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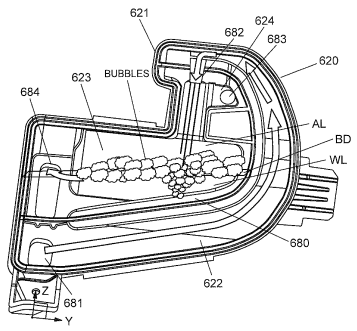
(54) WASHING MACHINE

(57) A washing machine includes a water tub for storing washing solution, a rotary drum contained in the water tub and for housing clothes, a housing tub provided with the water tub and the rotary drum, and a bubble generator for generating bubbles and supplying the generated bubbles to the housing tub. Moreover, the bubble generator includes a bubble generation chamber for storing the washing solution supplied from a circulation pump, and the washing solution supplied from the circulation pump collides with a liquid surface of the washing solution stored in the bubble generation chamber. Thus, the washing machine that has a simple configuration and is capable of efficiently washing clothes with bubbles can be provided.

FIG. 6



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Description

TECHNICAL FIELD

[0001] The present invention relates to a washing machine for washing clothes.

BACKGROUND ART

[0002] In a washing machine, dissolving a detergent as quickly as possible and allowing the detergent to permeate clothes in a washing process are very efficient to remove dirt of the clothes. Further, forming dissolved detergent solution into a foam shape and spraying the solution on the clothes are effective means for increasing the volume of the solution and spreading a highly concentrated detergent component (mainly a surfactant) throughout the clothes.

[0003] Conventionally, a washing machine, in which detergent solution stored in a water tub is circulated by a pump and air is introduced into a circulation flow passage to generate bubbles, has been disclosed (see PTL 1 and PTL 2).

[0004] In PTL 1, washing solution is circulated by using a circulation pump, and air is released from an air pump to a bubble generation tank provided in a circulation flow passage, thereby generating bubbles. However, the generated bubbles are relatively small, and cannot be widely spread into clothes. Further, the air pump is required to introduce the air.

[0005] In PTL 2, washing solution is circulated by using a circulation pump, and air is taken in from a front stage of the pump, thereby generating bubbles. However, the bubbles are easily vanished by water pressure in a flow passage, and it is difficult to spread the sufficient bubbles to clothes during introduction of the washing solution into a washing tub. Further, an air supply valve, such as a duckbill type valve, is required for an air intake part.

Citation List

Patent Literature

[0006]

PTL 1: Unexamined Japanese Patent Publication No. 2010-172547
PTL 2: Unexamined Japanese Patent Publication No. 2005-7224

SUMMARY OF THE INVENTION

[0007] In view of the conventional problems, an object of the present invention is to provide a washing machine with a simple configuration which efficiently washes clothes by dissolving a detergent and generating bubbles.

[0008] A washing machine according to an aspect of the present invention includes a water tub for storing washing solution, a rotary drum contained in the water tub and for housing clothes, a housing tub provided with the water tub and the rotary drum, a bubble generator for generating bubbles and supplying the generated bubbles to the housing tub, and a circulation pump for supplying the washing solution in the water tub to the bubble generator. Moreover, the bubble generator includes a bubble generation chamber for storing the washing solution supplied from the circulation pump, and the washing solution supplied from the circulation pump collides with a liquid surface of the washing solution stored inside the bubble generation chamber.

[0009] In this washing machine, water containing a detergent is supplied to the bubble generator by the circulation pump, and collides with the liquid surface of the washing solution stored inside the bubble generation chamber. As a result, air bubbles are generated in a solution layer of the washing solution. The washing solution whose volume is increased by the air bubbles is drained from the bubble generator to spread over the clothes in the housing tub. When the washing solution makes contact with and permeates through the clothes, the air bubbles become a foam film to cover the clothes. Since the foam film contains a high concentration surfactant, dirt of the clothes can be efficiently removed. The washing solution sprayed on the housing tub flows down to the water tub and is again supplied to the bubble generator by the circulation pump. Since the washing solution supplied from the circulation pump is stably supplied to a casing at a predetermined flow amount, the detergent is dissolved and bubbles can be generated with high reliability.

[0010] As mentioned above, in the washing machine according to the aspect of the present invention, there is no need to provide air introduction means using the air pump in PTL 1 or air intake means requiring the air supply valve, such as a duckbill type valve, in PTL 2 to generate air bubbles. Therefore, the washing machine with a simple configuration can efficiently wash the clothes by dissolving the detergent and generating the bubbles.

[0011] The washing machine according to the present invention has a simple configuration and can efficiently wash clothes with bubbles.

BRIEF DESCRIPTION OF DRAWINGS

[0012]

FIG. 1 is a schematic block diagram of a washing machine in a first exemplary embodiment of the present invention.
FIG. 2 is a schematic perspective view of the washing machine.
FIG. 3 is a schematic sectional view of the washing machine.
FIG. 4 is a schematic front view of the washing machine.
FIG. 5 is a schematic side view of the washing machine.
FIG. 6 is a schematic sectional view of a bubble generator of the washing machine.
FIG. 7 is a schematic sectional view of a washing machine in a second exemplary embodiment of the present invention.
FIG. 8 is a schematic sectional view of a washing machine in a third exemplary embodiment of the present invention.
FIG. 9 is a schematic sectional view of a washing machine in a fourth exemplary embodiment of the present invention.
FIG. 10 is a perspective view of an internal circulation path of a washing machine in a fifth exemplary embodiment of the present invention.
FIG. 11 is a perspective view showing a variation of the internal circulation path of the washing machine in the fifth exemplary embodiment.
FIG. 12 is a schematic sectional view of a bubble generator in a sixth exemplary embodiment of the present invention.
FIG. 13 is a schematic view of the bubble generator of the washing machine as viewed from above.
FIG. 14 is a schematic view showing circulation paths in a water tub of a washing machine in a seventh exemplary embodiment of the present invention.
FIG. 15 is a schematic view showing a circulation path in a water tub of a washing machine in an eighth exemplary embodiment of the present invention.
FIG. 16 is a schematic view of a casing of a circulation pump of the washing machine.
FIG. 17 is a schematic front view of a washing machine in a ninth exemplary embodiment of the present invention.
FIG. 18 is a schematic block diagram of a washing machine in a tenth exemplary embodiment of the present invention.
FIG. 19 is a schematic block diagram of a washing machine in an eleventh exemplary embodiment of the present invention.
FIG. 20 is a schematic block diagram of a washing machine in a twelfth exemplary embodiment of the present invention.
FIG. 21 is a schematic sectional view of a bubble generator of a washing machine according to a thirteenth exemplary embodiment of the present invention.
FIG. 22 is a schematic sectional view of a washing machine in a fourteenth exemplary embodiment of the present invention.

DESCRIPTION OF EMBODIMENTS

[0013] Hereinafter, a washing machine will be exemplarily described with reference to the drawings. It should be noted that terms representing the directions, such as "up", "down", "left", or "right", used in the following description is merely for clarification of the description. Therefore, the principle of the washing machine is not limited by these terms. The washing machine disclosed below has not only a washing function of washing clothes but also a drying function of drying clothes. Alternatively, a clothes treatment device may be a washing machine having no drying function.

(FIRST EXEMPLARY EMBODIMENT)

(WASHING MACHINE)

[0014] FIG. 1 is a schematic block diagram of washing machine 100 according to a first exemplary embodiment. Washing machine 100 is described with reference to FIG. 1. It should be noted that a solid line arrow shown in FIG. 1 indicates the flow of water. A dotted line arrow shown in FIG. 1 indicates the flow of air. A chain line arrow shown in FIG. 1 indicates a transmission path of a control signal.

[0015] Washing machine 100 includes main casing 200, controller 300, water supply mechanism 400, washing mechanism 500, circulation mechanism 600, and drying mechanism 700. Main casing 200 houses controller 300, water supply mechanism 400, washing mechanism 500, circulation mechanism 600, and drying mechanism 700. Controller 300 controls water supply mechanism 400, washing mechanism 500, circulation mechanism 600, and drying mechanism 700.

[0016] Washing machine 100 may sequentially perform a washing process of washing clothes, a rinsing process of rinsing clothes, a spin-drying process of spin-drying clothes, and a drying process of drying clothes.

[0017] Washing mechanism 500 includes housing tub 510 for housing clothes and motor 520 for driving housing tub 510. Motor 520 drives housing tub 510 under a control of controller 300. In the washing process, housing tub 510 stirs the clothes in liquid containing a detergent. As a result, the clothes are properly washed. In the rinsing process, housing tub 510 stirs the clothes in water having a detergent concentration lower than a detergent concentration of the liquid in the washing process. Further, water supply to housing tub 510 and drainage from housing tub 510 are repeated in the rinsing process. As a result, the detergent is properly removed from the clothes. In the spin-drying process, housing tub 510 spin-dries the clothes by utilizing centrifugal force. As a result, drying of the clothes is promoted. In the drying process, dry air is supplied to housing tub 510. Since the humidity of the dry air is low and the temperature of the dry air is high, the clothes are properly dried in housing tub 510. While the dry air is supplied, housing tub 510 stirs the clothes. As a result, the clothes are properly dried.

[0018] In the aforementioned washing process and rinsing process, water supply mechanism 400 supplies water to housing tub 510. Water supply mechanism 400 includes water supply port 410 connected to a tap, switching valve 420, and detergent housing 430 in which a detergent is housed. Water supplied to water supply port 410 reaches switching valve 420. Switching valve 420 switches water supply passages between first water supply passage 421 for allowing the water to directly flow toward housing tub 510 and second water supply passage 422 for supplying the water to housing tub 510 through detergent housing 430. For example, first water supply passage 421 may be used in the rinsing process. As a result, tap water is directly supplied to housing tub 510. For example, second water supply passage 422 may be used in the washing process. When switching valve 420 opens second water supply passage 422, the water flows into detergent housing 430. The water and the detergent are mixed inside detergent housing 430. As a result, water containing the detergent flows into housing tub 510. In the present exemplary embodiment, a channel defining second supply path 422 is illustrated as a water supply pipe. Water supply mechanism 400 is illustrated as a water supply part.

[0019] Circulation mechanism 600 includes circulation pump 610 and bubble generator 620. In the aforementioned washing process and rinsing process, circulation mechanism 600 may circulate water between circulation pump 610 and housing tub 510. In the present exemplary embodiment, circulation mechanism 600 includes first circulation path 611 and second circulation path 612 to circulate the water between circulation pump 610 and housing tub 510. When first circulation path 611 is used, the water flows into housing tub 510 through bubble generator 620. When second circulation path 612 is used, the water is directly fed from circulation pump 610 to housing tub 510. A switching valve or another element capable of selectively defining a flow direction of water may be used to switch the circulation paths of the water. It should be noted that the water may be supplied from circulation pump 610 to first circulation path 611 and second circulation path 612 simultaneously. With this configuration, bubbles and washing solution can be efficiently supplied to housing tub 510 in a short time, and high detergency can be obtained. Since the water is fed to bubble generator 620 and housing tub 510 by single circulation pump 610, a space inside main casing 200 is effectively utilized, and washing machine 100 can be manufactured at low cost. Additionally, the use of single circulation pump 610 results in an increase in a degree of freedom in layout design inside main casing 200.

[0020] Bubble generator 620 generates bubbles. Detergent solution whose volume is increased by air bubbles is fed to housing tub 510 to spread over the clothes. When the detergent solution makes contact with and permeates through the clothes, the air bubbles become a foam film to cover the clothes. Since the foam film contains a high concentration surfactant, dirt of the clothes can be efficiently removed. It should be noted that, when the washing solution is discharged from second circulation path 612 to housing tub 510 at the same time that the washing solution is discharged from bubble generator 620 to housing tub 510, wettability of the clothes improves and thus the washing solution can be evenly poured to the clothes. Thus, a permeation ability of the high concentration bubbles increases, and high detergency can be obtained in a short time.

[0021] Drying mechanism 700 includes air filter 710 for receiving air sent from housing tub 510, heat exchanger 720 for exchanging heat with the air passed through air filter 710, and blower fan 730 for sending out the air passed through heat exchanger 720. Air filter 710 removes lint from the air sent from housing tub 510. Therefore, purified air flows into heat exchanger 720. In the drying process, controller 300 may start heat exchanger 720. Heat exchanger 720 dehumidifies and heats the air. As a result, dry air suitable for drying the clothes is generated. Controller 300 may stop heat exchanger 720 during a period from the washing process to the spin-drying process. As a result, heat exchanger 720 does not unnecessarily consume electric power. Alternatively, controller 300 may start heat exchanger 720 in the washing process. As a result, the detergent may be activated by utilizing heat transferred to the air from heat exchanger 720. In the present exemplary embodiment, drying mechanism 700 is illustrated as an air blower.

[0022] FIG. 2 is a schematic perspective view of washing machine 100. Washing machine 100 is further described with reference to FIGS. 1 and 2.

[0023] Main casing 200 includes front wall 210, rear wall 220 on a side opposite to front wall 210, left wall 230 erected between front wall 210 and rear wall 220, right wall 240 on a side opposite to left wall 230, top wall 250 surrounded by upper edges of front wall 210, rear wall 220, left wall 230, and right wall 240, and bottom wall 260 on a side opposite to top wall 250. Water supply port 410 described with reference to FIG. 1 is exposed on top wall 250. A user, for example,

can connect water supply port 410 to the tap (not shown) by using a hose.

[0024] Washing machine 100 further includes door body 101 mounted to front wall 210. Door body 101 is turned between a closed position along front wall 210 and an open position protruded from front wall 210. Door body 101 shown in FIG. 2 is at the open position. When door body 101 is at the open position, put-in port 511 defined by housing tub 510 is exposed. The user can move door body 101 to the open position and put the clothes into housing tub 510 through put-in port 511.

[0025] FIG. 3 is a schematic sectional view of washing machine 100. Washing machine 100 is further described with reference to FIGS. 1 and 3.

[0026] Housing tub 510 includes rotary drum 530 in which clothes are housed and water tub 540 in which rotary drum 530 is housed. Rotary drum 530 includes inner ring wall 531 for defining put-in port 511, inner bottom wall 532 on a side opposite to inner ring wall 531, and cylindrical inner peripheral wall 533 between inner ring wall 531 and inner bottom wall 532. Water tub 540 includes outer ring wall 541 disposed between front wall 210 and inner ring wall 531, outer bottom wall 542 disposed between rear wall 220 and inner bottom wall 532, and outer peripheral wall 543 surrounding inner peripheral wall 533 between outer ring wall 541 and outer bottom wall 542. In the present exemplary embodiment, rotary drum 530 is illustrated as an inner tub. Water tub 540 is illustrated as an outer tub.

[0027] Motor 520 includes main body 521 for generating driving force and drive shaft 522 for transmitting the driving force to rotary drum 530. Drive shaft 522 is connected to inner bottom wall 532 through outer bottom wall 542.

[0028] In addition to circulation pump 610 and bubble generator 620 (see FIG. 1), circulation mechanism 600 includes drain valve 690, upstream circulation pipe 640 for defining a path of water flowing from water tub 540 to circulation pump 610, and downstream circulation pipe 650 for defining a path of water returning from circulation pump 610 to water tub 540, and drain pipe 660 for defining a drain path to outside of main casing 200. Drain valve 690 is mounted to drain pipe 660. Controller 300 (see FIG. 1) controls drain valve 690. While the water is circulated between housing tub 510 and circulation pump 610, controller 300 closes drain valve 690. Controller 300 opens drain valve 690 to drain unnecessary water.

[0029] Downstream circulation pipe 650 includes main pipe 659 in which water discharged from circulation pump 610 flows, first branch pipe 651 branched from main pipe 659 and connected to bubble generator 620, and second branch pipe 652 branched from main pipe 659 and connected to outer ring wall 541. First branch pipe 651 defines first circulation path 611 described with reference to FIG. 1. Second branch pipe 652 defines second circulation path 612 described with reference to FIG. 1. Controller 300 controls a rotation direction and a rotation speed of circulation pump 610, and may selectively execute circulation of water through first branch pipe 651 and circulation of water through second branch pipe 652. In the present exemplary embodiment, downstream circulation pipe 650 is illustrated as a branch pipe via circulation pump 610.

[0030] In addition to air filter 710, heat exchanger 720, and blower fan 730, drying mechanism 700 includes intake pipe 750 for defining a flow path of air from housing tub 510 to blower fan 730 and feed pipe 760 for defining a flow of air sent from blower fan 730. Air filter 710 and heat exchanger 720 are disposed inside intake pipe 750. Blower fan 730 is disposed at a connection between intake pipe 750 and feed pipe 760. When blower fan 730 rotates, a negative pressure environment is created inside intake pipe 750, whereas a positive pressure environment is created inside feed pipe 760.

[0031] FIG. 4 is a schematic front view of washing machine 100, and FIG. 5 is a schematic side view of washing machine 100. Washing machine 100 is further described with reference to FIGS. 1, 3, 4, and 5.

[0032] Outer peripheral wall 543 of water tub 540 includes front peripheral wall 545 to which outer ring wall 541 is mounted, and rear peripheral wall 546 disposed between outer bottom wall 542 and front peripheral wall 545. Bubble generator 620 is mounted to an outside of water tub 540, more specifically, to front peripheral wall 545. In FIGS. 3 and 5, rotation axis RX of rotary drum 530 defined by motor 520 is shown. In the present exemplary embodiment, bubble generator 620 is disposed above rotation axis RX.

[0033] In the present exemplary embodiment, first branch pipe 651 of downstream circulation pipe 650 is illustrated to have a structure connected to front peripheral wall 545 of the water tub and reaching bubble generator 620 via an internal circulation path inside front peripheral wall 545. With this configuration, the space inside main casing 200 is effectively utilized and washing machine 100 can be manufactured at low cost. Additionally, the structure results in an increase in a degree of freedom in layout design inside main casing 200.

(BUBBLE GENERATOR)

[0034] FIG. 6 is a schematic sectional view of bubble generator 620. Bubble generator 620 is described with reference to FIGS. 3, 4, 5, and 6.

[0035] As shown in FIG. 5, circulation pump 610 is disposed below housing tub 510. Bubble generator 620 is disposed above rotation axis RX of rotary drum 530 (that is, above circulation pump 610). When circulation pump 610 rotates, the water is pumped up by circulation pump 610 toward bubble generator 620 through first branch pipe 651. As shown in

FIG. 5, second branch pipe 652 is connected to water tub 540 above circulation pump 610. It should be noted that a connecting position between second branch pipe 652 and water tub 540 is below rotation axis RX. Therefore, circulation pump 610 rotates at relatively low rotation speed and can feed the water to water tub 540.

[0036] When circulation pump 610 rotates at high rotation speed, the washing solution flows into first branch pipe 651 or second branch pipe 652. First branch pipe 651 guides the flowed washing solution to casing 621. Therefore, the washing solution flowed into first branch pipe 651 reaches bubble generator 620. The bubbles generated inside bubble generator 620 are then fed to housing tub 510. Second branch pipe 652 directly guides the water to water tub 540. Therefore, the water flowed into second branch pipe 652 directly flows into water tub 540. An inflow path of the washing solution controls a rotation direction of circulation pump 610 to be selected.

[0037] As shown in FIG. 6, bubble generator 620 includes casing 621, and an inside of casing 621 is partitioned into water supply passage 622 and bubble generation chamber 623 by partition wall 680. Inflow port 681 is formed on one end side of water supply passage 622, and discharge port 682 is formed at a position above bubble generation chamber 623 on the other end side of water supply passage 622. Water supply passage 622 is formed such that the sectional area is gradually reduced from inflow port 681 toward discharge port 682, and is configured to increase the flow velocity of washing water jetted out from discharge port 682 toward bubble generation chamber 623. Moreover, discharge port 682 is formed such that the diameter is gradually reduced toward a tip on the discharge side, and is configured to increase the flow velocity of the washing water jetted out from discharge port 682 toward bubble generation chamber 623. It should be noted that "the diameter is gradually reduced" can be paraphrased as "the sectional area is gradually reduced". In this manner, by increasing the flow velocity of the washing water jetted out from discharge port 682 toward bubble generation chamber 623, the amount of bubbles generated by collision with the washing water in bubble generation chamber 623 can be increased.

[0038] Air induction chamber 624 is formed between discharge port 682 and bubble generation chamber 623. Air induction chamber 624 is formed with air intake port 683. Outside air is induced from air intake port 683 due to the flow velocity of the washing water discharged from discharge port 682 toward bubble generation chamber 623, and the outside air is discharged to bubble generation chamber 623 with the washing water.

[0039] In bubble generation chamber 623, outflow port 684 is formed at a position separated from discharge port 682. The bottom surface of bubble generation chamber 623 is formed so as to be inclined toward outflow port 684, and outflow port 684 is in contact with the bottom surface of bubble generation chamber 623. With this configuration, the washing water supplied into bubble generation chamber 623 is discharged from outflow port 684 without remaining inside bubble generation chamber 623.

[0040] First branch pipe 651 described with reference to FIGS. 3, 4, and 5 is connected to inflow port 681 via the internal circulation path inside outer ring wall 541 of the water tub. When circulation pump 610 pumps up the washing solution to bubble generator 620, the washing solution flowed in from inflow port 681 is discharged from discharge port 682 toward an inside of bubble generator 620.

[0041] By the inflow of the washing solution to bubble generator 620, the washing solution is stored inside bubble generation chamber 623. An inflow amount of the washing solution from discharge port 682 and an outflow amount of the washing solution from outflow port 684 are in an equilibrium state. This state is shown in FIG. 6, and boundary BD between solution layer WL and air layer AL is formed inside bubble generator 620. The washing solution discharged from discharge port 682 collides with boundary BD and takes in air of air layer AL, so that air bubbles are mixed into solution layer WL. Since bubble generator 620 is configured so that the washing solution discharged from discharge port 682 collides with boundary BD with the increased flow velocity, the air bubbles are efficiently generated inside solution layer WL. Further, in air induction chamber 624, the outside air is induced from air intake port 683 by the washing solution from discharge port 682, and the outside air is taken into the washing solution and mixed into solution layer WL. Thus, the air bubbles are efficiently generated.

[0042] The washing solution whose volume is increased by the air bubbles is sprayed on the clothes in the housing tub from outflow port 684. A bore diameter of discharge port 682 may be adjusted according to an amount of pumped water so as to obtain the flow velocity in which the air bubbles are mixed into the solution layer. The flow velocity may be adjusted by the rotation speed of the circulation pump. Air intake port 683 is formed in a size capable of taking in the air necessary to form air layer AL. Further, in the present exemplary embodiment, connection of air intake port 683 to front peripheral wall 545 of the water tub is illustrated as a form of considering water leak.

[0043] In the present exemplary embodiment, water supply passage 622 and bubble generation chamber 623 are provided by partitioning the inside of casing 621 by partition wall 680. Thus, bubble generator 620 can be formed compact and can have a simplified structure.

[0044] It is only necessary that water supply passage 622 have a configuration capable of supplying the washing solution to bubble generation chamber 623. Water supply passage 622 can be provided by, for example, a hose, other than the configuration in the present exemplary embodiment.

[0045] Further, a venturi structure may be used for air intake port 683. The same advantages as in the aforementioned embodiment can be exhibited even by this structure. Moreover, both of air intake port 683 in the aforementioned em-

bodiment and an air intake port having the venturi structure may be provided.

(SECOND EXEMPLARY EMBODIMENT)

[0046] FIG. 7 is a schematic sectional view of a washing machine according to a second exemplary embodiment.

[0047] In the second exemplary embodiment, as shown in FIG. 7, annular bubble generator 620 formed with bubble generation chamber 623 is provided on an inner surface of rotary drum 530 on put-in port 511 side. Further, water tub 540 is formed with discharge port 682 for discharging washing water to bubble generation chamber 623.

[0048] When circulation pump 610 pumps up washing solution to bubble generation chamber 623, the washing solution is stored in bubble generation chamber 623, and the washing solution collides with the stored washing solution, thereby generating air bubbles. The generated air bubbles are supplied from an opening on an inner diameter side of bubble generator 620 to clothes inside rotary drum 530. Since the air bubbles generated in bubble generation chamber 623 are directly supplied into rotary drum 530 via an opening provided in bubble generator 620, the air bubbles can be efficiently supplied.

[0049] The washing solution stored in bubble generation chamber 623 can be supplied into rotary drum 530 by rotating rotary drum 530. Thus, the storage of the washing solution in bubble generation chamber 623 can be suppressed.

[0050] It should be noted that the configuration of bubble generator 620 in the present exemplary embodiment is appropriately changed according to a mounting part (place).

(THIRD EXEMPLARY EMBODIMENT)

[0051] FIG. 8 is a schematic sectional view of a washing machine according to a third exemplary embodiment.

[0052] As shown in FIG. 8, in the third exemplary embodiment, a so-called vertical type washing machine, in which a rotation axis of a rotary drum is set vertically and bubble generator 620 is formed at an inner upper part of rotary drum 530, is provided. Bubble generator 620 is formed on an inner surface of rotary drum 530. The upper surface of bubble generator 620 is opened, and bubble generator 620 and the inside of rotary drum 530 are communicated with each other. Discharge port 682 for supplying washing solution into bubble generator 620 is formed at a position above bubble generator 620.

[0053] When circulation pump 610 pumps up the washing solution to bubble generator 620, the washing solution is stored in bubble generator 620, and the washing solution collides with the stored washing solution, thereby generating air bubbles. The generated air bubbles are supplied from the opening on the upper surface of bubble generator 620 to clothes inside rotary drum 530. Since the air bubbles generated in bubble generator 620 are directly supplied from the opening at the upper part of bubble generator 620 into rotary drum 530, the air bubbles can be efficiently supplied.

[0054] It should be noted that the washing solution stored in bubble generator 620 can be supplied into rotary drum 530 by forming a discharge opening (not shown) on at least one of the side surface and the bottom surface of bubble generator 620. Thus, storage of the washing solution in bubble generator 620 can be suppressed.

[0055] It should be noted that the configuration of bubble generator 620 in the present exemplary embodiment is appropriately changed according to a mounting part (place).

(FOURTH EXEMPLARY EMBODIMENT)

[0056] FIG. 9 is a schematic sectional view of a washing machine according to a fourth exemplary embodiment.

[0057] As shown in FIG. 9, the washing machine according to the fourth exemplary embodiment is provided with bubble generator 620 between water tub 540 and rotary drum 530. Discharge port 682 for supplying washing solution toward bubble generator 620 is provided.

[0058] Air bubbles are generated in bubble generator 620 by discharging washing solution from discharge port 682 to bubble generator 620. When rotary drum 530 is rotated, stirring blade 535 disposed at the bottom of rotary drum 530 generates stirring flow inside water tub 540. Thus, air bubbles generated above bubble generator 620 flow into rotary drum 530 and make contact with clothes inside rotary drum 530.

[0059] It should be noted that the configuration of bubble generator 620 in the present exemplary embodiment is appropriately changed according to a mounting part (place).

(FIFTH EXEMPLARY EMBODIMENT)

[0060] In the present exemplary embodiment, an example of flow passage 950, which causes outflow port 684 and tub discharger 685 to communicate with each other and conveys bubbles generated in bubble generator 620 to the inside of water tub 540 in washing machine 100 according to the first exemplary embodiment, is described in detail. FIG. 10 is a perspective view for explaining an internal circulation path of washing machine 100 according to the present

exemplary embodiment. FIG. 11 is a perspective view for explaining a variation of the internal circulation path of washing machine 100 according to the present exemplary embodiment.

[0061] Also in the present exemplary embodiment, as shown in FIG. 5, circulation pump 610 is disposed below housing tub 510. Bubble generator 620 is disposed above rotation axis RX of rotary drum 530 (that is, above circulation pump 610). When circulation pump 610 rotates, water is pumped up by circulation pump 610 toward bubble generator 620 through first branch pipe 651. Moreover, as shown in FIG. 5, second branch pipe 652 is connected to water tub 540 above circulation pump 610. It should be noted that a connecting position between second branch pipe 652 and water tub 540 is below rotation axis RX. Therefore, circulation pump 1610 rotates at relatively low rotation speed and can feed the water to water tub 540.

[0062] When circulation pump 610 rotates at high rotation speed, washing solution flows into first branch pipe 651 or second branch pipe 652. First branch pipe 651 guides the flowed washing solution to casing 621. Therefore, the washing solution flowed into first branch pipe 651 reaches bubble generator 620. Further, it is only necessary that circulation mechanism 600 have a configuration capable of supplying the washing solution to bubble generator 620. In FIG. 3, circulation pump 610 having the two discharge ports is cited as an example. However, circulation pump 610 may have a configuration only having first branch pipe 651. Further, as shown in FIG. 11, circulation mechanism 600 may be configured so that washing solution is fed from single first branch pipe 1651 to bubble generator 620 and housing tub 510 via the internal circulation path inside an outer ring wall.

[0063] The bubbles generated in bubble generator 620 are then fed to housing tub 510 via tub discharger 685 connected to outflow port 684 of bubble generator 620. Tub discharger 685 is bent and connected to the flow passage in bubble generation chamber 623. By providing bent part 900 inside flow passage 950 extending from bubble generation chamber 623 to tub discharger 685, bent part 900 becomes resistance to a flow of the washing solution, and the washing solution is easily stored in bubble generation chamber 623. In the present exemplary embodiment, tub discharger 685 is provided separately from bubble generator 620. However, tub discharger 685 may be integrated with bubble generator 620.

[0064] In the present exemplary embodiment, bent part 900 is formed by bending flow passage 950 reaching tub discharger 685 with respect to bubble generator 620. However, a flow passage inside bubble generator 620 may be bent, or a flow passage reaching tub discharger 685 may be bent. Since the bent part is formed by bending any portion of the flow passage extending from bubble generator 620 to tub discharger 685, the resistance to the flow of the washing solution is formed, and the washing solution can be easily stored within bubble generation chamber 623.

[0065] Further, a throttle (not shown) for narrowing a sectional area may be formed at any portion of flow passage 950 extending from bubble generator 620 to tub discharger 685. Also in this configuration, the throttle becomes resistance to the flow of the washing solution, and the washing solution can be easily stored within bubble generation chamber 623.

[0066] It should be noted that the flow passage for guiding washing water from outflow port 684 to housing tub 510 is inclined so as to be lowered from outflow port 684 toward housing tub 510.

[0067] Second branch pipe 652 directly guides the water to water tub 540. Therefore, the water flowed into second branch pipe 652 directly flows into water tub 540. An inflow path of the washing solution controls a rotation direction of circulation pump 610 to be selected.

[0068] As shown in FIG. 6, bubble generator 620 includes casing 621, and an inside of casing 621 is partitioned into water supply passage 622 and bubble generation chamber 623 by partition wall 680. Inflow port 681 is formed on one end side of water supply passage 622, and discharge port 682 is formed at a position above bubble generation chamber 623 on the other end side of water supply passage 622. Water supply passage 622 is formed such that the sectional area is gradually reduced from inflow port 681 toward discharge port 682, and is configured to increase the flow velocity of the washing water jetted out from discharge port 682 toward bubble generation chamber 623. Moreover, discharge port 682 is formed such that the diameter is gradually reduced toward a tip on the discharge side, and is configured to increase the flow velocity of the washing water jetted out from discharge port 682 toward bubble generation chamber 623.

[0069] Air induction chamber 624 is formed between discharge port 682 and bubble generation chamber 623. Air induction chamber 624 is provided with air intake port 683. Outside air is induced from air intake port 683 due to the flow velocity of the washing solution discharged from discharge port 682 toward bubble generation chamber 623, and the outside air is discharged to bubble generation chamber 623 with the washing solution.

[0070] Bubble generation chamber 623 is formed with outflow port 684 at a position separated from discharge port 682. In bubble generation chamber 623, the washing solution flows in from discharge port 682 and flows out from outflow port 684 by driving of circulation pump 610. A predetermined water level of the washing solution is stored inside bubble generation chamber 623 in a state where an inflow amount of the washing solution from discharge port 682 and an outflow amount of the washing solution from outflow port 684 are in equilibrium.

[0071] Outflow port 684 is formed from the bottom surface of bubble generation chamber 623 to a position higher than the predetermined water level of the washing solution stored inside bubble generation chamber 623. Thus, outflow port 684 is formed so that bubbles floating on the washing solution can efficiently pass through outflow port 684.

[0072] The bottom surface of bubble generation chamber 623 is formed so as to be gradually inclined toward outflow port 684. Accordingly, when circulation pump 610 is stopped and supply of the washing solution to bubble generation

chamber 623 is stopped, the washing solution in bubble generation chamber 623 is discharged from outflow port 684 to housing tub 510 via tub discharger 685 without remaining in bubble generation chamber 623. Further, the bottom surface of bubble generation chamber 623 is formed in an inclination having a relatively gentle inclination angle toward outflow port 684, so that the washing solution is stored in bubble generation chamber 623 in a state where an amount of the washing solution flowed in from discharge port 682 and an amount of the washing solution flowed out from outflow port 684 are in equilibrium. Further, a flow passage for guiding the washing solution from outflow port 684 into housing tub 510 is inclined so as to be lowered from outflow port 684 toward housing tub 510.

(SIXTH EXEMPLARY EMBODIMENT)

[0073] FIG. 12 is a schematic sectional view of bubble generator 1620 serving as a variation of bubble generator 620 according to the first exemplary embodiment. FIG. 13 is a schematic view of bubble generator 1620 in the present exemplary embodiment as viewed from above. In the present exemplary embodiment, the description of parts, which show substantially the same functions and operation as in the aforementioned exemplary embodiments, is omitted.

[0074] In the present exemplary embodiment, water supply passage 1622 is extended to outflow port 684 side, and discharge port 682 is inclined and formed in a direction opposite to outflow port 684 side. Further, as shown in FIG. 13, in bubble generator 1620, a portion where washing solution from discharge port 682 collides with the washing solution inside bubble generator 620 is formed to be wider than other portions. Thus, generated bubbles can collide with the washing solution discharged from discharge port 682. Therefore, the generated bubbles are easily flowed to outflow port 684. Further, with this configuration, the washing solution can be easily stored in bubble generation chamber 623 due to the flow velocity of the washing solution discharged from discharge port 682. The washing solution is obliquely jetted to a liquid surface of the washing solution inside bubble generation chamber 623, thereby improving generation efficiency of the bubbles.

(SEVENTH EXEMPLARY EMBODIMENT)

[0075] In the present exemplary embodiment, an example of first circulation path 611 for supplying washing solution from circulation pump 610 to bubble generator 620 and second circulation path 612 for supplying the washing solution from circulation pump 610 into water tub 540 in the washing machine according to the first exemplary embodiment is described in detail.

[0076] FIG. 14 is a schematic view for explaining first circulation path 611 and second circulation path 612 according to the present exemplary embodiment. First circulation path 611 communicating with bubble generator 620 and second circulation path 612 communicating with housing tub 510 are described with reference to FIGS. 3, 4, 5, and 14.

[0077] Also in the present exemplary embodiment, as shown in FIG. 5, circulation pump 610 is disposed below housing tub 510. Bubble generator 620 is disposed at a position above rotation axis RX of rotary drum 530 (a position above a water level of washing water inside the water tub).

[0078] As shown in FIG. 14, first circulation path 611 communicating with bubble generator 620 is formed inside water tub 540. First communication path 611 is connected to bubble generator 620 and to first branch pipe 651 connected from circulation pump 610 to the lower side of water tub 540. Further, second circulation path 612 communicating with housing tub 510 is formed inside water tub 540. Second circulation path 612 is connected to second branch pipe 652 so as to supply the washing water into housing tub 510.

[0079] Exposure of first circulation path 611 and second circulation path 612 to the outside of water tub 540 can be minimized by disposing first circulation path 611 and second circulation path 612 inside water tub 540. Thus, a space inside the product is saved, and first circulation path 611 or second circulation path 612 can be prevented from making contact with main casing 200 or the like during oscillation of water tub 540.

[0080] Further, first circulation path 611 may be formed so as to have a uniform sectional area from first branch pipe 651 to bubble generator 620. With this configuration, it is possible to suppress a loss of water pressure and to efficiently pump up the washing solution.

[0081] First circulation path 611 and second circulation path 612 may be formed of the same parts. This realizes reduction of the number of parts and simplification of assembly. In the present exemplary embodiment, second circulation path 612 is formed in a ring shape, and first circulation path 611 is formed adjacent to second circulation path 612 in a left side portion in FIG. 14. Accordingly, space saving is attained.

[0082] Also in the present exemplary embodiment, as shown in FIG. 6, water supply passage 622 is formed so that the sectional area is gradually reduced from inflow port 681 toward discharge port 682. This can be paraphrased as the sectional area of first circulation path 611 is gradually reduced toward discharge port 682. This is because first circulation path 611 communicates with water supply passage 622. Thus, water supply passage 622 is configured so as to increase the flow velocity of the washing water jetted out from discharge port 682 toward bubble generation chamber 623. Moreover, as shown in FIG. 6, discharge port 682 is formed so that the sectional area is gradually reduced toward a tip

on the discharge side. With this configuration, water supply passage 622 is configured so as to increase the flow velocity of the washing water jetted out from discharge port 682 toward bubble generation chamber 623. By increasing the flow velocity of the washing water jetted out from discharge port 682, an amount of bubbles generated by collision with the washing water in bubble generation chamber 623 can be increased.

(EIGHTH EXEMPLARY EMBODIMENT)

[0083] In the present exemplary embodiment, an example of circulation pump 610 for supplying washing solution to at least one of first circulation path 611 and second circulation path 612 in the first exemplary embodiment is described in detail.

[0084] As shown in FIG. 15, first circulation path 611 communicating with bubble generator 620 is formed inside water tub 540. First circulation path 611 is connected to bubble generator 620 and to first branch pipe 651 connected from circulation pump 610 to the lower side of water tub 540. Further, second circulation path 612 communicating with housing tub 510 is formed inside water tub 540. Second circulation path 612 is connected to second branch pipe 652 so as to supply the washing solution into housing tub 510 via a plurality of solution discharge ports 613 formed at second circulation path 612. Positions and discharge amounts of tub discharger 685 and solution discharge ports 613 are set so that the washing solutions discharged from tub discharger 685 and solution discharge ports 613 do not collide with each other.

[0085] Exposure of first circulation path 611 and second circulation path 612 to the outside of water tub 540 can be minimized by disposing first circulation path 611 and second circulation path 612 inside water tub 540. Thus, a space inside the product is saved, and first circulation path 611 or second circulation path 612 can be prevented from making contact with main casing 200 or the like during oscillation of water tub 540.

[0086] Further, first circulation path 611 is formed in a shape having a uniform sectional area from first branch pipe 651 to bubble generator 620. With this configuration, it is possible to suppress a loss of water pressure and to efficiently pump up the washing solution.

[0087] First circulation path 611 and second circulation path 612 may be formed of the same parts. This can realize reduction of the number of parts and simplification of assembly. Second circulation path 612 is formed in a ring shape, and first circulation path 611 is formed adjacent to second circulation path 612 in a left side portion in FIG. 15. Accordingly, space saving can be realized.

(CIRCULATION PUMP)

[0088] FIG. 16 is a schematic view showing the shape of casing 900 of the circulation pump which serves as a drive device for circulating the washing solution.

[0089] Rotation direction A and rotation direction B shown in FIG. 16 indicate rotation directions of an impeller of circulation pump 610. The impeller of circulation pump 610 selectively rotates in rotation direction A or rotation direction B. Circulation pump 610 is formed with discharge port A910 and discharge port B920. Discharge port A910 is connected to first circulation path 611, and discharge port B920 is connected to second circulation path 612. Discharge port A910 and discharge port B920 are formed such that the sectional area of discharge port A910 is smaller than the sectional area of discharge port B920. Further, circulation pump 610 is provided with tongs 930 for drawing in water against rotation of the impeller.

[0090] When the impeller rotates in rotation direction A, the washing solution is discharged to discharge port A910 and discharge port B920, and the washing solution is supplied to first circulation path 611 and second circulation path 612. Discharge amounts to discharge port A910 and discharge port B920 are set substantially uniformly. When the impeller rotates in rotation direction A, the washing solution is supplied to bubble generator 620 via first circulation path 611, and the washing solution is supplied from tub discharger 685 to housing tub 510 with generated bubbles. Further, the washing solution is supplied from solution discharge ports 613 to housing tub 510 via second circulation path 612. In this state, the discharge amount is set so that the washing solution is discharged only from solution discharge ports 613 located below rotation axis RX of rotary drum 530. Thus, the bubbles supplied from tub discharger 685 to housing tub 510 are prevented from colliding with the washing solution discharged from solution discharge ports 613 to be defoamed.

[0091] The bubbles from tub discharger 685 and the washing solution from solution discharge ports 613 are supplied onto clothes inside housing tub 510 and permeated through the clothes. The bubbles become a foam film to cover the clothes. Then, dirt of the clothes is efficiently removed by the foam film containing a high concentration surfactant.

[0092] When the impeller rotates in rotation direction B, the washing solution is mainly discharged to discharge port B920. In this state, the washing solution is discharged from all of solution discharge ports 613 to housing tub 510. Accordingly, the washing solution can be efficiently circulated from an entire front side region of housing tub 510.

[0093] It should be noted that, in the present exemplary embodiment, in a case where the impeller of circulation pump 610 rotates in rotation direction A, the washing solution is discharged from solution discharge ports 613 located below

rotation axis RX of rotary drum 530 by the discharge amount of circulation pump 610. However, a control valve may be provided to perform similar operation. Alternatively, solution discharge ports 613 may be formed only at positions below rotation axis RX of rotary drum 530.

[0094] Further, in the present exemplary embodiment, when the impeller of circulation pump 610 rotates in rotation direction B, the washing solution is supplied to discharge port B920. However, the washing solution may be supplied to both of discharge port A910 and discharge port B920. In this configuration, an amount of the washing solution supplied to discharge port A910 is reduced. Accordingly, the washing solution is discharged from tub discharger 685 without being stored inside bubble generator 620. In this case, generation of bubbles in bubble generator 620 is small, and the bubbles are discharged from tub discharger 685 in a state of the washing solution. Hence, when the impeller rotates in rotation direction B, tub discharger 685 performs a function equivalent to the function of solution discharge ports 613. Therefore, the washing solution can be circulated more equally and efficiently from the entire front side region of housing tub 510 along with the discharge of the washing solution from solution discharge ports 613.

(NINTH EXEMPLARY EMBODIMENT)

[0095] In the present exemplary embodiment, an example of means for setting an amount of washing solution supplied from circulation pump 610 to at least one of first and second circulation paths in the washing machine according to the first exemplary embodiment is described in detail with reference to FIG. 17.

[0096] Circulation pump 610 selectively rotates in a first rotation direction or a second rotation direction. When circulation pump 610 rotates in the first rotation direction, the washing solution in water tub 540 is supplied to first branch pipe 651 and second branch pipe 652. Further, when circulation pump 610 rotates in the second rotation direction, the washing solution is supplied to second branch pipe 652.

[0097] When circulation pump 610 rotates in the first rotation direction, the washing solution is supplied to first circulation path 611 via first branch pipe 651 and is also supplied to second circulation path 612 via second branch pipe 652. An amount of the washing solution supplied from circulation pump 610 to first branch pipe 651 and an amount of the washing solution supplied from circulation pump 610 to second branch pipe 652 are set substantially equally.

[0098] When circulation pump 610 rotates in the first rotation direction, the washing solution is supplied to bubble generator 620 via first circulation path 611, and the washing solution is supplied from tub discharger 685 to housing tub 510 together with generated bubbles. A discharged state of the washing solution which contains the bubbles from tub discharger 685 to housing tub 510 is indicated by a solid line arrow in FIG. 17.

[0099] Further, the washing solution is supplied from solution discharge ports 613 to housing tub 510 via second circulation path 612. In this state, a discharge amount is set so that the washing solution is discharged only from solution discharge ports 613 located below rotation axis RX of rotary drum 530. Accordingly, the bubbles supplied from tub discharger 685 to housing tub 510 are prevented from colliding with the washing solution discharged from solution discharge ports 613 to be defoamed. A discharged state of the washing solution from solution discharge ports 613 to housing tub 510 is indicated by broken line arrows in FIG. 17. FIG. 17 shows a state where the washing solution is discharged from all of solution discharge ports 613.

[0100] The bubbles from tub discharger 685 and the washing solution from solution discharge ports 613 are supplied onto clothes inside housing tub 510 and permeated through the clothes. The bubbles become a foam film to cover the clothes. Then, dirt of the clothes is efficiently removed by the foam film containing a high concentration surfactant.

[0101] When circulation pump 610 rotates in the second rotation direction, the washing solution is discharged to second circulation path 612 via second branch pipe 652. In this state, the washing solution is discharged from all of solution discharge ports 613 to housing tub 510. Thus, the washing solution can be efficiently circulated from an entire front side region of housing tub 510.

[0102] It should be noted that, in the present exemplary embodiment, in a case where circulation pump 610 rotates in the first rotation direction, the washing solution is discharged from solution discharge ports 613 located below rotation axis RX of rotary drum 530 by the discharge amount of circulation pump 610. However, a control valve may be provided to perform similar operation. Alternatively, solution discharge ports 613 may be formed only at positions below rotation axis RX of rotary drum 530.

[0103] Further, in the present exemplary embodiment, when circulation pump 610 rotates in the second rotation direction, the washing solution is supplied to second branch pipe 652. However, the washing solution may be supplied to both of first branch pipe 651 and second branch pipe 652. In this configuration, an amount of the washing solution supplied to first branch pipe 651 is reduced, and accordingly, the washing solution is discharged from tub discharger 685 without being stored in bubble generator 620. In this case, generation of bubbles in bubble generator 620 is small, and the bubbles are discharged from tub discharger 685 in a state of the washing solution. Hence, when circulation pump 610 rotates in the second rotation direction, tub discharger 685 performs a function equivalent to the function of the solution discharge ports. Therefore, the washing solution can be circulated more equally and efficiently from an entire front side region of housing tub 510 along with the discharge of the washing solution from solution discharge ports 613.

(TENTH EXEMPLARY EMBODIMENT)

[0104] As compared with washing machine 100 according to the first exemplary embodiment, washing machine 1100 according to the present exemplary embodiment is provided with switching valve 615 for dividing the flow of pumped water of circulation pump 610 into first circulation path 611 and second circulation pump 612.

[0105] FIG. 18 is a schematic block diagram of washing machine 1100 according to the present exemplary embodiment. In the present exemplary embodiment, the description of parts, which show substantially the same functions and operation as in the aforementioned exemplary embodiments, is omitted.

[0106] With the configuration according to the present exemplary embodiment, circulation pump 610 does not need to use a pump that is rotatable in two directions, and a pump that is rotatable in one direction can be used.

[0107] Switching valve 615 selectively switches pumping of circulation pump 610 between first circulation path 611 and second circulation path 612. With this configuration, when switching valve 615 is switched to first circulation path 611, only bubbles generated by bubble generator 620 are supplied to housing tub 510. Since washing solution is not supplied from solution discharge ports 613, bubbles supplied form tub discharger 685 are not defoamed by the washing solution from solution discharge ports 613.

[0108] Further, switching valve 615 may be configured to adjustably switch the flow amount of the washing solution to first circulation path 611 and second circulation path 612. By having such a configuration capable of adjusting the flow amount of the washing solution to first circulation path 611 and second circulation path 612, switching valve 615 can perform operation similar to the operation in the aforementioned exemplary embodiments.

(ELEVENTH EXEMPLARY EMBODIMENT)

[0109] As compared with washing machine 100 according to the first exemplary embodiment, washing machine 2100 according to the present exemplary embodiment includes circulation pump 610 for pumping up washing solution to first circulation path 611 and circulation pump 610a for pumping up the washing solution to second circulation path 612.

[0110] FIG. 19 is a schematic block diagram of washing machine 2100 according to the present exemplary embodiment. In the present exemplary embodiment, the description of parts, which show substantially the same functions and operation as in the aforementioned exemplary embodiments, is omitted.

[0111] Circulation pump 610 and circulation pump 610a may be operated independently or simultaneously.

(TWELFTH EXEMPLARY EMBODIMENT)

[0112] As compared with washing machine 100 according to the first exemplary embodiment, washing machine 3100 according to the present exemplary embodiment includes heater 616 for heating washing solution supplied to second circulation path 612. FIG. 20 is a schematic block diagram of washing machine 3100 according to the present exemplary embodiment. In the present exemplary embodiment, the description of parts, which show substantially the same functions and operation as in the aforementioned exemplary embodiments, is omitted.

[0113] Heater 616 heats the washing solution supplied from solution discharge ports 613 to clothes or the like inside housing tub 510 via second circulation path 612. By heating the washing solution, dirt of the clothes or the like can be removed more efficiently.

(THIRTEENTH EXEMPLARY EMBODIMENT)

[0114] In the present exemplary embodiment, bubble generator 620 according to the first exemplary embodiment is further described in detail. FIG. 21 is a schematic sectional view of bubble generator 620.

[0115] As shown in FIG. 21, bubble generator 620 includes casing 621. The inside of casing 621 is partitioned into water supply passage 622 and bubble generation chamber 623 by partition wall 680. Inflow port 681 is formed on one end side of water supply passage 622, and discharge port 682 is formed at a position above bubble generation chamber 623 on the other end side of water supply passage 622. Water supply passage 622 is formed such that the sectional area is gradually reduced from inflow port 681 toward discharge port 682, and is configured to increase the flow velocity of washing water discharged from discharge port 682 toward bubble generation chamber 623. Moreover, discharge port 682 is formed such that the diameter is gradually reduced toward a tip on the discharge side, and is configured to increase the flow velocity of the washing water jetted out from discharge port 682 toward bubble generation chamber 623.

[0116] Air induction chamber 624 is formed between discharge port 682 and bubble generation chamber 623. Air induction chamber 624 is formed with air intake port 683. Air intake port 683 is communicated at a position higher than a water level of full water stored in water tub 540. Air in water tub 540 is induced from air intake port 683 due to the flow velocity of the washing water discharged from discharge port 682 toward bubble generation chamber 623. The induced air is discharged to bubble generation chamber 623 together with the washing water. Air intake port 683 is communicated

with water tub 540. Thus, even in a case where the washing water inside bubble generation chamber 623 overflows for some reason and leaks from air intake port 683, the leaked washing water is guided into water tub 540. As a result, a possibility of occurrence of a failure or the like caused by the leaked washing water is suppressed. It should be noted that, in the present exemplary embodiment, air intake port 683 is communicated with water tub 540. However, the communication is not limited to water tub 540. Other configuration may be used as long as outside air of bubble generator 620 can be guided.

[0117] Guide passage 625 for guiding the washing water discharged from discharge port 682 to bubble generation chamber 623 is formed on a downstream side of discharge port 682. Guide passage 625 includes first region 625a provided with air intake port 683 and second region 625b communicating with bubble generation chamber 623. The inner diameter of second region 625b is formed closer to the washing water discharged from discharge port 682. In other words, the inner diameter of second region 625b is smaller than a region of region 625a of the first region. With this configuration, the air is efficiently sucked from air intake port 683 by induction due to the flow velocity of the washing water discharged from discharge port 682. The sucked air is guided toward a liquid surface of the washing water inside bubble generation chamber 623 together with the washing water, and bubbles are efficiently generated.

[0118] In bubble generation chamber 623, outflow port 684 is formed at a position separated from discharge port 682. The bottom surface of bubble generation chamber 623 is formed so as to be inclined toward outflow port 684, and outflow port 684 is in contact with the bottom surface of bubble generation chamber 623. With this configuration, the washing water supplied into bubble generation chamber 623 is discharged from outflow port 684 without remaining inside bubble generation chamber 623. Since air is efficiently sucked from air intake port 683 and guided to bubble generation chamber 623, the pressure inside bubble generation chamber 623 rises, and the washing water inside bubble generation chamber 623 is efficiently discharged from outflow port 684. Thus, a liquid surface of the washing water in bubble generation chamber 623 does not rise above a predetermined water level.

[0119] In the present exemplary embodiment, the inner diameter of second region 625b in guide passage 625 is formed closer to the washing water discharged from discharge port 682. Accordingly, the air is efficiently sucked from air intake port 683 due to inducing action of the flow velocity of the washing water. It may be configured that a blower is connected to air intake port 683 and the outside air is guided from air intake port 683 by air blown from the blower. In this configuration, it is preferable that the outside air from air introduction port 683 be guided to a position where the washing water from discharge port 682 collides with the liquid surface of the washing water in bubble generation chamber 623. With this configuration, it is possible to form the inner diameter of guide passage 625 larger by adjusting the blow pressure and the blow amount of the blower.

[0120] First branch pipe 651 described with reference to FIGS. 3, 4, and 5 is connected to inflow port 681 via an internal circulation path inside outer ring wall 541 of the water tub. When circulation pump 610 pumps up the washing solution to bubble generator 620, the washing solution flowed in from inflow port 681 is discharged from discharge port 682 toward bubble generator 620

[0121] By the inflow of the washing solution to bubble generator 620, the washing solution is stored in bubble generation chamber 623, and an inflow amount of the washing solution from discharge port 682 and an outflow amount of the washing solution from outflow port 684 are in an equilibrium state. This state is shown in FIG. 21, and boundary BD between solution layer WL and air layer AL is formed in bubble generator 620. When the washing solution discharged from discharge port 682 collides with boundary BD and takes in air of air layer AL, air bubbles are mixed into solution layer WL. Since bubble generator 620 is configured so that the washing solution discharged from discharge port 682 collides with boundary BD with the increased flow velocity, the air bubbles are efficiently generated inside solution layer WL. Further, in air induction chamber 624, the outside air is induced from air intake port 683 by the washing solution from discharge port 682, and the outside air is taken into the washing solution and mixed into solution layer WL. Accordingly, the air bubbles are efficiently generated.

[0122] The washing solution whose volume is increased by the air bubbles is sprayed on clothes in a housing tub from outflow port 684. The bore diameter of discharge port 682 may be adjusted according to an amount of pumped water so as to obtain the flow velocity in which the air bubbles are mixed into the solution layer. The flow velocity may be adjusted by rotation speed of the circulation pump. Air intake port 683 is formed in a size capable of taking in the air necessary to form air layer AL. Further, in the present exemplary embodiment, connection of air intake port 683 to front peripheral wall 545 of the water tub is illustrated as a form of considering water leak.

[0123] In the present exemplary embodiment, water supply passage 622 and bubble generation chamber 623 are configured by partitioning the inside of casing 621 by partition wall 680. With this configuration, bubble generator 620 can be formed compact and can have a simplified structure.

[0124] It is only necessary that water supply passage 622 have a configuration capable of supplying the washing solution to bubble generation chamber 623. Water supply passage 622 can be provided by, for example, a hose, other than the configuration in the present exemplary embodiment.

(FOURTEENTH EXEMPLARY EMBODIMENT)

[0125] FIG. 22 is a schematic sectional view of a washing machine according to a fourteenth exemplary embodiment.

[0126] In the present exemplary embodiment, as shown in FIG. 22, annular bubble generator 620 formed with bubble generation chamber 623 is provided on an inner surface of rotary drum 530 on put-in port 511 side. Further, water tub 540 is formed with discharge port 682 for discharging washing water to bubble generation chamber 623.

[0127] When circulation pump 610 pumps up washing solution to bubble generation chamber 623, the washing solution is stored in bubble generation chamber 623, and the washing solution collides with the stored washing solution, thereby generating air bubbles. The generated air bubbles are supplied from an opening on the inner diameter side of bubble generator 620 to clothes inside rotary drum 530. Since the air bubbles generated in bubble generation chamber 623 are directly supplied into rotary drum 530 via an opening provided in bubble generator 620, the air bubbles can be efficiently supplied.

[0128] The washing solution stored in bubble generation chamber 623 can be supplied into rotary drum 530 by rotating rotary drum 530. Thus, the storage of the washing solution in bubble generation chamber 623 can be suppressed.

[0129] Not only the above-described respective exemplary embodiments but also any combinations of the above-described exemplary embodiments are within the scope of the present invention.

[0130] As described above, a washing machine according to a first aspect of the present invention includes water tub 540 for storing washing solution, rotary drum 530 contained in water tub 540 and for housing clothes, housing tub 510 provided with water tub 540 and rotary drum 530, bubble generator 620 for generating bubbles and supplying the generated bubbles to housing tub 510, and circulation pump 610 for supplying the washing solution inside the water tub to bubble generator 620. Moreover, bubble generator 620 includes bubble generation chamber 623 for storing the washing solution supplied from circulation pump 610, and the washing solution supplied from circulation pump 610 collides with a liquid surface of the washing solution stored inside the bubble generation chamber.

[0131] Thus, the washing machine with a simple configuration can efficiently wash the clothes with the bubbles.

[0132] A washing machine according to a second aspect of the present invention, in the washing machine according to the first aspect, is configured that bubble generator 620 includes discharge port 682 for discharging the washing solution toward the washing solution stored inside the bubble generation chamber, and outflow port 684 for supplying the bubbles generated in bubble generator 620 to housing tub 510. Outflow port 684 is formed from the bottom surface of the bubble generation chamber to a position above a liquid surface of the washing solution stored.

[0133] The washing solution sprayed on the housing tub flows down to the water tub and is again supplied to the bubble generator by the circulation pump. When the circulation pump is stopped, the washing solution inside the bubble generator is drained via the outflow port. Since the outflow port performs not only a function of supplying bubbles but also a function of a drain path after the circulation pump is stopped, the outflow port can be manufactured at low cost with a simple configuration and without requiring a new drain path. Further, in order to drain the solution from the outflow port, the sectional area of the drain path can be increased, and clogging of fibers of the clothes occurring in the washing and rinsing processes can be prevented.

[0134] A washing machine according to a third aspect of the present invention, in the washing machine according to the second aspect, is configured that the bottom surface of bubble generation chamber 623 is inclined so as to be gradually lowered toward outflow port 684.

[0135] Thus, when the circulation pump is stopped, the washing solution in the bubble generation chamber is efficiently drained from the outflow port. When the bottom surface of the bubble generation chamber is formed to have a gentle inclination to store the washing solution in the bubble generation chamber, the washing solution is easily stored in the bubble generation chamber. Then, by colliding the washing solution from the discharge port with the liquid surface of the stored washing solution to a degree that the washing solution foams, the bubbles can be efficiently generated by containing surrounding air.

[0136] A washing machine according to a fourth aspect of the present invention, in the washing machine according to the second aspect, further includes tub discharger 685 for supplying the washing solution from bubble generation chamber 623 into the housing tub. Bent part 900 is provided on the flow passage for guiding the washing water from outflow port 684 into the housing tub.

[0137] With this configuration, since the bent part becomes resistance to the flow of the washing solution, the washing solution is easily stored in the bubble generation chamber. Thus, the washing solution from the discharge port can be collided with the liquid surface of the stored washing solution to the degree that the washing solution foams, and the bubbles can be efficiently generated by containing the surrounding air.

[0138] A washing machine according to a fifth aspect of the present invention, in the washing machine according to the first aspect, further includes first circulation path 611 for circulating and supplying the washing solution from circulation pump 610 to bubble generator 620, and second circulation path 612 for circulating and supplying the washing solution from the circulation pump into the water tub. The circulation pump supplies the washing solution to first circulation path 611 and second circulation path 612.

[0139] With this configuration, the washing solution can be discharged to the housing tub at the same time the aforementioned bubbles are generated and sprayed onto the housing tub. Thus, wettability of the clothes improves in a short time, a contact with the washing solution increases, and the clothes can be washed evenly and efficiently. Therefore, the washing machine with the simple configuration can efficiently wash the clothes by simultaneously spraying the bubbles and the washing solution onto the clothes.

[0140] A washing machine according to a sixth aspect of the present invention, in the washing machine according to the first aspect, is configured that bubble generator 620 includes water supply passage 622 serving as a passage for guiding the washing solution supplied from circulation pump 610 to bubble generation chamber 623, and water supply passage 622 and bubble generation chamber 623 are partitioned by partition wall 680.

[0141] With this configuration, the bubble generator can be formed compact and the structure can be simplified.

INDUSTRIAL APPLICABILITY

[0142] The principle of the present exemplary embodiments is preferably applicable to a device that has a function of washing clothes by utilizing bubbles.

REFERENCE MARKS IN THE DRAWINGS

[0143]

100, 1100, 2100, 3100:	washing machine
300:	controller
400:	water supply mechanism
422:	second water supply path
430:	detergent housing
500:	washing mechanism
510:	housing tub
511:	put-in port
530:	rotary drum
540:	water tub
600:	circulation mechanism
610, 610a:	circulation pump
611:	first circulation path
612:	second circulation path
620, 1620:	bubble generator
621:	casing
622, 1622:	water supply passage
623:	bubble generation chamber
AL:	air layer
BD:	boundary
WL:	solution layer
650:	downstream circulation pipe
651, 1651:	first branch pipe
652:	second branch pipe
684:	outflow port
685:	tub discharger
700:	drying mechanism
730:	blower fan
950:	flow passage

Claims

1. A washing machine comprising:

a water tub for storing washing solution;
a rotary drum contained in the water tub and for housing clothes;
a housing tub provided with the water tub and the rotary drum;

a bubble generator for generating bubbles and supplying the generated bubbles to the housing tub; and
a circulation pump for supplying the washing solution in the water tub to the bubble generator,
wherein
the bubble generator includes a bubble generation chamber for storing the washing solution supplied from the circulation pump, and
the washing solution supplied from the circulation pump to the bubble generation chamber collides with a liquid surface of the washing solution stored in the bubble generation chamber.

2. The washing machine according to claim 1, wherein the bubble generator is disposed outside the water tub.

3. The washing machine according to claim 1, wherein
the bubble generator includes a discharge port for discharging the washing solution toward the washing solution stored in the bubble generation chamber, and an outflow port for supplying the bubbles generated in the bubble generator to the housing tub, and
the outflow port is formed to extend from a bottom surface of the bubble generation chamber to a position above the liquid surface of the washing solution stored in the bubble generation chamber.

4. The washing machine according to claim 3, wherein the bottom surface of the bubble generation chamber is inclined so as to be gradually lowered toward the outflow port.

5. The washing machine according to claim 3, further comprising a flow passage for guiding the washing water from the outflow port into the housing tub,
wherein the flow passage is inclined so as to be lowered from the outflow port toward the housing tub.

6. The washing machine according to claim 3, further comprising a tub discharger for supplying the washing solution from the bubble generation chamber into the housing tub,
wherein a bent part is provided on a flow passage for guiding the washing water from the outflow port into the housing tub.

7. The washing machine according to claim 6, wherein a throttle is provided inside the second flow passage extending from an inside of the bubble generation chamber to the tub discharger.

8. The washing machine according to claim 3, wherein the discharge port discharges the washing solution in a direction opposite to the outflow port.

9. The washing machine according to claim 1, further comprising:

a first circulation path for circulating and supplying the washing solution from the circulation pump to the bubble generator; and
a second circulation path for circulating and supplying the washing solution from the circulation pump into the water tub, wherein
the bubble generator is disposed at a position above a water level of the washing solution in the water tub.

10. The washing machine according to claim 9, wherein the first circulation path and the second circulation path are disposed inside the water tub.

11. The washing machine according to claim 9, wherein the first circulation path and the second circulation path are disposed adjacent to each other.

12. The washing machine according to claim 9, wherein the first circulation path and the second circulation path are formed of identical parts.

13. The washing machine according to claim 9, wherein
the first circulation path includes a discharge port for discharging the washing water toward the washing water stored in the bubble generation chamber, and
a sectional area of the first circulation path is gradually reduced toward the discharge port.

14. The washing machine according to claim 9, wherein

the first circulation path includes a discharge port for discharging the washing water toward the washing water stored in the bubble generation chamber, and
a sectional area of the discharge port is gradually reduced toward a discharge side tip.

15. The washing machine according to claim 1, further comprising:

a first circulation path for circulating and supplying the washing solution from the circulation pump to the bubble generator; and
a second circulation path for circulating and supplying the washing solution from the circulation pump into the water tub,
wherein the circulation pump supplies the washing solution to at least one of the first circulation path and the second circulation path.

16. The washing machine according to claim 15, wherein the circulation pump supplies the washing solution to the first circulation path and the second circulation path simultaneously.

17. The washing machine according to claim 15, further comprising:

a tub discharger for supplying the washing solution from the bubble generator into the housing tub; and
a solution discharge port for supplying the washing solution from the second circulation path into the housing tub,
wherein the solution discharge port for discharging the washing solution to the housing tub is disposed below the tub discharger.

18. The washing machine according to claim 17, wherein the washing solution supplied from the tub discharger to the housing tub and the washing solution supplied from the solution discharge port to the housing tub do not collide with each other.

19. The washing machine according to claim 1, further comprising:

a first circulation path for circulating and supplying the washing solution from the circulation pump to the bubble generator; and
a second circulation path for circulating and supplying the washing solution from the circulation pump into the water tub,
wherein an amount of the washing solution supplied through the first circulation path and an amount of the washing solution supplied through the second circulation path are set by a rotation direction of the circulation pump.

20. The washing machine according to claim 1, further comprising:

a first circulation path for circulating and supplying the washing solution from the circulation pump to the bubble generator;
a second circulation path for circulating and supplying the washing solution from the circulation pump into the water tub; and
a switching mechanism for dividing a flow of pumped water by the circulation pump into the first circulation path and the second circulation path,
wherein an amount of the washing solution supplied through the first circulation path and an amount of the washing solution supplied through the second circulation path are set by a control of the switching mechanism.

21. The washing machine according to claim 1, further comprising:

a first circulation path for circulating and supplying the washing solution from the circulation pump to the bubble generator;
a second circulation path for circulating and supplying the washing solution from the circulation pump into the water tub; and
heating means for heating the washing solution supplied to the second circulation path.

22. The washing machine according to claim 1, wherein
the bubble generator includes a water supply passage serving as a passage for guiding the washing solution supplied

from the circulation pump to the bubble generation chamber, and
the water supply passage and the bubble generation chamber are partitioned by a partition wall.

23. The washing machine according to claim 22, wherein the water supply passage includes a discharge port for discharging the washing solution toward the washing solution stored in the bubble generation chamber.

24. The washing machine according to claim 23, wherein an air intake port for taking in outside air to the bubble generator is provided near the discharge port.

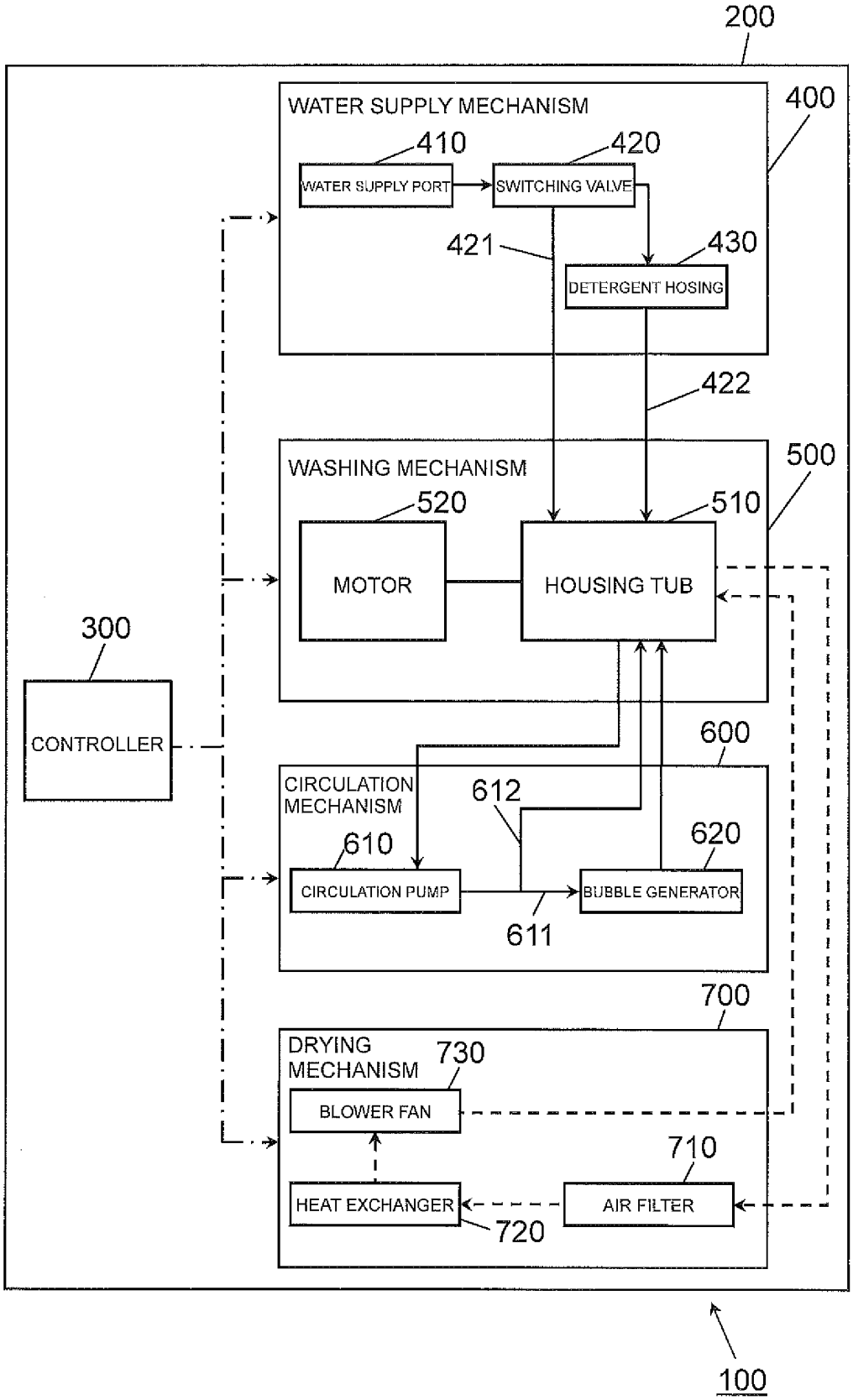
25. The washing machine according to claim 24, further comprising a guide passage for guiding washing solution discharged from the discharge port to the bubble generation chamber,
wherein
the guide passage includes a first region provided with the air intake port and a second region communicating with the bubble generation chamber, and
an inner diameter of the second region is formed smaller than an inner diameter of the first region.

26. The washing machine according to claim 24, wherein the air intake port is formed on an upstream side of the guide passage.

27. The washing machine according to claim 24, further comprising a blower for supplying intake port with air.

28. The washing machine according to claim 26, wherein the air intake port communicates with the water tub.

FIG. 1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DETERGENT HOSING
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WASHING MECHANISM
500
520
510
MOTOR
HOUSING TUB
300
CONTROLLER
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CIRCULATION MECHANISM
612
610
620
CIRCULATION PUMP
BUBBLE GENERATOR
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700
DRYING MECHANISM
730
BLOWER FAN
710
HEAT EXCHANGER
AIR FILTER
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FIG. 2

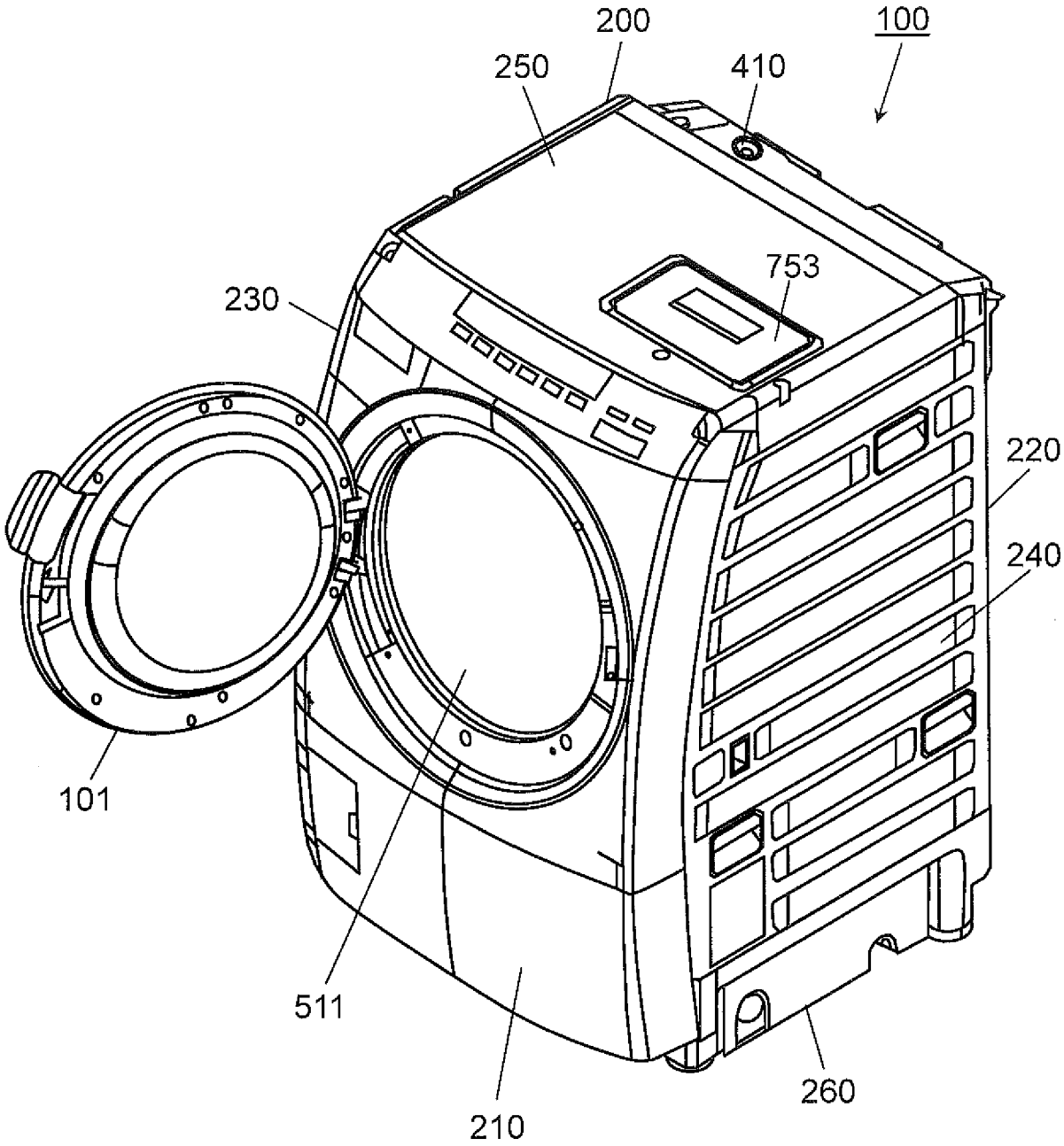
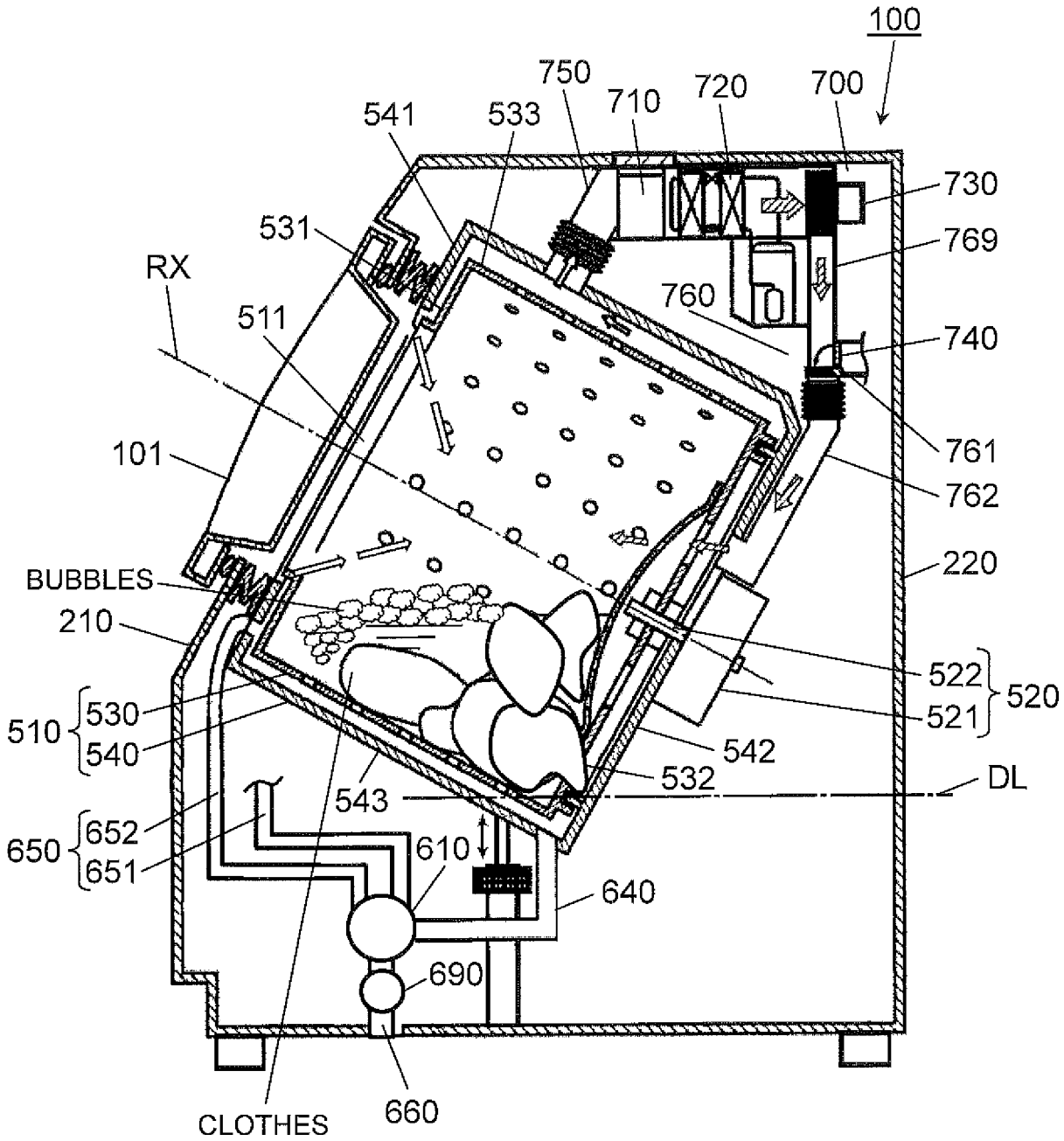


FIG. 3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CLOTHES

FIG. 4

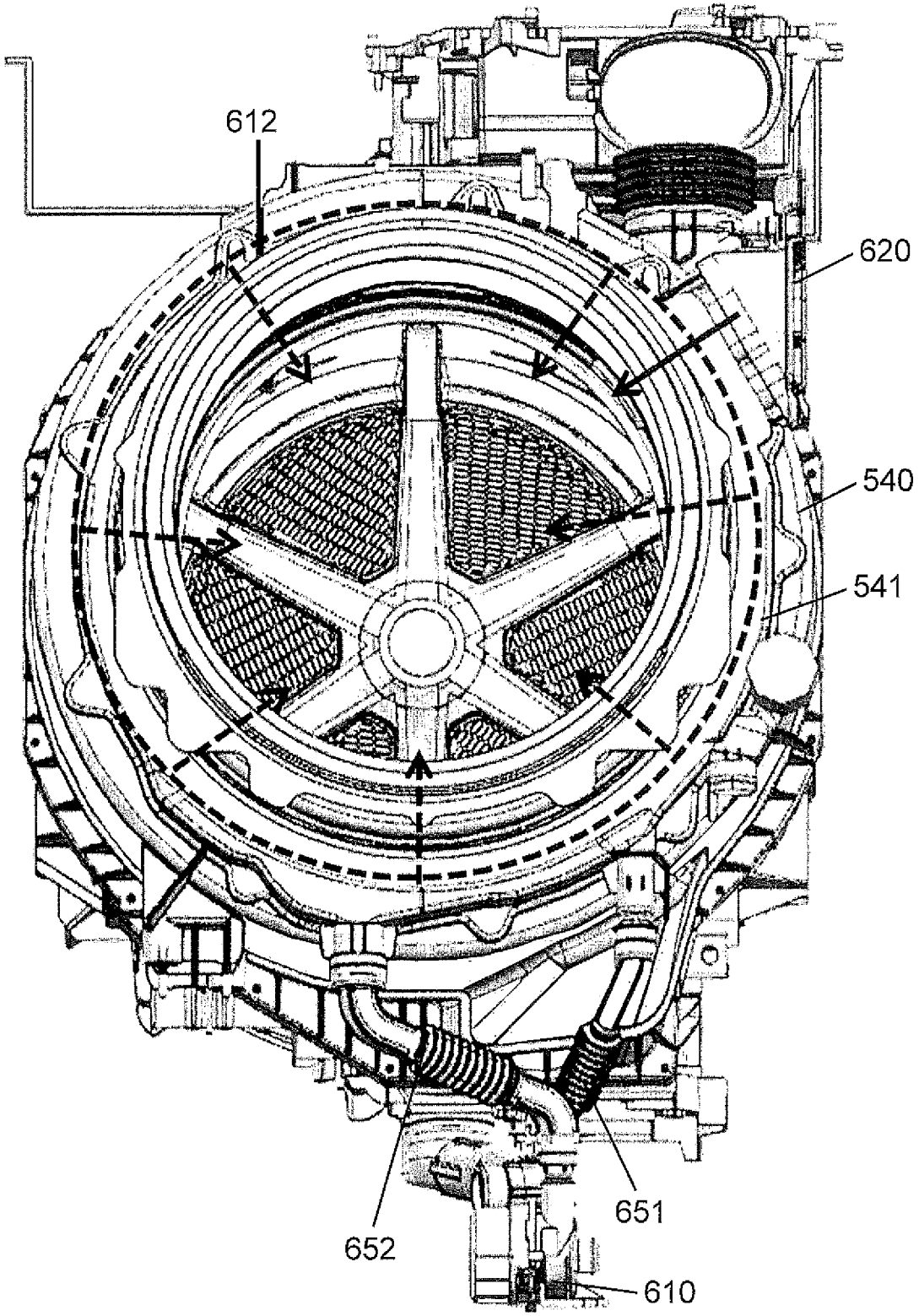


FIG. 5

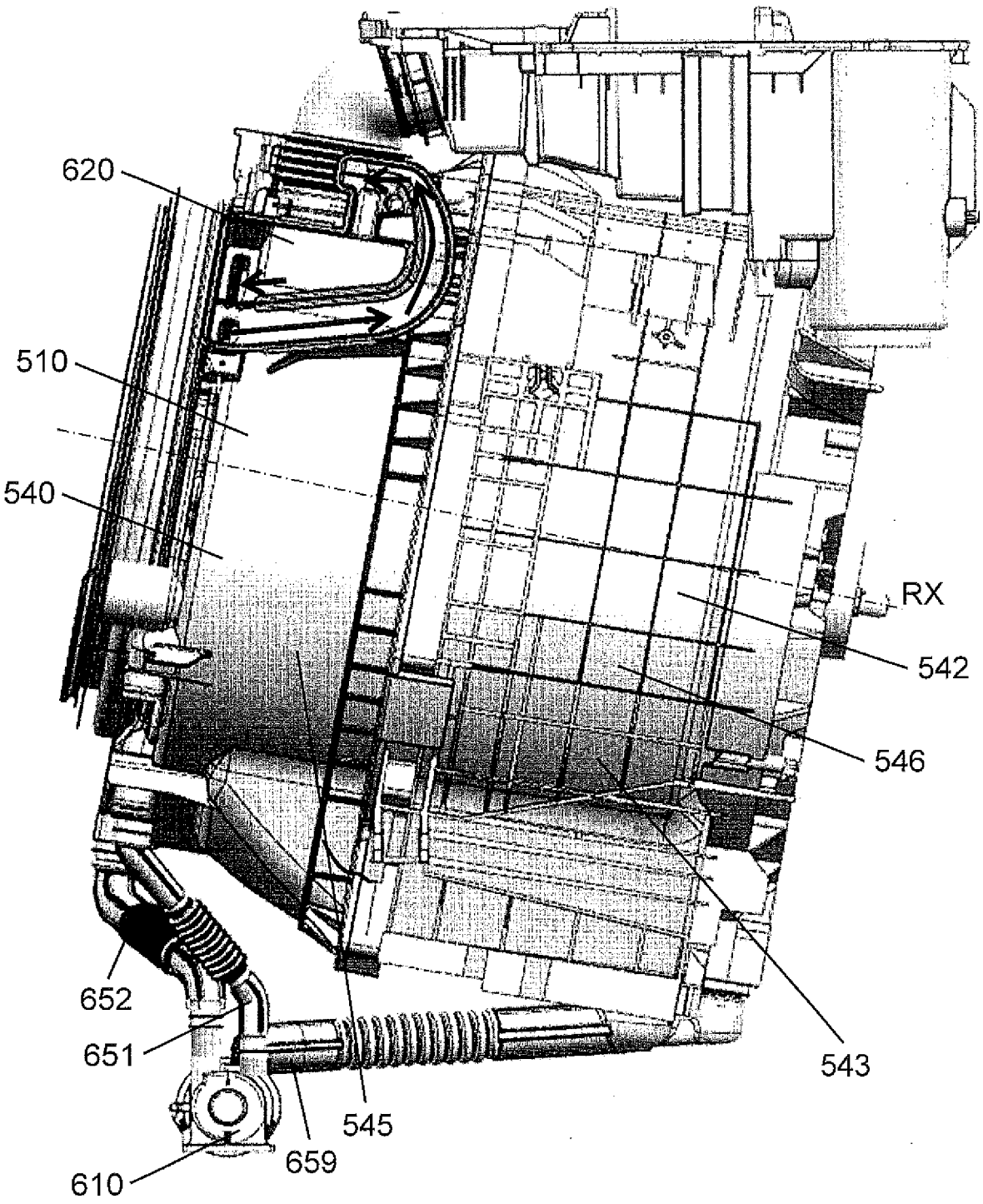


FIG. 6

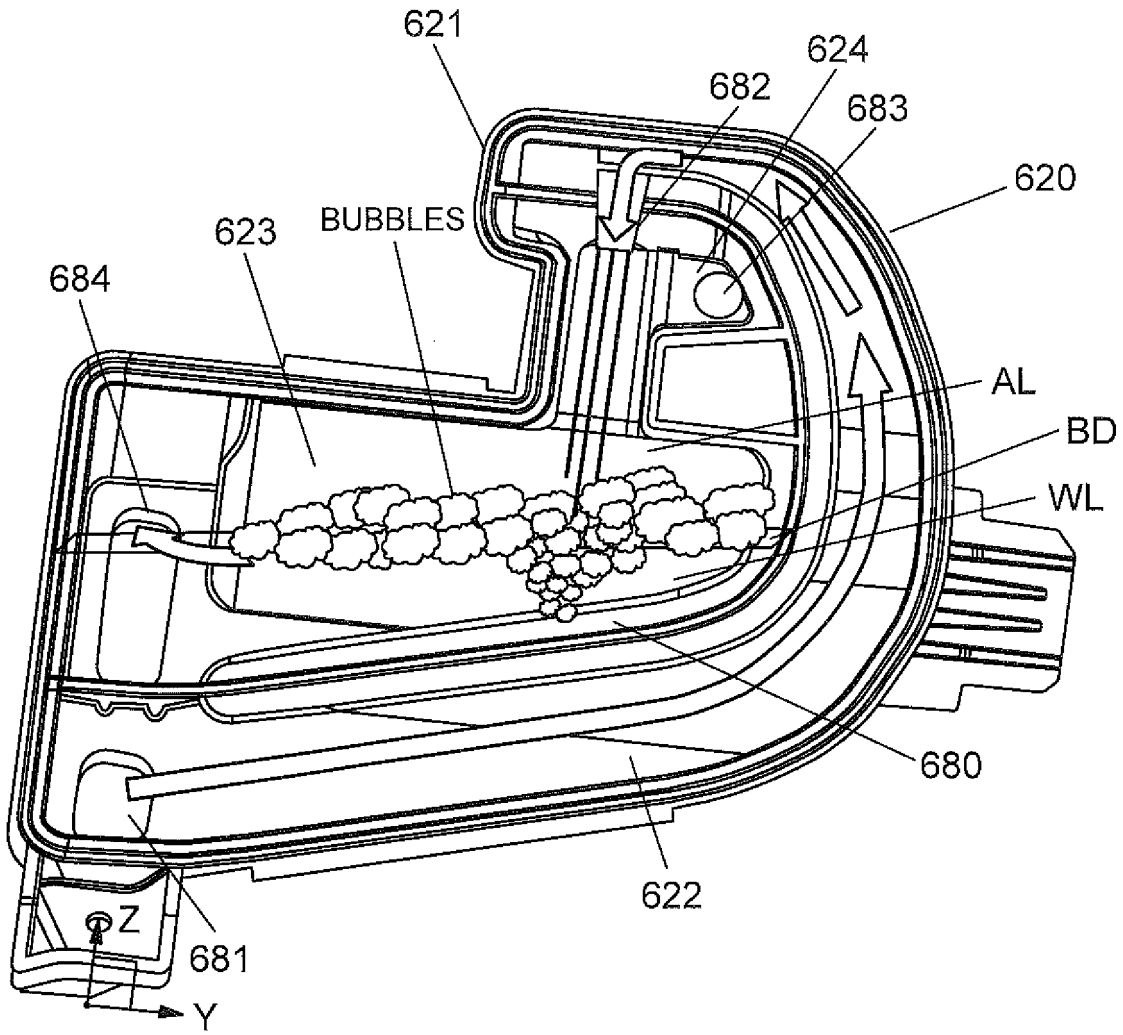
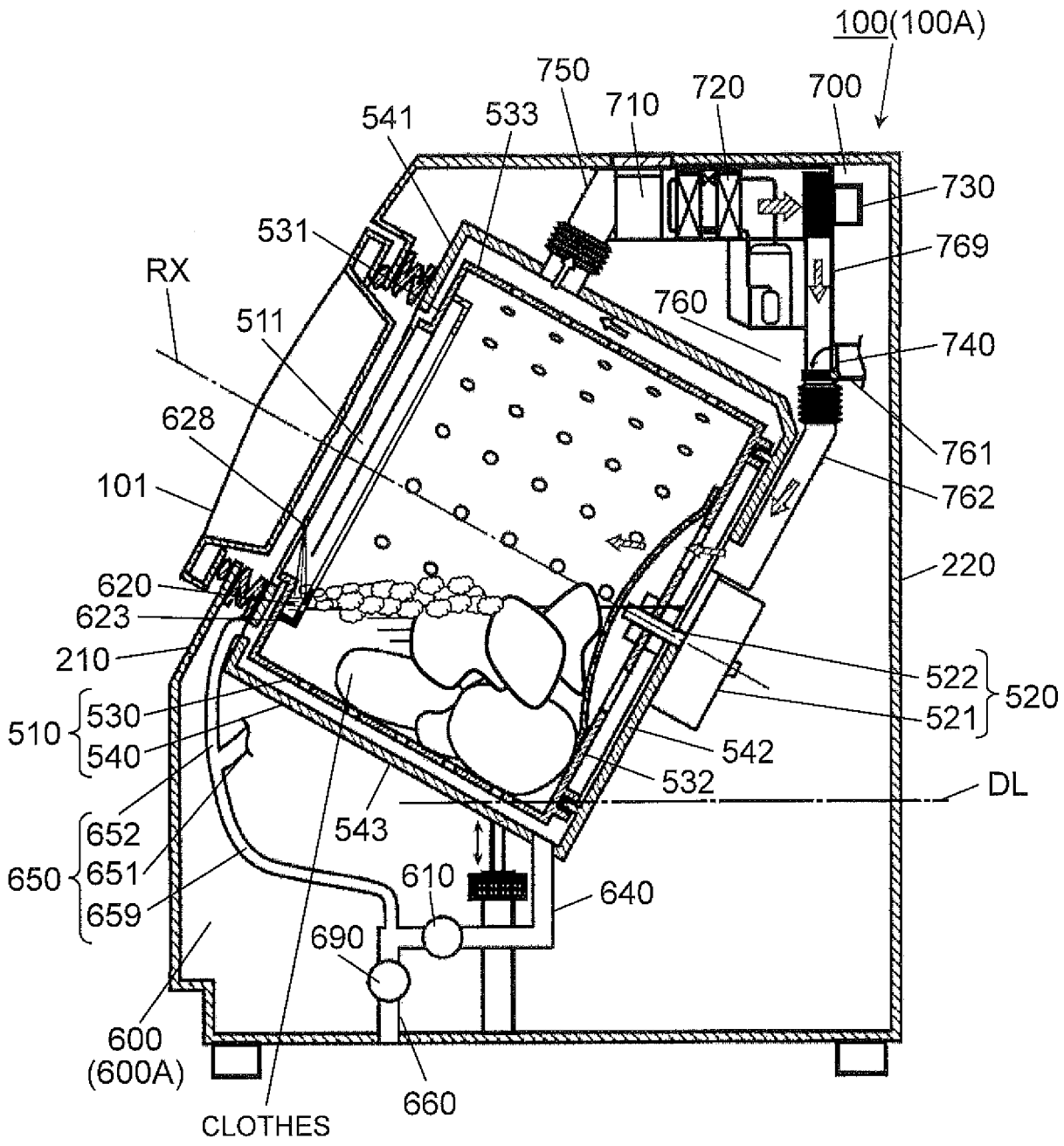


FIG. 7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CLOTHES

FIG. 8

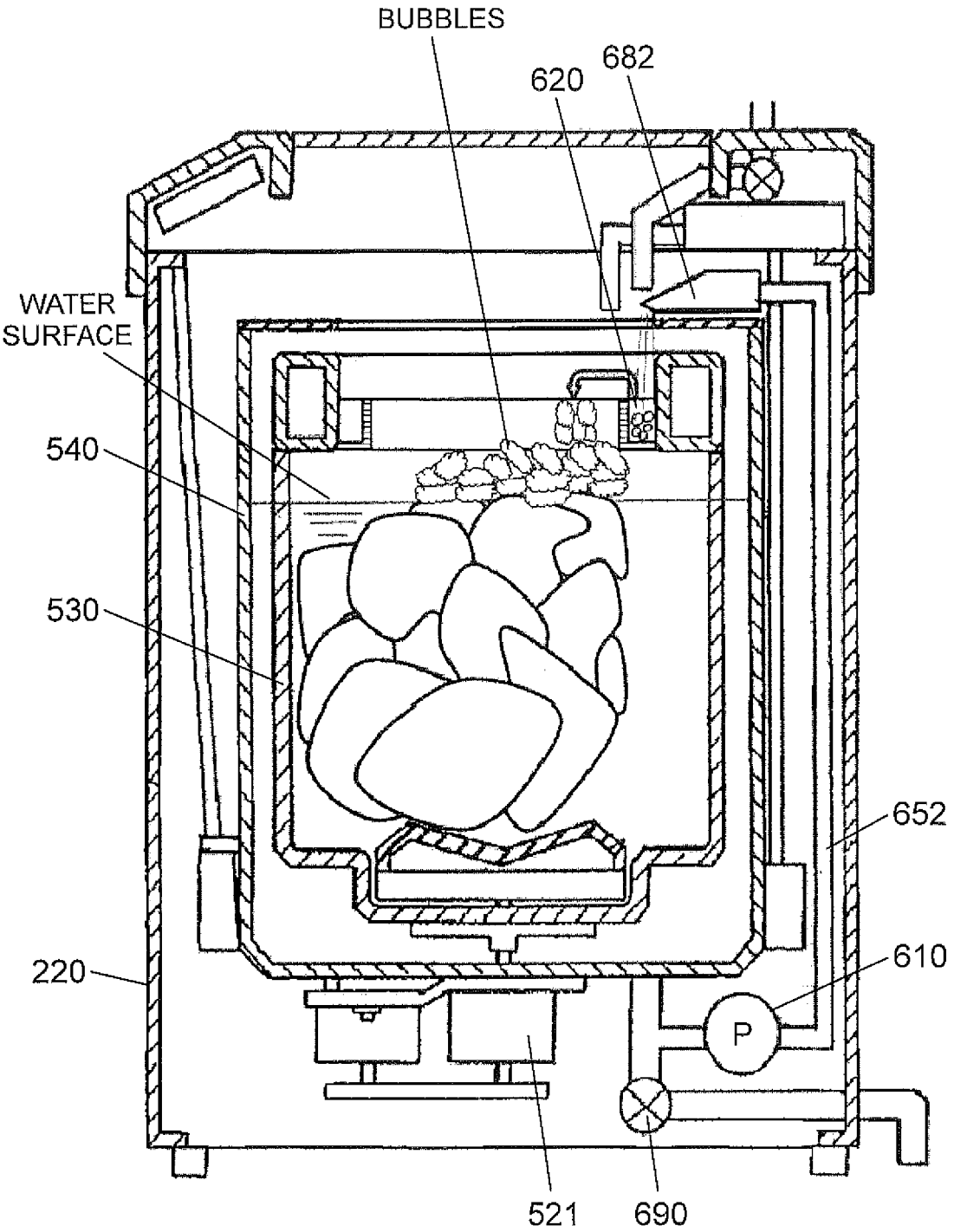
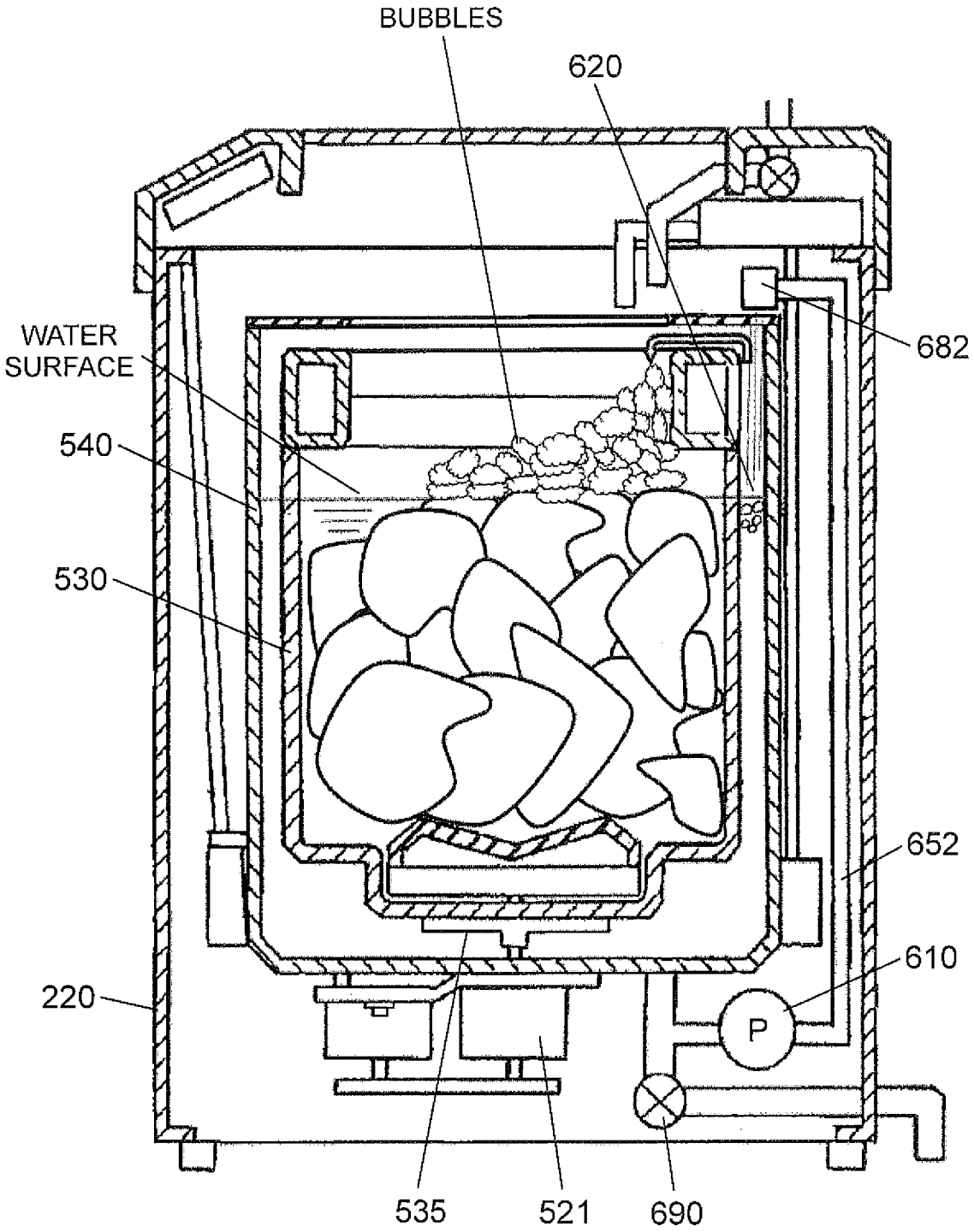


FIG. 9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WATER SURFACE
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FIG. 10

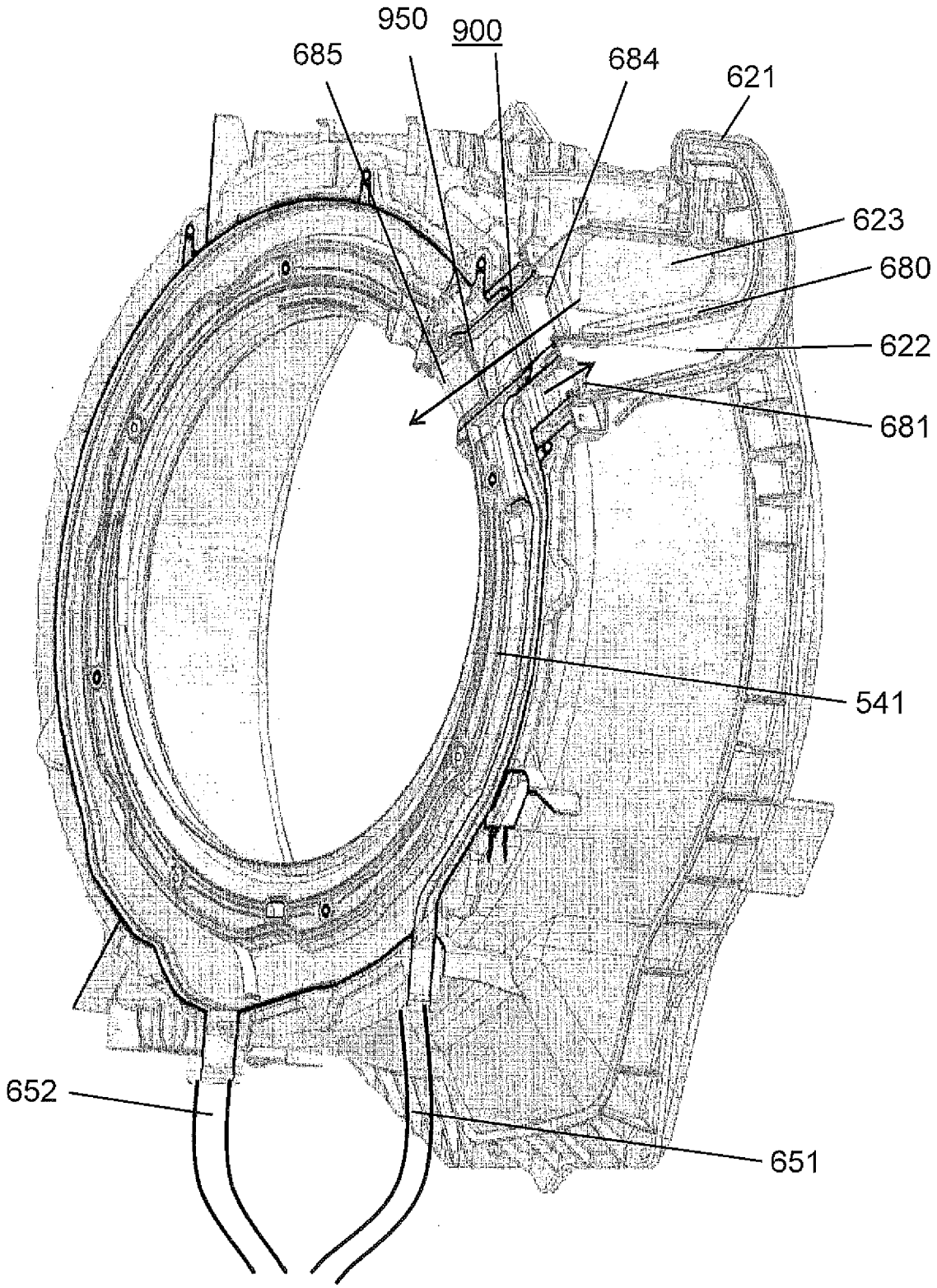

FIG. 11

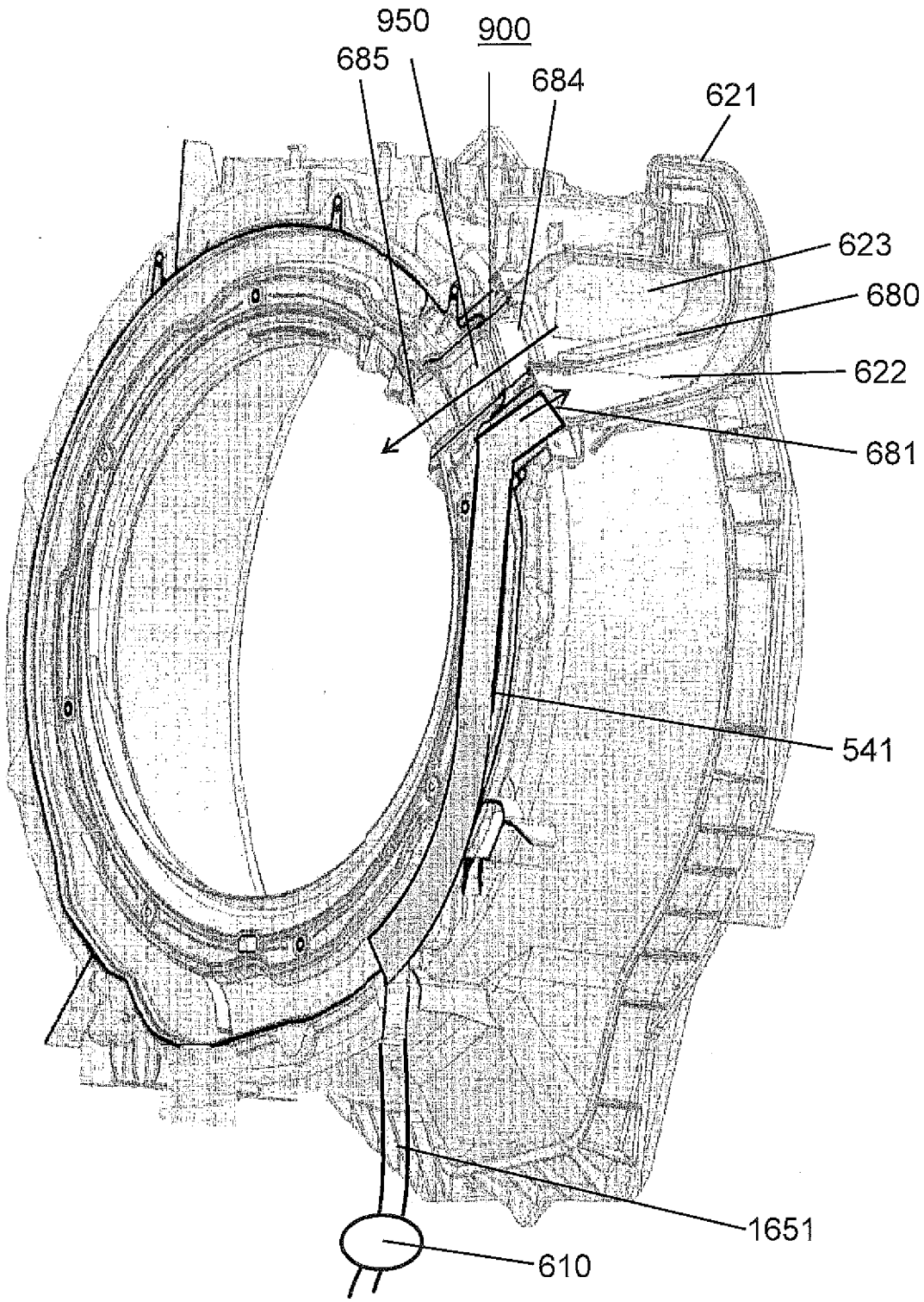

FIG. 12

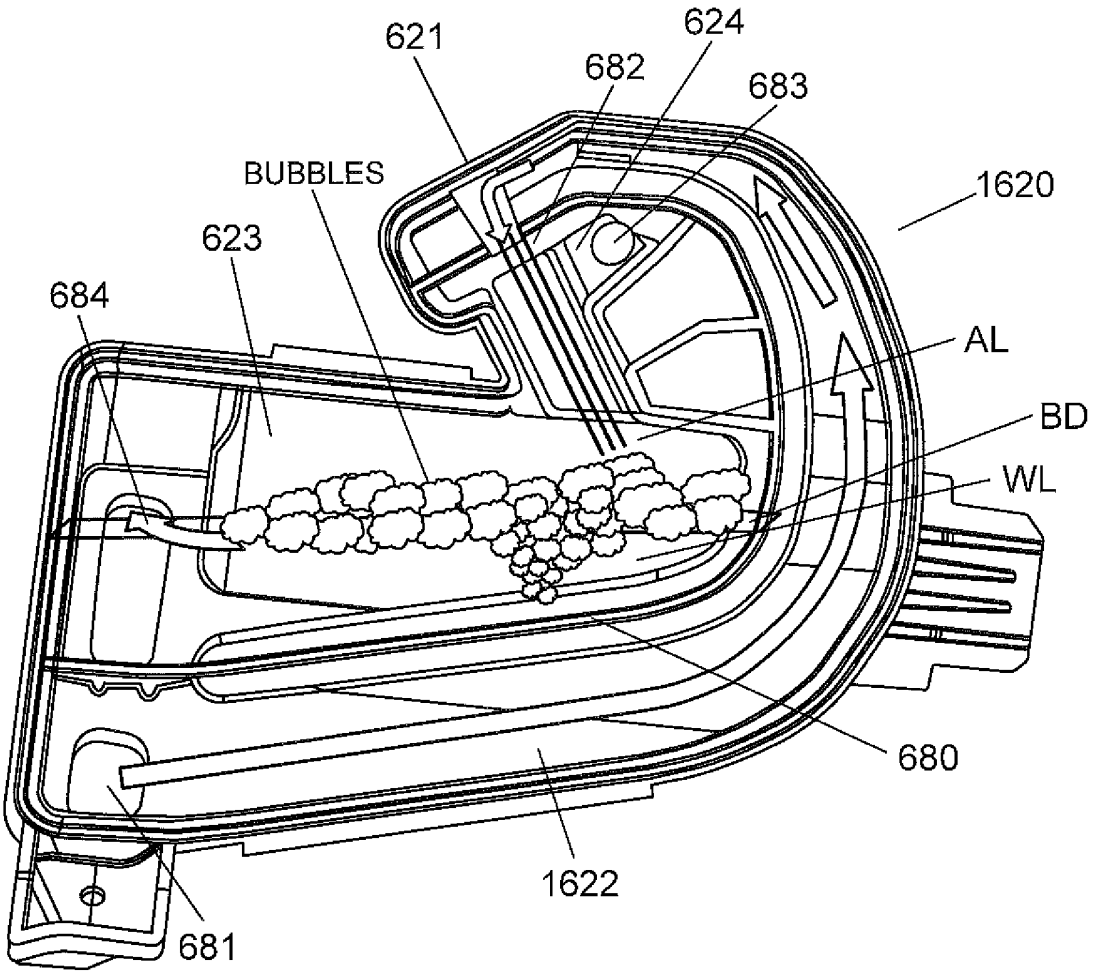
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FIG. 13

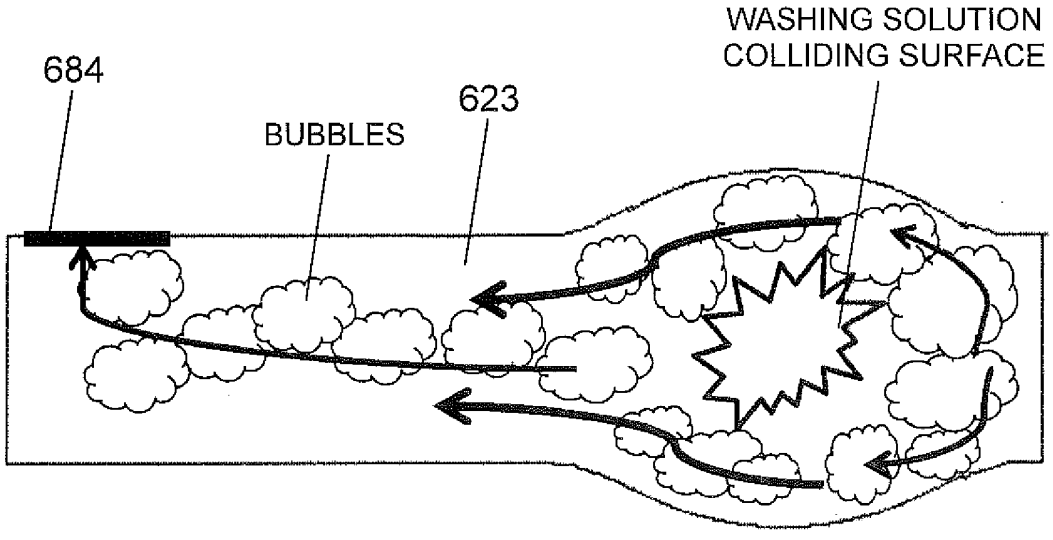
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FIG. 14

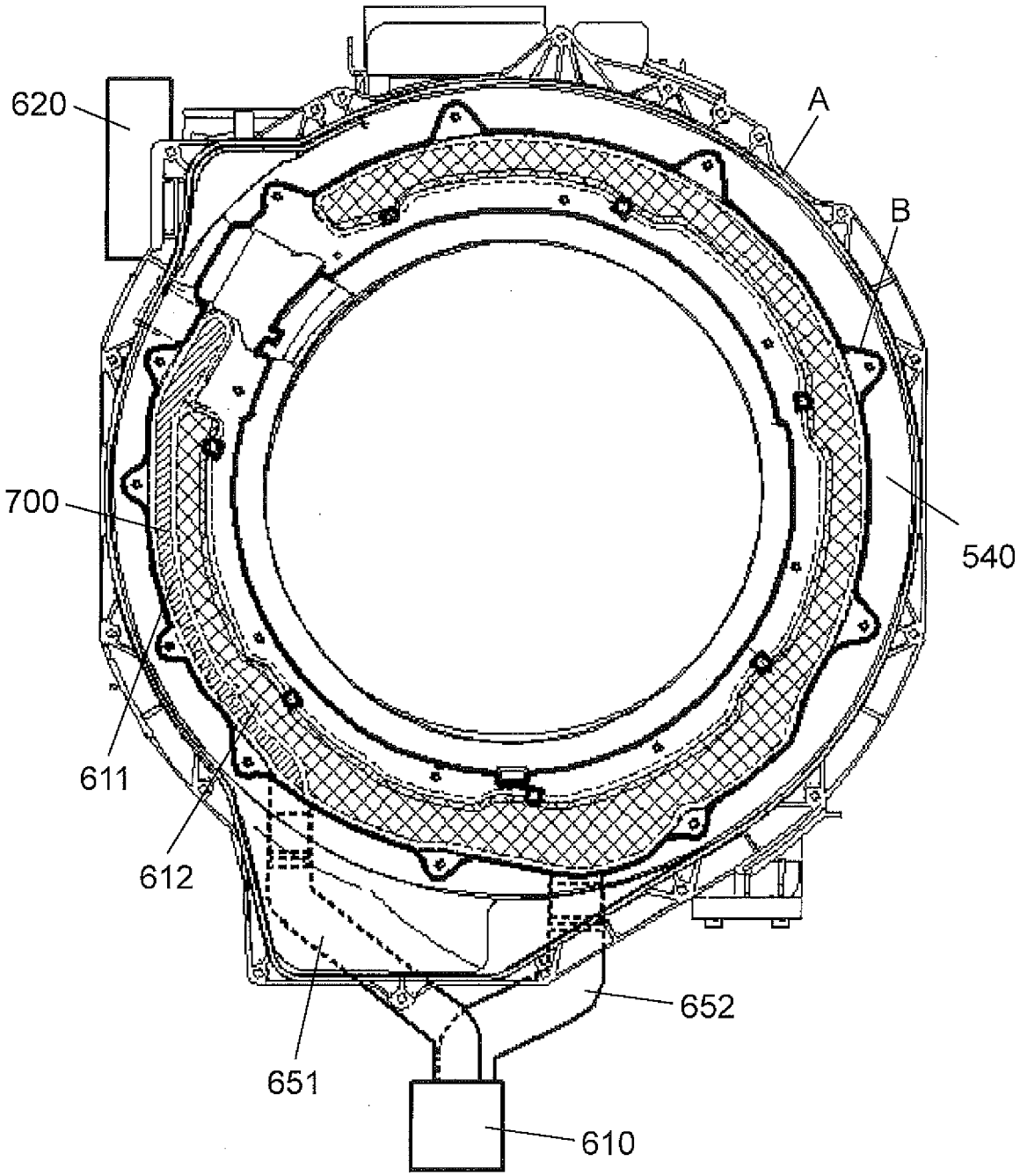


FIG. 15

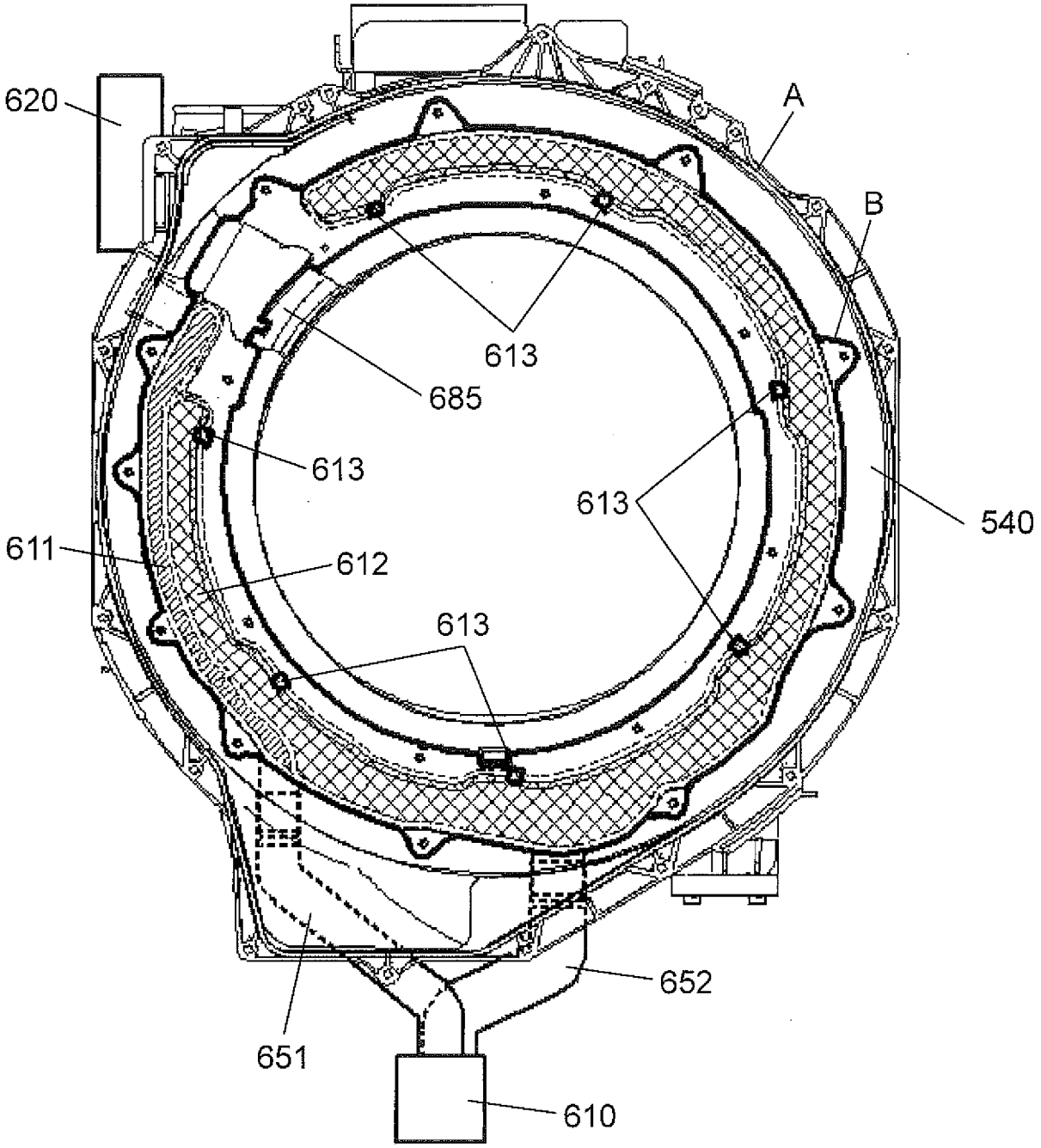
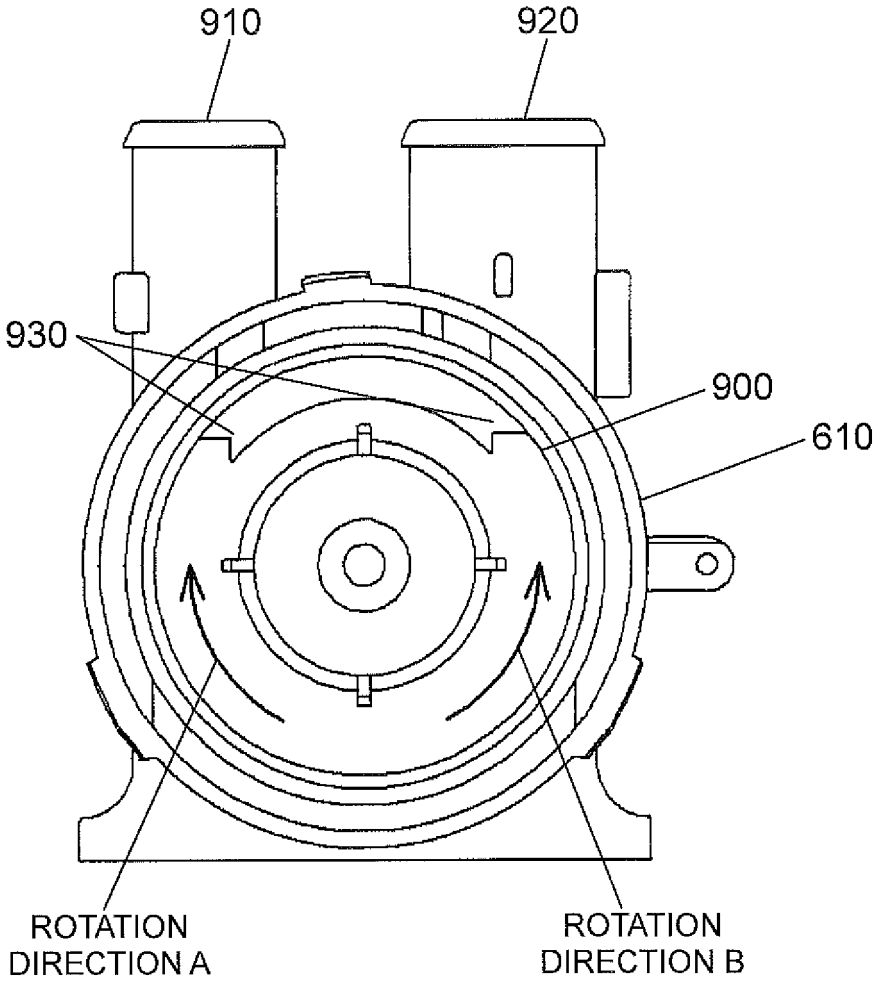


FIG. 16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ROTATION DIRECTION A
ROTATION DIRECTION B

FIG. 17

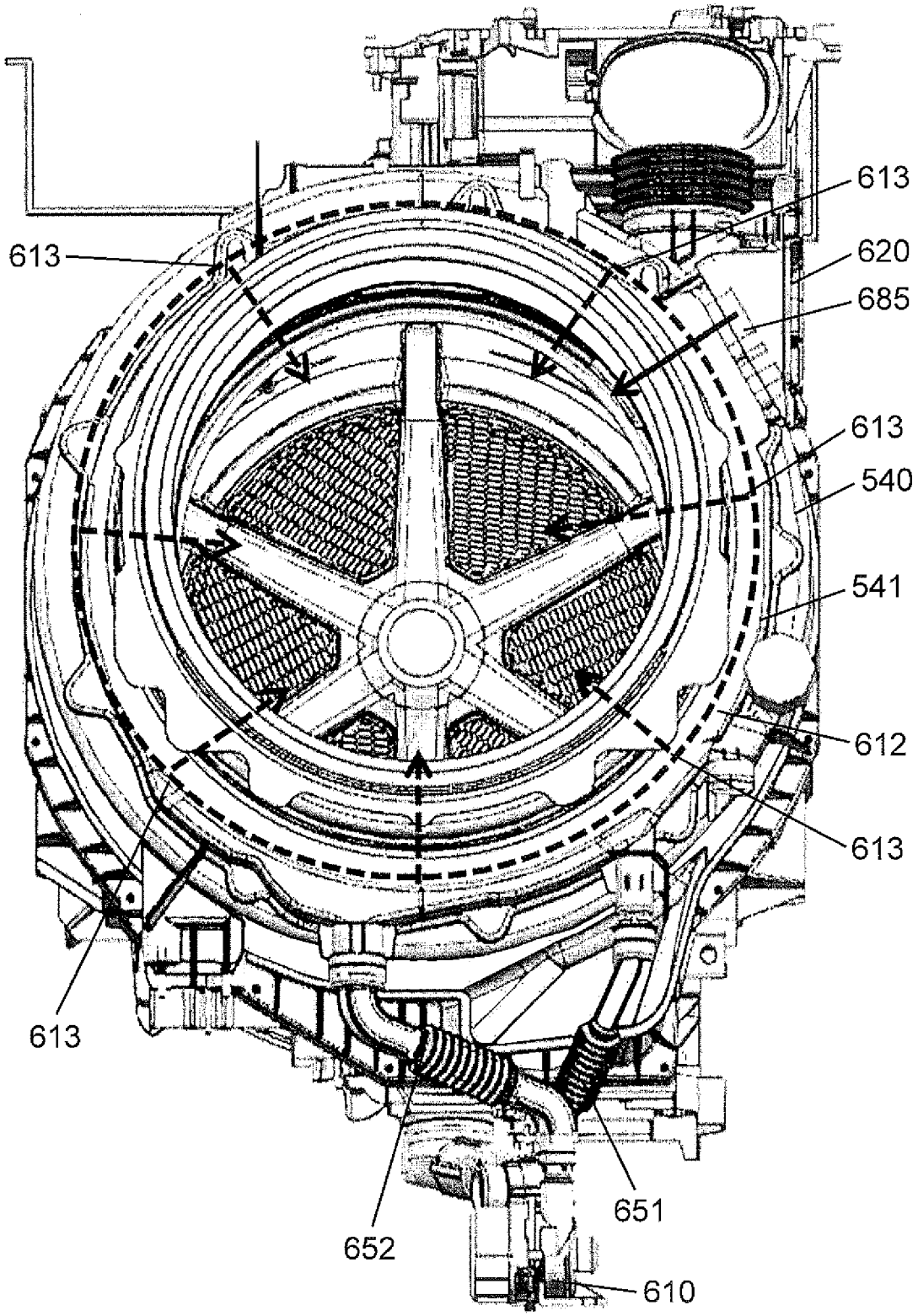
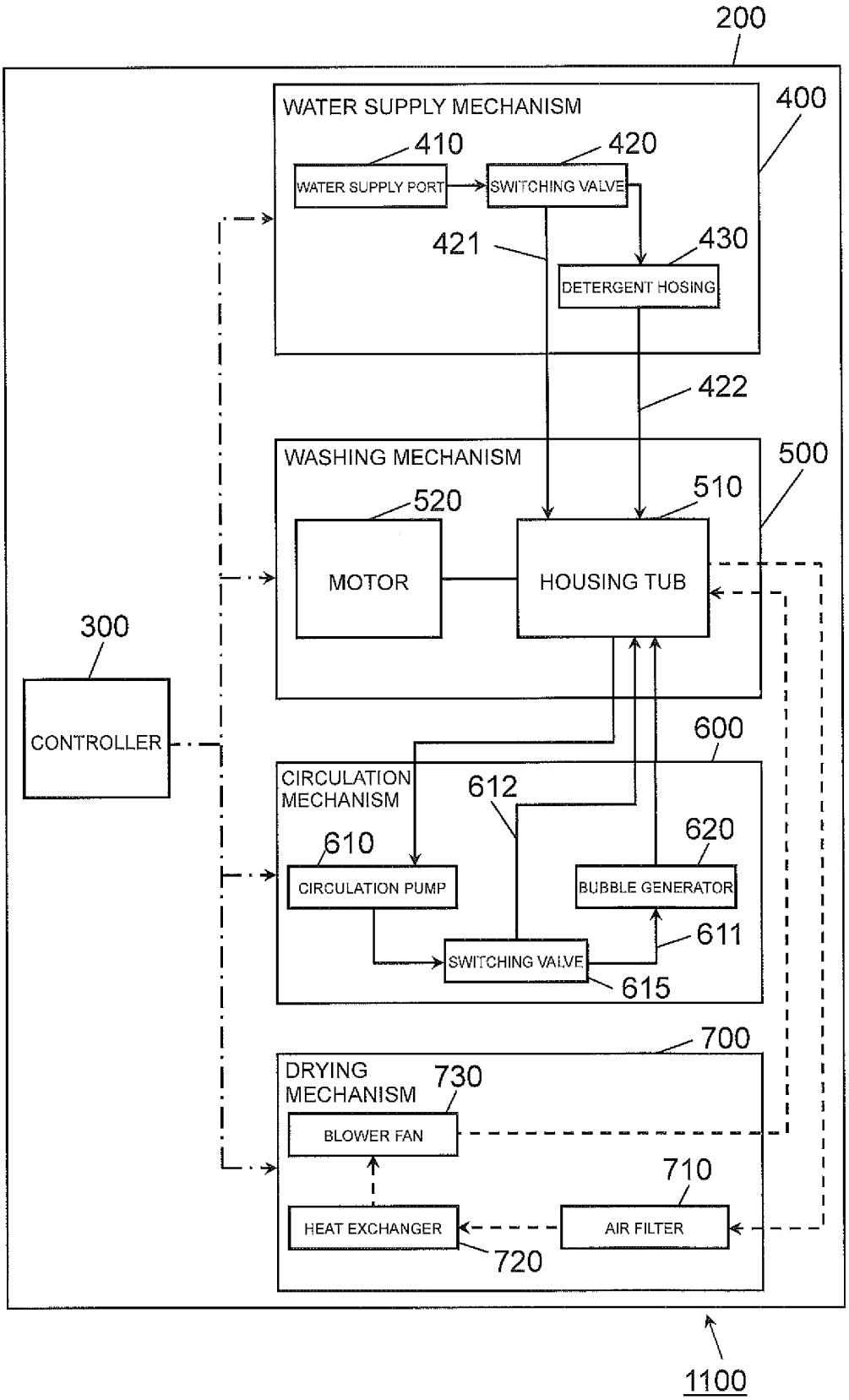


FIG. 18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HOUSING TUB
300
CONTROLLER
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620
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CIRCULATION PUMP
BUBBLE GENERATOR
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HEAT EXCHANGER
AIR FILTER
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FIG. 19

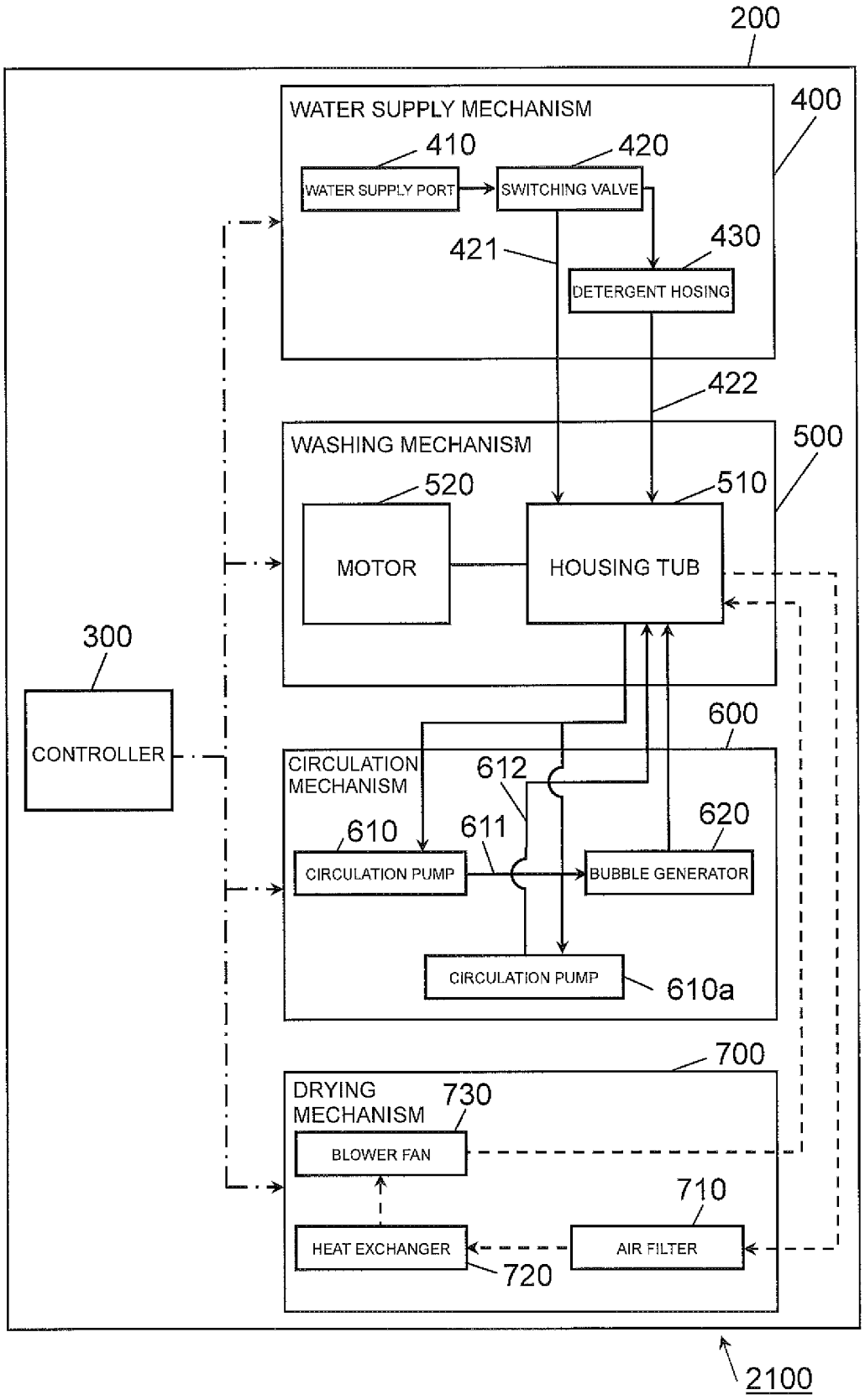
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FIG. 20

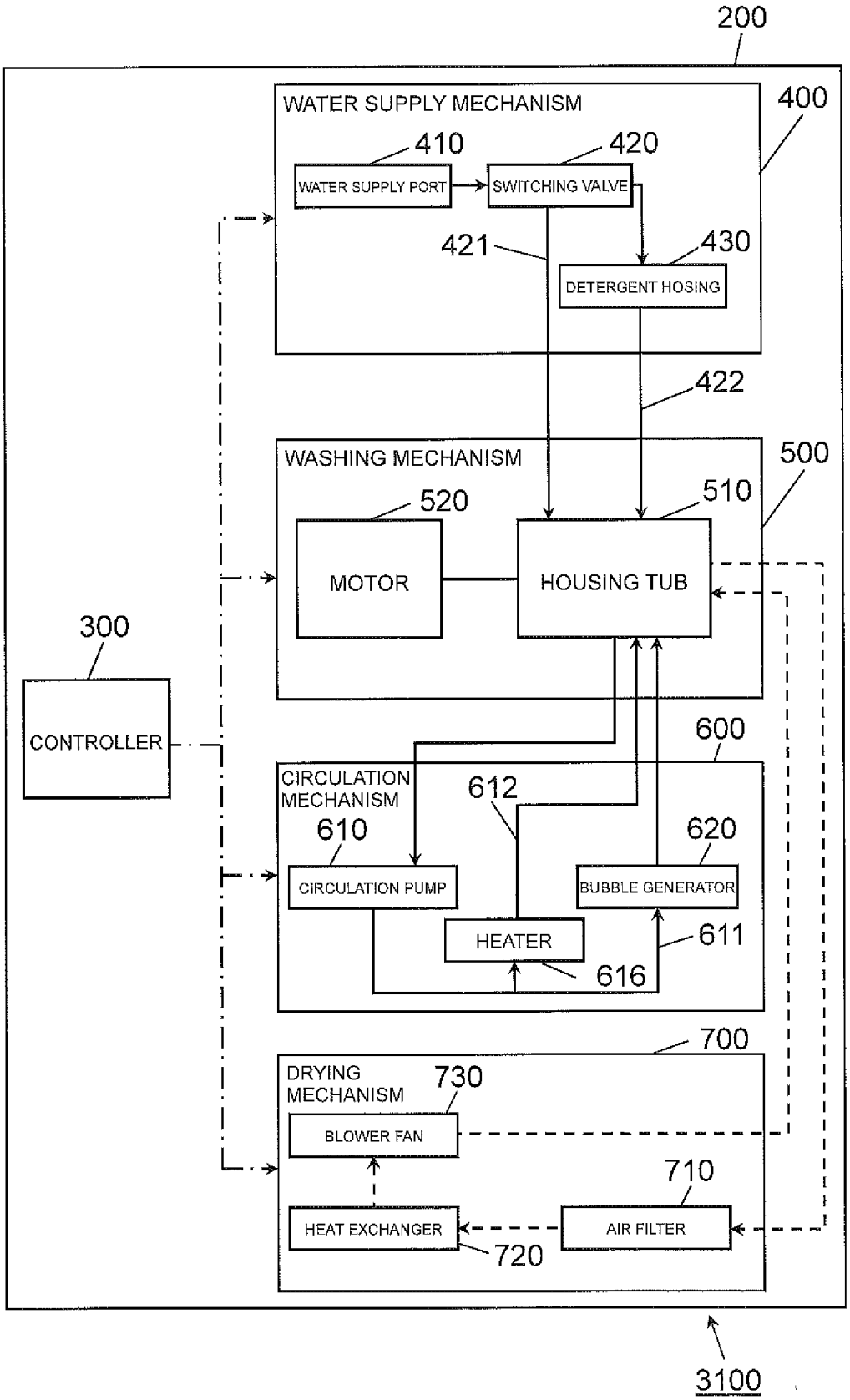
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FIG. 21

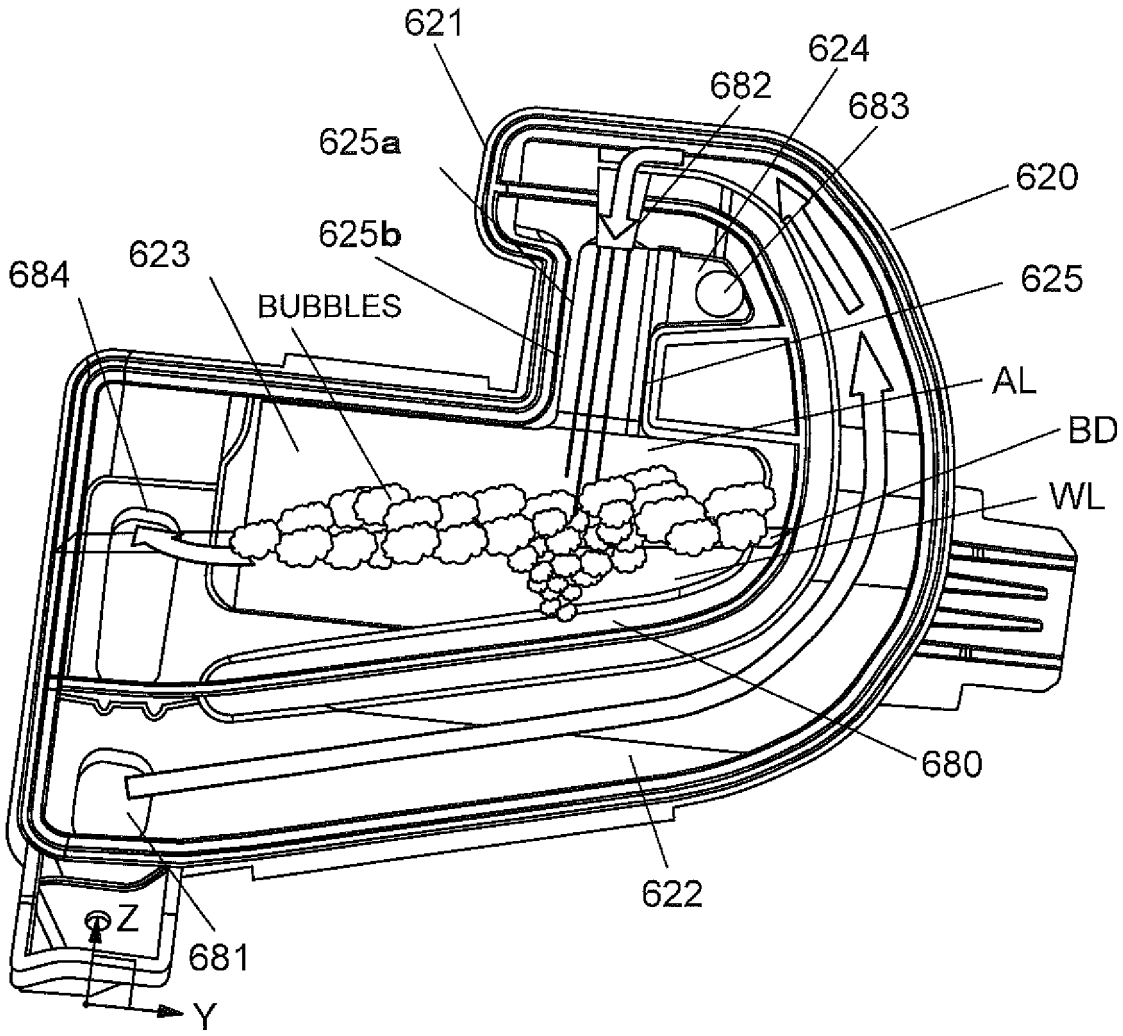
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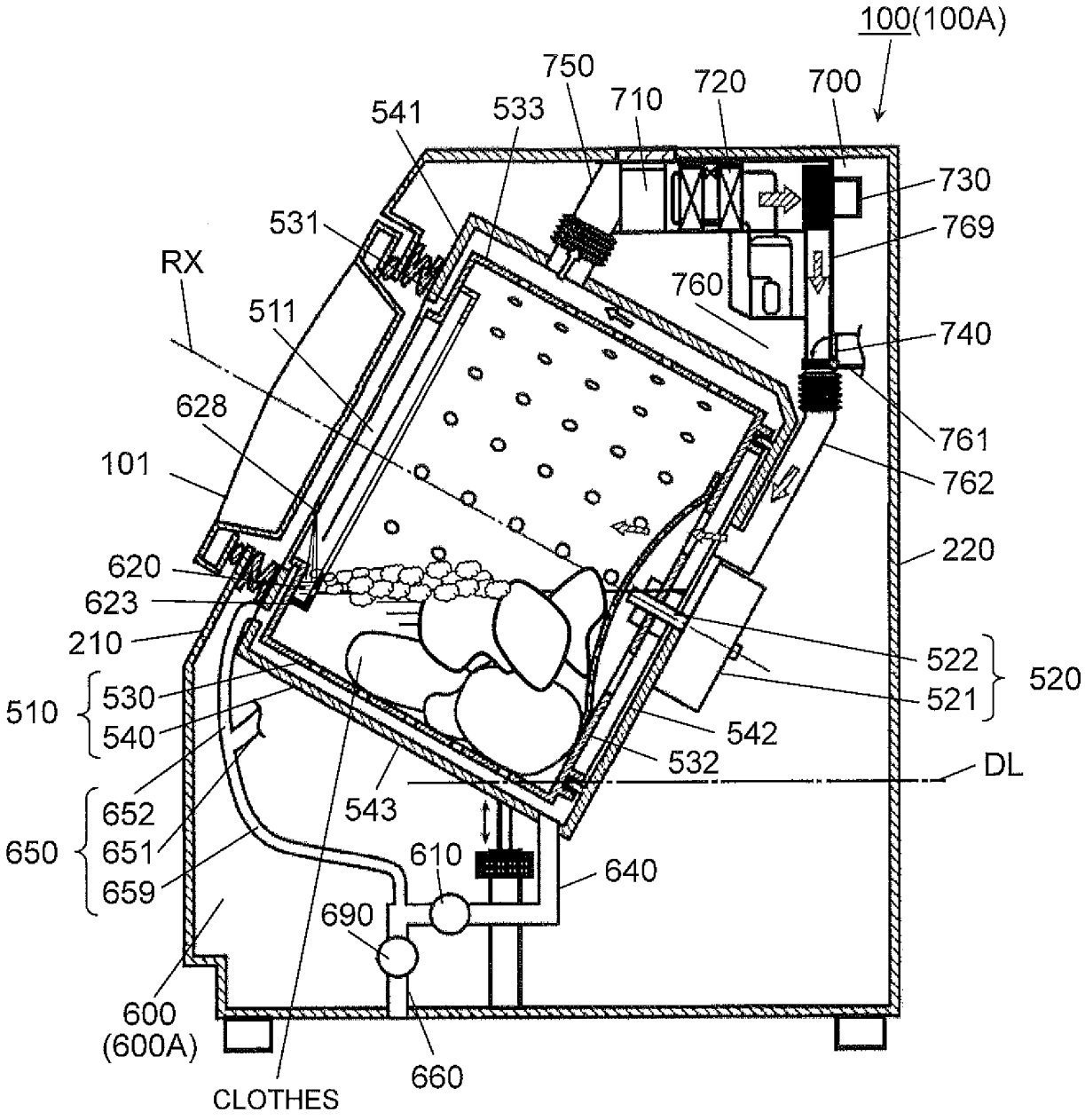
FIG. 22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CLOTHES

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2015/003394

A. CLASSIFICATION OF SUBJECT MATTER
D06F39/00(2006.01)i, *D06F39/08*(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)
D06F39/00, D06F39/08

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 1996-2015
Kokai Jitsuyo Shinan Koho 1971-2015 Toroku Jitsuyo Shinan Koho 1994-2015

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 2014-128351 A (Panasonic Corp.), 10 July 2014 (10.07.2014), paragraphs [0005], [0018], [0026] to [0028], [0036], [0039], [0044], [0052], [0061], [0066] to [0078]; fig. 1, 3 to 4, 6 to 11 (Family: none)	1-3,5,9-10, 12,15-21 4,6-8,11, 13-14,22-28
Y A	JP 3066964 U (Yoshiaki TAKEI), 07 March 2000 (07.03.2000), paragraphs [0035], [0047] to [0048]; fig. 2 (Family: none)	1-3,5,9-10, 12,15-21 4,6-8,11, 13-14,22-28
Y	WO 2011/024409 A1 (Panasonic Corp.), 03 March 2011 (03.03.2011), paragraph [0020]; fig. 3A to 4 & US 2012/0137740 A1 & EP 2471992 A1 & CN 102482834 A & TW 201111578 A	10

☒ 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
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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Date of the actual completion of the international search	Date of mailing of the international search report
15 September 2015 (15.09.15)	29 September 2015 (29.09.15)
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) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2015/003394

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 2014-510607 A (LG Electronics Inc.), 01 May 2014 (01.05.2014), paragraph [0035]; fig. 4 & US 2014/0033449 A1 & WO 2012/141410 A3 & EP 2698462 A2 & AU 2012243646 A & CN 103547724 A & KR 10-2014-0023986 A & CN 104233694 A & RU 2013150619 A	16
Y	JP 2008-73128 A (Hitachi Appliances, Inc.), 03 April 2008 (03.04.2008), paragraphs [0082] to [0084]; fig. 5 to 7 (Family: none)	19
Y	JP 2009-50639 A (Toshiba Corp.), 12 March 2009 (12.03.2009), paragraphs [0013], [0032]; fig. 1 (Family: none)	21
A	JP 2004-89417 A (Matsushita Electric Industrial Co., Ltd.), 25 March 2004 (25.03.2004), paragraphs [0010] to [0042]; fig. 1 to 7 & US 2004/0040344 A1 & TW 200403372 A & KR 10-2004-0019849 A & CN 1478943 A & MY 135744 A	1-28

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Patent documents cited in the description

- JP 2010172547 A **[0006]**
- JP 2005007224 A **[0006]**