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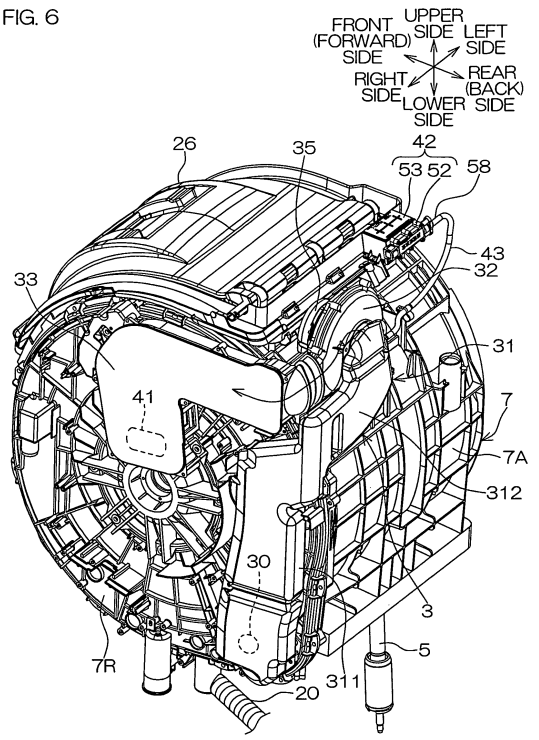
(54) WASHING MACHINE

(57) A washing machine according to the present invention is configured such as to prevent intrusion of water into an ozone generator (42). That is, the washing machine is configured such that an introduction tube (43) extends downward from the ozone generator (42) to be connected to an air duct member (31). With this arrangement, even if water is condensed in the introduction tube (43) due to a temperature difference between the inside and the outside of the introduction tube (43), water droplets resulting from the water condensation do not intrude into the ozone generator (42), but fall down toward the air duct member (31) by their gravity. Further, even if water bubbles and detergent bubbles generated in an outer tub (7) during a washing process enter the introduction tube (43) and are broken to form water droplets, these water droplets, like the water drops resulting from the water condensation, do not intrude into the ozone generator (42), but fall down toward the air duct member (31) by their gravity. (Fig. 6)

FIG. 6



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Description

TECHNICAL FIELD

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

BACKGROUND ART

[0002] Patent Document 1 proposes a prior art washing machine which is adapted to supply ozone generated by an ozone generator into a washing tub through a connection tube for sterilization of laundry in the washing tub. Patent Document 1: Japanese Unexamined Patent Publication No. 2002-320792

DISCLOSURE OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0003] In the washing machine disclosed in Patent Document 1, the connection tube horizontally extends from the ozone generator to be connected to a water supply case. Therefore, the ozone generated by the ozone generator flows horizontally through the connection tube into the water supply case, and then flows down through a duct to be supplied into the washing tub.

[0004] When a temperature difference occurs between the inside and the outside of the connection tube, water is condensed in the connection tube. If water droplets resulting from the water condensation adhere to the interior surface of the connection tube, the water droplets are liable to flow horizontally through the connection tube into the ozone generator. If the water droplets intrude into the ozone generator and adhere to ozone generating electrodes of the ozone generator, the ozone generation efficiency, i.e., the laundry sterilization efficiency, is disadvantageously reduced. Further, water bubbles and detergent bubbles generated in the washing tub during a washing process are liable to enter the connection tube through the duct and the water supply case. If the bubbles are broken to form water droplets, these water droplets, like the water droplets resulting from the water condensation, are liable to intrude into the ozone generator.

[0005] Of course, it is desirable to position the aforementioned components in a compact and functionally efficient manner in the washing machine.

[0006] In view of the foregoing, it is a principal object of the present invention to provide a washing machine which is arranged to efficiently clean laundry while preventing water from intruding into a gas generator that generates a gas effective for cleaning the laundry.

[0007] It is another object of the present invention to provide a washing machine which includes a gas generator that generates a gas effective for cleaning laundry, and yet has a compact construction.

[0008] It is further another object of the present invention to provide a washing machine which is functionally efficient and yet has a simplified construction.

MEANS FOR SOLVING THE PROBLEMS

[0009] According to an inventive aspect as set forth in claim 1, there is provided a washing machine, which includes: a washing tub in which laundry is contained; an air duct through which air is introduced into the washing tub; a gas generator which generates a gas effective for cleaning the laundry contained in the washing tub, the gas generator being disposed above the washing tub; and a conduit through which the gas generated by the gas generator is introduced into the air duct, the conduit extending downward from the gas generator to be connected to the air duct.

[0010] According to an inventive aspect as set forth in claim 2, the gas generator includes a gas generating member having a gas generating surface that generates the gas effective for cleaning the laundry, and the gas generating member is disposed with its gas generating surface being perpendicular to a horizontal plane or inclined with respect to the horizontal plane in the washing machine of claim 1.

[0011] According to an inventive aspect as set forth in claim 3, there is provided a washing machine, which includes: a washing tub in which laundry is contained; an air duct through which air is introduced into the washing tub; a gas generator which generates a gas effective for cleaning the laundry contained in the washing tub; a conduit through which the gas generated by the gas generator is introduced into the air duct, the conduit communicating with the air duct and the gas generator; wherein the gas generator includes a gas generating member having a gas generating surface that generates the gas effective for cleaning the laundry, and the gas generating member is disposed with its gas generating surface being perpendicular to a horizontal plane or inclined with respect to the horizontal plane.

[0012] According to an inventive aspect as set forth in claim 4, the washing machine of any of claims 1 to 3 further includes an air blower which supplies the air into the washing tub from the air duct, the air blower being disposed in the air duct, wherein the conduit is connected to a portion of the air duct upstream of the air blower with respect to an air flowing direction in which the air flows from the air duct to the washing tub, and the air blower is disposed adjacent the gas generator.

[0013] According to an inventive aspect as set forth in claim 5, the washing machine of claim 4 further includes: a first water supply unit which supplies water into the washing tub; a housing which accommodates the first water supply unit and the gas generator in adjacent relation and serves as an outer casing of the washing machine; and a wall provided in the housing to isolate the first water supply unit and the gas generator from each other.

[0014] According to an inventive aspect as set forth in claim 6, the housing has a load/unload opening through

which the laundry is loaded into and unloaded from the washing tub in the washing machine of claim 5. The washing machine of claim 5 further includes a door which covers and uncovers the load/unload opening, the door being provided in the housing in a slidable manner, wherein the gas generator is disposed in a door sliding region of the housing in which the door is slid, and the first water supply unit is disposed outside the door sliding region in the housing.

[0015] According to an inventive aspect as set forth in claim 7, the sliding of the door is guided by the wall in the washing machine of claim 6.

[0016] According to an inventive aspect as set forth in claim 8, the washing machine of claim 6 or 7 further includes a second water supply unit which supplies water into the washing tub, wherein the air blower is disposed between the second water supply unit and the gas generator.

[0017] According to an inventive aspect as set forth in claim 9, the second water supply unit is disposed outside the door sliding region in the housing in the washing machine of claim 8.

[0018] According to an inventive aspect as set forth in claim 10, there is provided a washing machine, which includes: a washing tub in which laundry is contained; a gas generator which generates a gas effective for cleaning the laundry contained in the washing tub; and a conduit through which the gas generated by the gas generator is introduced into the washing tub; wherein the gas generator includes a gas generating member having a gas generating surface that generates the gas effective for cleaning the laundry, and the gas generating member is disposed with its gas generating surface being perpendicular to a horizontal plane or inclined with respect to the horizontal plane.

[0019] According to an inventive aspect of claim 11, the washing machine of claim 10 further includes: a first water supply unit which supplies water into the washing tub; a housing which accommodates the first water supply unit and the gas generator in adjacent relation and serves as an outer casing of the washing machine; and a wall provided in the housing to isolate the first water supply unit and the gas generator from each other.

[0020] According to an inventive aspect as set forth in claim 12, the housing has a load/unload opening through which the laundry is loaded into and unloaded from the washing tub in the washing machine of claim 11. The washing machine of claim 11 further includes a door which covers and uncovers the load/unload opening, the door being provided in the housing in a slidable manner, wherein the gas generator is disposed in a door sliding region of the housing in which the door is slid, and the first water supply unit is disposed outside the door sliding region in the housing.

[0021] According to an inventive aspect of claim 13, the sliding of the door is guided by the wall in the washing machine of claim 12.

EFFECTS OF THE INVENTION

[0022] According to the inventive aspect of claim 1, the gas generated by the gas generator is introduced into the air duct through the conduit, and carried on the air flowing through the air duct to be supplied into the washing tub, whereby the laundry contained in the washing tub is cleaned. The conduit extends downward from the gas generator to be connected to the air duct. Therefore, even if water is condensed in the conduit due to a temperature difference occurring between the inside and the outside of the conduit, water droplets resulting from the water condensation do not intrude into the gas generator, but flow down toward the air duct by their gravity. Even if water bubbles and detergent bubbles generated in the washing tub enter the conduit and are broken to form water droplets, these water droplets, like the water droplets resulting from the water condensation, do not intrude into the gas generator, but flow down toward the air duct by their gravity. Since the gas generator is disposed above the washing tub, the intrusion of the water droplets is more reliably prevented. This prevents water from intruding into the gas generator, thereby ensuring efficient cleaning of the laundry.

[0023] According to the inventive aspect of claim 2, the gas generating surface is perpendicular to the horizontal plane, or is inclined with respect to the horizontal plane. Therefore, even if the water droplets adhere to the gas generating surface, the water droplets fall down by their gravity. This prevents the water from intruding into the gas generating surface, thereby ensuring further efficient cleaning of the laundry.

[0024] According to the inventive aspect of claim 3, the gas generated by the gas generating surface of the gas generating member included in the gas generator is introduced into the air duct through the conduit, and carried on the air flowing through the air duct to be supplied into the washing tub, whereby the laundry contained in the washing tub is cleaned. The gas generating surface is perpendicular to the horizontal plane, or is inclined with respect to the horizontal plane. Therefore, even if the water droplets adhere to the gas generating surface, the water droplets fall down by their gravity. This prevents the water from intruding into the gas generating surface, thereby ensuring efficient cleaning of the laundry.

[0025] According to the inventive aspect of claim 4, the portion of the air duct upstream of the air blower with respect to the air flowing direction in which the air flows from the air duct to the washing tub has a negative internal pressure when the air blower disposed in the air duct is driven. The conduit is connected to the upstream portion of the air duct. Therefore, when the air blower is driven, the gas generated by the gas generator is efficiently supplied into the air duct. Since the air blower is disposed adjacent the gas generator, the conduit has a relatively short length, and the gas generated by the gas generator is further efficiently supplied into the air duct. The relatively short length of the conduit reduces the temperature

difference between the inside and the outside of the conduit, so that the water condensation is less liable to occur. This ensures further efficient cleaning of the laundry.

[0026] According to the inventive aspect of claim 5, the wall isolates the first water supply unit and the gas generator from each other, so that the water from the first water supply unit is prevented from intruding into the gas generator. The first water supply unit and the gas generator are accommodated in adjacent relation in the housing, whereby the washing machine has a compact construction.

[0027] According to the inventive aspect of claim 6, the first water supply unit is disposed outside the door sliding region in the housing, so that the sliding of the door is unlikely to interfere with the water supply from the first water supply unit. Thus, the first water supply unit has a simplified construction as compared with a case in which the first water supply unit is disposed in the door sliding region. On the other hand, the first water supply unit and the gas generator are isolated from each other, because the gas generator is disposed in the door sliding region in the housing. Thus, the water from the first water supply unit is prevented from intruding into the gas generator, thereby ensuring further efficient cleaning of the laundry.

[0028] According to the inventive aspect of claim 7, the wall functions to isolate the first water supply unit and the gas generator from each other for prevention of the intrusion of the water into the gas generator as well as to guide the sliding of the door. Thus, the washing machine has improved functionality, and yet has a simplified construction.

[0029] According to the inventive aspect of claim 8, the air blower isolates the second water supply unit and the gas generator from each other, so that the water from the second water supply unit is prevented from intruding into the gas generator.

[0030] According to the inventive aspect of claim 9, the second water supply unit is disposed outside the door sliding region in the housing, so that the sliding of the door is unlikely to interfere with the water supply from the second water supply unit. Therefore, the second water supply unit has a simplified construction as compared with a case in which the second water supply unit is disposed in the door sliding region. On the other hand, the second water supply unit and the gas generator are isolated from each other, because the gas generator is disposed in the door sliding region in the housing. Thus, the water from the second water supply unit is prevented from intruding into the gas generator, thereby ensuring further efficient cleaning of the laundry.

[0031] According to the inventive aspect of claim 10, the gas generated by the gas generating surface of the gas generating member included in the gas generator is supplied into the washing tub through the conduit to clean the laundry in the washing tub. The gas generating surface is perpendicular to the horizontal plane, or is inclined with respect to the horizontal plane. Therefore, even if water droplets adhere to the gas generating surface, the water droplets fall down by their gravity. This prevents the water from intruding into the gas generating surface, thereby ensuring efficient cleaning of the laundry.

[0032] According to the inventive aspect of claim 11, the wall isolates the first water supply unit and the gas generator from each other, so that the water from the first water supply unit is prevented from intruding into the gas generator. Further, the first water supply unit and the gas generator are accommodated in adjacent relation in the housing, whereby the washing machine has a compact construction.

[0033] According to the inventive aspect of claim 12, the first water supply unit is disposed outside the door sliding region in the housing, so that the sliding of the door is unlikely to interfere with the water supply from the first water supply unit. Therefore, the first water supply unit has a simplified construction as compared with the case in which the first water supply unit is disposed in the door sliding region. On the other hand, the first water supply unit and the gas generator are isolated from each other, because the gas generator is disposed in the door sliding region in the housing. Thus, the water from the first water supply unit is prevented from intruding into the gas generator, thereby ensuring further efficient cleaning of the laundry.

[0034] According to the inventive aspect of claim 13, the wall functions to isolate the first water supply unit and the gas generator from each other for prevention of the intrusion of the water into the gas generator as well as to guide the sliding of the door. Thus, the washing machine has improved functionality, and yet has a simplified construction.

BRIEF DESCRIPTION OF THE DRAWINGS

[0035]

Fig. 1 is a perspective view of a drum-type washing machine 1 according to one embodiment of the present invention.

Fig. 2 is a perspective view of major portions of the drum-type washing machine 1 as seen from the rear upper right side.

Fig. 3 is a plan view of the major portions of the drum-type washing machine 1 shown in Fig. 2.

Fig. 4 is a vertical sectional view of the drum-type washing machine 1 taken along a lateral vertical plane and viewed from the front side.

Fig. 5A is a vertical sectional view of the drum-type washing machine 1 taken along an anteroposterior vertical plane and viewed from the right side with its opening 4 covered with an outer lid 2A.

Fig. 5B illustrates the drum-type washing machine of Fig. 5A with its opening 4 uncovered with the outer lid 2A.

Fig. 6 is a perspective view illustrating an outer tub 7, a drying unit 3 and peripheral components as seen from the rear upper right side.

Fig. 7 is a right side view illustrating the outer tub 7, the drying unit 3 and the peripheral components shown in Fig. 6.

Fig. 8(a) is a perspective view of an ozone generator 42 as seen from the rear upper right side. Fig. 8(b) illustrates the ozone generator of Fig. 8(a) with its case cap 64 detached. Fig. 8(c) illustrates an ozone plate 51 taken out of the ozone generator of Fig. 8 (b). Fig. 8(d) is a right side view of the ozone plate 51 of Fig. 8(c).

Fig. 9 is a block diagram showing the electrical construction of the drum-type washing machine 1.

Fig. 10 is a flow chart showing a control sequence to be performed by a control section 40 when the drum-type washing machine 1 starts a predetermined washing process.

DESCRIPTION OF REFERENCE CHARACTERS

[0036]

1: Drum-type washing machine
2: Housing
2A: Outer lid
2B: Tap water supply valve
2D: Bath water pump
4: Opening
7: Outer tub
10: Drum
16L: Partition wall
31: Air duct member
32: Fan
33: Guide hood
42: Ozone generator
43: Introduction tube
51: Ozone plate

BEST MODE FOR CARRYING OUT THE INVENTION

[0037] With reference to the drawings, embodiments of the present invention will hereinafter be described more specifically.

Construction of Drum-Type Washing Machine

[0038] Fig. 1 is a perspective view of a so-called top open drum-type washing machine 1 which is an exemplary washing machine according to one embodiment of the present invention. Description of the geometry of the drum-type washing machine 1 is based on directional arrows shown on an upper right part of Fig. 1. Fig. 2 is a perspective view of major portions of the drum-type washing machine 1 as seen from the rear upper right side. Fig. 3 is a plan view of the major portions of the drum-type washing machine 1 shown in Fig. 2. Fig. 4 is a vertical sectional view of the drum-type washing machine 1 taken along a lateral vertical plane and viewed from the front side. Fig. 5A is a vertical sectional view of the drum-type washing machine 1 taken along an anteroposterior vertical plane and viewed from the right side with its opening 4 covered with an outer lid 2A. Fig. 5B illustrates the drum-type washing machine of Fig. 5A with its opening 4 uncovered with the outer lid 2A.

Housing

[0039] As shown in Fig. 1, the drum-type washing machine 1 includes a housing 2 which defines an outer casing thereof. A top wall of the housing 2 has an arc shape as seen in side section, and extends forwardly downward from an anteroposteriorly generally middle position continuously to a front wall in a gradually curved manner. The housing 2 has an opening 4 provided in an anteroposteriorly and laterally middle portion of the top wall thereof and serving as a load/unload opening through which laundry is loaded into and unloaded from the housing 2. The opening 4 has a generally rectangular shape elongated anteroposteriorly, and is covered and uncovered with an outer lid 2A (door). A pair of guide rails 21L, 21R are provided on a portion of the top wall of the housing 2 formed with the opening 4 as extending along a left edge and a right edge of the opening 4, and the outer lid 2A is anteroposteriorly slidable along the guide rails 21L, 21R.

[0040] The outer lid 2A is biased rearward in an opening uncovering direction by springs 38 (see Fig. 5A). During the operation of the drum-type washing machine 1, an outer lid lock mechanism 49 (not shown in Fig. 1) provided in the housing 2 (e.g., on a front edge of the opening 4) engages the outer lid 2A to lock the outer lid 2A in a closed state.

[0041] A detergent container 8 which contains a detergent to be used for washing the laundry is provided in a withdrawable manner in an anteroposteriorly generally middle position of the top wall of the housing 2 on the left side of the opening 4. An operation/display panel 6 for various settings and indications for the operation of the drum-type washing machine 1 is provided in a front half portion of the top wall of the housing 2 on the right side of the opening 4.

[0042] A lid opening button 6A to be operated to disengage the outer lid 2A from the aforementioned outer lid lock mechanism 49 (see Fig. 5A) for opening the outer lid 2A is provided on the operation/display panel 6. When the lid opening button 6A is pressed with the outer lid 2A being closed, the outer lid 2A is disengaged from the outer lid lock mechanism. Then, the outer lid 2A is slid rearward of the opening 4 by a biasing force of the springs 38 (see Fig. 5A), thereby uncovering the opening 4. A handle 2C is provided on a front edge of the outer lid 2A. For covering the opening 4 with the outer lid 2A when the opening 4 is uncovered, the outer lid 2A is slid forward over the opening 4 by holding the handle 2C. With the opening 4 being uncovered, the handle 2C abuts against a rear edge of the opening 4 to prevent the outer lid 2A from sliding further rearward.

[0043] A housing portion 15 of a laterally elongated and generally rectangular box shape having an open top as shown in Fig. 2 is provided unitarily with the housing 2 inwardly of (or below) a rear portion of the top wall of the housing 2 on the rear side of the opening 4. The inside of the housing portion 15 is partitioned into a first chamber 27, a second chamber 28 and a third chamber 29 (as designated from the left side) by a partition wall 16L and a partition wall 16R which respectively have upper edges continuous to the guide rails 21L and the guide rail 21R and each serve as a wall. Since the partition walls 16L and 16R are continuous to the guide rails 21L and 21R, respectively, as described above, the sliding of the outer lid 2A (see Fig. 1) is guided by the guide rails 21L, 21R as well as the upper edges of the partition walls 16L, 16R. As shown in Figs. 5A and 5B, the outer lid 2A constantly covers an upper portion of the second chamber 28 whether the opening 4 is covered or uncovered. With the outer lid 2A being open as shown in Fig. 5B, the outer lid 2A except for a second chamber covering portion which covers the upper portion of the second chamber 28 is accommodated along a rear wall of the housing 2 below the housing portion 15.

[0044] As shown in Fig. 2, a tap water supply valve 2B (first water supply unit) is disposed in the first chamber 27, and a bath water pump 2D (second water supply unit) is disposed in the third chamber 29. The tap water supply valve 2B and the bath water pump 2D each have a water supply port provided on an upper portion thereof. As shown in Fig. 1, the water supply ports are exposed at corresponding positions from the top wall of the housing 2. Therefore, tap water can be supplied into the washing machine by connecting the tap water supply valve 2B to external water supply equipment (e.g., a tap water faucet) via a water supply hose not shown. Similarly, bath water can be supplied into the washing machine by connecting a water supply hose (not shown) to the bath water pump 2D with one end of the water supply hose being submerged in a bath tub. Further, the tap water supply valve 2B and the bath water pump 2D communicate with the detergent container 8.

[0045] As described above, the second chamber 28, the first chamber 27 and the third chamber 29 are isolated from each other by the partition wall 16L and the partition wall 16R as shown in Fig. 3, and the upper portion of the second chamber 28 is constantly covered with the outer lid 2A (see Fig. 1). Therefore, even if the water happens to leak from either of the tap water supply valve 2B and the bath water pump 2D, there is no possibility that leaking water flows into the second chamber 28.

Outer Tub and Drum

[0046] As shown in Fig. 4, an outer tub 7 is accommodated in the housing 2, more specifically, below the housing portion 15 (see Fig. 2). The outer tub 7 includes a generally cylindrical peripheral wall 7A having opposite end faces closed by end face walls (a left end face wall 7L and a right end face wall 7R), thereby having a liquid-tight and air-tight structure. The outer tub 7 is disposed with its axis extending laterally (generally horizontally). A lower portion of the peripheral wall 7A of the outer tub 7 is supported by a plurality of dampers 5 (see Fig. 5A).

[0047] A drum 10 in which the laundry is contained is disposed in the outer tub 7. The drum 10 includes a generally cylindrical peripheral wall 10C having opposite end faces closed by end face walls (a left end face wall 10L and a right end face wall 10R), and is disposed with its axis extending laterally (generally horizontally). The outer tub 7 and the drum 10 serve as a washing tub.

[0048] Rotation shafts 11L and 11R extending along the axis of the drum 10 are attached to the left and right end face walls 10L and 10R, respectively, of the drum 10. The rotation shafts 11L and 11R are rotatably attached to the left and right end face walls 7L and 7R, respectively, of the outer tub 7. A drum-driving motor 12 of a so-called DD (direct drive) type is connected to the left rotation shaft 11L. By rotatively driving the motor 12, the drum 10 connected to the rotation shaft 11L is rotated about its axis at the same rotation speed as that of the motor. Three baffles 10B which lift the laundry within the drum 10 during the rotation of the drum 10 are provided on an interior surface of the peripheral wall 10C of the drum 10 in equiangularly spaced relation (e.g., in 120-degree spaced relation) along the inner periphery of the peripheral wall 10C as projecting inward and extending laterally.

[0049] As shown in Fig. 5A, the peripheral wall 10C of the drum 10 has an opening 22 through which the laundry is loaded into or unloaded from the drum 10. The peripheral wall 7A of the outer tub 7 has an opening 23 provided in opposed relation to the opening 4 of the housing 2.

[0050] The opening 22 of the drum 10 is covered and uncovered with a drum lid 25 which is pivotal outward, and the opening 23 of the outer tub 7 is covered and uncovered with an intermediate lid 26 which is pivotal outward. With the outer lid 2A, the intermediate lid 26 and the drum lid 25 being open, the laundry can be loaded into and unloaded from the drum 10 through the opening 4 of the housing 2, the opening 23 of the outer tub 7 and the opening 22 of the drum 10.

[0051] For loading or unloading the laundry into/from the drum 10, the drum lid 25 is permitted to be opened only when the opening 22 of the drum 10 is located in opposed relation to the opening 23 of the outer tub 7. Therefore, as shown in Fig. 4, a drum position fixing device 9 is attached to a lower portion of the left end face wall 7L of the outer tub 7. The drum position fixing device 9 is adapted to engage the motor 12 during the stop of the drum-type washing machine 1 so that the rotational position of the drum 10 is fixed at a position at which the opening 22 of the drum 10 (see Fig. 5A) is opposed to the opening 23 (see Fig. 5A) of the outer tub 7.

[0052] As shown in Fig. 5A, a water supply hose 17 communicating with the inside of the detergent container 8 is connected to a rear end portion of the peripheral wall

7A of the outer tub 7. By opening the tap water supply valve 2B (see Fig. 1) or by driving the bath water pump 2D (see Fig. 1), the tap water or the bath water (hereinafter referred to generally as "water") is supplied from the tap water supply valve 2B or the bath water pump 2D (see Fig. 1) into the outer tub 7 through the detergent container 8 (see Fig. 1) and the water supply hose 17. The water supply hose 17 is, for example, a flexible bellows hose, and functions to supply the water into the outer tub 7 as well as to prevent vibrations occurring in the outer tub 7 during the rotation of the drum 10 from being conducted to the housing 2. As shown in Fig. 2, a water supply trap 24 is provided between the water supply hose 17 and the detergent container 8. The water supply trap 24 temporarily retains the water flowing from the detergent container 8 to the water supply hose 17 to isolate the detergent container 8 and the water supply hose 17 from each other by the retained water, thereby preventing air communication between the outer tub 7 and the outside.

[0053] As shown in Fig. 4, a drain port 19 is provided in a lower right portion of the peripheral wall 7A of the outer tub 7. A drain valve 18 is connected to the drain port 19. By supplying water into the outer tub 7 with the drain valve 18 being closed, the water is retained in the outer tub 7. The drum 10 has a multiplicity of water communication perforations 10A formed in substantially the entire peripheral wall 10C thereof except for the opening 22 thereof. The water supplied into the outer tub 7 also flows into the drum 10 through the water communication perforations 10A. By opening the drain valve 18, the water retained in the outer tub 7 is drained outside the washing machine through the drain port 19 and a drain hose 20. One end of an overflow tube 37 (see Fig. 2) is connected to an intermediate portion of the drain hose 20. The other end of the,overflow tube 37 is connected to the right end face wall 7R of the outer tub 7 at a predetermined height level. When the water is retained to the predetermined height level or higher, excess water is forcibly drained outside the washing machine through the overflow tube 37 and the drain hose 20 (see Fig. 4). An overflow trap 45 is provided between the overflow tube 37 and the drain hose 20 (see Fig. 4). The overflow trap 45 temporarily retains water flowing through the overflow tube 37 and/or the drain hose 20 (see Fig. 4), thereby preventing air communication between the outer tub 7 and the outside through the overflow tube 37 and/or the drain hose 20 by the retained water.

Drying Unit

[0054] As shown in Fig. 4, the drum-type washing machine 1 is capable of performing a drying process for drying the laundry, and a drying unit 3 having a drying function is attached to an outer surface of the right end face wall 7R of the outer tub 7.

[0055] Fig. 6 is a perspective view illustrating the outer tub 7, the drying unit 3 and peripheral components as seen from the rear upper right side. Fig. 7 is a right side view illustrating the outer tub 7, the drying unit 3 and the peripheral components shown in Fig. 6.

[0056] As shown in Fig. 6, the drying unit 3 includes an air duct member 31 which sucks air from the outer tub 7 and guides the air upward, a fan 32 serving as an air blower which supplies the air from the air duct member 31 into the outer tub 7, a guide hood 33 which guides the air fed by the fan 32 into the outer tub 7, and a pair of heaters 34A, 34B (see Fig. 7) which heat the air to be fed into the outer tub 7. The air duct member 31 and the guide hood 33 cooperatively function as an air duct for introducing the air or airstream flowing therethrough into the outer tub 7. The fan 32 is disposed in the air duct, more specifically, in an upper portion of the air duct member 31 with its generally upper half portion accommodated in the second chamber 28 (see Fig. 3) of the housing portion, and is rotatively driven by a blower motor 35. The heaters 34A, 34B (see Fig. 7) are laterally juxtaposed in the guide hood 33.

[0057] As shown in Fig. 4, an air outlet port 71 having a generally rectangular shape as seen from the front side is provided in a lower rear portion, e.g., a laterally generally middle portion, of the peripheral wall 7A of the outer tub 7. The air duct member 31 has a drain hole 30 (see Fig. 7) provided in a lower end portion thereof. The air outlet port 71 and the drain hole 30 (see Fig. 7) are connected to each other through a laterally extending connection pipe 72, so that the inside of the air duct member 31 communicates with the inside of the outer tub 7. When the fan 32 (see Fig. 6) is rotatively driven, the air duct member 31 located upstream of the fan 32 with respect to an air flowing direction has a negative internal pressure. Therefore, air in the outer tub 7 is taken into the drying unit 3 (air duct member 31) through the air outlet port 71 and the connection pipe 72.

[0058] The outer tub 7 has an opening 7B provided in a center portion of the right end face wall 7R thereof, and the guide hood 33 (see Fig. 7) has an air blowing port 41 (see Fig. 7) provided in an lower end portion thereof. Since the air blowing port 41 and the opening 7B (see Fig. 7) of the outer tub 7 communicate with each other, the inside of the guide hood 33 (see Fig. 7) communicates with the inside of the outer tub 7. Thus, as shown in Fig. 6, the air taken into the air duct member 31 out of the outer tub 7 is fed into the guide hood 33 by the fan 32 and then blown into the outer tub 7 from the air blowing port 41, whereby the air is circulated in an air circulation passage defined by the air duct member 31, the fan 32 and the guide hood 33 (i.e., the drying unit 3), and the outer tub 7. Further, as shown in Fig. 4, the drum 10 has an opening 10D provided in a center portion of the right end face wall 10R thereof in opposed relation to the opening 7B of the outer tub 7, so that the air circulating in the air circulation passage is also supplied to the laundry in the drum 10.

[0059] During the drying process, for example, the air circulated in the air circulation passage is heated by the

heaters 34 and supplied into the drum 10 from the air blowing port 41 (see Fig. 7) through the opening 7B of the outer tub 7 and the opening 10D of the drum 10, while the drum 10 is rotated. Thus, an operation such that the laundry is lifted by the baffles 10B in the drum 10 and allowed to naturally fall from a certain height is repeatedly performed. Therefore, the heated air is evenly applied to the laundry, whereby the laundry is properly dried.

[0060] It is possible to supply lower temperature air into the drum 10 by energizing one of the heaters 34 (the heater 34A and the heater 34B) shown in Fig. 7 to drive the heaters 34 at a lower level (e.g., at about 700 W) and to supply higher temperature air into the drum 10 by energizing both of the heaters 34 to drive the heaters 34 at a higher level (e.g., at about 1400 W). It is also possible to supply intermediate temperature air (heated at a level between the lower level and the higher level) into the drum 10 by energizing both of the heaters 34A, 34B and performing AC half-wave control on one of the heaters (controlling the driving of one of the heaters by utilizing AC in each alternate half cycle) to drive the heaters 34 at an intermediate level (e.g., at about 1000 W).

[0061] As shown in Fig. 6, the air duct member 31 has the drain hole 30 provided in the lower end portion thereof as described above, and includes a first air duct member 311 and a second air duct member 312 integrally provided, the first air duct member 311 extending upward from the lower end portion along the right end face wall 7R of the outer tub 7, the second air duct member 312 being connected to an upper end of the first air duct member 311 and projecting leftward to be opposed to the peripheral wall 7A of the outer tub 7. The first air duct member 311 has a planar shape having a laterally measured thickness that is smaller than an anteroposteriorly measured thickness. On the other hand, the second air duct member 312 has a planar shape having an anteroposteriorly measured thickness that is smaller than a laterally measured thickness.

[0062] As shown in Fig. 7, the first air duct member 311 has a supply port 36 provided in a left side wall thereof at a position slightly lower than a junction between the first air duct member 311 and the second air duct member 312. A supply pipe (not shown) is connected to an outer side of the supply port 36. By opening a supply valve 14 (not shown in Fig. 7) communicating with the supply pipe (not shown), cooling water (tap water) is caused to flow at a predetermined flow rate (e.g., at about 0.5 liter per minute) into the first air duct member 311 through the supply pipe (not shown) and the supply port 36. During the drying process, the cooling water is supplied into the first air duct member 311 from the supply port 36 with the supply valve 14 being open. Thus, the first air duct member 311 functions as a heat exchanger for cooling air containing moisture (water vapor) emanated from the laundry to condense the water vapor.

Ozone Generator

[0063] Fig. 8 (a) is a perspective view of an ozone generator 42 (gas generator) as seen from the rear upper right side. Fig. 8 (b) illustrates the ozone generator 42 of Fig. 8(a) with its case cap 64 detached. Fig. 8(c) illustrates an ozone plate 51 (gas generating member) taken out of the ozone generator of Fig. 8(b). Fig. 8(d) is a right side view of the ozone plate 51 of Fig. 8(c).

[0064] As shown in Fig. 6, the drum-type washing machine 1 includes an ozone generator 42 which generates ozone as one example of a gas effective for cleaning the laundry, and an introduction tube 43 (conduit) which permits communication between the ozone generator 42 and the air duct member 31 for introducing the ozone generated by the ozone generator 42 into the air duct member 31. Exemplary processes for the cleaning of the laundry with the use of the gas include washing, deodorization, sterilization and aromatization (for imparting the laundry with comfortable fragrance).

[0065] As shown in Fig. 2, the ozone generator 42 is accommodated in the second chamber 28 in the housing portion 15 of the housing 2. More specifically, the ozone generator 42 is disposed on the left side of the fan 32 in the second chamber 28 in adjacent relation to the tap water supply valve 2B with the intervention of the partition wall 16L. The ozone generator 42 is located at a higher level than the outer tub 7, the air duct member 31 and the guide hood 33.

[0066] As shown in Fig. 8(a), the ozone generator 42 includes an ozone plate 51 which actually generates the ozone, a casing 52 which accommodates the ozone plate 51, and a frame 53 to which the casing 52 is attached for fixing the casing 52 to the housing portion 15 of the housing 2.

[0067] As shown in Fig. 8(c), the ozone plate 51 is a laterally elongated thin plate. The ozone plate 51 has a rear surface which is perpendicular to a horizontal plane or parallel to a vertical plane. The ozone plate 51 includes a laterally elongated electrode 54A provided on a vertically generally middle portion thereof, and a laterally elongated electrode 54B provided therein and having a slightly smaller size than the ozone plate 51. The electrode 54A and the electrode 54B are disposed in anteroposteriorly spaced relation, and their longitudinally opposite ends are electrically connected to a power source board (not shown) via wirings 55. When a high voltage is applied between the electrode 54A and the electrode 54B from the power source board (not shown) via the wirings 55, silent discharge occurs (as indicated by broken lines in Fig. 8(d)), whereby ozone is generated in air present around the rear surface of the ozone plate 51.

[0068] As shown in Fig. 8(a), the casing 52 is divided into two portions, i.e., a front half portion and a rear half portion, which are respectively designated as a case base 63 and a case cap 64. As shown in Fig. 8(b), the case base 63 is fixed to the frame 53.

[0069] With the case base 63 and the case cap 64

unified, as shown in Fig. 8(a), the casing 52 includes a main body 56, an air inlet portion 57 disposed on the right side of the main body 56, and an ozone outlet portion 58 disposed on the left side of the main body 56.

[0070] The main body 56 has an anteroposteriorly elongated, hollow and generally rectangular box shape, and has openings (not shown) provided in laterally opposite side faces thereof. The aforementioned ozone plate 51 is accommodated in the main body 56. Further, three thread portions 59 each formed with a screw hole are provided in laterally equidistantly spaced relation on each of the vertically opposite faces of the front half portion (the case base 63) of the main body 56. Insertion portions 60 each formed with an insertion hole are provided on the rear half portion (the case cap 64) of the main body 56 at positions corresponding to the thread portions 59. Screws 61 are respectively inserted through the insertion portions 60 and screwed into the thread portions 59, whereby the case base 63 and the case cap 64 are unified with the front half portion and the rear half portion of the main body 56 being combined with each other. As shown in Fig. 8(b), an upper edge and a lower edge of the ozone plate 51 accommodated in the main body 56 are each fringed with a rubber packing 67. With the rubber packings 67 pressed against the case base 63 and the case cap 64 thus unified, it is possible to prevent the water from intruding into the ozone plate 51 through a junction between the case base 63 and the case cap 64 and to prevent the ozone plate 51 from rattling.

[0071] As shown in Fig. 8(a), the air inlet portion 57 has a hollow and generally cubic shape, and has openings respectively provided in vertically opposite faces, laterally opposite faces and a rear face thereof. Therefore, the inside of the air inlet portion 57 communicates with the inside of the main body 56 through the right opening of the main body 56. A sponge filter 66 is fitted in the air inlet portion 57, so that external air is supplied to the ozone plate 51 in the main body 56 after dust particles contained in the air are trapped by the sponge filter 66.

[0072] The ozone outlet portion 58 has a hollow cylindrical shape, and a right end of the ozone outlet portion 58 is connected to the left opening of the main body 56 via a check valve 65. Thus, the inside of the ozone outlet portion 58 communicates with the inside of the main body 56. Since a left end of the ozone outlet portion 58 is connected to the introduction tube 43, air containing the ozone generated by the ozone plate 51 flows into the introduction tube 43 through the ozone outlet portion 58. The check valve 65 permits the ozone and the air to flow into the introduction tube 43 from the main body 56, but prevents the ozone and the air from flowing back into the main body 56 from the introduction tube 43.

[0073] The frame 53 has a hollow and generally rectangular box shape. The wirings 55 for the ozone plate 51 and the power source board (not shown) are accommodated in the frame 53. The inside of the frame 53 is filled with a flame-resistant and insulative urethane resin, thereby preventing the wirings 55 and the power source board (not shown) from contacting water and preventing electric leakage of the wirings 55 and the power source board (not shown). Attachment stays 62 are provided on laterally opposite ends of a bottom of the frame 53. As shown in Fig. 2, the ozone generator 42 is fixed in the second chamber 28 by fastening the attachment stays 62 to attachment portions (not shown) of the second chamber 28 (see Fig. 2) of the housing portion 15 by screws or the like.

[0074] As shown in Fig. 6, one end of the introduction tube 43 is connected to the ozone outlet portion 58 of the ozone generator 42. The other end of the introduction tube 43 is connected to a left wall of the second air duct member 312 of the air duct member 31, more specifically, to a portion of the second air duct member 312 adjacent to the fan 32, whereby the inside of the ozone generator 42 communicates with the inside of the air circulation passage including the air duct member 31, i.e., the drying unit 3. The introduction tube 43 is moderately bent downward from the one end thereof, then bent in a middle portion thereof to extend further downward, and further bent to form a passage extending to the other end thereof. Therefore, the air containing the ozone generated by the ozone generator 42 flows down through the introduction tube 43 to be supplied into the air duct member 31. When the fan 32 is rotatively driven, the air duct member 31 has a negative internal pressure as described above. This promotes the supply of the ozone to the air duct member 31 from the ozone generator 42. Washing Process in Drum-Type Washing Machine

[0075] Fig. 9 is a block diagram showing the electrical construction of the drum-type washing machine 1.

[0076] As shown in Fig. 9, the operation of the drum-type washing machine 1 is controlled by a control section 40 including a microcomputer. The control section 40 further includes a CPU 41, a ROM 42, a RAM 43, a timer 44 and the like.

[0077] The operation/display section 6 (see Fig. 1) is connected to the control section 40 for input and output. Further, signals are inputted to the control section 40 from a water level sensor (not shown) for detecting the water level in the outer tub 7, a temperature sensor (not shown) for detecting the temperature of air flowing out of the air outlet port 71 of the outer tub 7 (see Fig. 4), and a door switch (not shown) for detecting the opening and closing of the outer lid 2A.

[0078] The motor 12, the blower motor 35, the heaters 34, the tap water supply valve 2B, the bath water pump 2D, the supply valve 14, the drain valve 18, the outer lid lock mechanism 49 and the ozone generator 42 are connected to the control section 40 via a load drive section 48.

[0079] Fig. 10 is a flow chart showing a control sequence to be performed by the control section 40 when the drum-type washing machine 1 starts a predetermined washing process.

Washing Step

[0080] When the operation of the drum-type washing machine 1 is started, as shown in Fig. 10, the control section 40 (see Fig. 9) first performs a first washing step for a predetermined period (e.g., for six minutes) (step S1). At the beginning of the first washing step, the water is supplied by opening the tap water supply valve 2B (see Fig. 9) or by driving the bath water pump 2D (see Fig. 9). At this time, a detergent preliminarily put in the detergent container 8 shown in Fig. 1 is dissolved in the supplied water, and the detergent-containing water is retained in the outer tub 7. After the completion of the supply of the water into the outer tub 7 shown in Fig. 4, first intermittent control (e.g., 10-second ON and 3-second OFF) in which the motor 12 is rotated at 45 rpm alternately in a forward direction and in a reverse direction with a predetermined interval, second intermittent control (e.g., 10-second ON and 3-second OFF) in which the motor 12 is rotated at 30 rpm alternately in the forward direction and in the reverse direction with a predetermined interval, and third intermittent control (e.g., 10-second ON and 3-second OFF) in which the motor 12 is rotated at 60 rpm alternately in the forward direction and in the reverse direction with a predetermined interval are repeatedly performed in a predetermined sequence in the first washing step. In the first intermittent control, an operation (so-called tumbling operation) such that the laundry present in the drum 10 is lifted by the baffles 10B and caused to naturally fall from a certain height is repeatedly performed to achieve so-called beat-washing. In the second intermittent control, the laundry present on the bottom of the drum 10 is tumbled by the baffles 10B to achieve so-called rub-washing. In the third intermittent control, the drum 10 is rotated with the laundry kept adhering on the peripheral wall 10C of the drum 10. The water retained in the outer tub 7 is absorbed by the laundry when the laundry comes to the bottom of the outer tub 7, and dirt of the laundry is removed together with the water from the laundry when the water absorbed by the laundry is extracted from the laundry by a centrifugal force. At the end of the first washing step, the water retained in the outer tub 7 is drained from the outer tub 7, so that the laundry remains in the drum 10 with the water and the detergent component contained therein.

[0081] After the completion of the first washing step, as shown in Fig. 10, the control section 40 performs a second washing step for a predetermined period (e.g., for 14 minutes) (Step S2). In the second washing step, as shown in Fig. 4, the drum 10 is rotated, while steam is supplied into the outer tub 7 to warm the laundry by utilizing the drying unit 3. Thus, the water contained in the laundry is warmed, and a part of the laundry containing the warmed water is rubbed with the other part of the laundry or with the interior surface of the drum 10, or bumped against the interior surface of the drum 10 by the rotation of the drum 10. As shown in Fig. 7, the steam is generated by atomizing the cooling water supplied into the first air duct member 311 from the supply port 36 and heating the atomized water by the heaters 34 to evaporate the water. In the second washing step, there is no need to supply the water into the outer tub 7, so that the water consumption can be reduced as compared with a case in which the laundry is washed in water contained in the outer tub 7 by rotating the drum 10. Intermediate Dehydrating Step

[0082] After the completion of the second washing step, as shown in Fig. 10, the control section 40 performs an intermediate dehydrating step (Step S3). In the intermediate dehydrating step, as shown in Fig. 4, the drum 10 is rotated at a higher speed (e.g., at 300 to 1000 rpm), whereby the water contained in the laundry is extracted from the laundry in the drum 10, then spun out toward the outer tub 7 through the water communication perforations 10A of the drum 10, and drained from the drain port 19. In the intermediate dehydrating step, the detergent component as well as the water contained in the laundry is extracted from the laundry. Rinsing Step

[0083] After the completion of the intermediate dehydrating step, as shown in Fig. 10, the control section 40 performs a rinsing step a plurality of times (e.g., twice) (Step S4). At the beginning of the rinsing step, water is supplied into the outer tub 7 by opening the tap water supply valve 2B (see Fig. 9) or by driving the bath water pump 2D (see Fig. 9), and then the drum 10 is rotated with a predetermined amount of water being retained in the outer tub 7. Thus, the laundry is tumbled in the drum 10. In the rinsing step, the detergent component remaining in the laundry is diluted. At the end of the rinsing step, the water retained in the outer tub 7 is drained from the outer tub 7. The final rinsing step uses the tap water alone. Final Dehydrating Step

[0084] After the completion of the rinsing step, as shown in Fig. 10, the control section 40 performs a final dehydrating step (Step S5). In the final dehydrating step, as shown in Fig. 4, the drum 10 is rotated at a higher speed (e.g., at 300 to 1000 rpm), whereby the water contained in the laundry is extracted from the laundry in the drum 10 by a centrifugal force. Drying Step

[0085] After the completion of the final dehydrating step, i.e., after the water contained in the laundry is sufficiently removed from the laundry, as shown in Fig. 10, the control section 40 performs the drying step (Step S6).

[0086] In the drying step, as descried above and shown in Fig. 4, the control section 40 (see Fig. 9) rotates the drum 10 to tumble the laundry in the drum 10, while feeding the air heated by the heaters 34 into the outer tub 7 from the drying unit 3. Thus, the heated air is evenly applied to the laundry in the drum 10, whereby the laundry is properly dried.

[0087] In the drying step, as shown in Fig. 7, the blower motor 35 is driven (e.g., at 4500 rpm), and the heaters 34 (34A, 34B) are energized to be driven at the higher level. In the drying step, the air containing moisture emanated from the laundry in the drum 10 flows into the air duct member 31 (first air duct member 311) from the outer

tub 7 through the air outlet port 71 (see Fig. 4) and the connection pipe 72 (see Fig. 4), then heated by the heaters 34, and fed again into the outer tub 7 (drum 10). In the drying step, the supply valve 14 (see Fig. 9) is opened to supply the cooling water into the first air duct member 311 from the supply port 36, whereby the moisture-containing air is cooled by the cooling water in the first air duct member 311 and the water contained in the air is condensed through the heat exchange. Therefore, when the air flowing into the first air duct member 311 passes through the first air duct member 311, the water is removed from the air, which is in turn heated by the heaters 34 and fed again into the outer tub 7 (drum 10). The water is condensed on the interior surface of the first air duct member 311 through the heat exchange, and flows on the interior surface. The water flowing on the interior surface of the first air duct member 311 reaches the bottom of the air duct member 311, and flows out together with the cooling water from the drain hole 30. Then, as shown in Fig. 4, the water flows into the outer tub 7 through the connection pipe 72 and the air outlet port 71, and is drained from the drain port 19.

[0088] In the drying step, a so-called cool-down operation is performed for a predetermined period for cooling the dried laundry to a predetermined temperature by supplying unheated air into the drum 10. During the cool-down operation, as shown in Fig. 2, the control section 40 (see Fig. 9) causes the ozone generator 42 to generate ozone. The generated ozone flows into the air duct member 31 through the introduction tube 43, whereby the ozone is fed together with the air flowing through the aforementioned air circulation passage into the outer tub 7 (drum 10) and applied onto the laundry. Thus, a dirt component, an odor component and a bacterial component remaining in the laundry are oxidized by the supplied ozone, so that the laundry can be cleaned, deodorized and sterilized. During the supply of the ozone into the outer tub 7, as shown in Fig. 9, the tap water supply valve 2B, the supply valve 14 and the drain valve 18 are kept closed, and the driving of the bath water pump 2D is kept stopped by the control section 40. Further, as shown in Fig. 2, water is trapped in the water supply trap 24 when the water is supplied in the washing step, and trapped in the overflow trap 45 when the water is drained. Thus, the outer tub 7 is kept air-tight, thereby eliminating the possibility that the ozone leaks outside the washing machine. During the supply of the ozone into the outer tub 7, as shown in Fig. 9, the control section 40 causes the outer lid lock mechanism 49 to lock the outer lid 2A in the closed state (see Fig. 1) until all the supplied ozone is consumed by an oxidation reaction and the ozone concentration is reduced to a level that exerts no influence on a human body. Miscellaneous

[0089] Since the ozone easily penetrates into the dried laundry, a higher cleaning effect can be provided by supplying the ozone to the dry laundry. Therefore, the cleaning of the laundry with the ozone may be performed not only during the aforementioned drying step but also before the cleaning step. Where the laundry is cleaned with the ozone before the washing step, there is a possibility that no water is trapped in the water supply trap 24 (see Fig. 2) and the overflow trap 45 (see Fig. 2). In order to keep the outer tub 7 air-tight as described above, the control section 40 properly opens or closes the tap water supply valve 2B, the supply valve 14 and the drain valve 18 and drives the bath water pump 2D to retain the water in the water supply trap 24 and the overflow trap 45. The ozone may be supplied before the washing step or during the drying step, or before the washing step as well as during the drying step. As the ozone supply period increases, the cleaning of the laundry is promoted. The ozone cleaning function of the drum-type washing machine 1 makes it possible to clean laundry that cannot be wetted with water. Effects

[0090] In the drum-type washing machine 1, as described above and shown in Fig. 6, the ozone generated by the ozone generator 42 is introduced into the air duct member 31 through the introduction tube 43, and carried on the air flowing in the aforementioned air circulation passage including the air duct member 31 to be supplied into the outer tub 7, whereby the laundry is cleaned with the ozone in the drum 10. The introduction tube 43 extends downward from the ozone generator 42 to be connected to the air duct member 31. Therefore, even if water condensation occurs in the introduction tube 43 due to the temperature difference between the inside and the outside of the introduction tube 43, water droplets resulting from the water condensation do not intrude into the ozone generator 42, but fall down toward the air duct member 31 by their gravity. Further, even if water bubbles and detergent bubbles generated in the outer tub 7 during the washing process enter the introduction tube 43 and are broken to form water droplets, these water droplets, like the water droplets resulting from the water condensation, do not intrude into the ozone generator 42, but fall down toward the air duct member 31 by their gravity. Since the ozone generator 42 is disposed above the outer tub 7, the intrusion of the water droplets is more reliably prevented. This prevents the water from intruding into the ozone generator 42, thereby ensuring efficient cleaning of the laundry.

[0091] As shown in Fig. 8, the ozone plate 51 which actually generates ozone in the ozone generator 42 is disposed with its rear surface (ozone generating surface) being perpendicular to the horizontal plane. Therefore, even if the water droplets adhere to the rear surface, the water droplets fall down by their gravity. This prevents the water from intruding into the rear surface of the ozone plate 51, thereby ensuring further efficient cleaning of the laundry. The rear surface may be inclined with respect to the horizontal plane, as long as it is possible to cause the adhering water droplets to fall down.

[0092] As shown in Fig. 6, when the fan 32 disposed in the aforementioned air duct (including the air duct member 31 and the guide hood 33) is driven, the portion of the air duct upstream of the fan 32 with respect to the

air flowing direction in which the air flows from the air duct to the outer tub 7, i.e., the air duct member 31, has a negative internal pressure. Since the introduction tube 43 is connected to the air duct member 31, the ozone generated by the ozone generator 42 is efficiently supplied into the air duct member 31 when the fan 32 is driven. Further, the fan 32 is disposed adjacent the ozone generator 42, so that the introduction tube 43 has a relatively short length. Thus, the gas generated by the ozone generator 42 can be more efficiently supplied into the air duct member 31. Further, the relatively short length of the introduction tube 43 reduces the temperature difference between the inside and the outside of the introduction tube 43, so that the water condensation is less liable to occur. Thus, the drum-type washing machine 1 is capable of efficiently cleaning of the laundry, and yet has a compact construction.

[0093] As shown in Fig. 3, the ozone generator 42 accommodated in the second chamber 28 is isolated from the tap water supply valve 2B accommodated in the first chamber 27 by the partition wall 16L in the housing portion 15 of the housing 2, so that the water from the tap water supply valve 2B is prevented from intruding into the ozone generator 42. Since the tap water supply valve 2B and the ozone generator 42 are disposed in adjacent relation, the drum-type washing machine 1 has a compact construction. As shown in Fig. 2, the upper edge of the partition wall 16L is continuous to the guide rail 21L, so that the sliding of the outer tub 2A (see Fig. 1) is guided by the guide rail 21L as well as the upper edge of the partition wall 16L. Therefore, the partition wall 16L functions to isolate the tap water supply valve 2B and the ozone generator 42 from each other for prevention of the intrusion of the water into the ozone generator 42 as well as to guide the sliding of the outer tub 2A. Thus, the drum-type washing machine 1 has improved functionality, and yet has a simplified construction.

[0094] As shown in Fig. 3, the ozone generator 42 is disposed on the left side of the fan 32 in adjacent relation to the fan 32 in the second chamber 28. That is, the fan 32 is disposed on a side of the ozone generator 42 opposite from the tap water supply valve 2B in adjacent relation to the ozone generator 42. Further, the fan 32 is disposed between the bath water pump 2D and the ozone generator 42. Therefore, the fan 32 isolates the bath water pump 2D and the ozone generator 42 from each other, so that water from the bath water pump 2D is prevented from intruding into the ozone generator 42. Since the tap water supply valve 2B, the ozone generator 42, the fan 32 and the bath water pump 2D are located in this order, the drum-type washing machine 1 has a compact construction.

[0095] As shown in Figs. 5A and 5B, the outer lid 2A constantly covers the upper portion of the second chamber 28 whether the opening 4 is covered or uncovered. Therefore, the ozone generator 42 is disposed in the outer lid sliding region in which the outer lid 2A is slid. On the other hand, the first chamber 27 which accommodates the tap water supply valve 2B and the third chamber 29 which accommodates the bath water pump 2D are disposed outside the outer lid sliding region as shown in Fig. 3. Therefore, the tap water supply valve 2B, the bath water pump 2D and the ozone generator 42 are isolated from each other, so that the water from the tap water supply valve 2B and the bath water pump 2D is prevented from intruding into the ozone generator 42. This ensures further efficient cleaning of the laundry. In addition, the sliding of the outer lid 2A is unlikely to interfere with the water supply to the outer tub 7 from the tap water supply valve 2B and the bath water pump 2D. Further, the washing machine has a simplified construction as compared with a case in which the tap water supply valve 2B and the bath water pump 2D are disposed in the outer lid sliding region.

Modifications

[0096] The present invention is not limited to the embodiments described above, but various modifications may be made within the purviews of the appended claims.

[0097] The axis of the drum 10 is not necessarily required to extend laterally, but may extend anteroposteriorly. In this case, the direction of the axis of the drum is not limited to a generally horizontal direction, but the axis of the drum may be inclined at an angle smaller than a predetermined angle (e.g., up to about 30 degrees) with respect to the horizontal direction. Further, the axis of the drum may extend vertically.

[0098] The drum-type washing machine 1 is of a top open type in which the upper lid 2A is provided on the top wall of the housing 2, but may be of a so-called front open type in which a lid is provided on the front wall.

[0099] In the embodiments described above, the drum-type washing machine 1 having the drying function has been described as an example of the inventive drum-type washing machine. The present invention is applicable to a drum-type washing machine having no drying function and to a vortex-type washing machine employing a pulsator. The washing machine having no drying function may be configured such that the ozone generated by the ozone generator 42 (gas generator) is supplied directly to the washing tub.

[0100] The ozone generator 42 adapted to generate the ozone which is effective for the cleaning, the deodorization and the sterilization of the laundry is used as the gas generator, but the gas generator may be adapted to generate a gas which is effective, for example, for aromatization of the laundry.

Claims

1. A washing machine comprising:

a washing tub in which laundry is contained;
an air duct through which air is introduced into

the washing tub;
a gas generator which generates a gas effective for cleaning the laundry contained in the washing tub, the gas generator being disposed above the washing tub; and
a conduit through which the gas generated by the gas generator is introduced into the air duct, the conduit extending downward from the gas generator to be connected to the air duct.

2. A washing machine as set forth in claim 1, wherein the gas generator includes a gas generating member having a gas generating surface that generates the gas effective for cleaning the laundry, wherein the gas generating member is disposed with its gas generating surface being perpendicular to a horizontal plane or inclined with respect to the horizontal plane.

3. A washing machine comprising:

a washing tub in which laundry is contained;
an air duct through which air is introduced into the washing tub;
a gas generator which generates a gas effective for cleaning the laundry contained in the washing tub;
a conduit through which the gas generated by the gas generator is introduced into the air duct, the conduit communicating with the air duct and the gas generator;

wherein the gas generator includes a gas generating member having a gas generating surface that generates the gas effective for cleaning the laundry; wherein the gas generating member is disposed with its gas generating surface being perpendicular to a horizontal plane or inclined with respect to the horizontal plane.

4. A washing machine as set forth in any of claims 1 to 3, further comprising:

an air blower which supplies the air into the washing tub from the air duct, the air blower being disposed in the air duct;

wherein the conduit is connected to a portion of the air duct upstream of the air blower with respect to an air flowing direction in which the air flows from the air duct to the washing tub;
wherein the air blower is disposed adjacent the gas generator.

5. A washing machine as set forth in claim 4, further comprising:

a first water supply unit which supplies water into the washing tub;
a housing which accommodates the first water supply unit and the gas generator in adjacent relation and serves as an outer casing of the washing machine; and
a wall provided in the housing to isolate the first water supply unit and the gas generator from each other.

6. A washing machine as set forth in claim 5, wherein the housing has a load/unload opening through which the laundry is loaded into and unloaded from the washing tub;
the washing machine further comprising:

a door which covers and uncovers the load/unload opening, the door being provided in the housing in a slidable manner;

wherein the gas generator is disposed in a door sliding region of the housing in which the door is slid;
wherein the first water supply unit is disposed outside the door sliding region in the housing.

7. A washing machine as set forth in claim 6, wherein the sliding of the door is guided by the wall.

8. A washing machine as set forth in claim 6 or 7, further comprising:

a second water supply unit which supplies water into the washing tub;

wherein the air blower is disposed between the second water supply unit and the gas generator.

9. A washing machine as set forth in claim 8, wherein the second water supply unit is disposed outside the door sliding region in the housing.

10. A washing machine comprising:

a washing tub in which laundry is contained;
a gas generator which generates a gas effective for cleaning the laundry contained in the washing tub; and
a conduit through which the gas generated by the gas generator is introduced into the washing tub;

wherein the gas generator includes a gas generating member having a gas generating surface that generates the gas effective for cleaning the laundry, wherein the gas generating member is disposed with its gas generating surface being perpendicular to a horizontal plane or inclined with respect to the horizontal plane.

11. A washing machine as set forth in claim 10, further comprising:

a first water supply unit which supplies water into the washing tub;
a housing which accommodates the first water supply unit and the gas generator in adjacent relation and serves as an outer casing of the washing machine; and
a wall provided in the housing to isolate the first water supply unit and the gas generator from each other.

12. A washing machine as set forth in claim 11,
wherein the housing has a load/unload opening through which the laundry is loaded into and unloaded from the washing tub;
the washing machine further comprising:

a door which covers and uncovers the load/unload opening, the door being provided in the housing in a slidable manner;

wherein the gas generator is disposed in a door sliding region of the housing in which the door is slid,
wherein the first water supply unit is disposed outside the door sliding region in the housing.

13. A washing machine as set forth in claim 12, wherein the sliding of the door is guided by the wall.

FIG. 1

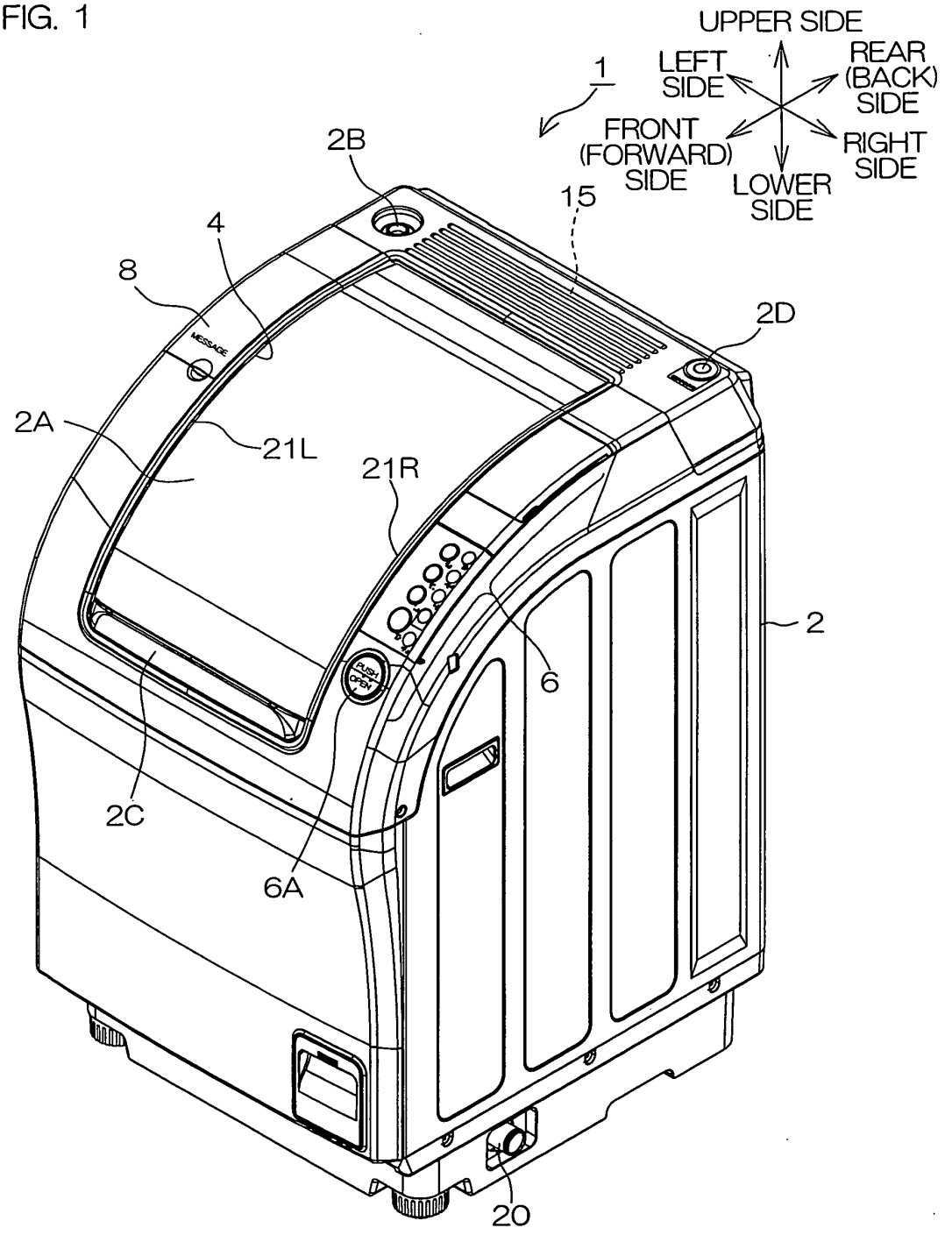

UPPER SIDE
1
LEFT SIDE
REAR (BACK) SIDE
FRONT (FORWARD) SIDE
RIGHT SIDE
LOWER SIDE
2B
15
4
8
MESSAGE
2D
2A
21L
21R
2
6
2C
6A
20

FIG. 2

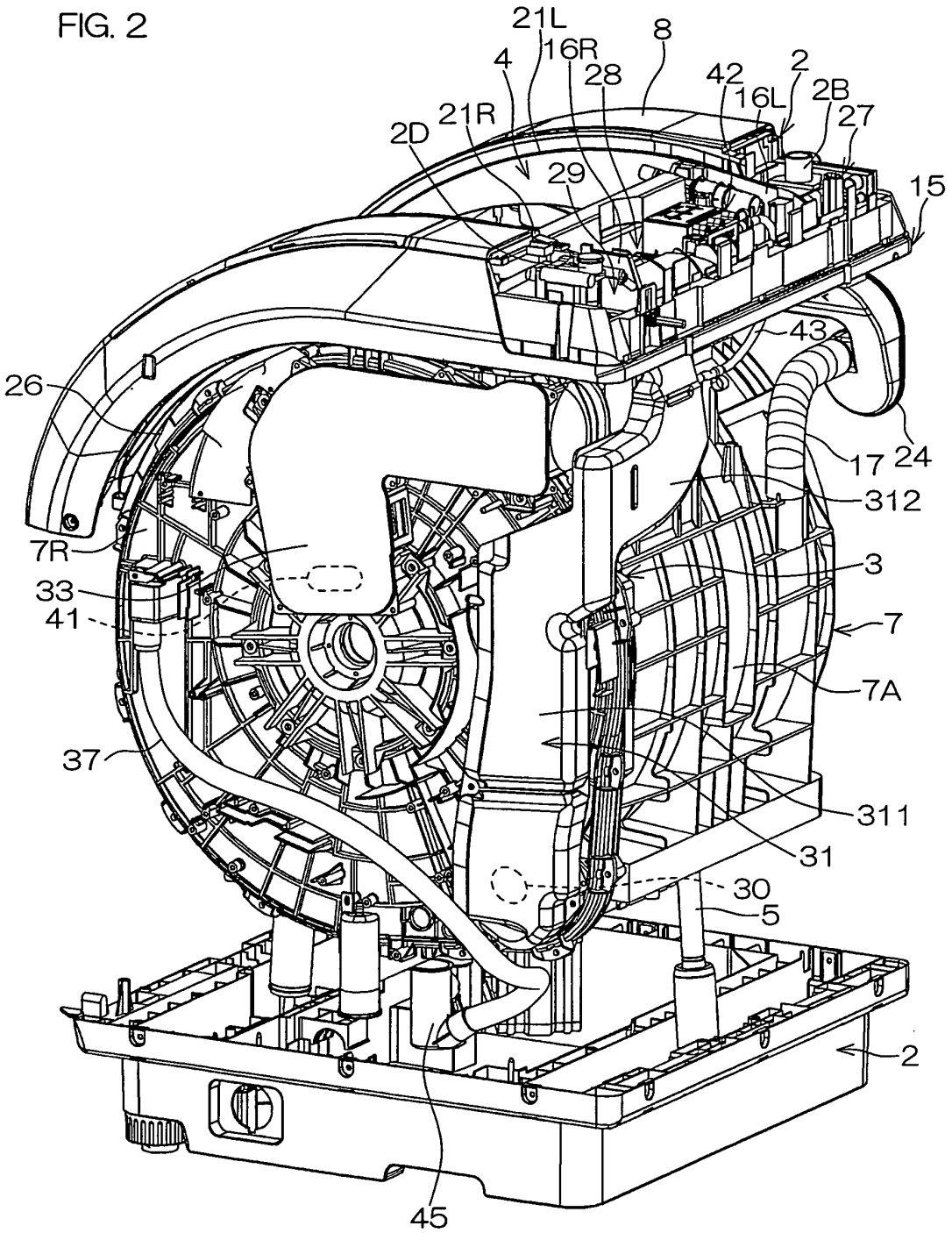

21L
8
4
16R
28
42
2
16L
2B
27
2D
21R
29
15
43
26
17
24
312
7R
3
33
41
7
7A
37
311
31
30
5
2
45

FIG. 3

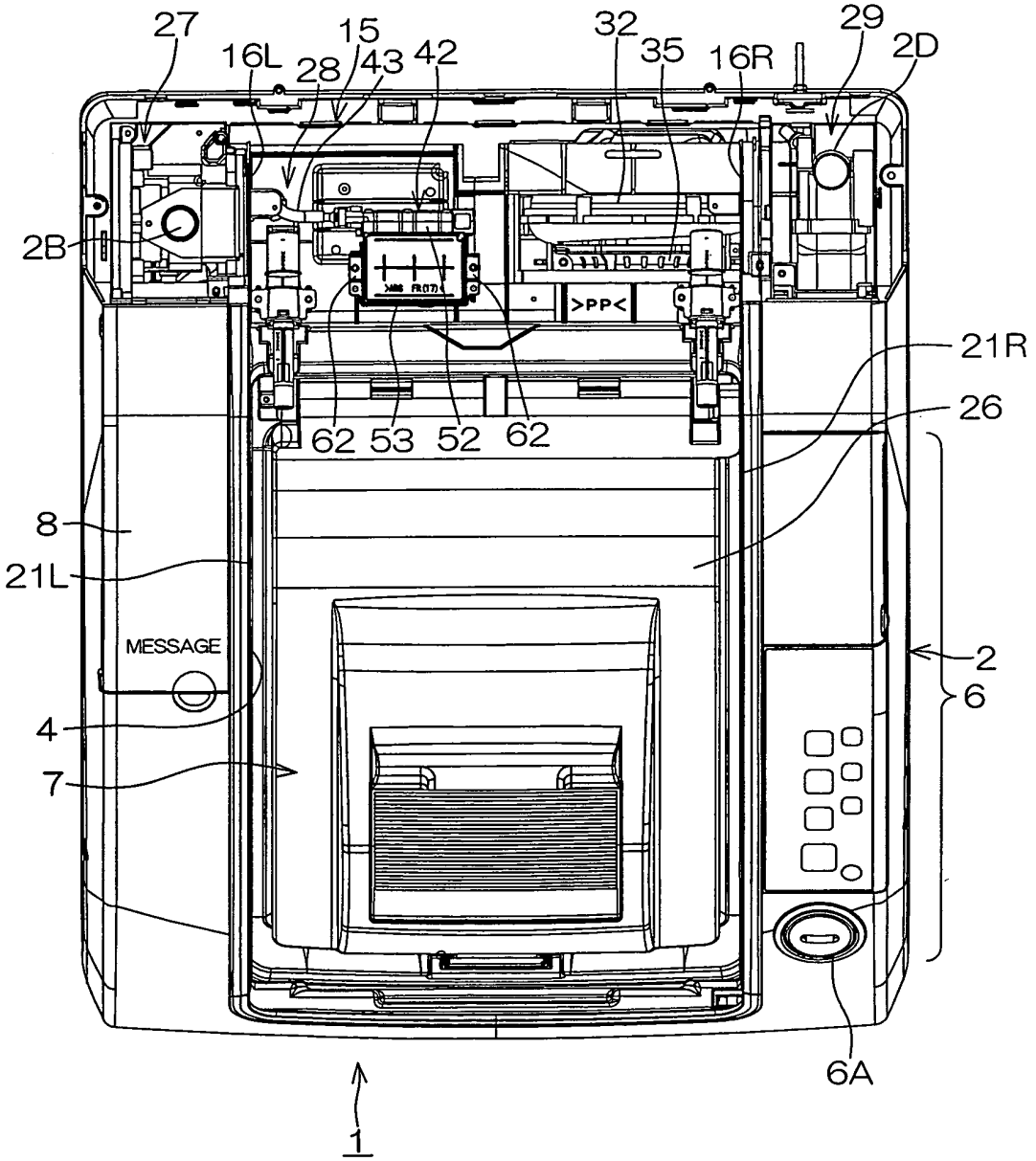

27
16L
28
15
43
42
32
35
16R
29
2D
2B
>PP<
21R
26
62
53
52
62
8
21L
MESSAGE
4
7
2
6
6A
1

FIG. 4

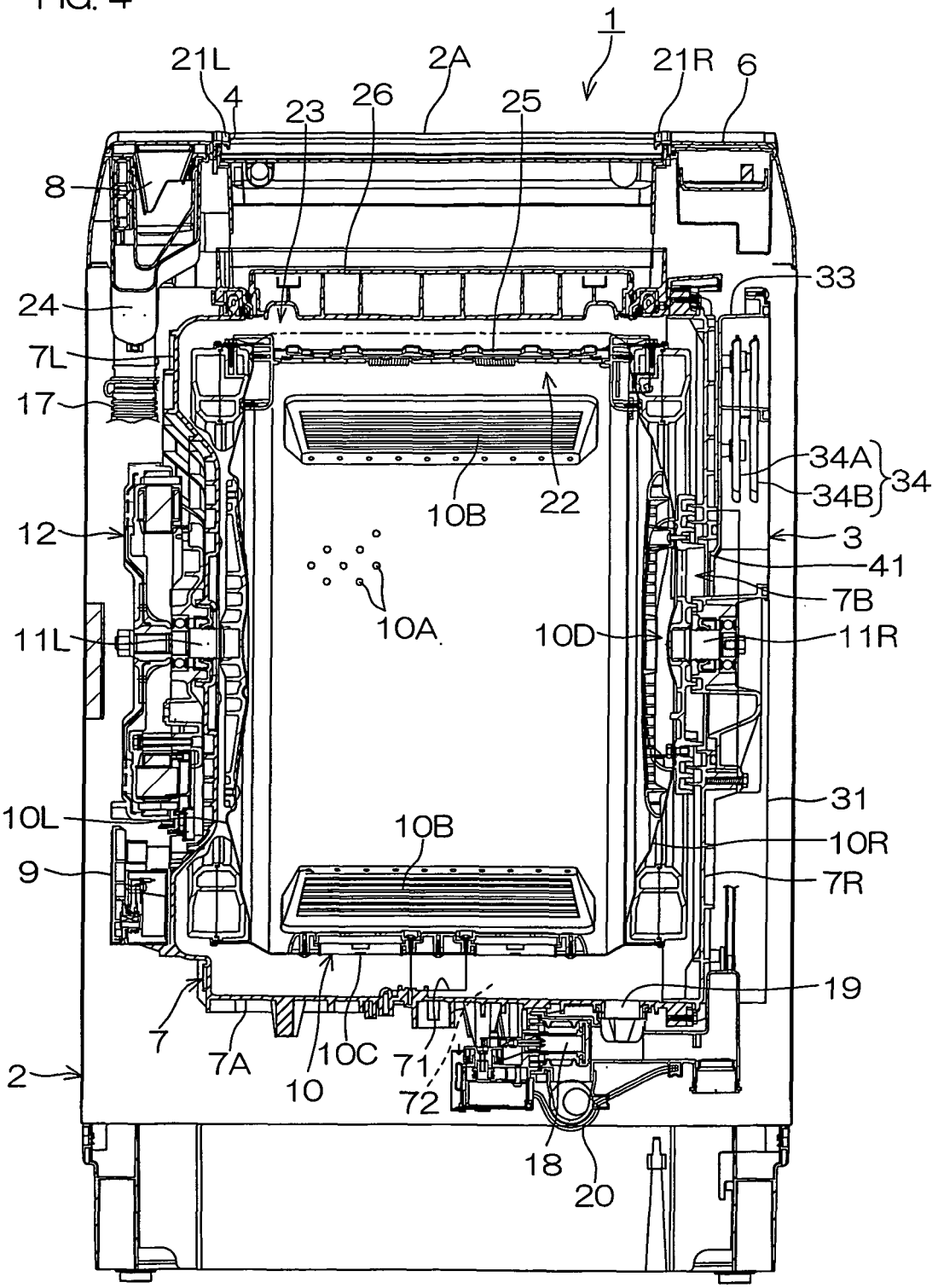

1
21L
4
23
26
2A
25
21R
6
8
24
7L
17
33
34A
34B
34
10B
22
12
3
41
7B
10A
10D
11R
11L
31
10L
10B
10R
9
7R
19
7
7A
10C
71
10
72
2
18
20

FIG. 5A

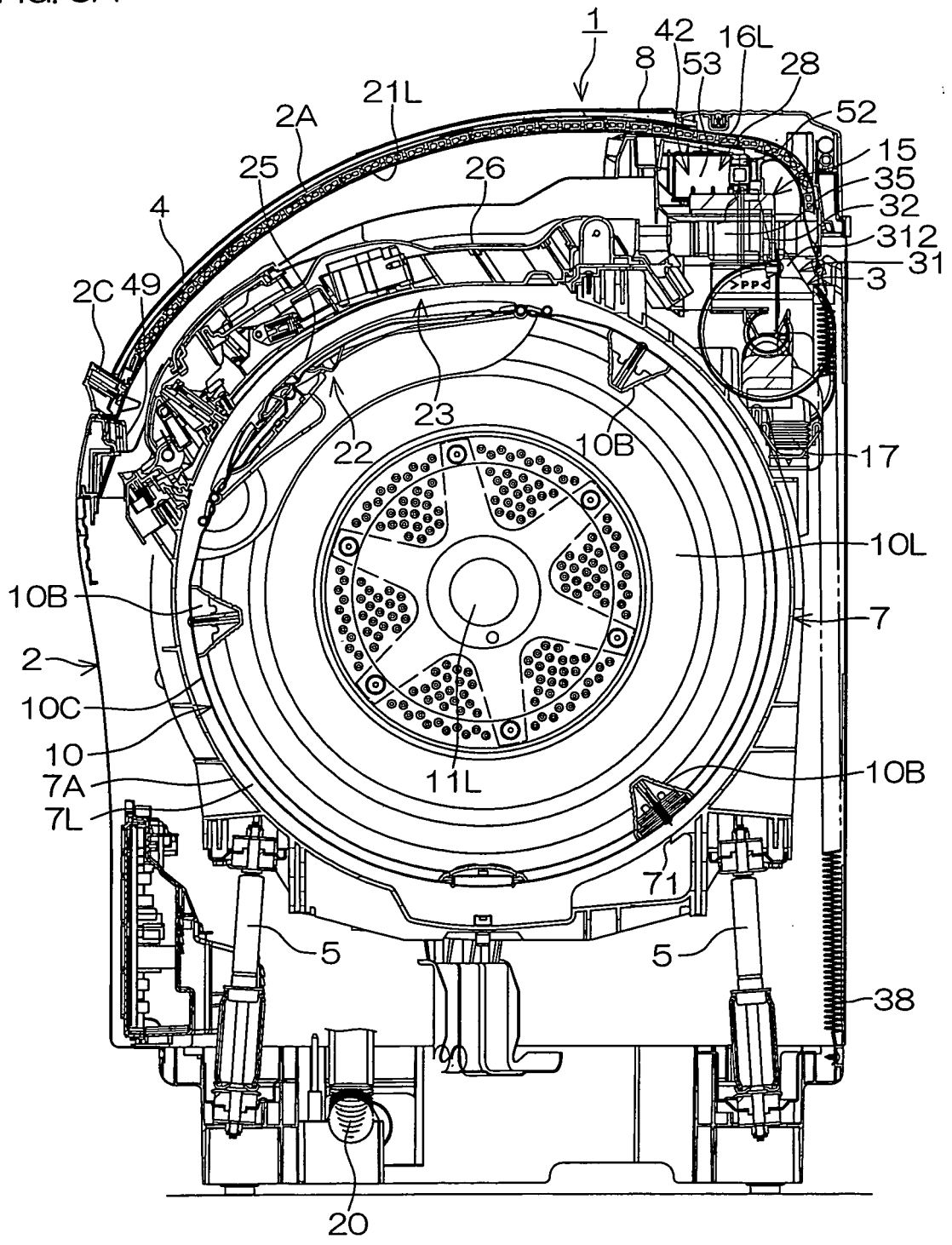

1
42
16L
8
53
28
52
21L
2A
15
25
26
35
4
32
312
31
2C
49
3
23
22
10B
17
10L
10B
7
2
10C
10
11L
10B
7A
7L
71
5
5
38
20

FIG. 5B

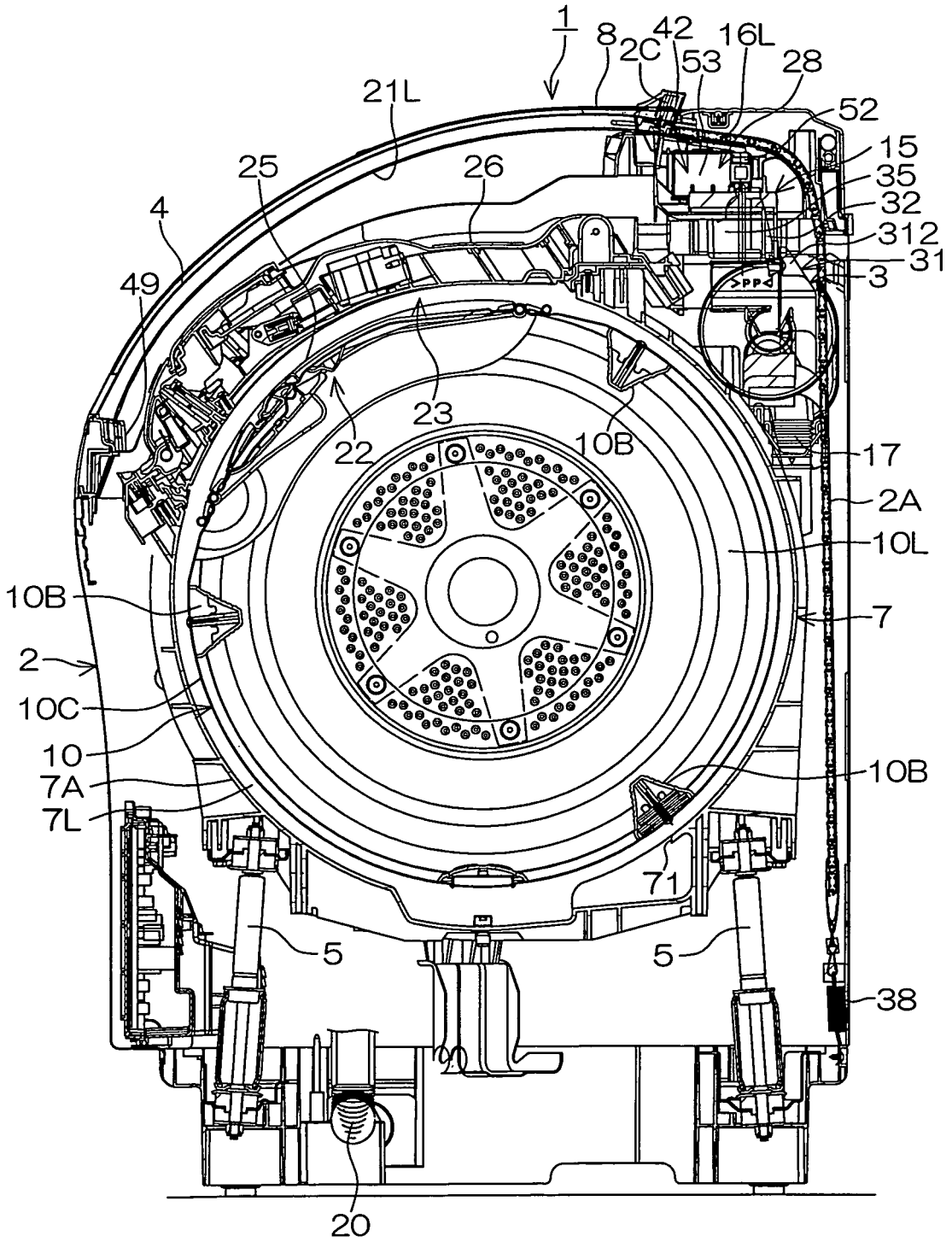

1
8
2C
42
53
16L
28
52
15
35
32
312
31
3
21L
25
26
4
49
22
23
10B
17
2A
10L
7
10B
2
10C
10
7A
7L
71
5
5
38
20

FIG. 6

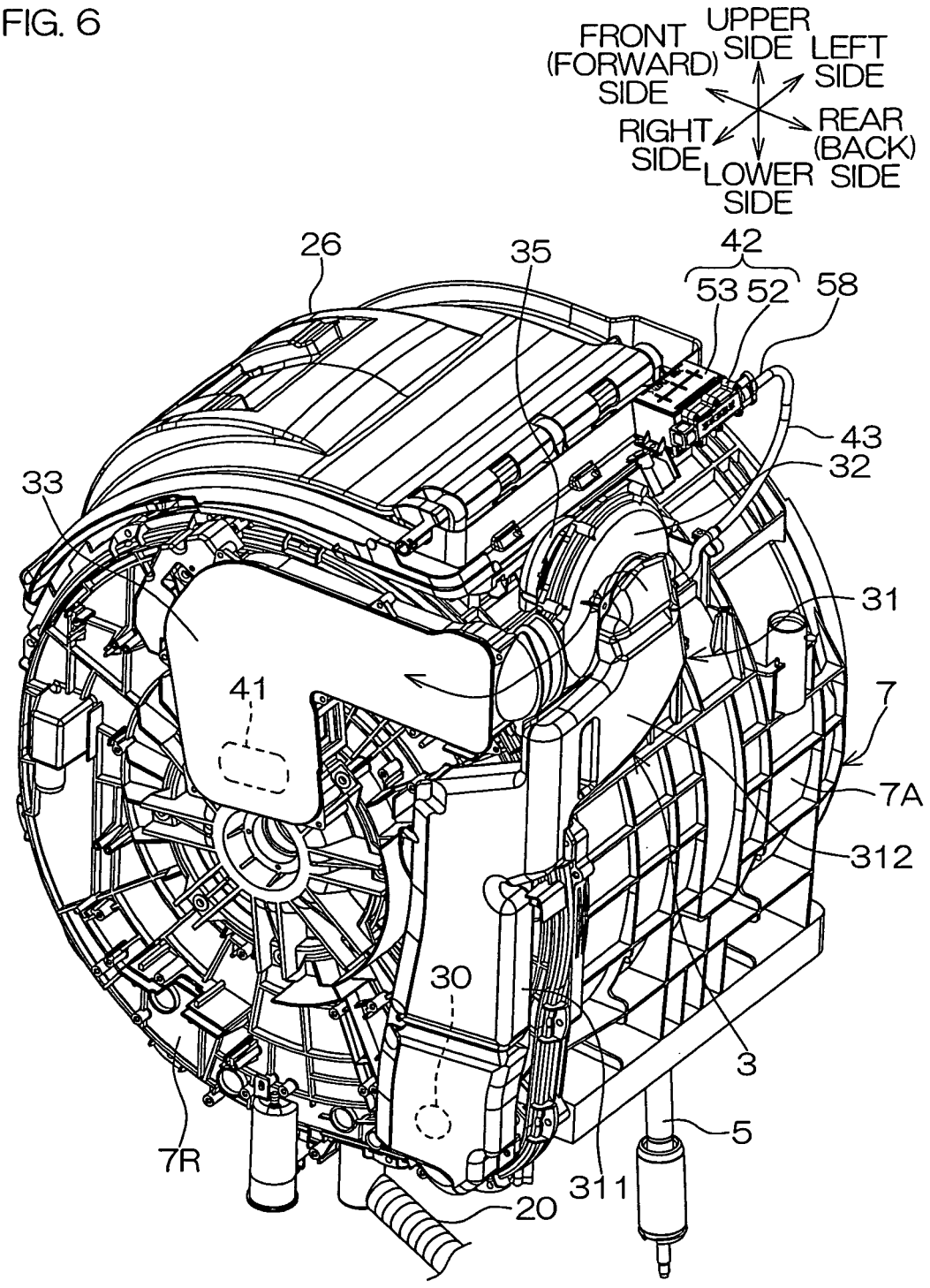
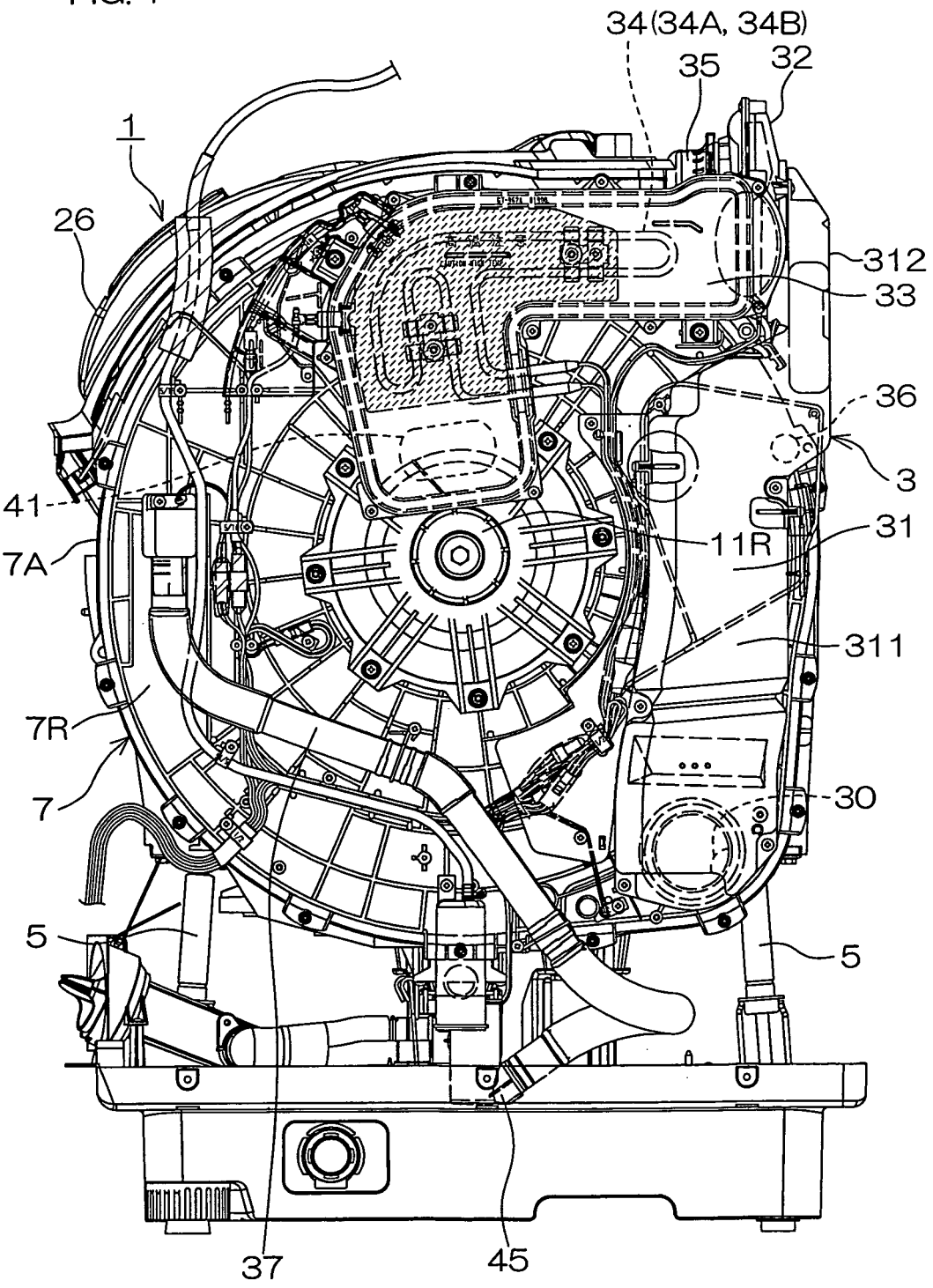

UPPER SIDE
FRONT (FORWARD) SIDE
LEFT SIDE
REAR (BACK) SIDE
RIGHT SIDE
LOWER SIDE
26
35
42
53
52
58
43
32
33
31
41
7
7A
312
30
3
5
7R
311
20

FIG. 7



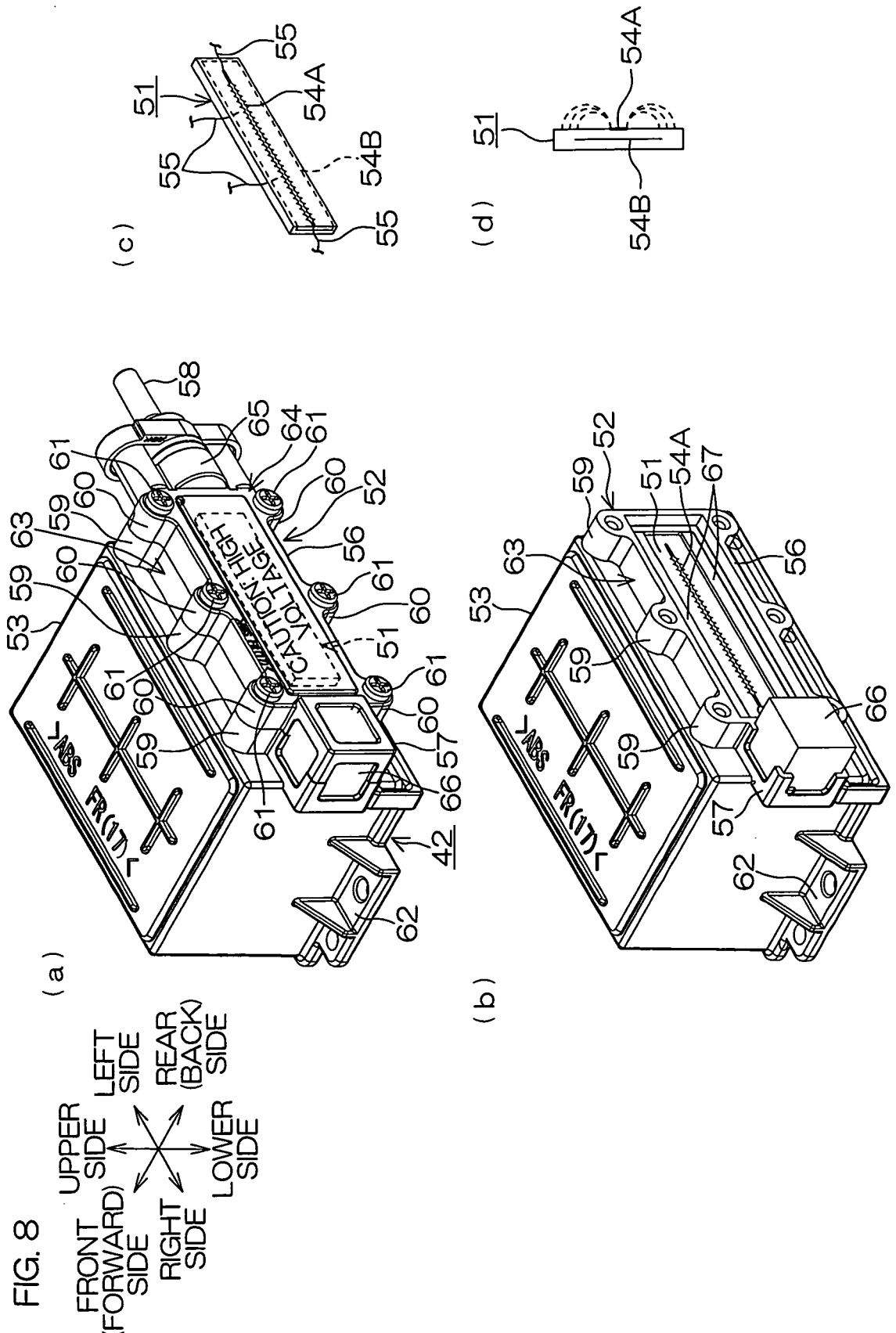

(a)
(b)
(c)
(d)
FR(IT)
CAUTION: HIGH VOLTAGE
UPPER SIDE
LOWER SIDE
LEFT SIDE
REAR (BACK) SIDE
FRONT (FORWARD) SIDE
RIGHT SIDE

FIG. 8

FIG. 9

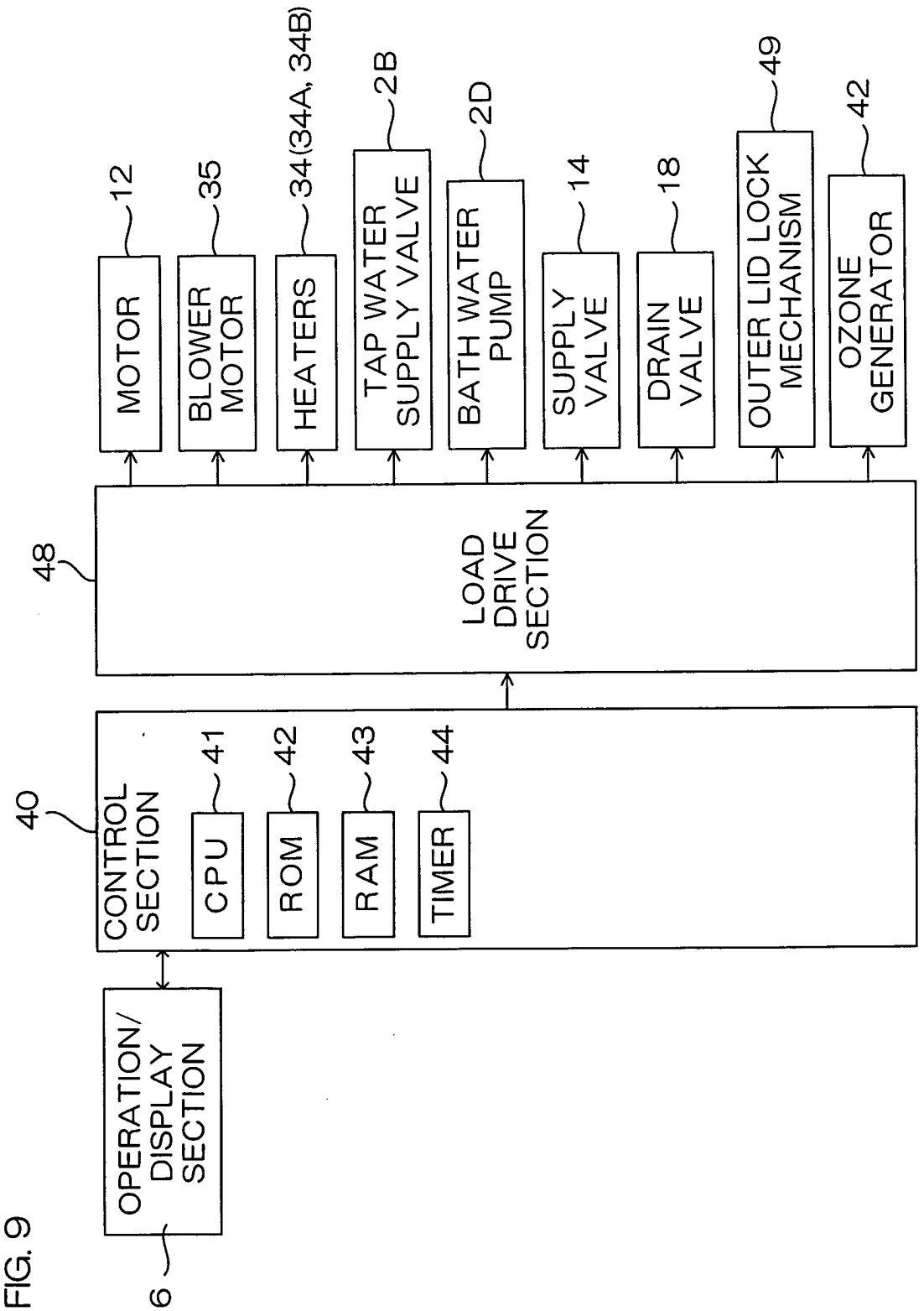
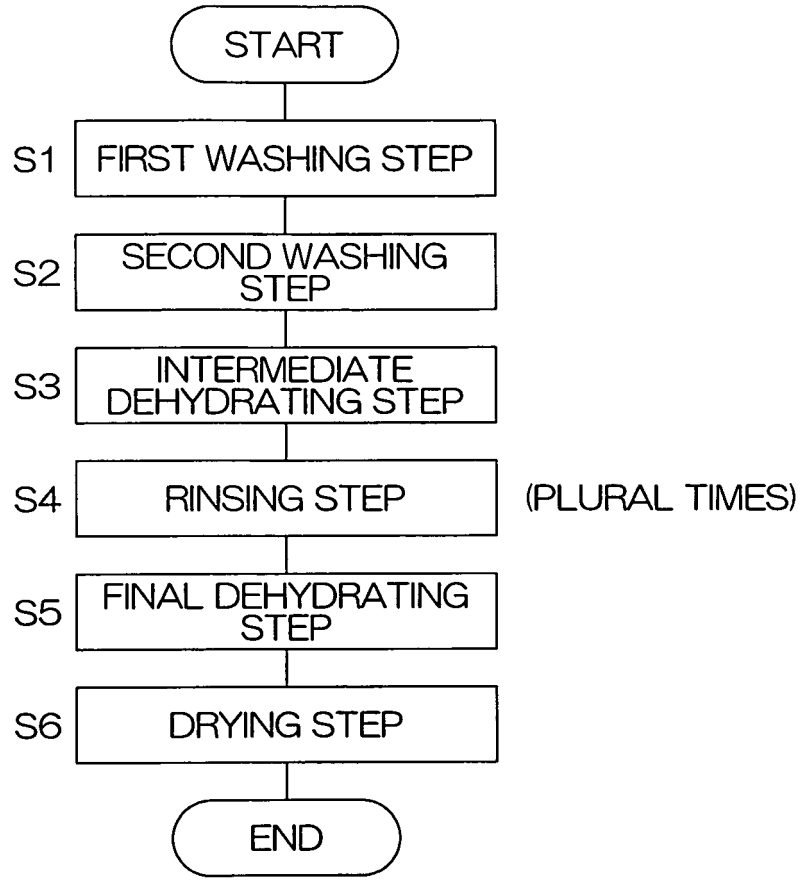

OPERATION/
DISPLAY
SECTION
6
CONTROL
SECTION
40
CPU
41
ROM
42
RAM
43
TIMER
44
LOAD
DRIVE
SECTION
48
MOTOR
12
BLOWER
MOTOR
35
HEATERS
34(34A, 34B)
TAP WATER
SUPPLY VALVE
2B
BATH WATER
PUMP
2D
SUPPLY
VALVE
14
DRAIN
VALVE
18
OUTER LID LOCK
MECHANISM
49
OZONE
GENERATOR
42

FIG. 10


START
S1
FIRST WASHING STEP
S2
SECOND WASHING STEP
S3
INTERMEDIATE DEHYDRATING STEP
S4
RINSING STEP
(PLURAL TIMES)
S5
FINAL DEHYDRATING STEP
S6
DRYING STEP
END

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2007/050600

A. CLASSIFICATION OF SUBJECT MATTER
D06F17/12(2006.01)i, *D06F25/00*(2006.01)i, *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)
D06F17/12, D06F25/00, 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 1996-2007
Kokai Jitsuyo Shinan Koho 1971-2007 Toroku Jitsuyo Shinan Koho 1994-2007

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.
P,Y	JP 2006-141579 A (Sharp Corp.), 08 June, 2006 (08.06.06), Page 6, left column, lines 15 to 28; page 6, right column, lines 15 to 25; Figs. 2 to 3 & WO 2006/054423 A1	1-4,10
Y	JP 2005-21633 A (Toshiba Corp.), 27 January, 2005 (27.01.05), Page 3, line 49 to page 4, line 2; page 4, lines 13 to 17; Fig. 1 (Family: none)	1-4,10
Y	JP 2001-87590 A (Toshiba Corp.), 03 April, 2001 (03.04.01), Page 6, left column, lines 36 to 48; Figs. 6 to 7 (Family: none)	2-4,10

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

Date of the actual completion of the international search	Date of mailing of the international search report
07 February, 2007 (07.02.07)	20 February, 2007 (20.02.07)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2007/050600

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2005-348923 A (Sanyo Electric Co., Ltd.), 22 December, 2005 (22.12.05), Page 5, right column, lines 17 to 49; Figs. 3 to 5 (Family: none)	5-9,11-13

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2002320792 A **[0002]**