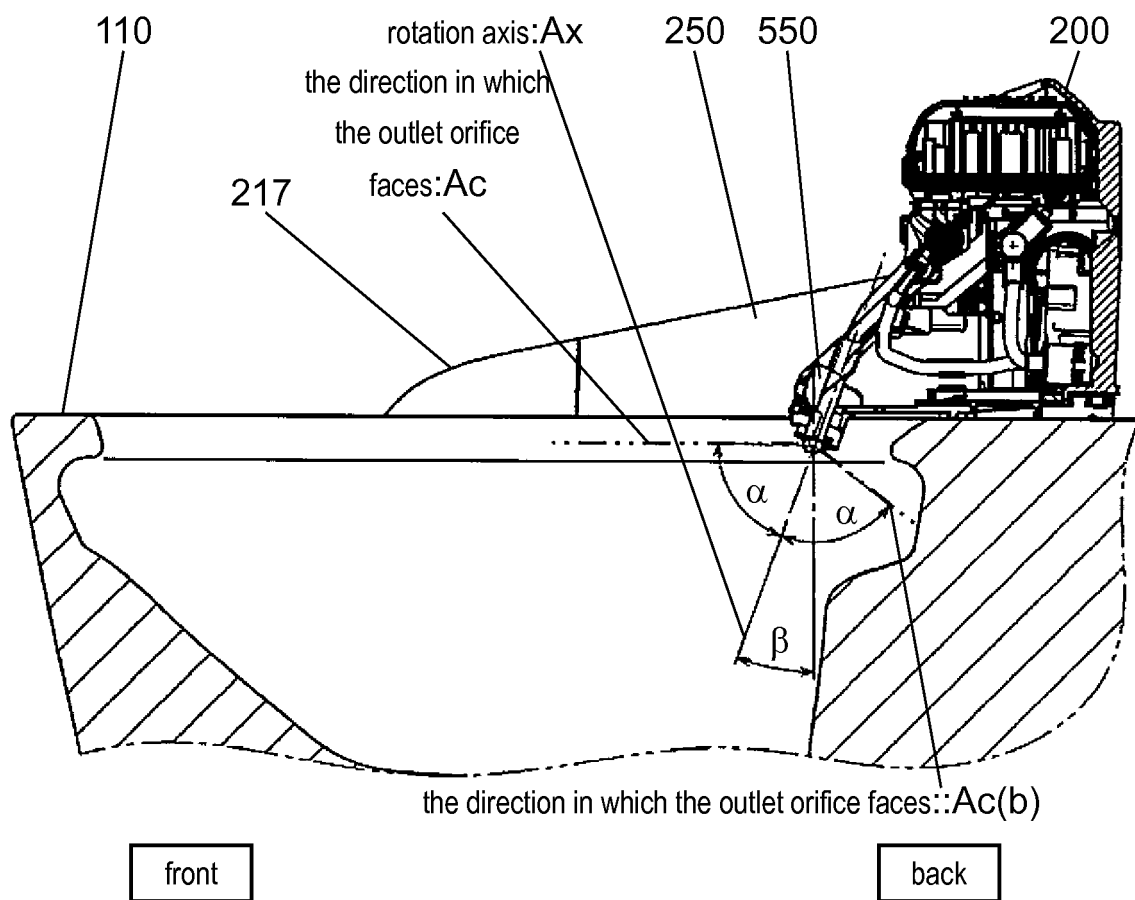


FIG. 34

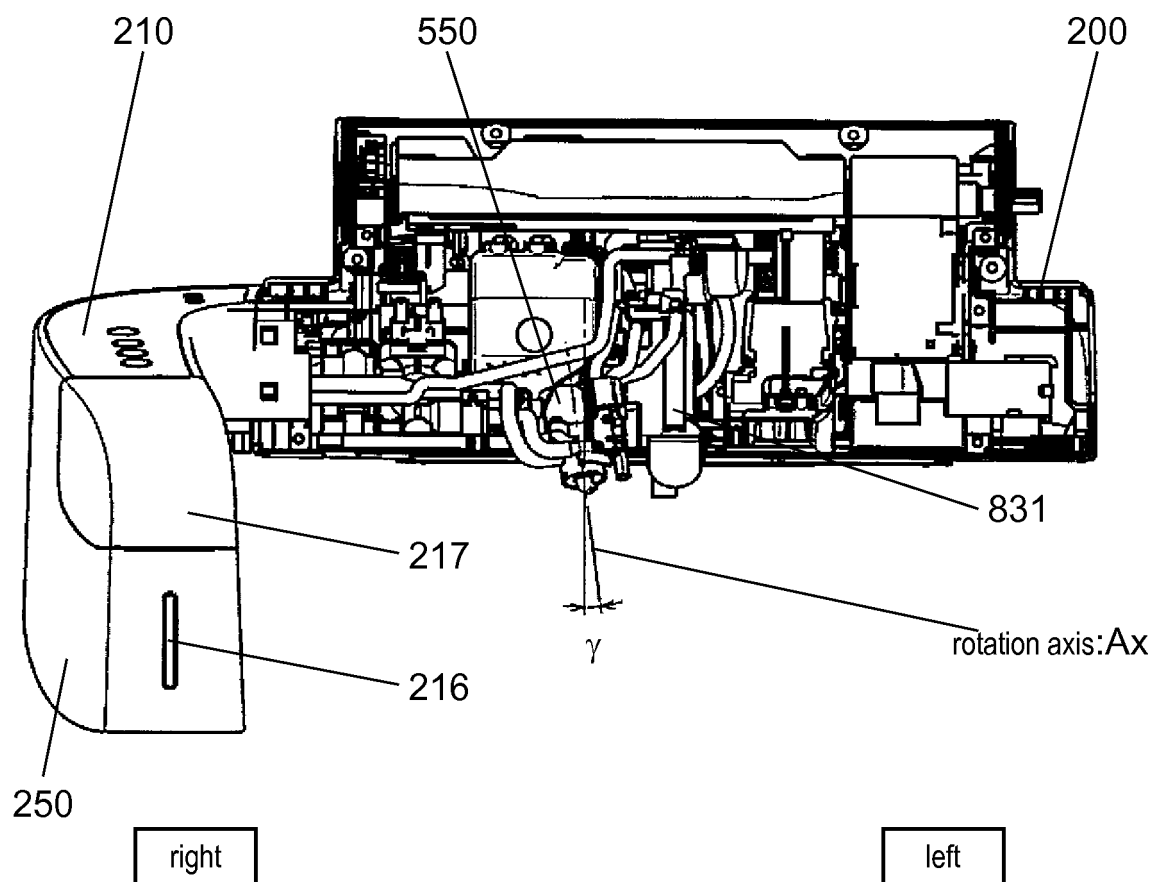


FIG. 35

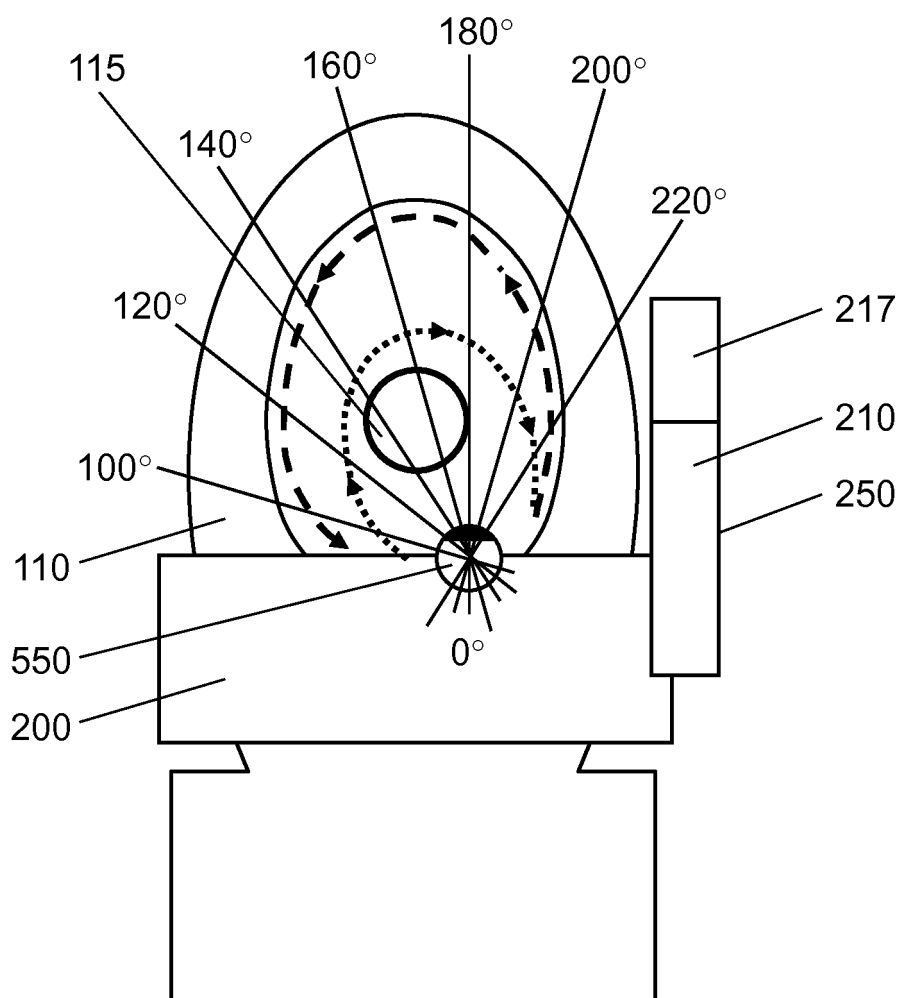


FIG. 36

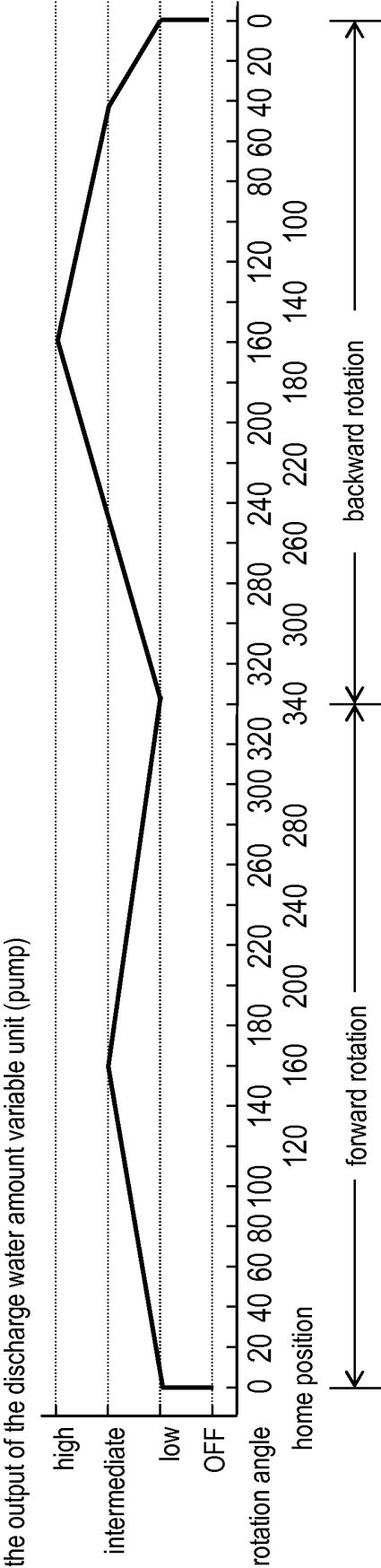


FIG. 37

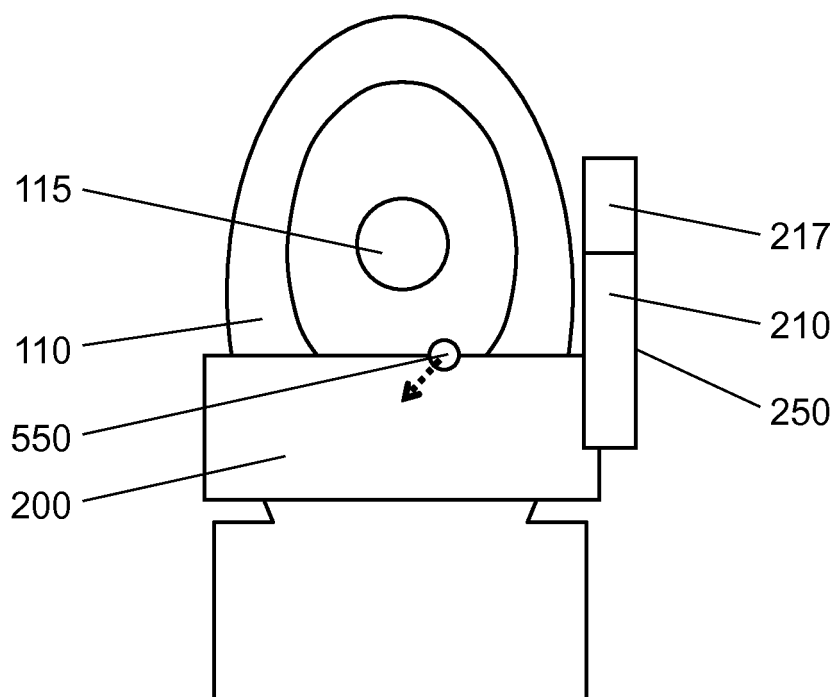
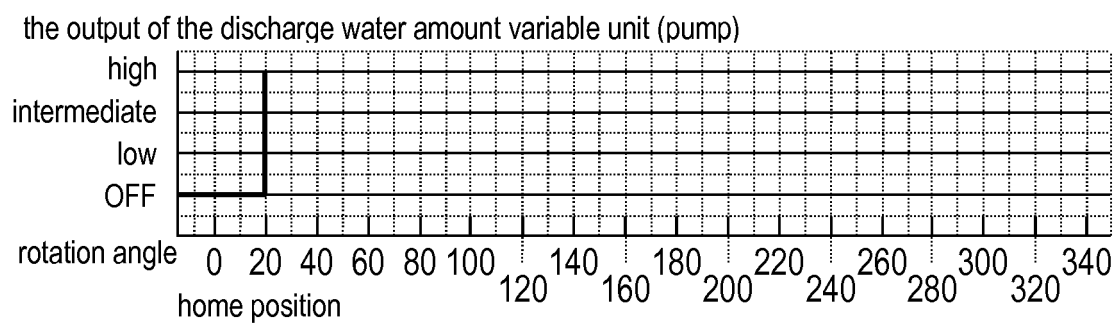


FIG. 38

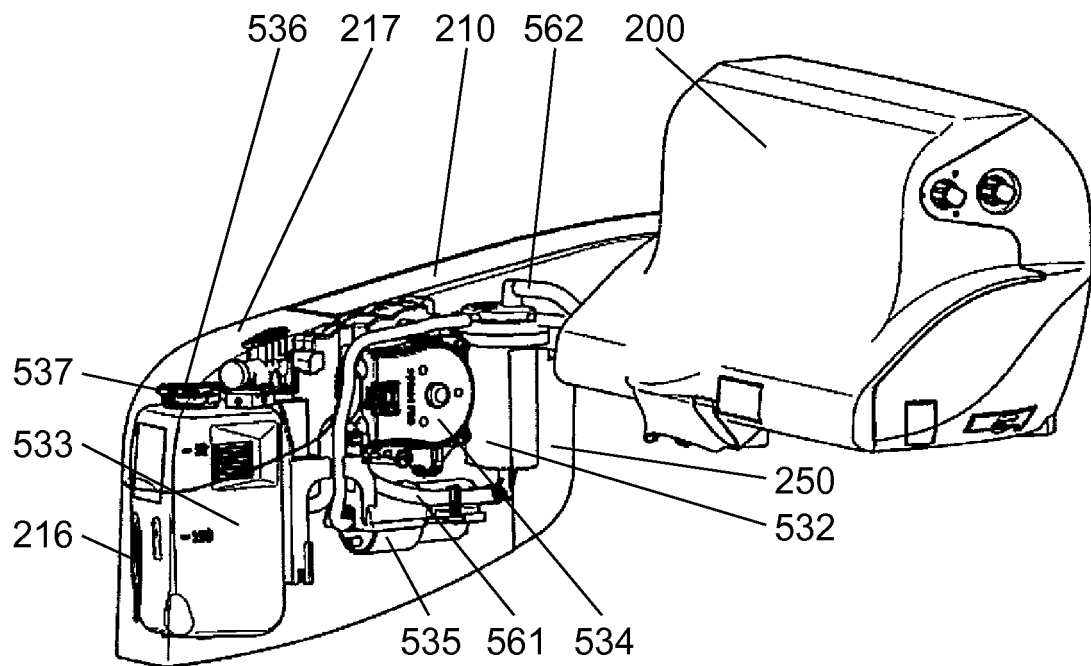


FIG. 39

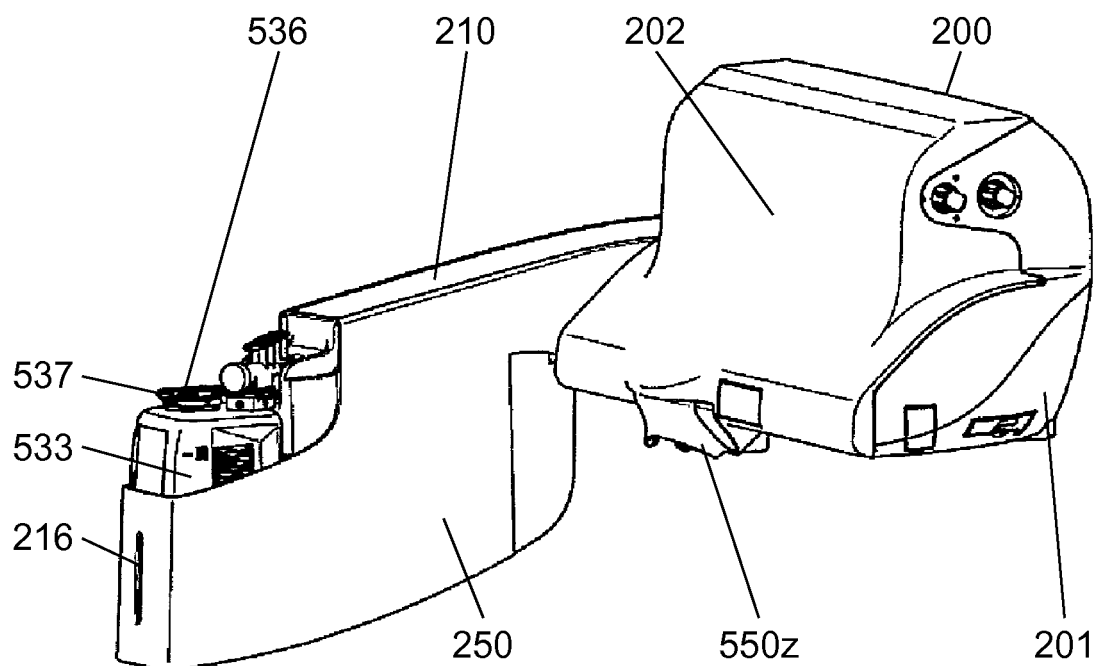


FIG. 40

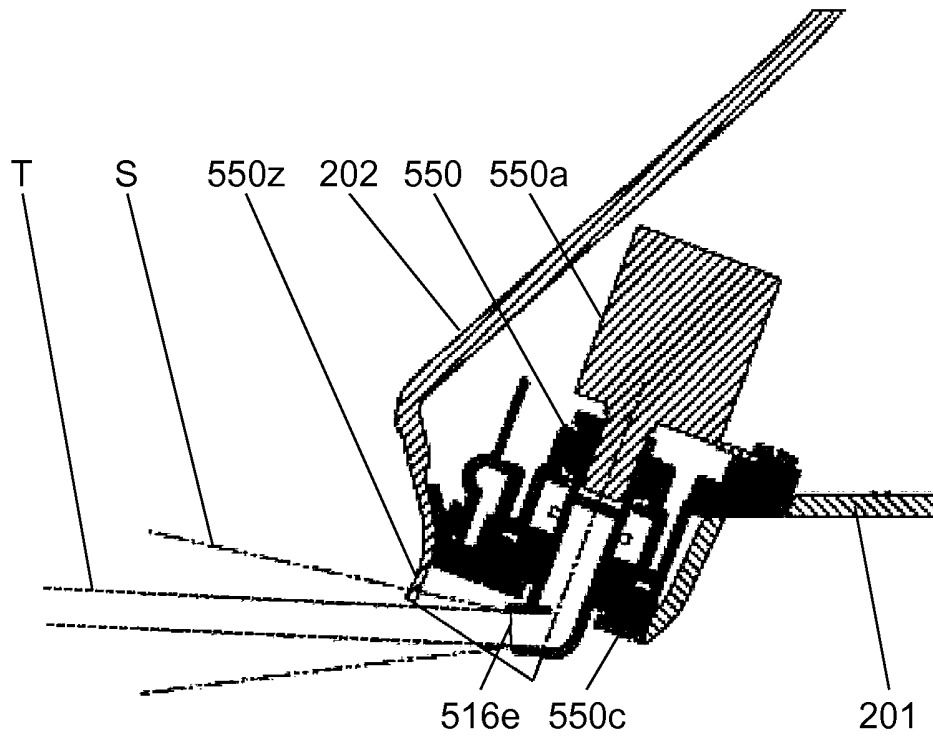


FIG. 41

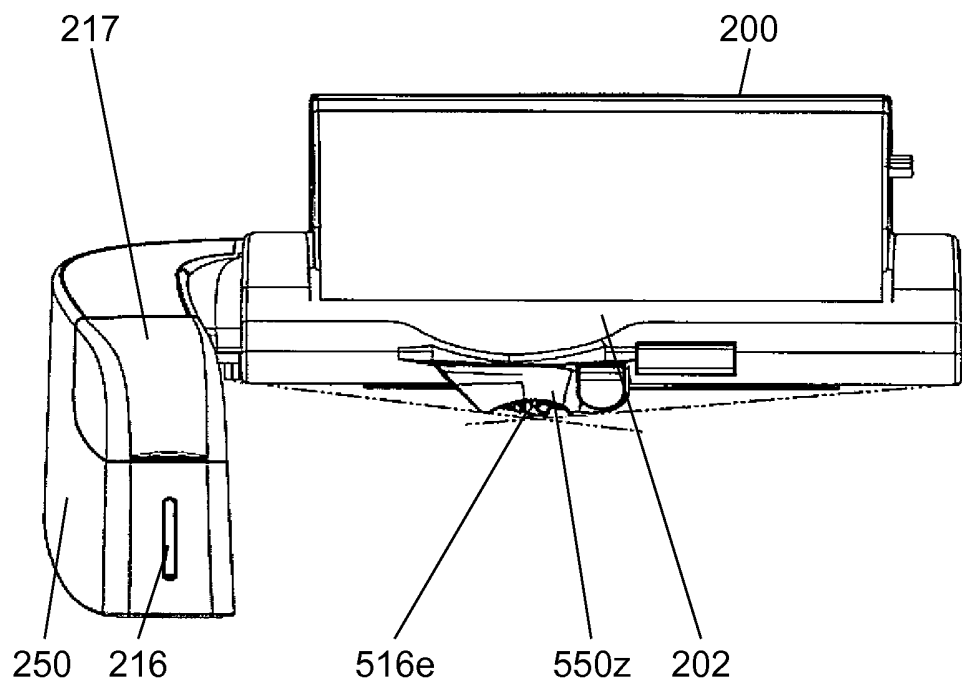


FIG. 42

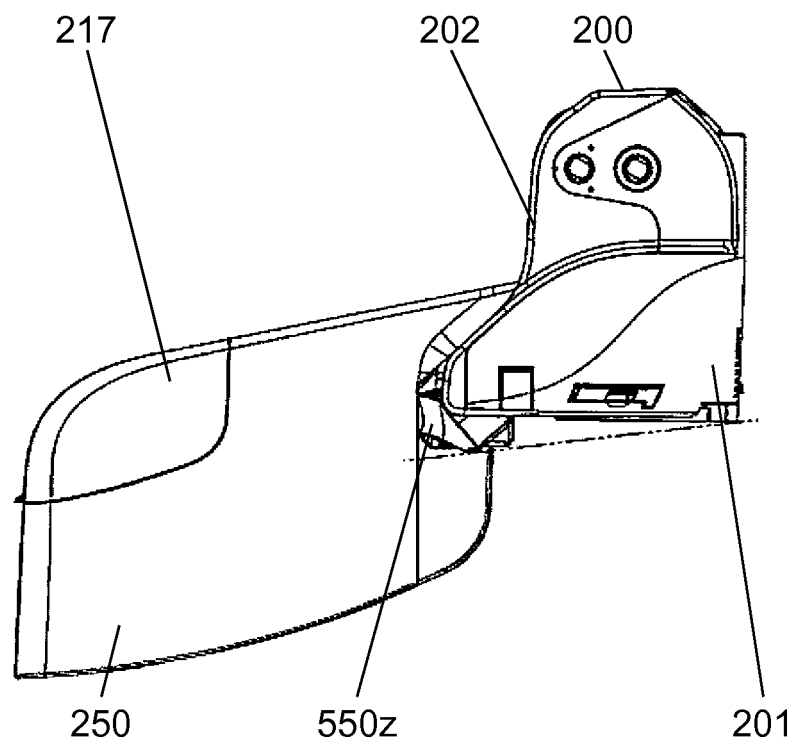


FIG. 43

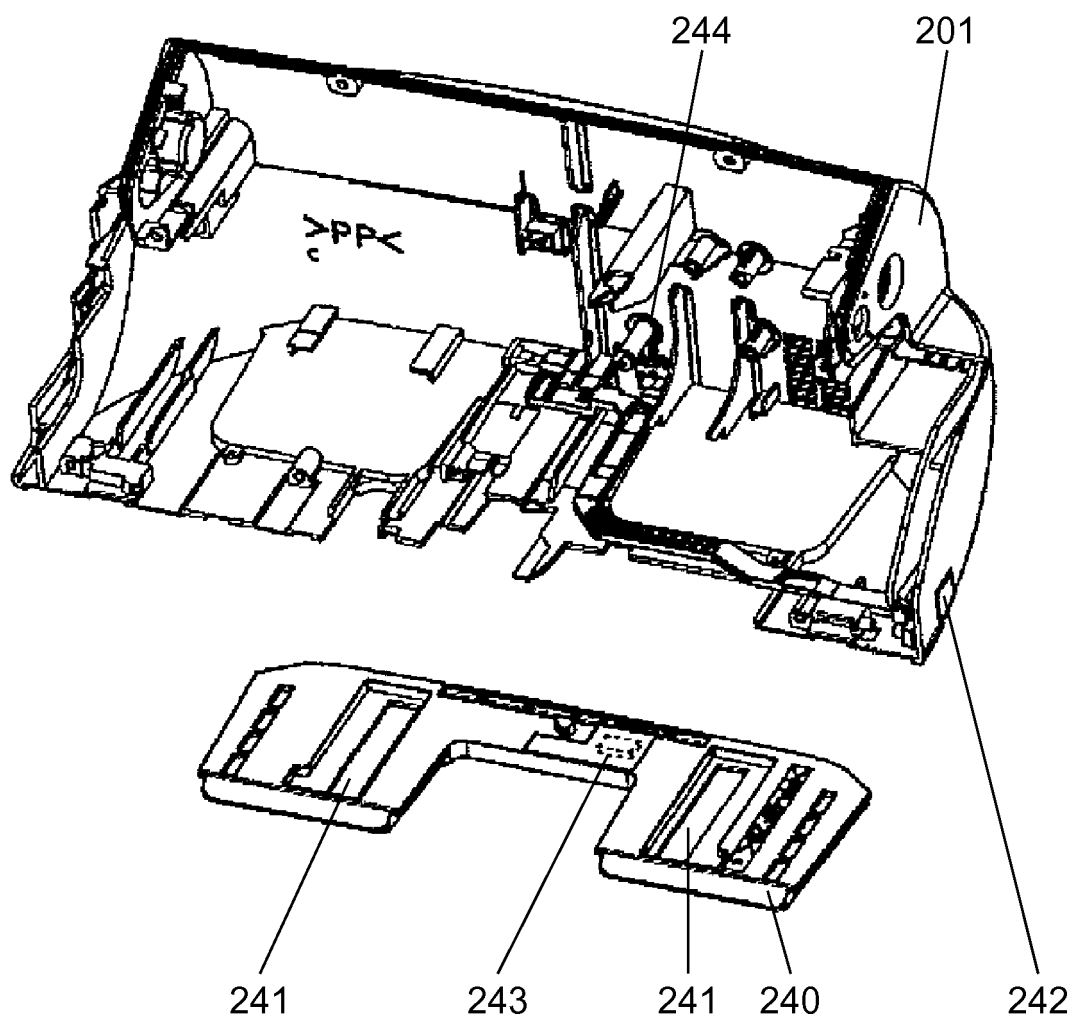


FIG. 44

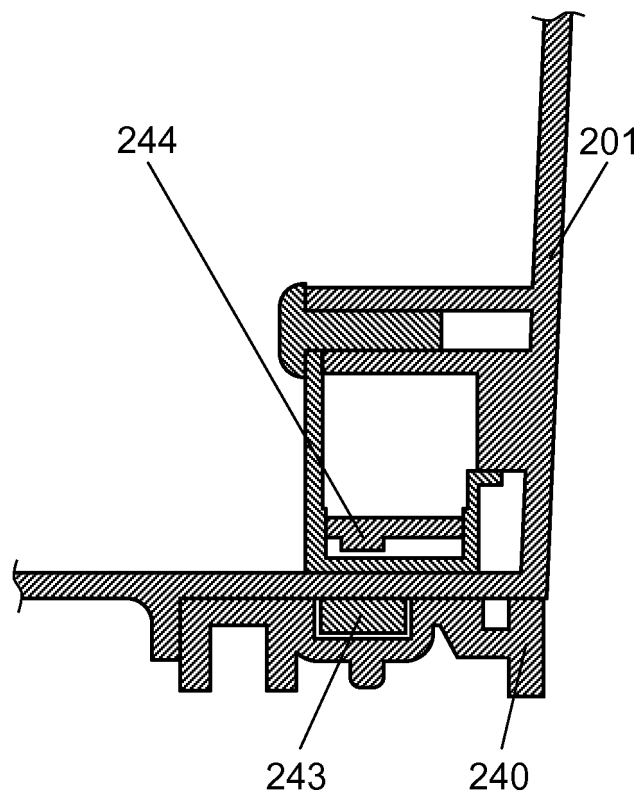


FIG. 45

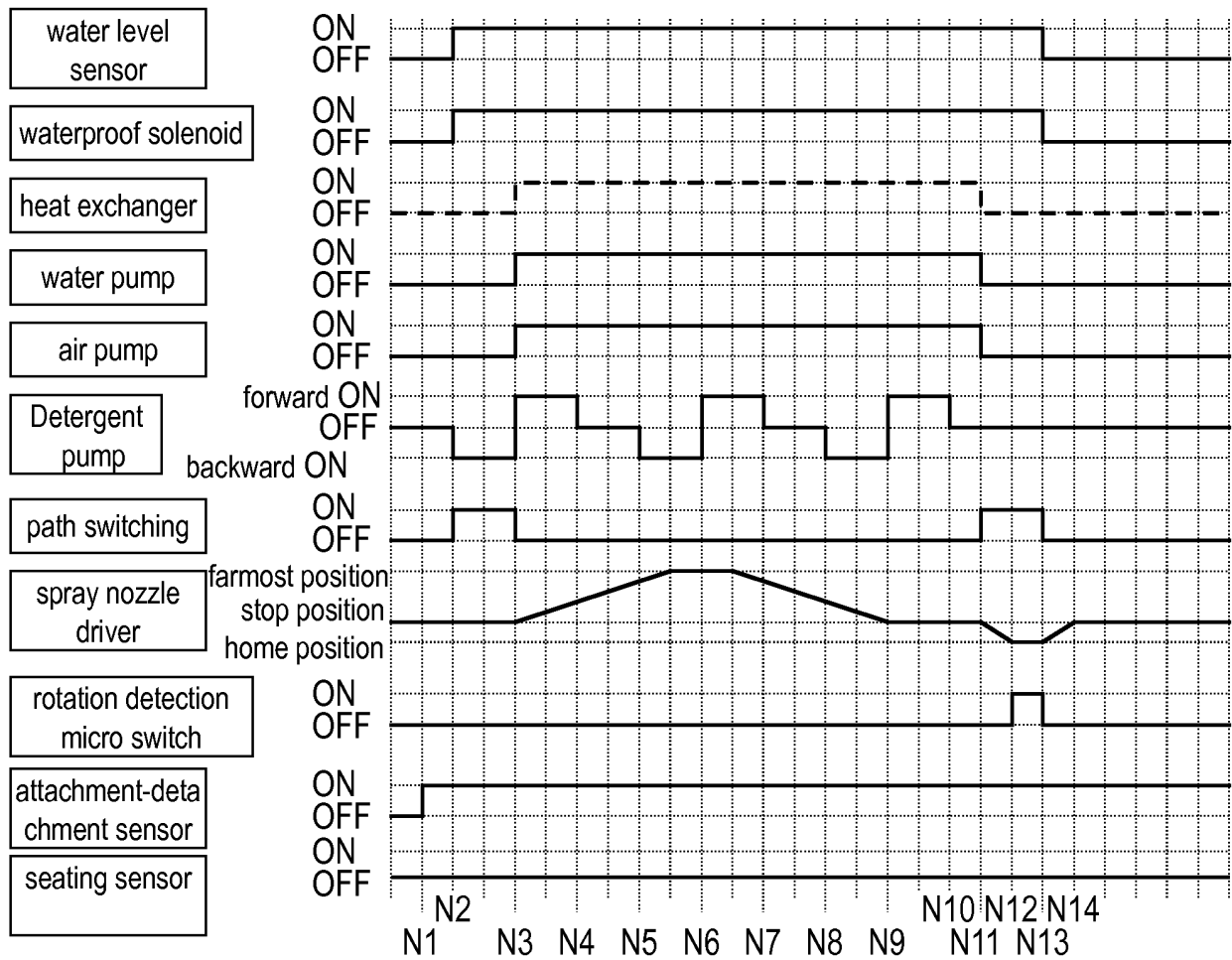


FIG. 46

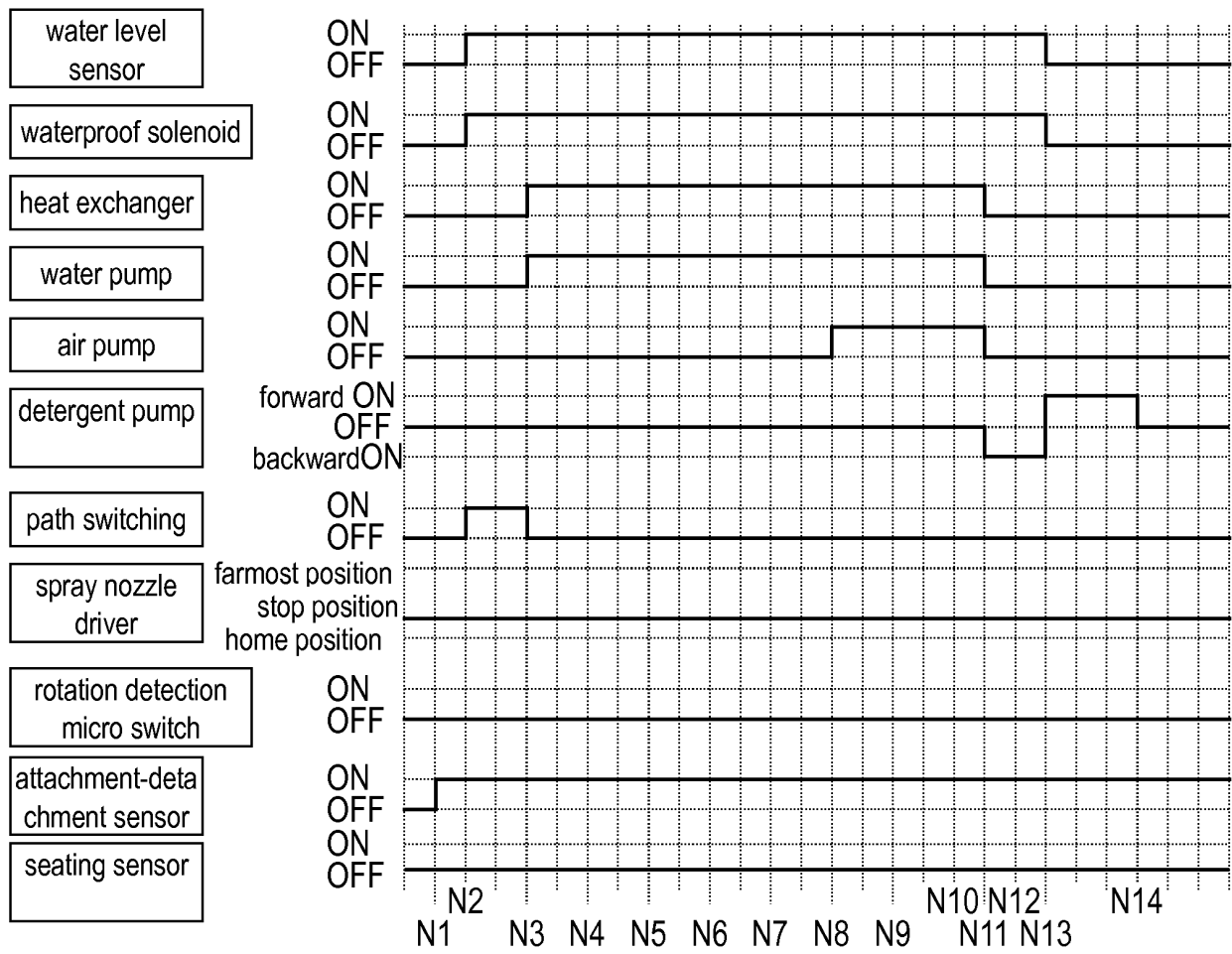


FIG. 47

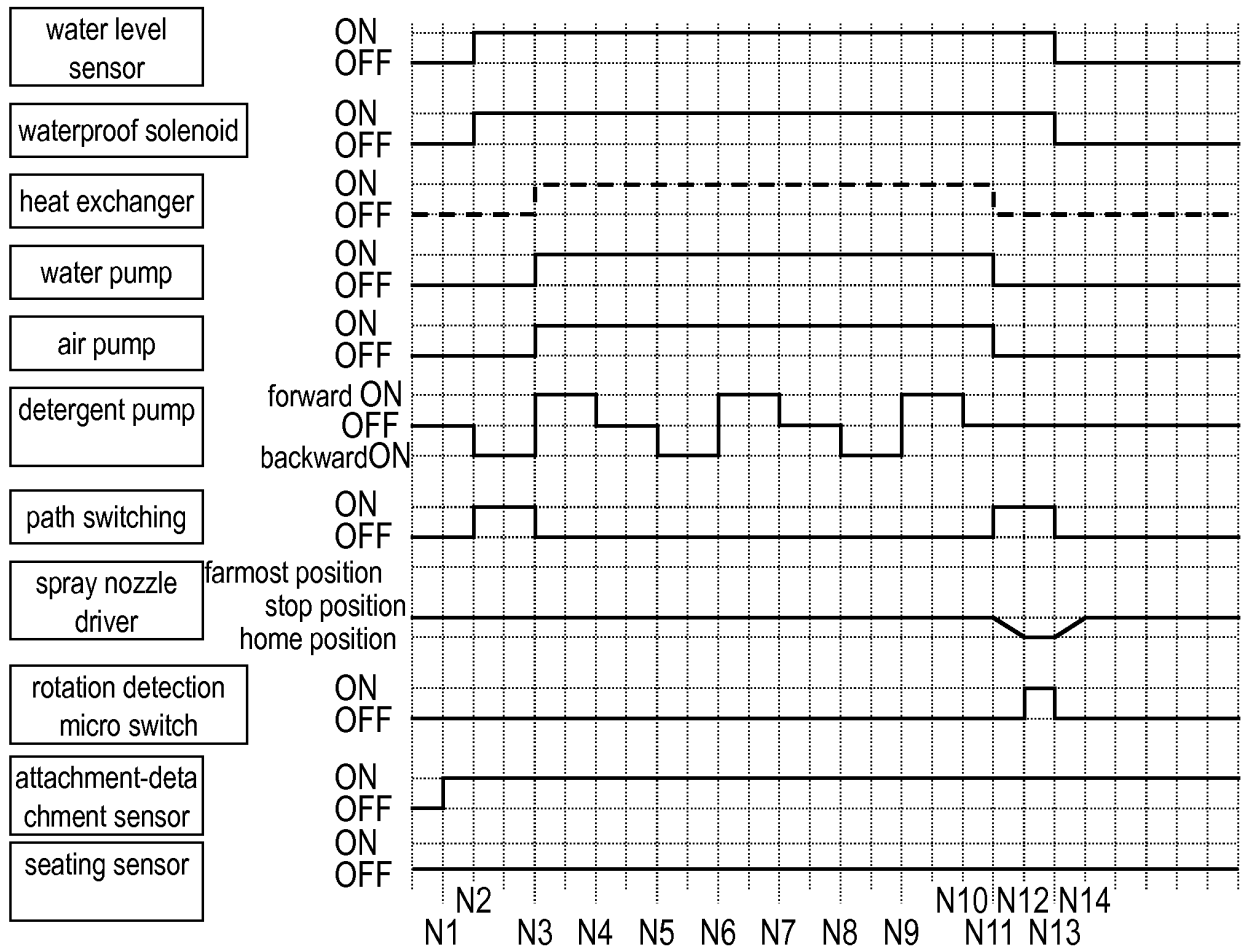


FIG. 48

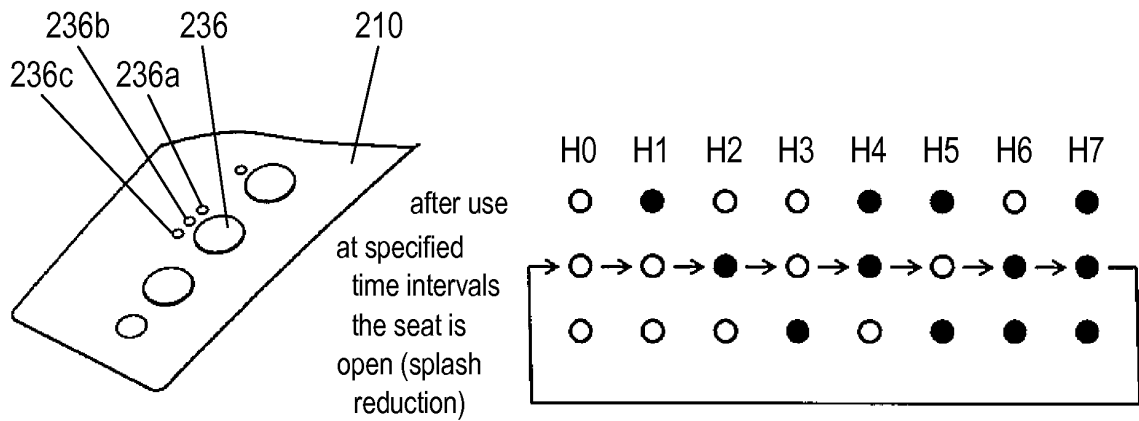


FIG. 49

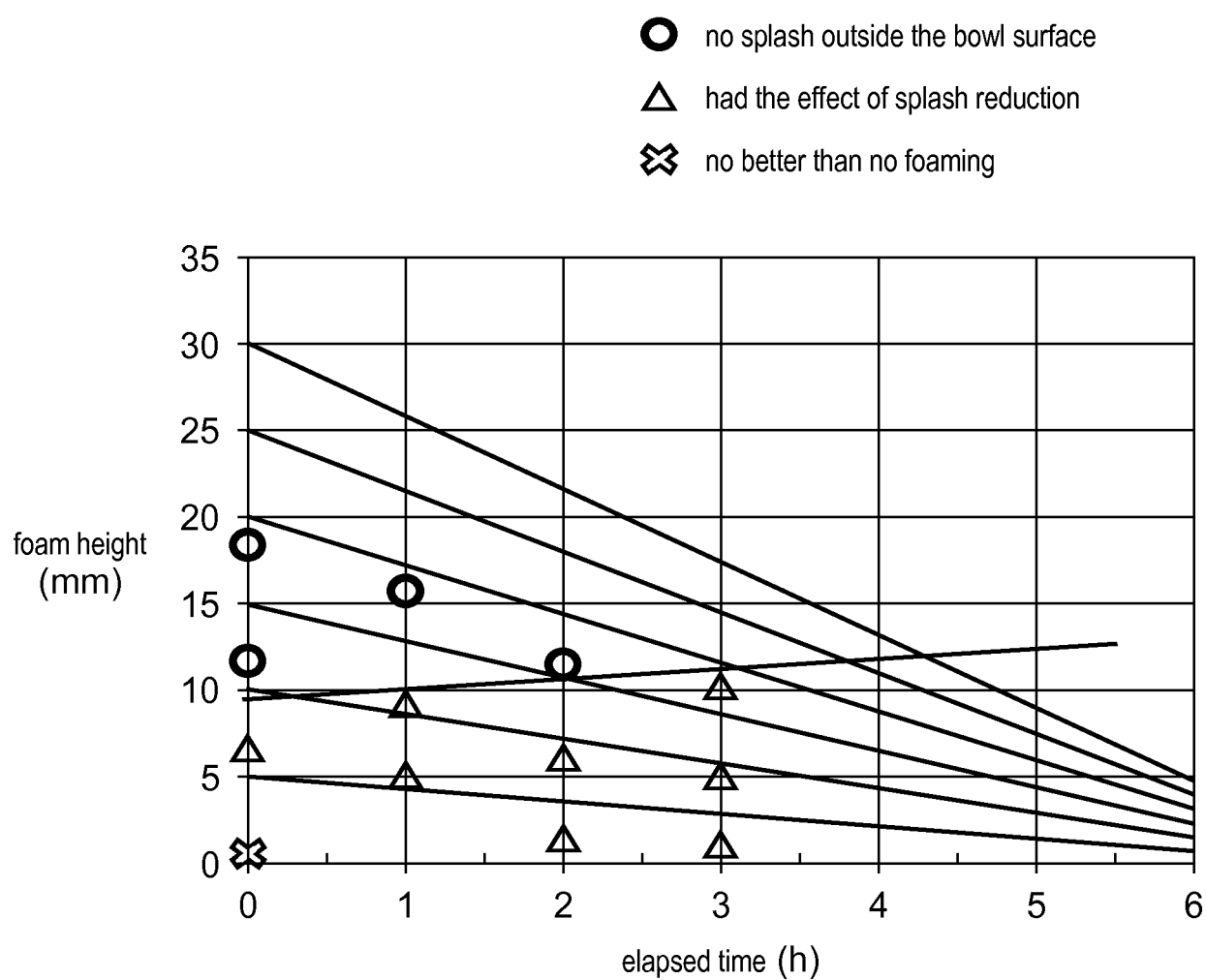


FIG. 50

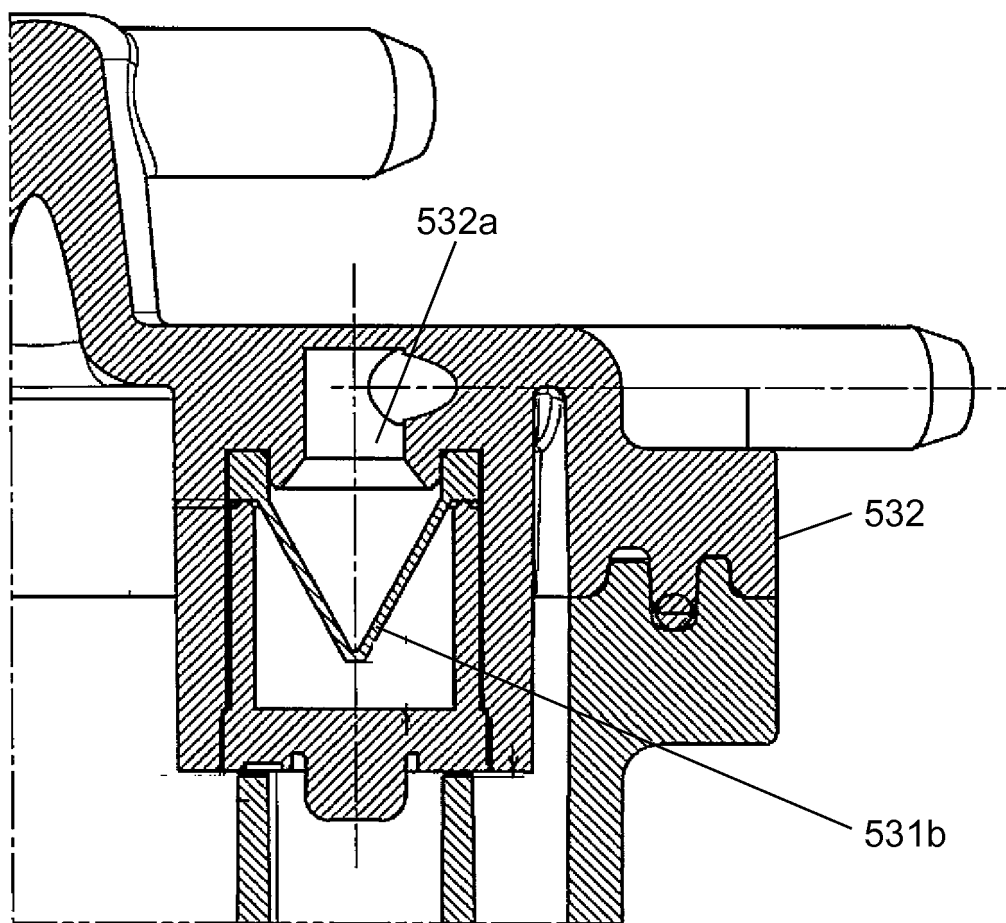
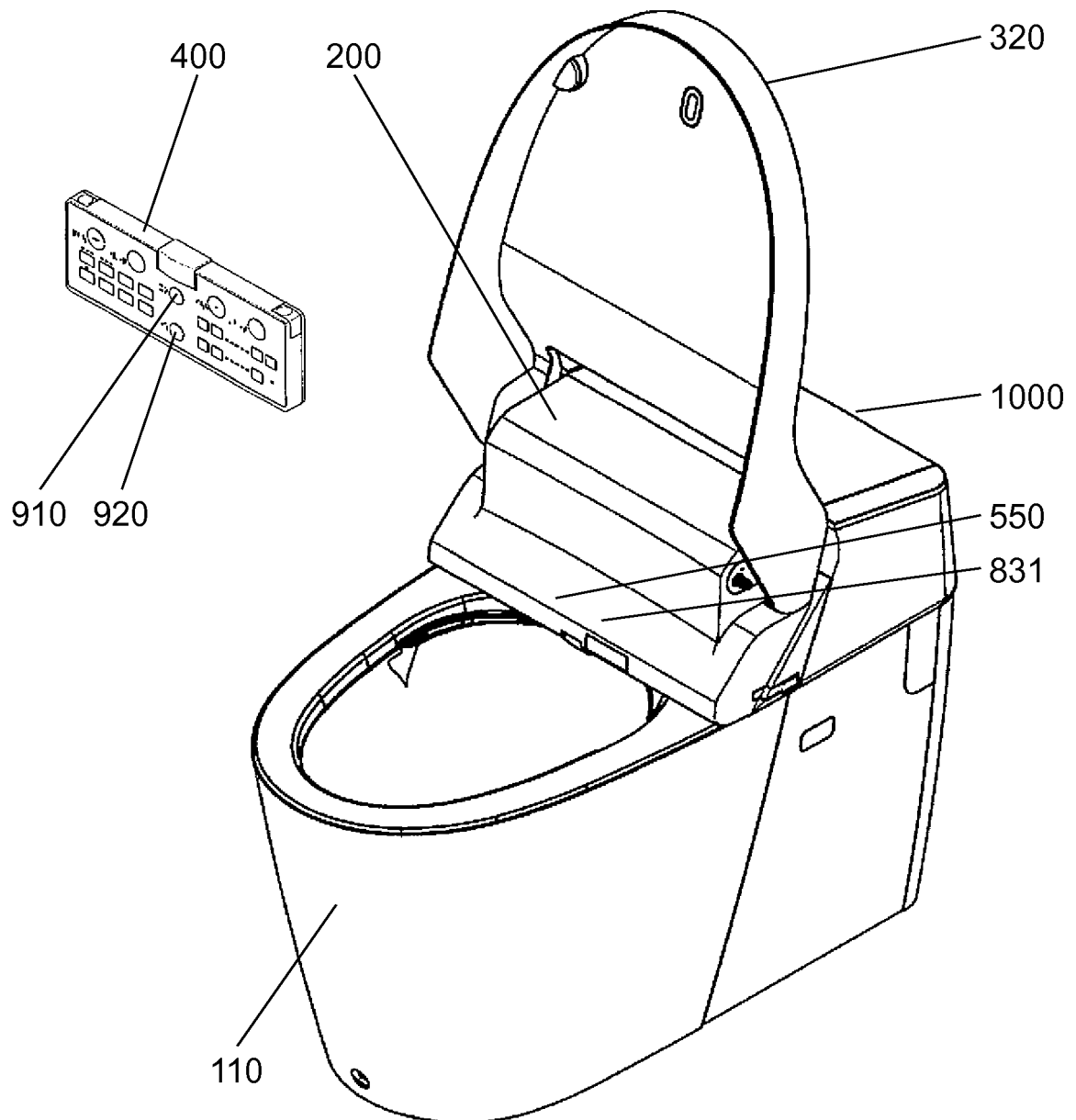


FIG. 51



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2017/005478

A. CLASSIFICATION OF SUBJECT MATTER

E03D9/08(2006.01)i, E03D11/02(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)

E03D1/00-7/00, 9/00-9/16, 11/00-13/00

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 1996-2017
 Kokai Jitsuyo Shinan Koho 1971-2017 Toroku Jitsuyo Shinan Koho 1994-2017

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.
Y A	JP 2008-138422 A (Matsushita Electric Works, Ltd.), 19 June 2008 (19.06.2008), paragraphs [0017] to [0029], [0034]; fig. 1, 2, 4, 9, 10 (Family: none)	1, 4-6 2, 3
Y A	JP 2001-146783 A (Seiko Precision Inc.), 29 May 2001 (29.05.2001), paragraphs [0016], [0020] to [0024]; fig. 1, 2, 5 to 8 (Family: none)	1, 4-6 2, 3

☒ Further documents are listed in the continuation of Box C.
 ☐ See patent family annex.

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"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

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"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

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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

"&"

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 Date of the actual completion of the international search
 18 April 2017 (18.04.17)

 Date of mailing of the international search report
 09 May 2017 (09.05.17)

 Name and mailing address of the ISA/
 Japan Patent Office
 3-4-3, Kasumigaseki, Chiyoda-ku,
 Tokyo 100-8915, Japan

Authorized officer

Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2017/005478

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2003-64759 A (Matsushita Electric Works, Ltd.), 05 March 2003 (05.03.2003), paragraphs [0028], [0029], [0037]; fig. 2, 14, 15 (Family: none)	4-6
Y	JP 2003-247259 A (Matsushita Electric Works, Ltd.), 05 September 2003 (05.09.2003), paragraphs [0013] to [0015]; fig. 1 (Family: none)	5, 6

Form PCT/ISA/210 (continuation of second sheet) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2000104319 A [0006]