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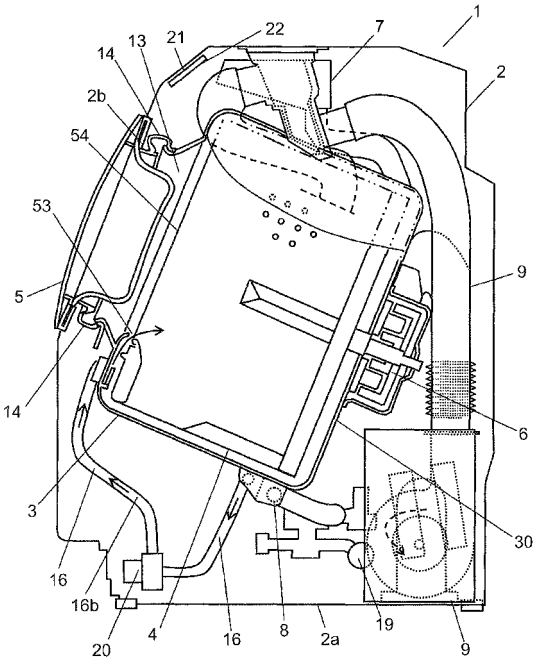
# (54) DRUM TYPE WASHING MACHINE

(57) includes bottomed, cylindrical water tub (3) having water tub opening (13), provided inside cabinet (2); bottomed, cylindrical rotating drum (4) having drum opening (54), provided inside water tub (3); and motor (6) attached onto outer bottom surface (30) of water tub (3), for rotating drum (4) on a rotation axis horizontal or downward inclined toward the bottom. Further includes circulation tube (16) communicatively connecting the bottom side of water tub (3) with the side of water tub opening (13), for circulating washing water in water tub (3) from the bottom side to the side of water tub opening (13); and a plurality of ejection holes (53) for ejecting washing water circulated toward the inside of rotating drum (4). Washing water ejected from the plurality of ejection holes (53) toward the inside of rotating drum (4) is fed to the laundry efficiently, thereby increasing the washing power.

FIG. 1

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## Description

### TECHNICAL FIELD

**[0001]** The present invention relates to a drum type washing machine including a rotating drum with its rotation axis horizontal or downward inclined toward its bottom.

### BACKGROUND ART

**[0002]** A drum type washing machine uses a circulation unit including a circulation pump to circulate washing water retained in the water tub. For example, a drum type washing machine described in patent literature 1 ejects washing water into the rotating drum through the nozzle of the circulation unit. The nozzle has a large number of ejection holes formed therein from the front surface of the rotating drum toward its center with their ejection directions gradually changed. That is to say, the washing water is ejected through a large number of ejection holes. This structure allows even a large amount of laundry such as clothes to be washed efficiently.

**[0003]** Meanwhile, a drum type washing machine described in patent literature 2 includes a circulation pump having two pump discharge outlets. The two outlets are switched by the rotation directions (forward/reverse) of the impeller of the pump. The two outlets respectively have circulation hoses connected thereto so as to change the direction of washing water ejected into the rotating drum. This structure allows the direction of washing water ejected while washing and rinsing according to the rotation directions (forward/reverse) of the rotating drum.

**[0004]** However, the machine of patent literature 1 ejects washing water through a large number of ejection holes, which increases the usage of washing water, making water saving difficult.

**[0005]** Meanwhile, the machine of patent literature 2 pours washing water over the laundry falling in the rotating drum, which increases the weight of the laundry with the washing water having soaked into it. The resulting laundry rushes down in the rotating drum, which increases the washing efficiency. Such a way of washing is called beat washing. With the drum type washing machine of patent literature 2, however, the weight of the laundry increases insufficiently for a large amount of laundry, which does not bring a state of beat washing.

### Citation List

### Patent Literature

**[0006]**

**PTL 1** Japanese Patent Unexamined Publication No. H10-127978 **PTL 2** Japanese Patent Unexamined Publication No. 2008-073128

### SUMMARY OF THE INVENTION

**[0007]** The present invention efficiently feeds the laundry in the rotating drum with washing water in the water tub while circulating the water, thereby providing a drum type washing machine with high washing power.

**[0008]** A drum type washing machine according to the present invention includes a cabinet; a bottomed cylindrical water tub having a tub opening, provided inside the cabinet; a bottomed cylindrical rotating drum having a drum opening, provided inside the water tub; and a motor attached onto the outer bottom surface of the water tub, for rotating the rotating drum on a rotation axis horizontal or downward inclined toward its bottom. The washing machine further includes a circulation tube communicatively connecting the bottom side with the side of the water tub opening, for circulating washing water in the water tub from the bottom side to the side of the water tub opening; and a plurality of ejection holes for ejecting washing water circulated through the circulation tube, toward the inside of the rotating drum.

**[0009]** This configuration allows washing water circulated to be ejected toward the inside of the rotating drum through the plurality of ejection holes, thereby feeding the washing water efficiently as well as increasing washing power of the drum type washing machine.

### BRIEF DESCRIPTION OF DRAWINGS

**[0010]**

FIG. 1 is a sectional view of a drum type washing machine according to the first exemplary embodiment of the present invention.

FIG. 2A is a sectional view of a circulation pump incorporated into the drum type washing machine according to the same embodiment.

FIG. 2B is a side view of the circulation pump.

FIG. 3A is a perspective view of the substantial part of the water tub of the washing machine.

FIG. 3B is a plan view of the front-surface wall of the water tub, viewed from the inside.

FIG. 4 is a sectional view of a water duct and its proximity in the circulation tube of the drum type washing machine.

FIG. 5A is a sectional view of a discharge outlet and its proximity in the circulation tube of the drum type washing machine.

FIG. 5B is a sectional view of another discharge outlet and its proximity in the circulation tube of the drum type washing machine.

FIG. 6 is an explanatory diagram of the drum type washing machine, showing a state of washing water being ejected.

FIG. 7A is a sectional view of a discharge outlet and its proximity in the circulation tube of a drum type washing machine according to the second exemplary embodiment of the present invention.

FIG. 7B is a sectional view of another discharge outlet and its proximity in the circulation tube of the drum type washing machine.

FIG. 8 is a sectional view of a discharge outlet in the circulation tube of a drum type washing machine according to the third exemplary embodiment of the present invention.

FIG. 9 is a sectional view of ejection holes in the circulation tube of a drum type washing machine according to the fourth exemplary embodiment of the present invention.

FIG. 10A is a sectional view of ejection holes in the circulation tube of a drum type washing machine according to the fifth exemplary embodiment of the present invention.

FIG. 10B is a sectional view of another type of ejection holes in the circulation tube of the drum type washing machine.

FIG. 11 is a sectional view of ejection holes in the circulation tube of a drum type washing machine according to the sixth exemplary embodiment of the present invention.

FIG. 12 is a sectional view of a discharge outlet and its proximity in the circulation tube of a drum type washing machine according to the seventh exemplary embodiment of the present invention.

FIG. 13 is a plan view of the front-surface wall of the water tub of a drum type washing machine according to the eighth embodiment of the present invention, viewed from the inside.

FIG. 14A is a sectional view of a discharge outlet and its proximity in the circulation tube of the drum type washing machine.

FIG. 14B is a sectional view of another discharge outlet and its proximity in the circulation tube of the drum type washing machine.

FIG. 15A is a plan view of the front-surface wall of another water tub of the drum type washing machine, viewed from the inside.

FIG. 15B is a plan view of the front-surface wall of still another water tub of the drum type washing machine, viewed from the inside.

FIG. 16A is a sectional view of still another discharge outlet and its proximity in the circulation tube of the drum type washing machine.

FIG. 16B is a partial sectional view taken along line 16B-16B in FIG. 16A.

## DESCRIPTION OF EMBODIMENTS

### FIRST EXEMPLARY EMBODIMENT

**[0011]** FIG. 1 is a sectional view of a drum type washing machine according to the first exemplary embodiment of the present invention. FIG. 2A is a sectional view of a circulation pump incorporated into the drum type washing machine. FIG. 2B is a side view of the circulation pump incorporated into the drum type washing machine.

**[0012]** Drum type washing machine 1 of the embodiment has cabinet 2 that contains water tub 3, feed water unit 7, drain unit 8, and circulation tube 16. Water tub 3 is provided therein with rotating drum 4. Both water tub 3 and rotating drum 4 are bottomed and cylindrical. Rotating drum 4 is rotated by motor 6 attached onto outer bottom surface 30 of water tub 3. Motor 6 rotates both clockwise and counterclockwise, which means that motor 6 rotates in the forward/reverse directions. With this configuration, washing, rinsing, and spin-drying steps are performed. Further, drum type washing machine 1 performs a drying step with dryer unit 9 provided as required. Circulation tube 16 is provided to communicatively connect the bottom side of water tub 3 with the side of water tub opening 13 (described later). Washing water retained in water tub 3 circulates from the bottom side of water tub 3 to the side of water tub opening 13 through circulation tube 16. This causes a detergent to quickly dissolve into the washing water and prevents the detergent from unevenly dissolving into the washing water.

**[0013]** Feed water unit 7, connected to water supply, feeds water tub 3 with water by opening the feed water valve (not shown). Feed water unit 7 is provided therein with a detergent compartment (not shown). Water fed from water supply, while dissolving a detergent in the detergent compartment, becomes washing water to enter water tub 3. Meanwhile, drain unit 8 opens drain valve 19 when a washing step or rinsing step ends to drain the washing water out of cabinet 2. Circulation tube 16 repeats the behavior of drawing washing water retained in water tub 3 from the bottom side of water tub 3 using circulation pump 20; sending it to the side of water tub opening 13; and returning it to water tub 3.

**[0014]** Drum type washing machine 1 has operation panel 21 on the top front surface of cabinet 2. When a user instructs an operation start using operation panel 21, the instruction reaches control unit 22. Control unit 22 makes the display unit (not shown) of operation panel 21 display that operation has been started; closes drain valve 19; opens the feed water valve to start feeding water. After that, control unit 22 performs operation such as washing, rinsing, spin-drying, and drying.

**[0015]** Cabinet 2 has main body opening 2b formed in the front side thereof, opened and closed with door 5. Rotating drum 4 has drum opening 54 formed in the front side thereof. Water tub 3 has water tub opening 13 formed in the front side thereof. Here, the front sides of rotating drum 4 and water tub 3 refer to the surfaces facing the respective bottoms. The laundry is put into and out of rotating drum 4 through main body opening 2b, water tub opening 13, and drum opening 54. Between main body opening 2b and water tub opening 13 of water tub 3, ring-shaped sealing material 14 is attached, thereby preventing washing water from springing out of water tub 3 when door 5 is closed.

**[0016]** Motor 6 has a forward/reverse partial rotation drive mode and a forward/reverse continuous rotation drive mode to drive rotating drum 4. The partial mode is

a drive mode in which rotating drum 4 repeats rapid partial rotations by 90 to 180 degrees in the forward and reverse directions. Meanwhile, the continuous mode is a drive mode in which rotating drum 4 continuously rotates and repeats forward and reverse rotations alternately. With the continuous mode, the laundry lifted by rotation of rotating drum 4 repeats the behavior of falling due to its self weight; and again being lifted by rotation of rotating drum 4. In a washing step or washing and rinsing step, the partial and continuous modes are executed alternately.

**[0017]** In the forward/reverse partial rotation drive mode, the laundry is lifted by 90 to 180 degrees, and after that the laundry peels off from the inner surface of rotating drum 4 due to an inertial force or the self weight. The laundry contains washing water to swell, loosen, and become slippery, resulting in being disentangled due to a fall. Further, a mechanical force caused by the fall is exerted on the laundry, thereby increasing the washing power of drum type washing machine 1. Meanwhile, in the forward/reverse partial rotation drive mode, forward and reverse partial rotations are repeated alternately, and thus positions from which the laundry is lifted and to which the laundry falls change alternately, which prevents the laundry from being entangled, twisting, and wrinkling.

**[0018]** Here, in the forward/reverse partial rotation drive mode, it is difficult for laundry pieces to exchange their vertical positions, and laundry pieces at the bottom of rotating drum 4 is resistant to moving, thus easily causing uneven washing. To cope with this problem, the forward/reverse continuous rotation drive mode is used, which causes the laundry pieces (including those at the bottom of rotating drum 4) to exchange their vertical positions. In this way, the partial mode prevents the laundry from being entangled, twisting, and wrinkling while the continuous rotation mode allows the laundry pieces to exchange their vertical positions to a large degree, thereby washing the laundry uniformly.

**[0019]** Circulation pump 20 is provided halfway through circulation tube 16 and is fixed to base plate 2a of cabinet 2. To the downstream side of circulation pump 20, discharge-side path 16b of circulation tube 16 is connected. As shown in FIGs. 2A and 2B, circulation pump 20 includes resin-made pump casing 20b containing impeller 20a and motor casing 20d containing circulation motor 20c. Impeller 20a is connected with circulation motor 20c through motor shaft 20e. Pump casing 20b and motor casing 20d are positioned by bearing diaphragm 20da at the opening side of pump casing 20b and are unified. Here, circulation pump 20 is fixed to base plate 2a with resin-made amounting base 35. Circulation motor 20c rotates to cause impeller 20a to rotate through motor shaft 20e. With the rotation of impeller 20a, washing water is sent from circulation pump suction inlet 20f to circulation pump discharge outlet 20g.

**[0020]** FIG. 3A is a perspective view of the substantial part of the water tub of the drum type washing machine according to the same embodiment. FIG. 3B is a plan view of the front-surface wall of the water tub, viewed from the inside. FIG. 4 is a sectional view of a water duct and its proximity in the circulation tube of the drum type washing machine. As shown in FIGs. 3A and 3B, the lower half of front-surface wall 3h of water tub 3 has substantially Y-shaped evaginated part 3a formed thereon evaginated toward the front (upward right in FIG. 3A). Evaginated part 3a has cover 55 substantially the same as evaginated part 3a in outer shape, attached to the inside of water tub 3 using screw 55f. As shown in FIG. 4, cover 55 is attached to evaginated part 3a through packing 55a to form water duct 55b.

**[0021]** FIG. 5A is a sectional view of a discharge outlet and its proximity in the circulation tube of the drum type washing machine. FIG. 5B is a sectional view of another discharge outlet and its proximity in the circulation tube of the drum type washing machine. The bottom end of evaginated part 3a is connected to one end of joint 51 laterally extending. The other end of joint 51 is connected to discharge-side path 16b of circulation tube 16. Each of the right and left front ends of cover 55 has notch 55c formed therein. Notch 55c is formed by notching cover 55 as well as by notching the sealing member of packing 55a. This structure forms discharge outlet 55d having an opening expanding in the circumferential direction between the inside surface of front-surface wall 3h of water tub 3 and the outside surface of front-surface wall 4b of rotating drum 4, at the right and left front ends of water duct 55b formed of evaginated part 3a and cover 55 branching into a substantially Y shape. Here, the inside surface of front-surface wall 3h of water tub 3 is the surface visible from the inside of water tub 3, which means that the surface of water tub 3 faces inward.

**[0022]** Washing water sent by circulation pump 20 flows from joint 51 into water duct 55b through discharge-side path 16b of circulation tube 16. The washing water that has flown into water duct 55b is discharged from discharge outlet 55d toward the space between the inside surface of front-surface wall 3h of water tub 3 and the outside surface of front-surface wall 4b of rotating drum 4 (i.e. the surface facing the inside surface of front-surface wall 3h). As shown in FIG. 5A, the washing water that has been discharged from water duct 55b through discharge outlet 55d passes through flow path 52 and is ejected to the inside of rotating drum 4 from arc-shaped ejection holes 53. Here, a plurality of discharge outlets 55d are provided in the rotation direction of rotating drum 4 so as to face arc-shaped ejection holes 53. This structure allows the washing water to be efficiently ejected to a wide range inside rotating drum 4. Consequently, the washing water is efficiently fed regardless of the amount of the laundry.

**[0023]** Here, front-surface wall 3h of water tub 3 includes slope 3ha and guide surface 56 subsequent thereto, from the position corresponding to discharge outlet 55d. The washing water that has been discharged from discharge outlet 55d into flow path 52 flows from slope

3ha along guide surface 56. Herewith, the washing water passes from ejection holes 53 through drum opening 54 and is ejected toward the inner part of rotating drum 4 as shown by arrow A in FIG. 5A. The washing water reaches the inner part of rotating drum 4, which means that the laundry is fed with the washing water more efficiently.

**[0024]** As shown in FIG. 5B, providing guide surface 57 with a gradient angle different from that of guide surface 56 allows washing water to be ejected at different angles. For example, assumption is made that a (refer to FIG. 5A) is a gradient angle of guide surface 56 corresponding to discharge outlet 55d (the right side in FIG. 3B) at the left side viewed from the front side of water duct 55b that has branched and that b (refer to FIG. 5B) is a gradient angle of guide surface 57 corresponding to discharge outlet 55d (the left side in FIG. 3B) at the right side viewed from the front side of water duct 55b. Then, guide surfaces 56 and 57 are formed so as to satisfy the inequality a > b.

**[0025]** FIG. 6 is an explanatory diagram of the drum type washing machine according to same embodiment, showing a state of washing water being ejected. Washing water ejected from left-side ejection holes 53 viewed from the front side of drum type washing machine 1 (i.e. washing water ejected in the direction shown by arrow A in FIG. 5A) is ejected upward as shown in shower shape S1 of FIG. 6. Meanwhile, washing water ejected from right-side ejection holes 53 viewed from the front side of drum type washing machine 1 (i.e. washing water ejected in the direction shown by arrow B in FIG. 5B) is ejected downward compared to shower shape S1, as shown in shower shape S2 of FIG. 6. In other words, each washing water that has been discharged from respective discharge outlets 55d flows along guide surface 56 or 57 with a gradient angle different from each other. After that, the washing water is ejected from ejection holes 53 to the inside of rotating drum 4 through drum opening 54, thus with different ejection angles.

**[0026]** The gradient angles of guide surfaces 56 and 57 affect how washing water diffuses after being ejected. For a small gradient angle (i.e. guide surface 57 with gradient angle b in this embodiment), washing water that has flown along slope 3ha is sharply changed in flowing direction by guide surface 57. In other words, the washing water enters a state of colliding with guide surface 57. In this state, the washing water flows along guide surface 57 and diffuses due to the collision. Meanwhile, for a large gradient angle (i.e. guide surface 56 with gradient angle a in this embodiment), washing water that has flown along slope 3ha flows along guide surface 56 without being changed and is ejected with a minimum of diffusion. In other words, as shown in FIG. 6, shower shape S2 of washing water that has been ejected from right-side ejection holes 53 (with a small gradient angle) is more widely open than shower shape S1 of washing water that has been ejected from left-side ejection holes 53 (with a large gradient angle). This means that washing water ejected from right and left ejection holes 53 have diffusion angles different from each other. For example, for a gradient angle smaller than approximately 120 degrees, washing water is ejected diffusing to a large degree; for a gradient angle larger than approximately 130 degrees, washing water is ejected diffusing to a small degree in a film state. In this way, as a result that washing water is ejected at different ejection angles and in different diffusion states, the washing water can be ejected suitably according to the amount of the laundry.

**[0027]** Here, immediately after washing is started, the laundry does not contain washing water and thus is in a bulky state with a large volume. For example, when left-side ejection holes 53 shown in FIG. 6 are blocked by the laundry, washing water is ejected from right-side ejection holes 53 to rotating drum 4. From right-side ejection holes 53, the washing water is ejected diffusing to a large degree, thereby allowing the laundry near left-side ejection holes 53 to be soaked quickly. The laundry containing washing water decreases in volume, which resolves blockage of left-side ejection holes 53.

**[0028]** Meanwhile, washing water ejected from right-side ejection holes 53 largely diffuses, and thus it is difficult for the water to reach the inner part of rotating drum 4. However, washing water ejected from left-side ejection holes 53 diffuses to a small degree, and thus is sent toward the center of rotating drum 4 to reach the inner part, allowing the laundry at the inner part of rotating drum 4 to be soaked quickly. As a result that the laundry is soaked quickly, the laundry in rotating drum 4 quickly becomes easy to move, thereby increasing the effect of beat washing. The laundry soaked quickly decreases in volume quickly. This produces gaps among the laundry pieces, allowing washing water to be ejected to the laundry efficiently, which means that washing water is fed to the laundry efficiently.

**[0029]** Here, the ejection direction of ejection holes 53, namely the ejection direction of washing water relative to the perpendicular line passing through the center of drum opening 54, can be made different according to the shape of ejection holes 53. For example, as a result that the angle formed between the ejection direction of right and left ejection holes 53 and the perpendicular line passing through the center of drum opening 54 is made 0 degrees, namely the ejection direction and the above-described perpendicular line are made parallel to each other, the washing water passes through gaps among the laundry pieces to become easy to reach the inner part of rotating drum 4. Besides, as a result that the angle formed between the ejection direction of right-side (washing water diffuses to a larger degree) ejection holes 53 and the above-described perpendicular line is made 35 to 45 degrees, and at the same time the angle formed between the ejection direction of left-side (washing water diffuses to a smaller degree) ejection holes 53 and the above-described perpendicular line is made 50 to 60 degrees, collision among the washing water is suppressed, which reduces loss when washing water is fed. Herewith, the laundry can be soaked efficiently, thereby increasing

the washing efficiency of drum type washing machine 1.

**[0030]** The above configuration allows washing water to be fed efficiently and the laundry to be soaked efficiently for both large and small amounts of laundry. The laundry soaked efficiently saves water as well. Discharge outlet 55d is provided at a position where outlet 55d does not contact the laundry in rotating drum 4. Accordingly, the laundry is not caught at discharge outlet 55d, which does not cause interference while washing, rinsing, or drying. Further, the laundry is not damaged or broken. In the forward/reverse continuous rotation drive mode, the laundry pieces exchange their vertical positions; in the forward/reverse partial rotation drive mode, the laundry pieces exchange their lateral positions, which increases the effect of washing water ejected. In this embodiment, the description is made of a case of two discharge outlets 55d; however, a case of three or more discharge outlets 55d can be implemented in the same way.

## SECOND EXEMPLARY EMBODIMENT

**[0031]** FIG. 7A is a sectional view of a discharge outlet and its proximity in the circulation tube of a drum type washing machine according to the second exemplary embodiment of the present invention. FIG. 7B is a sectional view of another discharge outlet and its proximity in the circulation tube of the drum type washing machine. A component same as that of the first embodiment is given the same reference mark for description.

**[0032]** As shown in FIGs. 7A and 7B, drum type washing machine 1 of this embodiment is different from that of the first embodiment in that guide surfaces 58 and 59 link to slope 3ha curving smoothly. Guide surface 58 is different from guide surface 59 in curve radius. For example, curve radius c of guide surface 58 shown in FIG. 7A is larger than curve radius d of guide surface 59 shown in FIG. 7B, namely the inequality $c > d$ is satisfied. Washing water, when flowing from slope 3ha along guide surface 58, is ejected in the direction indicated by arrow C in FIG. 7A. Meanwhile, washing water, when flowing from slope 3ha along guide surface 59, is ejected in the direction indicated by arrow D in FIG. 7B. In a case where guide surface 58 is used for left-side ejection holes 53 (viewed from the front side of drum type washing machine 1) and where guide surface 59 is used for right-side ejection holes 53, washing water is ejected in shower shapes S1 and S2, respectively, shown in FIG. 6. In other words, the washing water that has flown along guide surface 58 is ejected upward in shower shape S1; meanwhile, the washing water that has flown along guide surface 59 is ejected downward in shower shape S2. In this way, changing the curve radius of a guide surface allows changing the shape of washing water ejected.

**[0033]** Further, the curve radiuses of guide surfaces 58 and 59 affect the diffusion state of washing water after being ejected. For a small curve radius (i.e. guide surface 59 with curve radius d in this embodiment), the washing water that has flown along slope 3ha is sharply changed in flowing angle by guide surface 59. In other words, the washing water enters a state of colliding with guide surface 59. In this state, the washing water flows along guide surface 59 and diffuses due to the collision. Meanwhile, for a large curve radius (i.e. guide surface 58 with curve radius c in this embodiments), the washing water that has flown along slope 3ha flows along guide surface 58 without being changed and is ejected with a minimum of diffusion. In other words, as shown in FIG. 6, shower shape S2 of the washing water that has been ejected from right-side ejection holes 53 (with a small curve radius) is more widely open than shower shape S1 of the washing water that has been ejected from left-side ejection holes 53 (with a large curve radius). In this way, changing the curve radius of a guide surface provides the same effects and advantages as those of the first embodiment.

## THIRD EXEMPLARY EMBODIMENT

**[0034]** FIG. 8 is a sectional view of a discharge outlet in the circulation tube of a drum type washing machine according to the third exemplary embodiment of the present invention. A component same as that of the first embodiment is given the same reference mark for description.

**[0035]** As shown in FIG. 8, drum type washing machine 1 of this embodiment has guide surface 61 with a gradient angle different from that of slope 3ha. Guide surface 61 links to slope 3ha through curved surface 60. Washing water that has been discharged from discharge outlet 55d flows more smoothly than the first embodiment as a result of flowing through curved surface 60, which further stabilizes the washing water ejected from ejection holes 53.

**[0036]** The degree with which washing water collides with guide surface 61 is determined by the curve radius of curved surface 60. In other words, adjusting the curve radius of curved surface 60 allows adjusting the diffusion degree of washing water. Accordingly, the ejection pattern of washing water can be set by adjusting the ejection angle of washing water according to the gradient angle of guide surface 61 and the diffusion degree of washing water according to the curve radius of curved surface 60.

## FOURTH EXEMPLARY EMBODIMENT

**[0037]** FIG. 9 is a sectional view of ejection holes in the circulation tube of a drum type washing machine according to the fourth exemplary embodiment of the present invention. A component same as that of the first to third embodiments is given the same reference mark for description.

**[0038]** As shown in FIG. 9, drum type washing machine 1 of this embodiment is different from that of the third embodiment in that guide surface 62 has a plurality of gradient angles. Guide surface 62 has gradient angle e

near a position linked to slope 3ha through curved surface 60. Further, guide surface 62 has gradient angle f near guide surface front end 63. Here, the inequality f > e is satisfied. With this configuration, washing water collides with the part with a small gradient angle, thereby diffusing the washing water largely, and the washing water is ejected at a large ejection angle at the part with a large gradient angle. Here, with a large difference between gradient angles e and f, the washing water does not flow along guide surface 62 but is separated from guide surface 62 at guide surface front end 63, resulting in unstable ejection of the washing water. In this case, guide surface 62 formed with an intermediate gradient angle prevents the washing water from being separated.

## FIFTH EXEMPLARY EMBODIMENT

**[0039]** FIG. 10A is a sectional view of ejection holes in the circulation tube of a drum type washing machine according to the fifth exemplary embodiment of the present invention. FIG. 10B is a sectional view of another type of ejection holes in the circulation tube of the drum type washing machine. A component same as that of the first to fourth embodiments is given the same reference mark for description.

**[0040]** As shown in FIGs. 10A and 10B, drum type washing machine 1 of this embodiment is different from that of the fourth embodiment in the shape of the extreme front end of guide surface 62. The extreme front end of guide surface 62 is, in other words, an end of the inside surface of front-surface wall 3h. The ejection angle of washing water is affected in a tangential direction of the extreme front end of guide surface 62. Accordingly, the ejection angle of washing water can be set according to the shape of the extreme front end of guide surface 62. For example, in FIG. 10A, extreme front end 65 of guide surface 62 is chamfer-shaped. The shape allows setting the ejection angle of washing water and prevents the laundry from being interfered with and from being damaged. In FIG. 10B, extreme front end 66 of guide surface 62 has a cross section substantially arc-shaped with roundness. The shape further prevents the laundry from being interfered with and from being damaged.

## SIXTH EXEMPLARY EMBODIMENT

**[0041]** FIG. 11 is a sectional view of ejection holes in the circulation tube of a drum type washing machine according to the sixth exemplary embodiment of the present invention. A component same as that of the first to fourth embodiments is given the same reference mark for description. Drum type washing machine 1 of this embodiment has ejection holes 53 as shown in FIG. 11 in consideration of a diffusion degree of ejecting washing water, an ejection angle, stability of ejection, damage to the laundry, and uneven thickness of resin forming guide surface 64. Concretely, ejection holes 53 are formed in guide surfaces 64 and 64a with a plurality of different gradient angles; and in curved surfaces 60, 60a, 60b, and 60c with a plurality of different curve radiuses. Further, these surfaces are gradually transformed to be smoothly linked. This configuration allows setting the diffusion degree and the angle of ejection in consideration of stability of ejecting washing water, damage to the laundry, and uneven thickness of resin forming guide surface 64.

## SEVENTH EXEMPLARY EMBODIMENT

**[0042]** FIG. 12 is a sectional view of a discharge outlet and its proximity in the circulation tube of a drum type washing machine according to the seventh embodiment of the present invention. A component same as that of the first embodiment is given the same reference mark for description.

**[0043]** In the first through sixth embodiments, the description is made of the case where washing water that has been discharged from discharge outlet 55d is ejected through ejection holes 53 toward rotating drum 4. Drum type washing machine 1 of this embodiment is structured to eject washing water directly from discharge outlet 55d toward rotating drum 4. Concretely, as shown in FIG. 12, discharge outlet 55d is provided at a position facing drum opening 54 in water tub 3. In other words, discharge outlet 55d is used as ejection holes 53, and vice versa, which dispenses with guide surface 56 forming ejection holes 53, for example. That is to say, this configuration eliminates guide surface 56 that may cause the laundry to be caught. Accordingly, interference does not occur while washing, rinsing, or drying. The laundry is not damaged or broken. Here, discharge outlet 55d can be provided in a member (e.g. cover 55) forming a seal.

## EIGHTH EXEMPLARY EMBODIMENT

**[0044]** FIG. 13 is a plan view of the front-surface wall of the water tub of a drum type washing machine according to the eighth embodiment of the present invention, viewed from the inside. FIG. 14A is a sectional view of a discharge outlet and its proximity in the circulation tube of the drum type washing machine. FIG. 14B is a sectional view of another discharge outlet and its proximity in the circulation tube of the drum type washing machine. FIG. 15A is a plan view of the front-surface wall of another water tub of the drum type washing machine, viewed from the inside. FIG. 15B is a plan view of the front-surface wall of still another water tub of the drum type washing machine, viewed from the inside. FIG. 16A is a sectional view of still another discharge outlet and its proximity in the circulation tube of the drum type washing machine. FIG. 16B is a partial sectional view taken along line 16B-16B in FIG. 16A. A component same as that of the first embodiment is given the same reference mark for description.

**[0045]** As shown in FIG. 13, opening width D1, which is a circumferential width of the opening of one discharge outlet 55d, is different from opening width D2, which is a

circumferential width of the opening of the other discharge outlet 55da. Making the opening widths different allows changing the respective ejection widths and flow rates from discharge outlets 55d and 55da. This allows the ejection pattern of washing water to be set appropriately, thereby appropriately feeding the laundry with washing water regardless of the amount of the laundry. Further, washing water appropriately fed increases the washing effect.

**[0046]** As shown in FIGs. 14A and 14B, making opening distance D3 different from opening distance D4 allows changing the flow rate of washing water ejected, where opening distance D3 is a distance of the opening of one discharge outlet 55d in the direction perpendicular to the circumferential direction; opening distance D4 is a distance of the opening of the other discharge outlet 55da in the direction perpendicular to the circumferential direction. This structure as well allows the ejection pattern of washing water to be set appropriately, thereby appropriately feeding the laundry with washing water regardless of the amount of the laundry. Further, washing water appropriately fed increases the washing effect.

**[0047]** Furthermore, as shown in FIGs. 15A and 15B, different opening angles of the right and left discharge outlets about rotation center Q of rotating drum 4 allow changing the directions in which washing water is ejected from right and left ejection holes 53. Here, a description is made of an opening angle using a case of discharge outlet 55da in FIG. 15A. Washing water ejected from ejection holes 53 through discharge outlet 55da is ejected in the direction of arrow E, which is defined as opening direction E. An angle formed by line segment Qd connecting the opening of discharge outlet 55da to rotation center Q of rotating drum 4; and opening direction E is defined as an opening angle. Accordingly, the opening angle of discharge outlet 55d in FIG. 5A is zero; the opening angle of discharge outlet 55db in FIG. 15B is k. Minutely, washing water ejected from ejection holes 53 through discharge outlet 55d is ejected in the direction of arrow F, which means that opening direction is F. Opening direction F is equal to the direction of rotation center Q of rotating drum 4, and thus the opening angle is zero. Meanwhile, washing water ejected from ejection holes 53 through discharge outlet 55db is ejected in the direction of arrow G, which means the opening direction is G. Opening direction G forms angle k with the direction of rotation center Q of rotating drum 4, and thus the opening angle is k. In this embodiment, washing water is ejected in the direction of arrow G by providing guide 67 at the front end of discharge outlet 55db. In other words, an opening direction and an opening angle can be set by changing the shape of the front end of a discharge outlet.

**[0048]** Here, guide surfaces 57, 56, and 57 respectively corresponding to discharge outlets 55d, 55da, and 55db are formed circularly centering on rotation center Q of rotating drum 4. Accordingly, the cross-section shapes of guide surfaces 56 and 57 are the same with respect to rotation center Q. Thus, washing water flowing along guide surfaces 56 and 57 is sharply curved in the direction toward rotation center Q of rotating drum 4, and is more gently curved farther away from the direction toward rotation center Q of rotating drum 4. Consequently, washing water that has been ejected toward rotation center Q of rotating drum 4 and has passed through discharge outlet 55d is ejected in a roughly symmetric shape, with a relatively narrow diffusion angle. Meanwhile, washing water that has been ejected upward deflected by angle j with respect to rotation center Q of rotating drum 4 and has passed through discharge outlet 55da; and washing water that has been ejected upward deflected by angle k with respect to rotation center Q of rotating drum 4 and has passed through discharge outlet 55db are ejected with a large diffusion angle.

**[0049]** Further, as shown in FIGs. 16A and 16B, rib 68 is provided near discharge outlet 55d inside water duct 55b in a direction interfering with the flow of washing water. Rib 68 is formed by projecting a part of cover 55. Rib 68 is large enough to block approximately 50%, for example, of the cross-sectional area of the flow path of water duct 55b.

**[0050]** Here, washing water that has flown to water duct 55b through circulation tube 16 has a velocity component in the direction same as the longitudinal direction of water duct 55b when discharged from discharge outlet 55d. The velocity component causes the washing water to be ejected deflected in the longitudinal direction of water duct 55b with respect to the direction from discharge outlet 55d and guide surface 56 toward rotating drum 4. Here, with rib 68 provided, washing water that has flown through water duct 55b collides with rib 68, which counteracts the above-described longitudinal velocity component of the washing water, resulting in being ejected along the direction from discharge outlet 55d and guide surface 56 toward rotating drum 4. In other words, the washing water is ejected in a direction according to those of discharge outlet 55d and guide surface 56. Here, as shown in FIGs. 15A and 15B, rib 68 can be provided near discharge outlets 55da and 55db inside water duct 55b.

## INDUSTRIAL APPLICABILITY

**[0051]** A drum type washing machine of the present invention feeds washing water with an optimum ejection angle and a diffusion angle regardless of the amount of the laundry, and thus is applicable to a washing machine with a rotating drum.

## REFERENCE MARKS IN THE DRAWINGS

**[0052]**

| | |
|---|---|
| 1 | Drum type washing machine |
| 2 | Cabinet |
| 2a | Base plate |
| 2b | Main body opening |
| 3 | Water tub |

| | |
|---|---|
| 3a | Evaginated part |
| 3h | Front-surface wall |
| 3ha | Slope |
| 4 | Rotating drum |
| 4b | Front-surface wall |
| 5 | Door |
| 6 | Motor |
| 7 | Feed water unit |
| 8 | Drain unit |
| 9 | Dryer unit |
| 13 | Water tub opening |
| 14 | Sealing material |
| 16 | Circulation tube |
| 16b | Discharge-side path |
| 19 | Drain valve |
| 20 | Circulation pump |
| 20a | Impeller |
| 20b | Pump casing |
| 20c | Circulation motor |
| 20d | Motor casing |
| 20da | Bearing diaphragm |
| 20e | Motor shaft |
| 20f | Circulation pump suction inlet |
| 20g | Circulation pump discharge outlet |
| 21 | Operation panel |
| 22 | Control unit |
| 30 | Outer bottom surface |
| 35 | Mounting base |
| 51 | Joint |
| 52 | Flow path |
| 53 | Ejection hole |
| 54 | Drum opening |
| 55 | Cover |
| 55a | Packing |
| 55b | Water duct |
| 55c | Notch |
| 55d | Discharge outlet |
| 55da | Discharge outlet |
| 55db | Discharge outlet |
| 55f | Screw |
| 56 | Guide surface |
| 57 | Guide surface |
| 58 | Guide surface |
| 59 | Guide surface |
| 60 | Curved surface |
| 60a | Curved surface |
| 60b | Curved surface |
| 60c | Curved surface |
| 61 | Guide surface |
| 62 | Guide surface |
| 63 | Guide surface front end |
| 64 | Guide surface |
| 64a | Guide surface |
| 65 | Extreme front end Extreme front end |
| 66 | Extreme front end |
| 67 | Guide |
| 68 | Rib |

## Claims

**1.** A drum type washing machine comprising:

a cabinet;
a bottomed cylindrical water tub having a water tub opening, placed inside the cabinet;
a bottomed cylindrical rotating drum having a drum opening, placed inside the water tub;
a motor attached to an outer bottom surface of the water tub for rotating the rotating drum on a rotation axis horizontal or tilted down toward the bottom of the rotating drum;
a circulation tube communicatively connecting a bottom side of the water tub with a side of the water tub opening for circulating washing water in the water tub from the bottom side to the side of the water tub opening; and
a plurality of ejection holes for ejecting the washing water circulated through the circulation tube toward the inside of the rotating drum.

**2.** The drum type washing machine of claim 1, wherein the washing water is ejected from the plurality of ejection holes in directions different from one another.

**3.** The drum type washing machine of claim 2, wherein the plurality of ejection holes are disposed to the right and left sides with respect to a perpendicular line passing through a center of the drum opening.

**4.** The drum type washing machine of claim 2, wherein the washing water ejected from each of the plurality of ejection holes has different diffusion angles.

**5.** The drum type washing machine of claim 2, wherein washing water is ejected simultaneously from the plurality of ejection holes.

**6.** The drum type washing machine of claim 2, wherein the washing water is ejected from the ejection holes into the rotating drum through between an inside surface of a front-surface wall of the water tub and an outside surface of a front-surface wall of the rotating drum.

**7.** The drum type washing machine of claim 1, further comprising:

a water duct at a front-surface wall of the water tub, connected to the circulation tube;
a plurality of discharge outlets in the water duct for discharging the washing water between an inside surface of the front-surface wall of the water tub and an outside surface of a front-surface wall of the rotating drum; and
a plurality of guide surfaces formed on the inside surface of the front-surface wall of the water tub

for guiding the washing water discharged from the discharge outlets to the ejection holes, wherein the guide surfaces have two or more different shapes.

**8.** The drum type washing machine of claim 7, wherein the plurality of guide surfaces are formed of slopes having two or more different gradient angles.

**9.** The drum type washing machine of claim 7, wherein the plurality of guide surfaces are formed of curved surfaces having two or more different curve radiuses.

**10.** The drum type washing machine of claim 7, wherein at least one of the plurality of guide surfaces is formed of a curved surface and a slope.

**11.** The drum type washing machine of claim 7, wherein at least one of the plurality of guide surfaces has a plurality of gradient angles.

**12.** The drum type washing machine of claim 7, wherein an extreme front end of each of the plurality of guide surfaces has a chamfered shape.

**13.** The drum type washing machine of claim 7, wherein an extreme front end of each of the guide surfaces has an arc-shaped rounded cross section with roundness.

**14.** The drum type washing machine of claim 7, wherein a rib for interfering with a flow of the washing water is provided inside the water duct near at least one of the plurality of discharge outlets inside the water duct.

**15.** The drum type washing machine of claim 1, further comprising:

a water duct at a front-surface wall of the water tub, connected to the circulation tube;
a plurality of discharge outlets in the water duct for discharging the washing water between an inside surface of the front-surface wall of the water tub and an outside surface of a front-surface wall of the rotating drum; and
a plurality of guide surfaces formed on the inside surface of the front-surface wall of the water tub for guiding the washing water discharged from the discharge outlets to the ejection holes,

wherein the plurality of discharge outlets have two or more different shapes.

**16.** The drum type washing machine of claim 15, wherein the plurality of discharge outlets have openings facing a rotation center of the rotating drum, and the openings have opening widths different from one another, the widths being circumferential sizes of the openings.

**17.** The drum type washing machine of claim 15, wherein the plurality of discharge outlets have openings facing a rotation center of the rotating drum, and the openings have opening distances different from one another, the distances being sizes in a direction perpendicular to a circumferential direction of the openings.

**18.** The drum type washing machine of claim 15, wherein at least one of the plurality of discharge outlets has an opening facing a direction shifted from a rotation center of the rotating drum.

**19.** The drum type washing machine of claim 15, wherein a rib for interfering with a flow of the washing water is provided inside the water duct near at least one of the discharge outlets inside the water duct.

FIG. 1

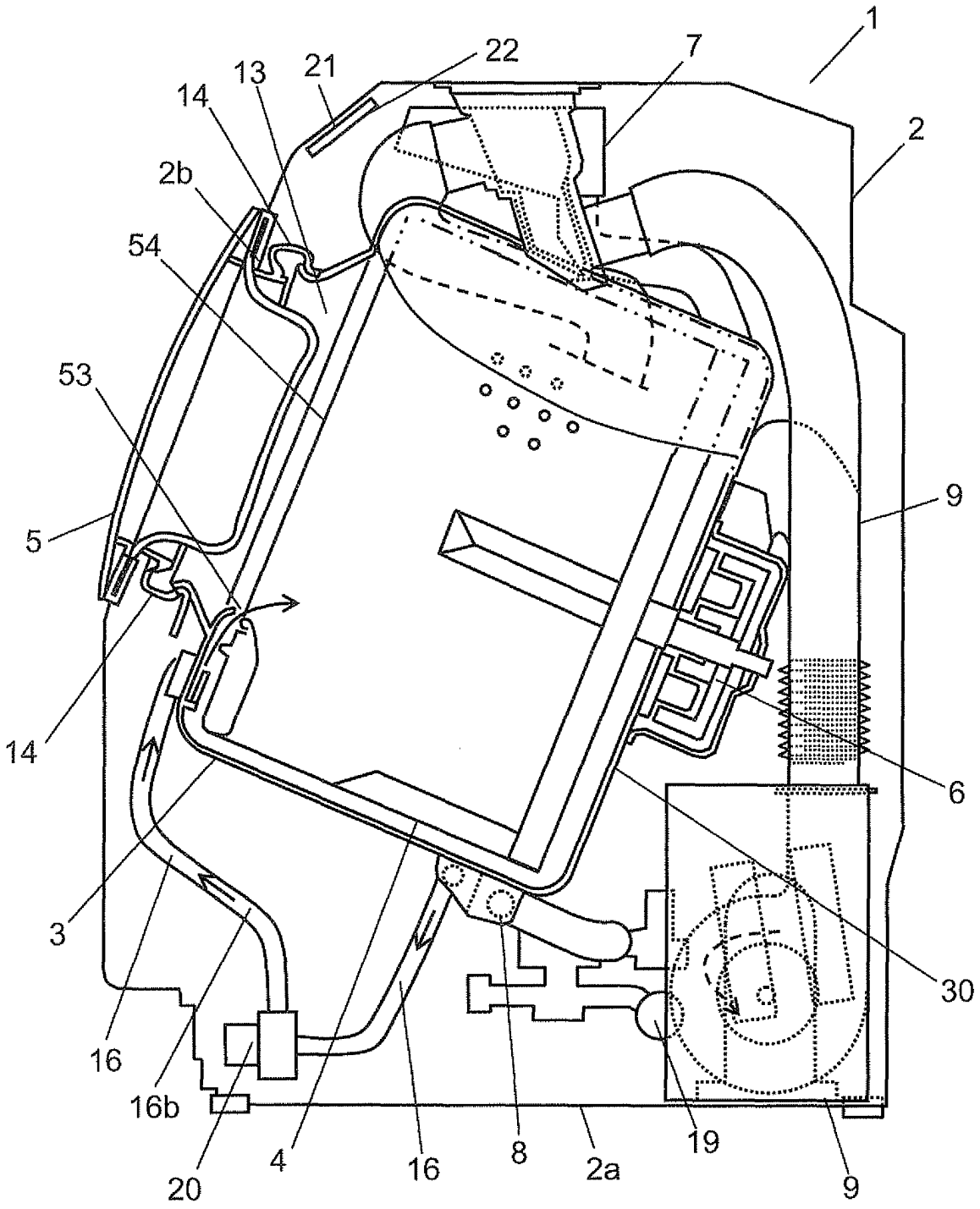


FIG. 2A

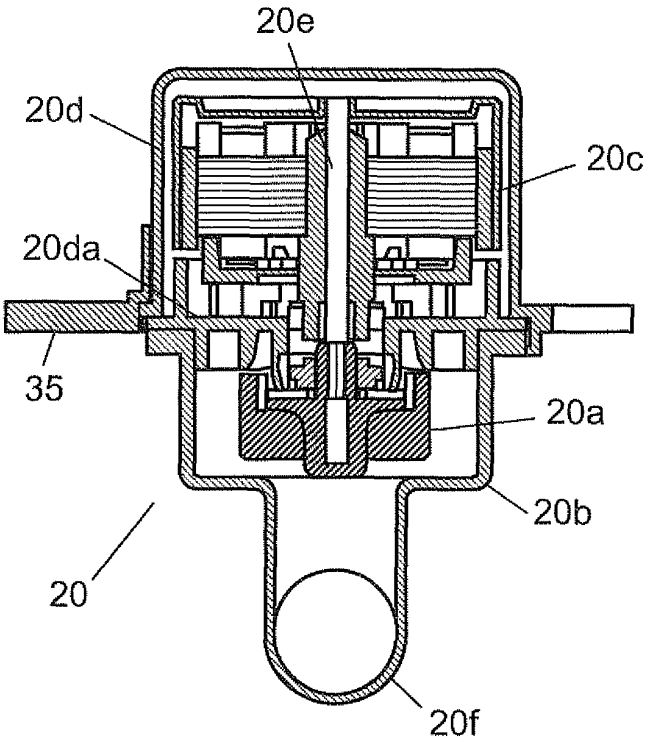



FIG. 2B

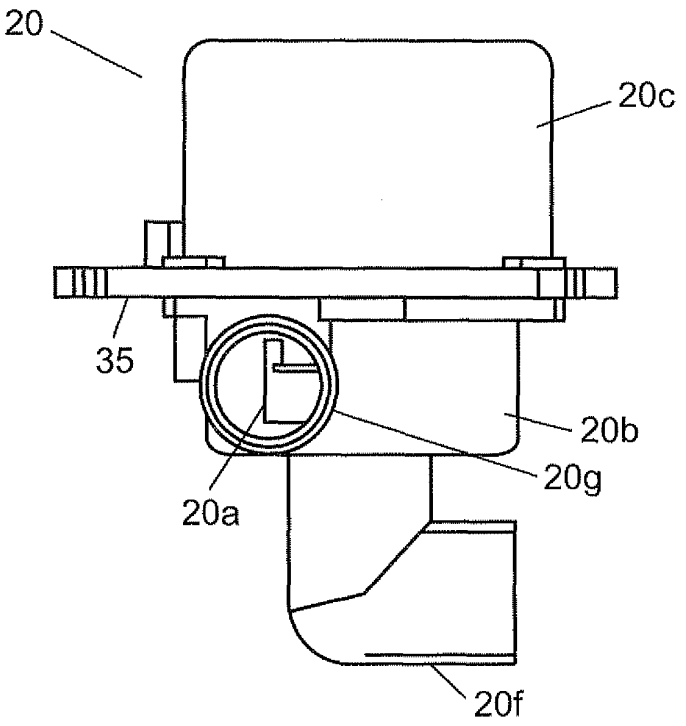


FIG. 3A

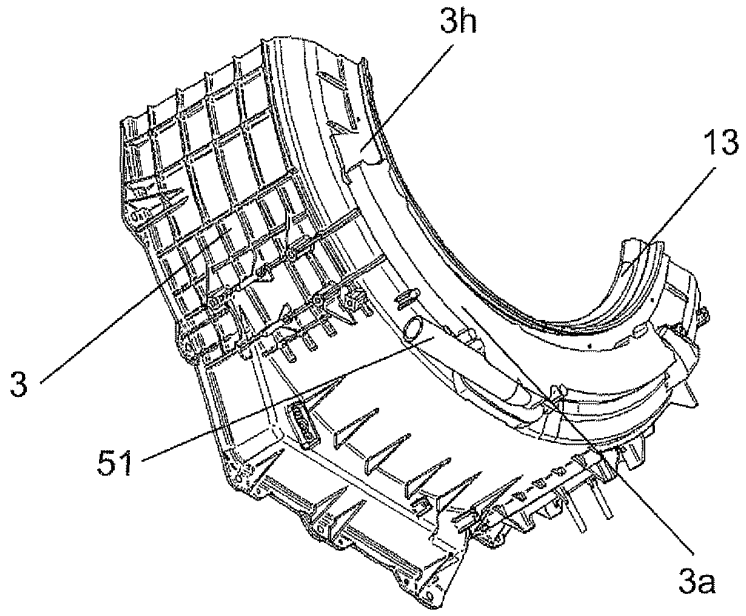



FIG. 3B

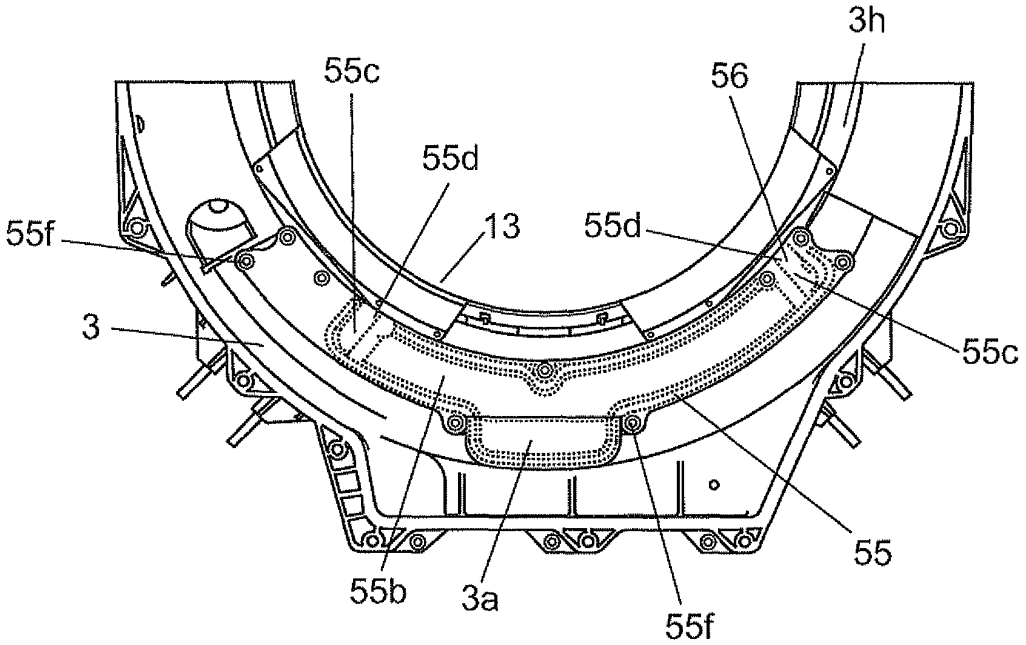


FIG. 4

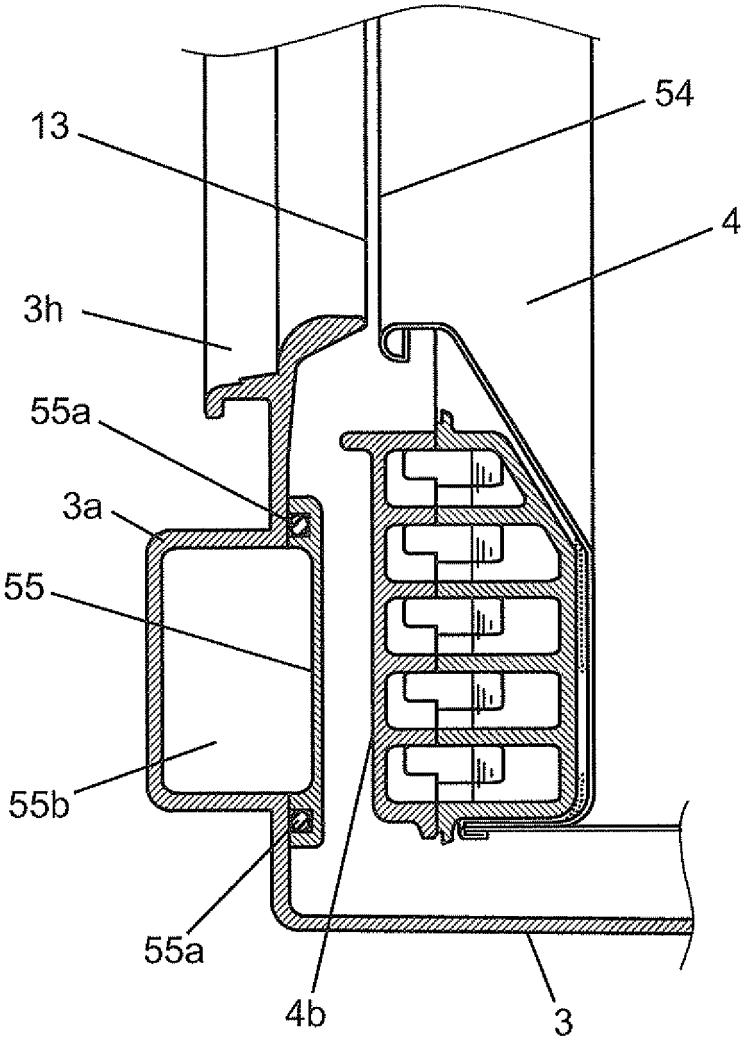


FIG. 5A

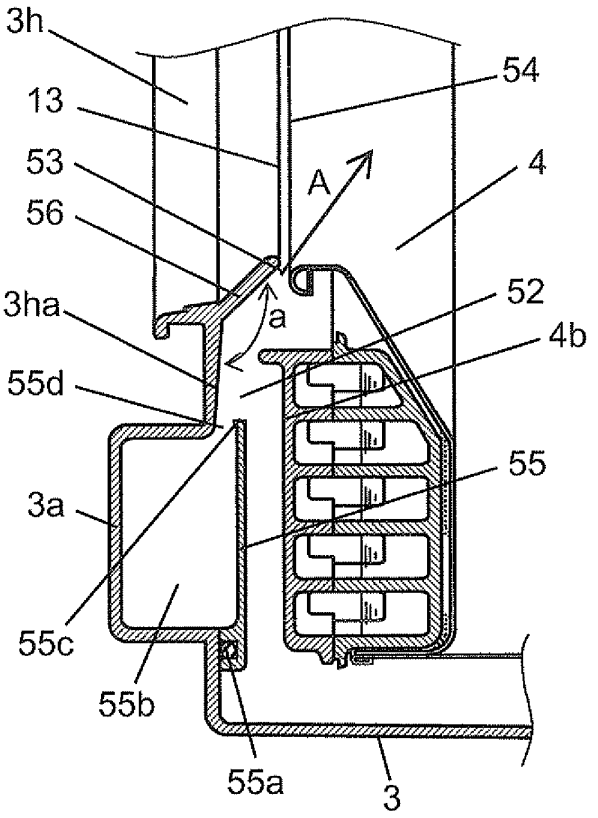

3h
13
53
56
3ha
55d
3a
55c
55b
55a
3
54
A
4
a
52
4b
55

FIG. 5B

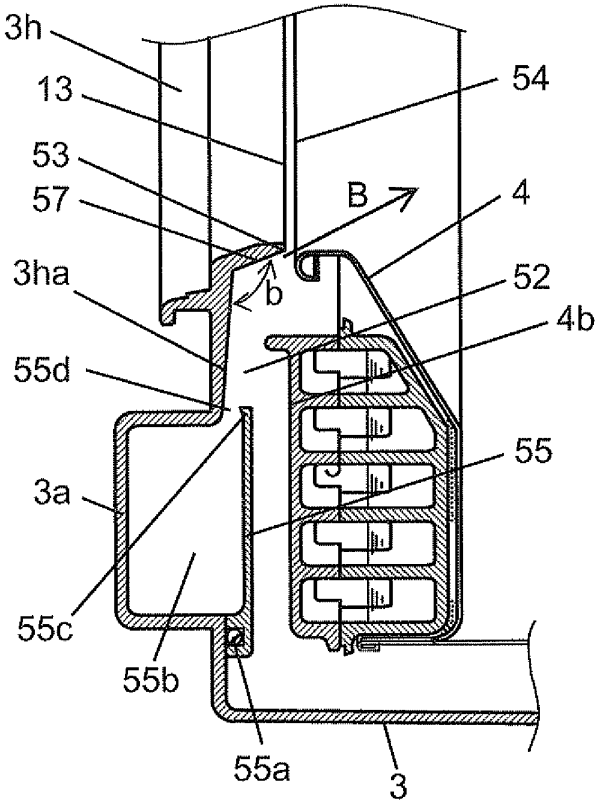

3h
13
53
57
3ha
55d
3a
55c
55b
55a
3
54
B
4
b
52
4b
55

FIG. 6

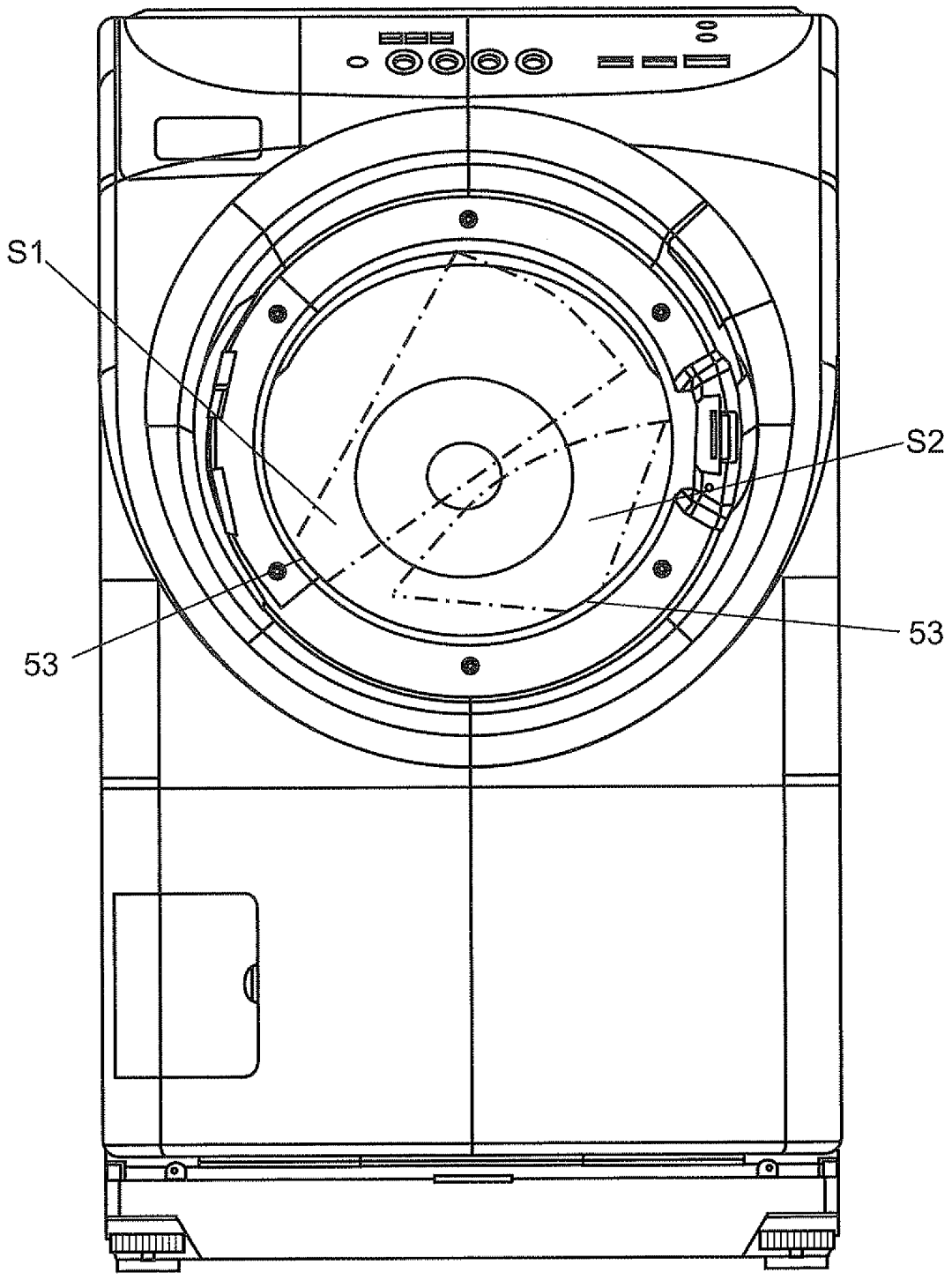


FIG. 7A

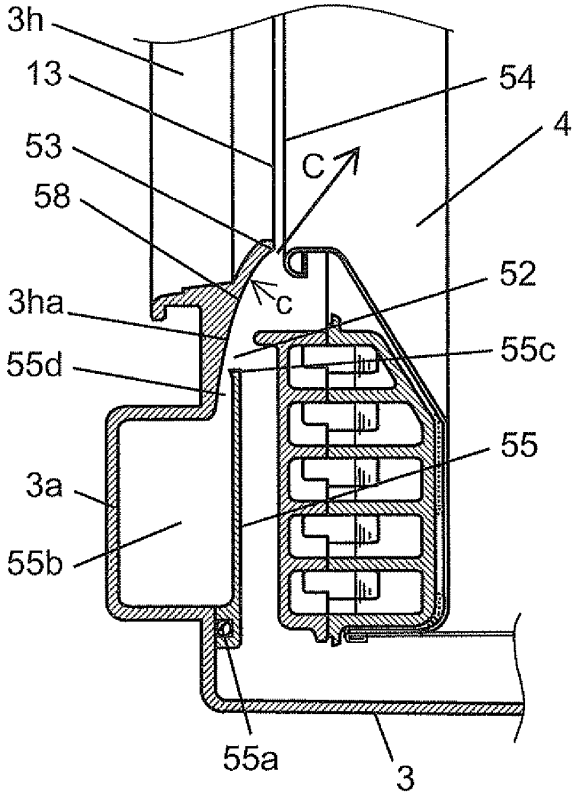

3h
13
53
58
3ha
55d
3a
55b
55a
3
54
4
C
c
52
55c
55

FIG. 7B

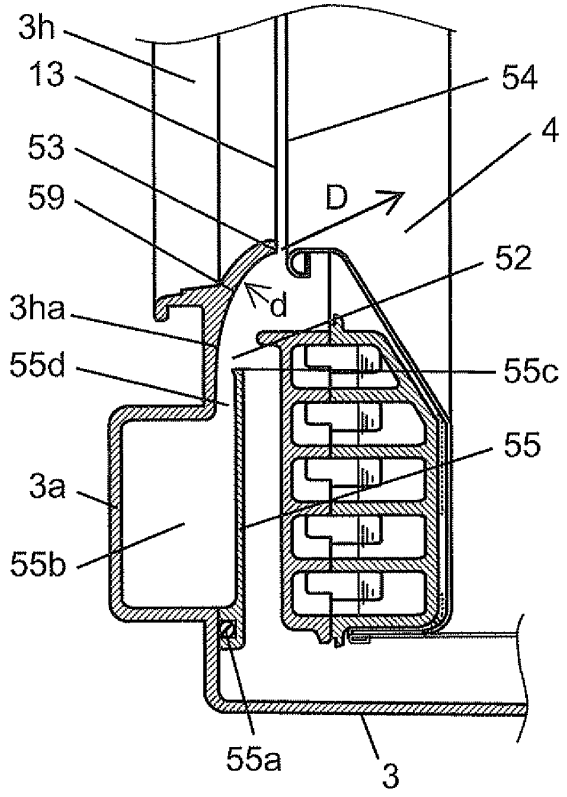

3h
13
53
59
3ha
55d
3a
55b
55a
3
54
4
D
d
52
55c
55

FIG. 8

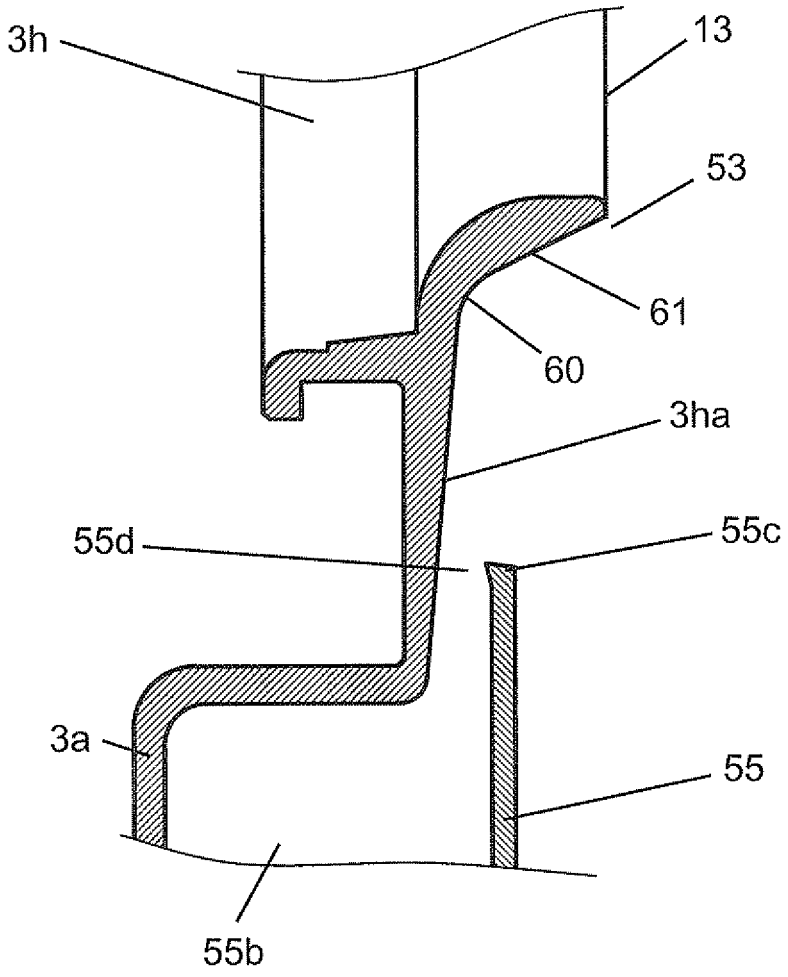


FIG. 9

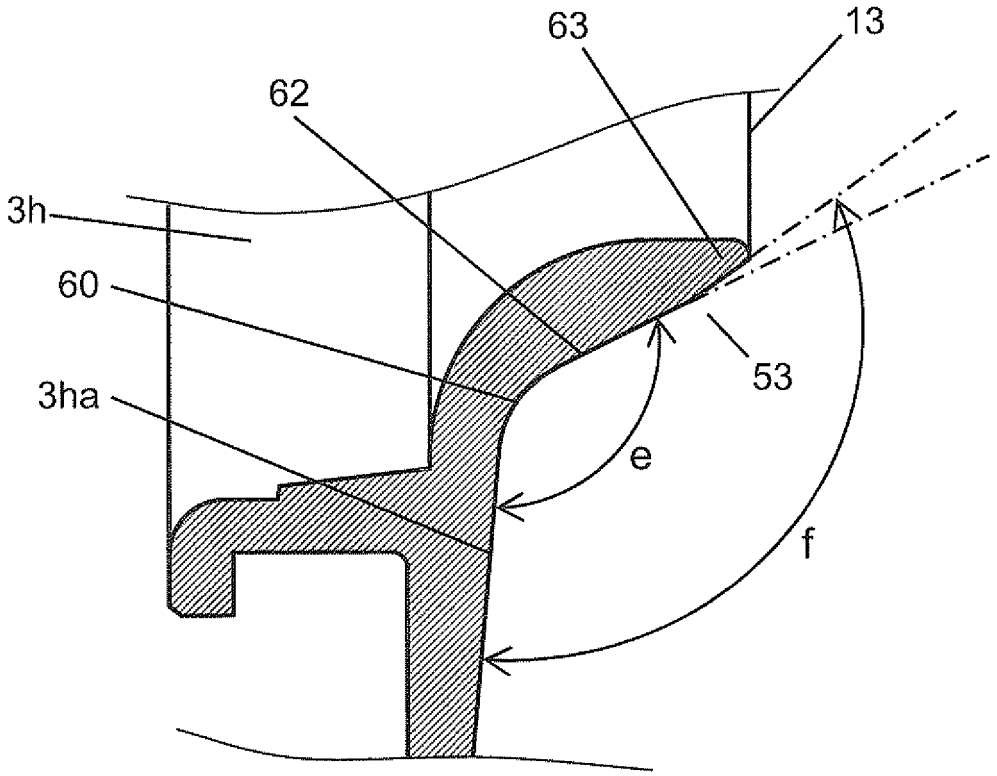


FIG. 10A

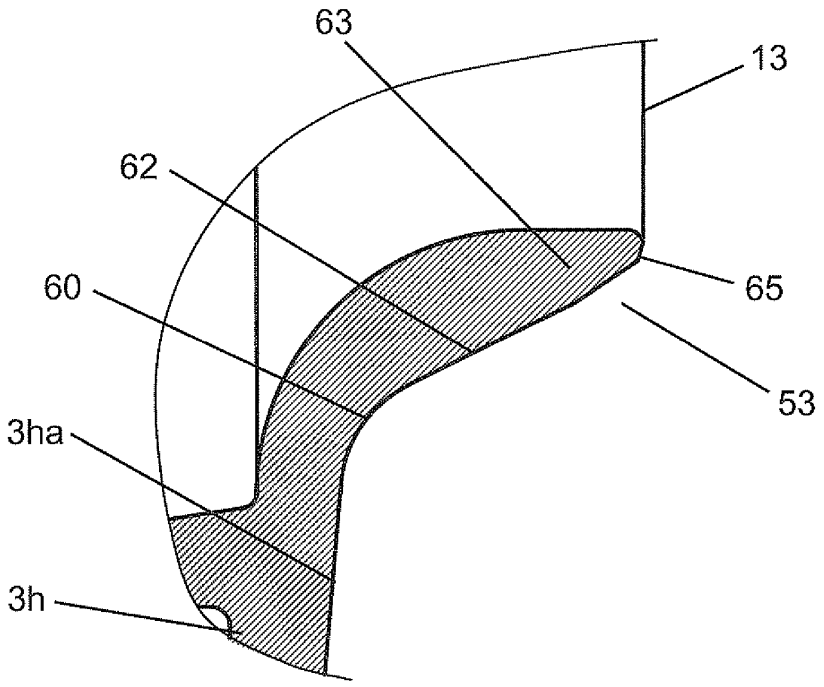



FIG. 10B

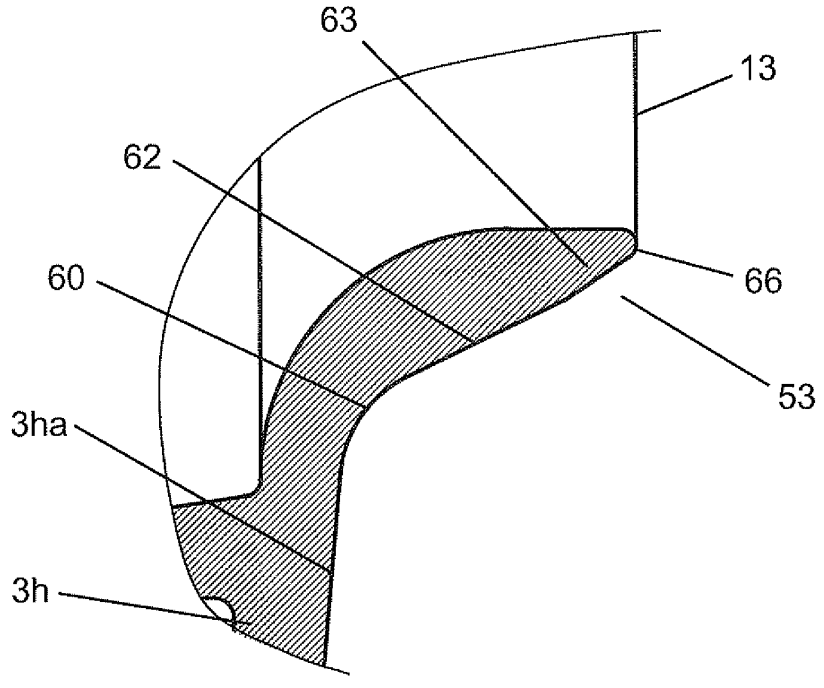


FIG. 11

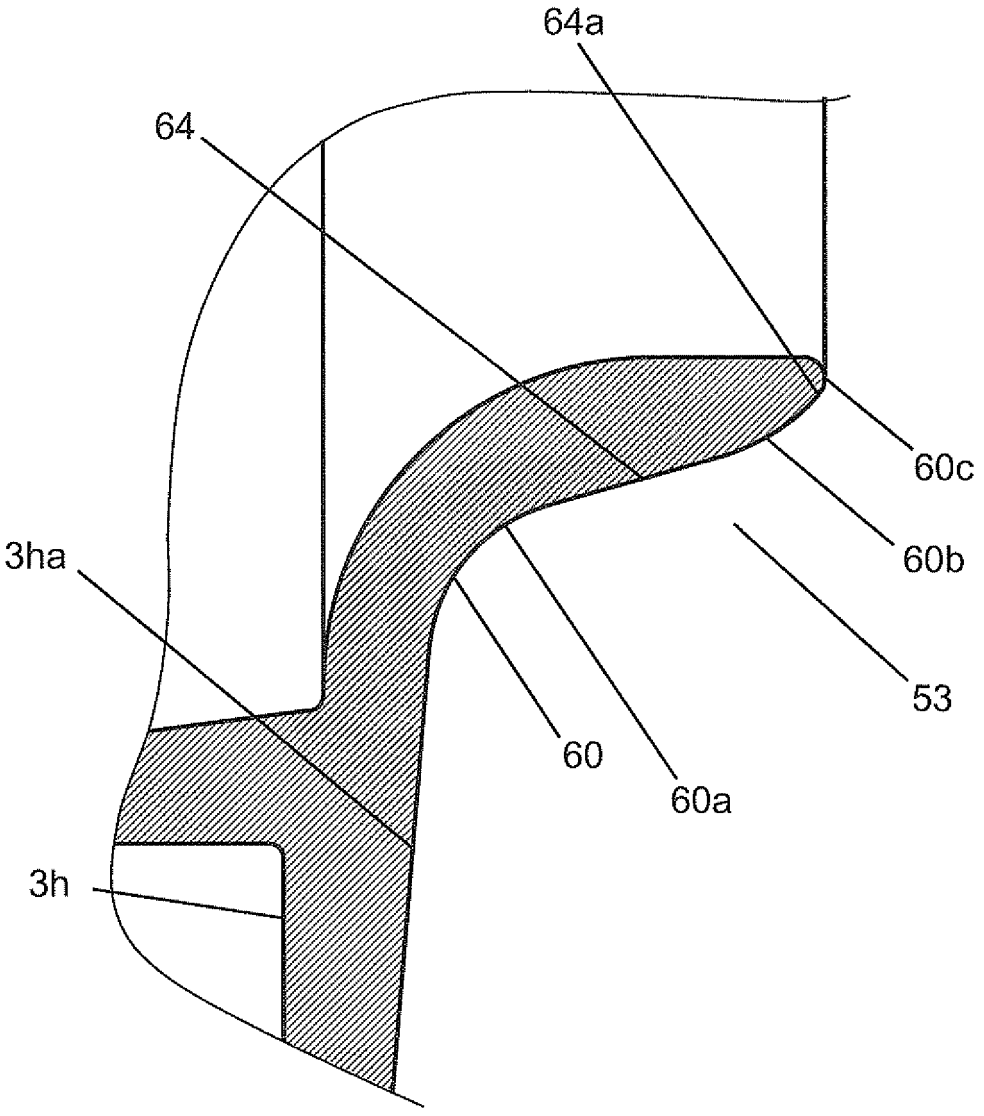


FIG. 12

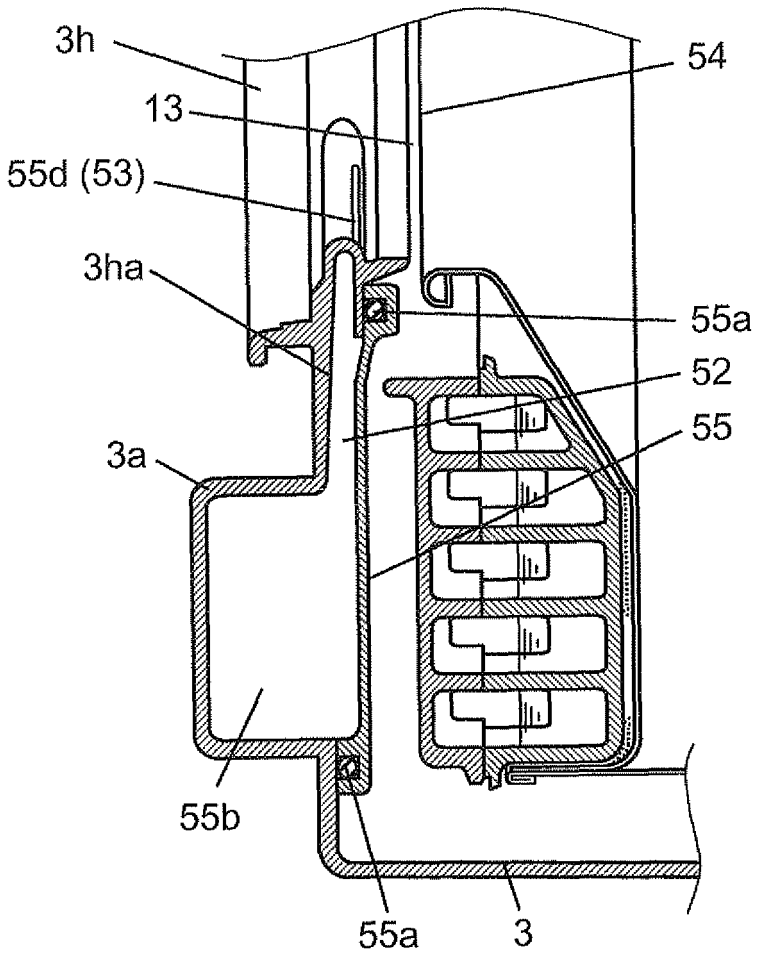


FIG. 13

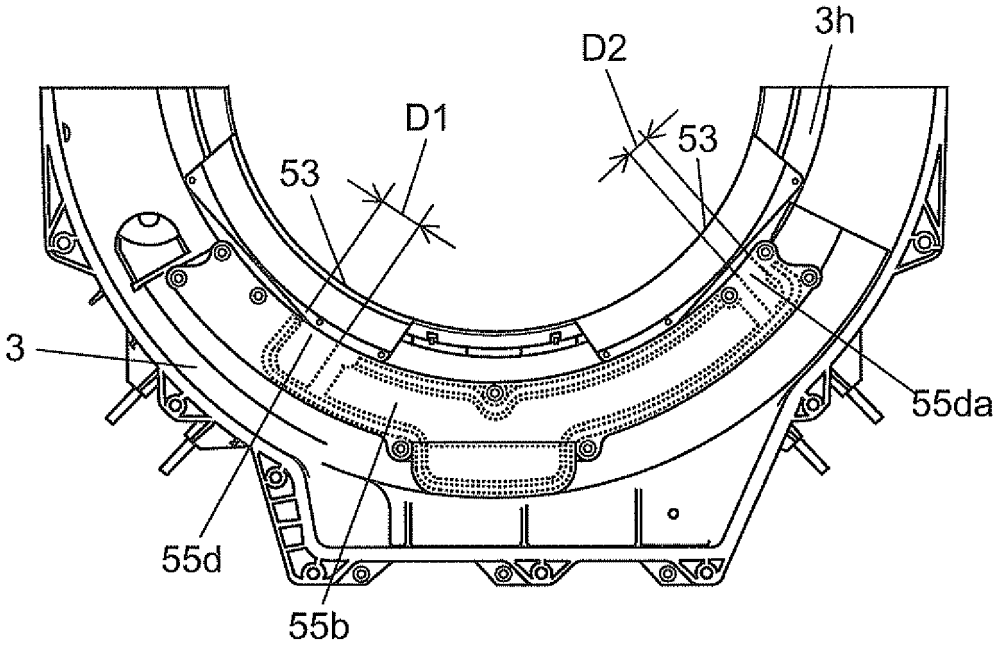


FIG. 14A

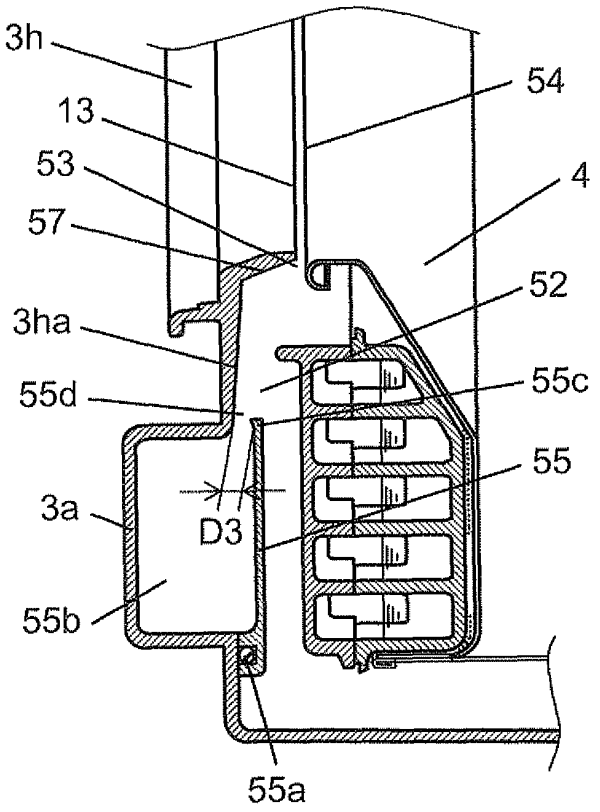



FIG. 14B

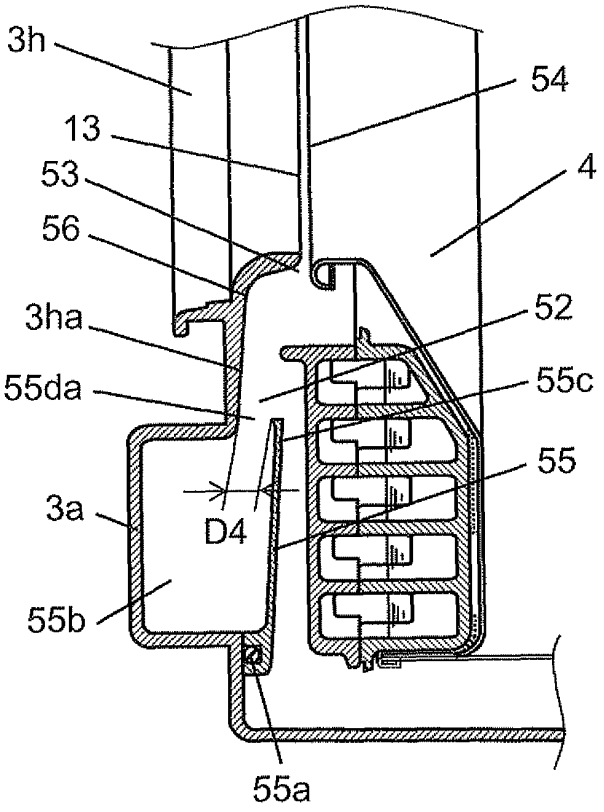


FIG. 15A

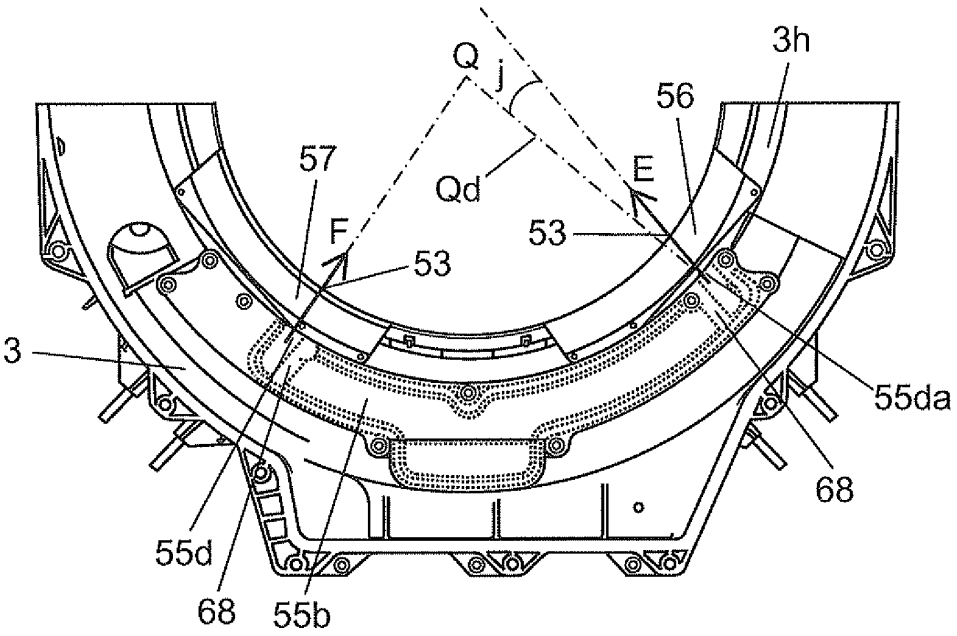



FIG. 15B

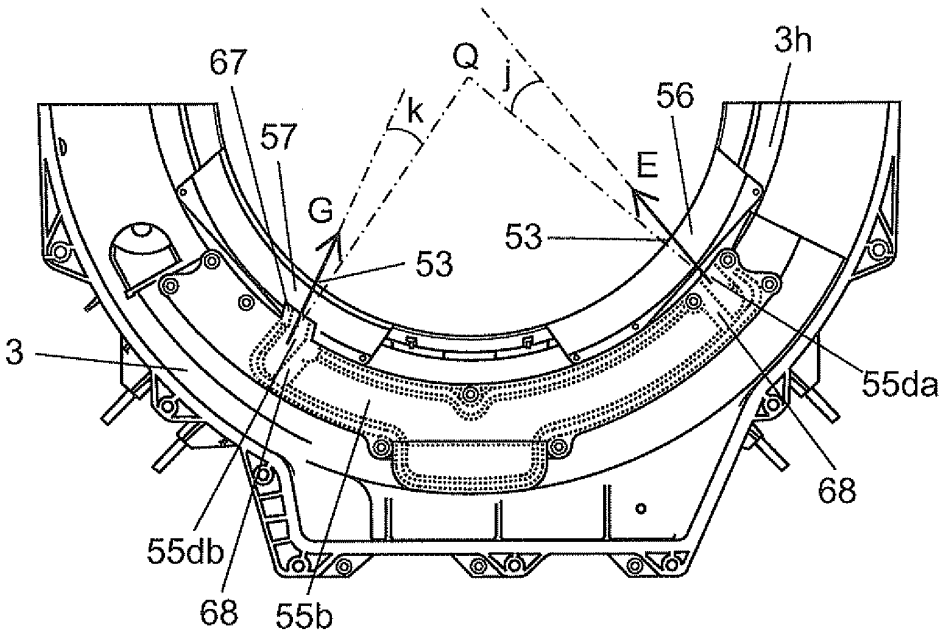


FIG. 16A

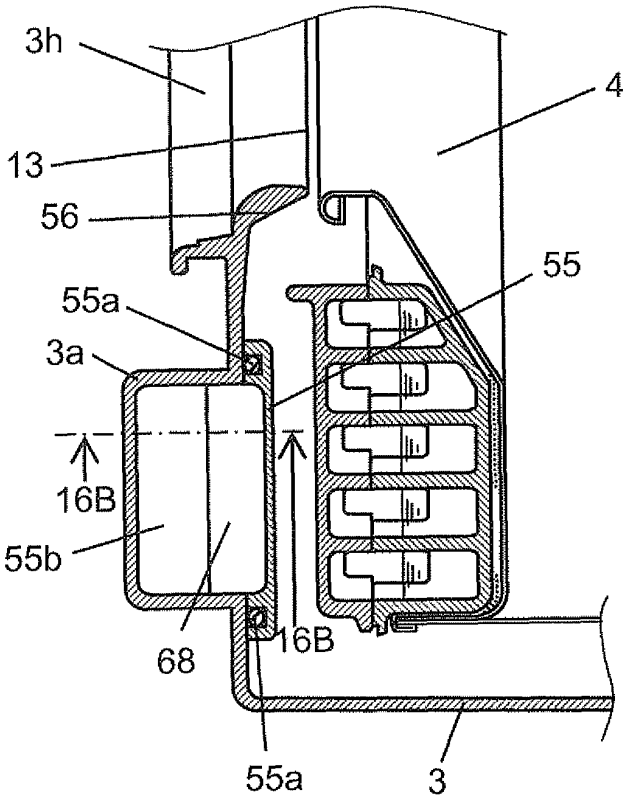
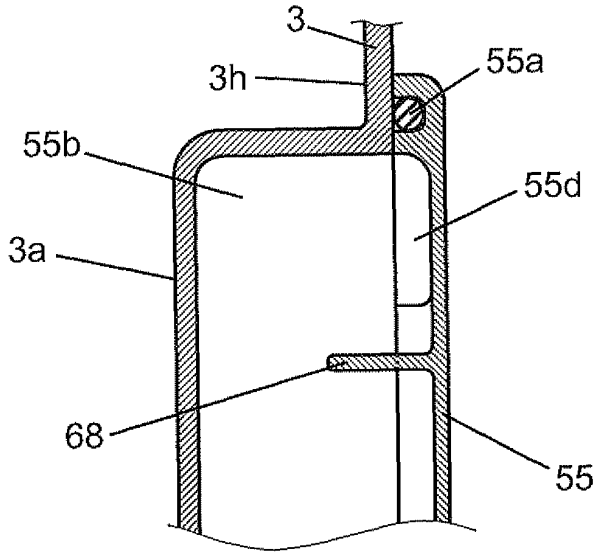



FIG. 16B



**INTERNATIONAL SEARCH REPORT**

International application No.
PCT/JP2010/005097

A. CLASSIFICATION OF SUBJECT MATTER
*D06F39/08*(2006.01)i, *D06F37/04*(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)
D06F39/08, D06F37/04

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 1996-2010
Kokai Jitsuyo Shinan Koho 1971-2010 Toroku Jitsuyo Shinan Koho 1994-2010

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X<br>Y<br>A | JP 2008-73128 A (Hitachi Appliances, Inc.),<br>03 April 2008 (03.04.2008),<br>paragraphs [0009] to [0047]; fig. 1, 4<br>(Family: none) | 1-4<br>5-6,15-19<br>7-14 |
| Y<br>A | JP 9-299684 A (Matsushita Electric Industrial Co., Ltd.),<br>25 November 1997 (25.11.1997),<br>paragraphs [0018] to [0030]; fig. 4<br>& TW 417702 Y & IN 191871 A<br>& CN 1165885 A | 5<br>1-4,6-19 |
| Y<br>A | JP 2006-192249 A (LG Electronics Inc.),<br>27 July 2006 (27.07.2006),<br>paragraphs [0045] to [0052]; fig. 4<br>& US 2006/0150687 A1 & EP 1679401 A2<br>& KR 10-2006-0081745 A & CN 1804190 A | 6,15-19<br>1-5,7-14 |

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 25 October, 2010 (25.10.10) | 02 November, 2010 (02.11.10) |
| Name and mailing address of the ISA/<br>Japanese Patent Office<br><br>Facsimile No. | Authorized officer<br><br>Telephone No. |

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

**INTERNATIONAL SEARCH REPORT**

International application No.
PCT/JP2010/005097

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 7-231994 A (Sharp Corp.), 05 September 1995 (05.09.1995), paragraphs [0012] to [0046]; fig. 1, 2 (Family: none) | 1-19 |

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

**INTERNATIONAL SEARCH REPORT**

International application No.
PCT/JP2010/005097

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

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

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

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

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

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

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

The search revealed that the invention in claim 1 is not novel, since the invention is disclosed in JP 2008-73128 A (Hitachi Appliances, Inc.), 3 April 2008 (03.04.2008), paragraphs [0009] - [0047], fig. 1, fig. 4.

Therefore, there is no matter common to all of the inventions in claims 1 - 19.

(continued to extra sheet)

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

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

**Remark on Protest**

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2010/005097

Continuation of Box No.III of continuation of first sheet(2)

Since there is no other common matter considered to be a special technical feature in the meaning of the second sentence of PCT Rule 13.2, any technical relationship in the meaning of PCT Rule 13 cannot be found among the inventions in claims 1 - 3, claim 4, claim 5, claim 6, and claims 7 - 19.

Consequently, it is obvious that the inventions in claims 1 - 19 do not comply with the requirement of unity of invention.

In conclusion, the number of the inventions in this international application is five as follows.

Claims 1 - 3, claim 4, claim 5, claim 6, claims 7 - 19

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## REFERENCES CITED IN THE DESCRIPTION

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### Patent documents cited in the description


- JP H10127978 B **[0006]**
- JP 2008073128 A **[0006]**