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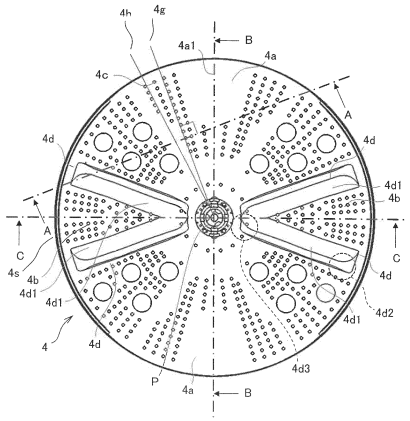
(54) WASHING MACHINE AND ROTATING BLADE PANEL FOR WASHING MACHINES

(57) In a washing machine having drying air discharged from above a washing and dewatering tub toward a rotating blade panel, a rotating blade panel (4) is provided on an upper surface thereof with raised sectors (4a), trough sectors (4b), and intermediate sectors (4c) each provided between the raised sector (4a) and the trough sector (4b). The trough sectors (4b) each have two ridges (4d) radially extending from an outer circumferential end toward an inner circumferential end. The two ridges (4d) form a tapered shape of circumferentially coming closer to each other toward the inner circumferential end. A bottom (4b1) between the two ridges (4d) is formed to have a gently curved surface.

FIG. 3



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Description

TECHNICAL FIELD

[0001] The present invention relates to a washing machine and a rotating blade panel to be used for washing machines.

BACKGROUND ART

[0002] A washing machine vertically having a washing tub is provided with a rotating blade panel at a bottom in the washing tub so that the rotating blade panel is rotated clockwise and counterclockwise for washing. Patent Document 1 discloses a rotating blade panel in a shape of a concave slope being non-continuously connected with a convex slope in order to apply an upward component force to a wash by rotation so that a slope angle decreases from the concave slope to the convex slope.

PRIOR ART

Patent Documents

[0003] Patent Document 1: Japanese Patent Application Publication No. 2015-204932

SUMMARY OF THE INVENTION

Problems to be solved

[0004] Patent Document 1 has a structure of a trough portion and a slope portion formed on the rotating blade panel boosting vertical turnover of a wash, to reduce uneven drying. However, this structure has been made with no consideration of a wash having wrinkes while being dried.

[0005] The present invention is intended to solve the above-identified problems and provide a washing machine and a rotating blade panel to prevent uneven drying and to prevent a wash from having wrinkles.

Solution to Problems

[0006] A washing machine includes: a washing tub; a rotating blade panel provided at a bottom in the washing tub; an outer tub configured to contain the washing tub and store washing water; a driving unit configured to rotate the washing tub and the rotating blade panel; and a discharge outlet through which drying air is discharged from above the washing tub toward the rotating blade panel, wherein the rotating blade panel is provided on an upper surface thereof with raised sectors, trough sectors, and intermediate sectors each provided between the raised sector and the trough sector, the trough sectors each have at least two ridges radially extending from an outer circumferential end toward an inner circumferential end, the two ridges of the at least two ridges form a tapered shape of circumferentially coming closer to each other from the outer circumferential end toward the inner circumferential end, and a bottom of the rotating blade panel between the two ridges is formed to have a gently curved surface.

[0007] Alternatively, a washing machine includes: a washing tub; a rotating blade panel provided at a bottom in the washing tub; an outer tub configured to contain the washing tub and store washing water; and a driving unit configured to rotate the washing tub and the rotating blade panel, wherein the rotating blade panel has an intermediate sector, a trough sector positioned lower than the lowest position of the intermediate sector, and a raised sector positioned higher than the highest position of the intermediate sector, the raised sector has a convex slope, the trough sector has a concave slope, the intermediate sector has a slope and is continuously connected to the trough sector and the raised sector, and the slope of the intermediate sector is formed to have a slope angle at a portion thereof closer to the raised sector being greater than that at a portion thereof closer to the trough sector.

Advantageous Effects of the Invention

[0008] The present invention provides a washing machine to prevent uneven drying and to prevent a wash from having crumpled.

BRIEF DESCRIPTION OF DRAWINGS

[0009]

FIG. 1 is a vertical cross-sectional view on the right side of a washing machine provided with a rotating blade panel according to an embodiment of the present invention;

FIG. 2 is a perspective view of the rotating blade panel to be provided in the washing machine of the embodiment;

FIG. 3 is a plan view of the rotating blade panel to be provided in the washing machine of the embodiment;

FIG. 4 is a cross-sectional view, taken along a line A-A in FIG. 3;

FIG. 5 is a cross-sectional view, taken along a line B-B in FIG. 3;

FIG. 6 is a perspective view of a bottom side of the rotating blade panel of the embodiment; and

FIG. 7 is a cross-sectional view, taken along a line C-C in FIG. 3.

DETAILED DESCRIPTION

[0010] Hereinbelow, a description is given in detail of an embodiment of the present invention, with reference to the drawings as required. Note that the description illustrates the invention with a washing machine S (so-

called vertical washing machine/dryer combo) capable of washing, rinsing, dewatering, and drying.

[0011] FIG. 1 is a vertical cross-sectional view on the right side of a washing machine provided with a rotating blade panel according to the embodiment. As shown in FIG. 1, the washing machine S includes an outer frame 1 as a housing, an outer tub 2 to store washing water, a washing and dewatering tub (washing tub) 3, a rotating blade panel (pulsator) 4, and a driving motor (driving unit) 10.

[0012] The outer frame 1 is made of a plate metal (iron plate) formed into a square cylinder shape by stamping or the like. The outer frame 1 is provided, under thereof, with a base 32 made of synthetic resin. In addition, the outer frame 1 is provided thereon with a top cover (top plate) 6 made of synthetic resin. Note that a reinforcing member is used inside the outer frame 1 to reinforce the outer frame 1. Additionally, the base 32 is reinforced with a grid-like rib or the like provided therein.

[0013] The outer tub 2 is made of synthetic resin, has a substantially bottomed cylinder shape, and is supported, via a vibration-proofing device, within the outer frame 1 at the center. The vibration-proofing device is made of rubber or elastic rubber, and hangs and supports the outer tub 2 from an upper portion inside the outer frame 1.

[0014] The washing and dewatering tub (washing tub) 3 has a bottomed cylindrical shape to place a wash (clothes) to be washed, dewatered, and dried. In addition, the washing and dewatering tub 3 has an axis of rotation oriented substantially in a vertical direction. Further, the washing and dewatering tub 3 is provided at the center inside the outer tub 2 and rotatably supported in the outer tub 2. Still further, the washing and dewatering tub 3 has many small through-holes 3a (FIG. 1 shows only some of them) in a circumferential wall thereof for passing water and air. Still further, the washing and dewatering tub 3 has through-holes 3b at a bottom wall thereof for passing water and air. Still further, the washing and dewatering tub 3 has a fluid balancer 3c provided at an upper end thereof. Still further, the washing and dewatering tub 3 has the rotating blade panel 4 rotatably provided at a bottom thereof, to stir washing water for washing or rinsing.

[0015] The rotating blade panel 4 is repeatedly rotated clockwise and counterclockwise during washing and drying. In addition, the rotating blade panel 4 is rotated at a high speed during dewatering, along with the washing and dewatering tub 3 and in conjunction with a wash in the washing and dewatering tub 3, to dewater moisture in a wash by centrifugal force. Note that the rotating blade panel 4 is described below in detail.

[0016] The driving motor 10 is provided in the outer frame 1 and selectively rotates the rotating blade panel 4 and the washing and dewatering tub 3. A DC brushless motor is used as the driving motor 10, for example. A DC brushless motor is controlled by vector control. The driving motor 10 may directly drive the rotating blade panel 4 and the washing and dewatering tub 3, or may employ a speed reduction mechanism, such as a belt, for the driving.

[0017] An outer lid 5 is provided above the outer frame 1 so as to be freely opened and closed. The outer lid 5 is axially supported, at a rear side thereof, by the top cover 6 provided at a top of the outer frame 1. An inner lid 34 is provided above the outer tub 2 but below the outer lid 5 so as to be opened and closed about an axis at a rear side thereof. A wash is taken in and out of the washing and dewatering tub 3 by opening the outer lid 5 and the inner lid 34.

[0018] A water supply unit 7 is provided in the outer frame 1, behind the outer lid 5 of the top cover 6. The water supply unit 7 has a water supply box (not shown) having water channels inside. The water supply unit 7 has water supplied from a water supply hose connection port 8 protruding upward from the top cover 6. Tap water or bath water is supplied from the water supply hose connection port 8 and poured into the outer tub 2. In addition, a detergent and finishing agent dispenser 35 is provided on a front side of the top cover 6. The detergent and finishing agent are poured between the outer tub 2 and the washing and dewatering tub 3 by a charging hose 36.

[0019] The washing machine S additionally includes a drying mechanism 9 for drying a wash. The drying mechanism 9 circulates and dehumidifies the drying air for drying a wash in the washing and dewatering tub 3. The drying mechanism 9 is mostly occupied by a drying air circulation path. The drying air circulation path includes a bottom circulation path 20 communicating with the bottom of the outer tub 2 and a dehumidifying vertical path 21 extending upward from the bottom circulation path 20.

[0020] The drying mechanism further includes a blower 22 and a heater (not shown) for producing dry air in a drying step of the washing machine S. The blower 22 has an inlet at a bottom thereof, which is connected to an upper end of the dehumidifying vertical path 21. A drying filter 45 is arranged between the blower 22 and the dehumidifying vertical path 21 to prevent foreign matter from flowing into the blower 22. The blower 22 has an outlet at a front of thereof, which is connected to and communicates with a return-connection circulation path 25. The return-connection circulation path 25 communicates with an upper portion of the outer tub 2 via an upper bellows hose 23 as a part thereof. The return-connection circulation path 25 is formed with a discharge port 23a for discharging the dry air into the washing and dewatering tub 3. The dry air is discharged through the upper bellows hose 23 from the discharge port 23a into the washing and dewatering tub 3 downward in the vertical direction, as indicated by an arrow in FIG. 1, so as to be blown to an outer circumferential region of the rotating blade panel 4.

[0021] The bottom circulation path 20 communicates with a bottom of the outer tub 2 via a lower bellows hose 26 as a part thereof. The lower bellows hose 26 is connected to a recessed bottom portion 31 of the outer tub 2. The recessed bottom portion 31 communicates with a

washing water drainage 42 for draining via a normally closed drain valve 44 to be opened only at the time of drainage.

[0022] The drain valve 44 is closed during washing operation and drying operation. The drain valve 44 opens at the time of draining the washing water to drain the water for washing or rinsing stored in the outer tub 2 through the washing water drainage 42 to the outside of the washing machine S (outside the machine).

[0023] The washing machine S includes a water level sensor 47 to detect a water level of the water for washing or rinsing stored in the outer tub 2. An air trap 50 is provided in vicinity to the bottom of the outer tub 2. An air tube 49 is communicably connected with the air trap 50, and the air tube 49 is communicably connected, at an upper end thereof, with the water level sensor 47.

[0024] The water for washing or rinsing stored in the outer tub 2 flow through circulation water channels 51a and 61a into circulation water channels 51b and 61b, and flow upward in the circulation water channels 51b and 61b. The washing water flowed upward in the circulation water channel 51b has lint removed by a lint filter 33 and enters the washing and dewatering tub 3. On the other hand, the washing water flowed upward in the circulation water channel 61b is showered from a slit-shaped discharge port 61c in and around the center of the washing and dewatering tub 3.

[0025] Next, a description is given in detail of the rotating blade panel 4. The rotating blade panel 4 is rotatably arranged in the center at the bottom of the washing and dewatering tub 3 (see FIG. 1). The rotating blade panel 4 is provided with protrusions formed with slopes to repeatedly apply an upward component force by rotation to a wash put on the rotating blade panel 4. The washing and dewatering tub 3 and the rotating blade panel 4 are configured to be selectively driven rotationally by the driving motor 10 (driving unit).

[0026] FIG. 2 is a perspective view of the rotating blade panel. As shown in FIG. 2, an upper surface of the rotating blade panel 4 includes raised sectors 4a, trough sectors 4b, and intermediate sectors 4c each provided between the raised sector 4a and the trough sector 4b. The present embodiment is provided with the two raised sectors 4a formed at positions facing each other across a rotation center (center area) P of the rotating blade panel 4, the two trough sectors 4b formed at positions facing each other across the rotation center P of the rotating blade panel 4, and the four intermediate sectors 4c connecting the raised sectors 4a with the trough sectors 4b.

[0027] In the rotating blade panel 4 of the present embodiment, the raised sector 4a and the intermediate sector 4c are continuously connected with each other. Likewise, the intermediate sector 4c and the trough sector 4b are continuously connected with each other. Note that such a condition of being continuously connected with each other means, in the present embodiment, that the surfaces are continuous at positions where the raised sector 4a shifts to the intermediate sector 4c and where the intermediate sector 4c shifts to the trough sector 4b.

[0028] The raised sector 4a has a convex slope 4a2 including a ridge line which is relatively high with respect to the center area (around the rotation center), and having both sides in a circumferential direction of the rotating blade panel 4 continuously sloping downward. That is, the raised sector 4a has a ridge line 4a1 having the highest position thereof in the center in the circumferential direction. Note that the raised sector 4a has a substantially sector shape in plan view (see FIG. 3 to be described below).

[0029] As described above, the rotating blade panel 4 is provided with a plurality of (two in the embodiment) the raised sectors 4a, each formed of a gentle slope (convex slope 4a2) to repeatedly apply an upward component force by rotation to a wash loaded on the rotating blade panel 4.

[0030] The trough sector 4b has a bottom 4b1 (concave slope, concave curved surface in a trough shape) including an area relatively lower than the center area (around the rotation center) and having both sides in the circumferential direction continuously sloping upward. The bottom 4b1 has a so-called bowl shape having a low center portion in the radial direction and high radially inner and outer portions with respect to the low center portion. The trough sector 4b is wider in the circumferential direction than the raised sector 4a. Note that the trough sector 4b also has a substantially sector shape in a plan view, as with the raised sector (see FIG. 3 to be described below).

[0031] The rotating blade panel 4 has two (two or more) ridges 4d in the trough sector 4b (foot of the raised sector 4a). The ridges 4d are arranged one by one on both sides in the circumferential direction of, at positions symmetrical with respect to, a bottommost portion 4b2. Additionally, the rotating blade panel 4 is provided with the two additional ridges 4d (a set of the ridges 4d) at positions symmetrical with respect to the rotation center P. As described above, the present embodiment is provided with the four ridges 4d in total (two sets of the ridges 4d, or two pairs of the ridges 4d).

[0032] The ridge 4d has a ridge slope 4d1 gently sloping down toward the bottommost portion 4b2 of the trough sector 4b. Here, the two ridges 4d are respectively provided, on side surfaces thereof facing each other, with the ridge slopes 4d1.

[0033] In addition, the ridge 4d has a side surface 4d5, standing substantially perpendicular to a surface of the trough sector 4b, on an opposite side in the circumferential direction thereof to the ridge slope 4d1. This causes a wash to be easily agitated by the side surfaces 4d5 when the rotating blade panel 4 is rotated.

[0034] The rotating blade panel 4 is formed, on the upper surface thereof, with a plurality of curved projections 4e in a spherical dome shape. The curved projections 4e are dispersedly arranged in the trough sectors 4b. The curved projections 4e thus arranged vertically shake a wash, to have an effect of improving detergency.

[0035] In addition, the rotating blade panel 4 is provided, on the upper surface thereof, with many through-holes 4f on both sides in the circumferential direction of the raised sectors 4a and at the trough sectors 4b, for passing water and air. Here, the through-hole 4f is not arranged in any of a crest area, which is in vicinity to the ridge line 4a1 of the raised sector 4a, the ridge 4d, and the curved projection 4e. Not having the through-hole 4f in the vicinity of the ridge line 4a1 or in the ridge 4d allows for suppressing engagement with a wash, to lead to a wash having less fabric damage. Additionally, not having the through-hole 4f in the ridge 4d allows for preventing flow of dry air from being disturbed.

[0036] FIG. 3 is a plan view (top view) of the rotating blade panel. As shown in FIG. 3, the two ridges 4d (a set of the ridges 4d) are each formed to extend linearly from an outer circumferential end (outermost circumferential end) 4d2 of the rotating blade panel 4 to an inner circumferential end 4d3 of the rotating blade panel 4. In addition, the two ridges 4d are arranged so as to be circumferentially farthest from each other at the outer circumferential end 4d2 and circumferentially closest to each other at the inner circumferential end 4d3. In other words, the two ridges 4d are arranged so as to form a tapered shape of circumferentially coming closer to each other toward radially inner ends thereof (so as to form a V-shape or an inverted V-shape in plan view).

[0037] Further, the two ridges 4d are formed to have the two ridge slopes 4d1 contacted and united with each other at the inner circumferential end 4d3.

[0038] The intermediate sector 4c is formed to have a predetermined angular range (e.g., 5 degrees) in the circumferential direction, and is located between the raised sector 4a and the trough sector 4b. The raised sector 4a and the intermediate sector 4c are connected to each other via a raised boundary 4g. The raised boundary 4g extends linearly in the radial direction from the rotation center P, when viewed from above. The trough sector 4b and the intermediate sector 4c are connected to each other via a trough boundary 4h. The trough boundary 4h extends linearly in the radial direction from the rotation center P, when viewed from above.

[0039] FIG. 4 is a schematic cross-sectional view of the intermediate sector, taken along a line A-A in FIG. 3 (only the intermediate sector is shown). Note that FIG. 4 is the view taken along the line orthogonal to the raised boundary 4g.

[0040] The intermediate sector 4c has a slope 4c1, with the raised boundary 4g located at the highest position of the slope 4c1 and the trough boundary 4h located at the lowest position of the slope 4c1.

[0041] As shown in FIG. 4, an angle (slope angle $\theta 1$) of a tangent line T1 to the intermediate sector 4c at the trough boundary 4h to a horizontal plane H preferably satisfies a relational expression of $30° \leq \theta 1 \leq 40°$. Likewise, an angle (slope angle $\theta 2$) of a tangent line T2 to the intermediate sector 4c at the raised boundary 4g to the horizontal plane H preferably satisfies a relational expression of $40° < \theta 2 \leq 60°$. This means that the slope angle $\theta 2$ is set larger than the slope angle $\theta 1$. That is, the intermediate sector 4c is set to be a curved surface in a so-called "convex downward" shape, with an inclination of a tangent line increasing from that to the trough sector 4b to that to the raised sector 4a.

[0042] FIG. 5 is a cross-sectional view of the rotating blade panel, taken along a line B-B in FIG. 3. Note that FIG. 5 shows a scene where the ridge line 4a1 of the raised sector 4a is sectioned. As shown in FIG. 5, the raised sector 4a is formed to have the height thereof gradually increasing from the rotation center (center area of the rotating blade panel 4) P outward in the radial direction (radially outer portion). In addition, the ridge line 4a1 of the raised sector 4a is configured to have the radially outer portion positioned higher than a flange surface 4s of the rotating blade panel 4. Further, the ridge line 4a1 of the raised sector 4a is configured to have a radially inner portion (portion closer to the center area) positioned lower than the flange surface 4s.

[0043] The rotating blade panel 4 is provided around the rotation center P with an upward projection 4t, along with a space for a fixing screw (not shown), so as to be fixed to a washing and dewatering driver (driving motor 10).

[0044] Incidentally, the larger the height difference is between the raised sector 4a and the trough sector 4b, the larger the vertical shaking of a wash becomes to improve detergency. However, if the raised sector 4a is made too high, there is a problem that a space in the washing and dewatering tub 3 for storing a wash is reduced. Therefore, the present embodiment has the maximum height h1 of the raised sector 4a from the flange surface set to greater than or equal to 20 mm but smaller than or equal to 25 mm, to prevent the space for storing a wash from being reduced.

[0045] FIG. 6 is a perspective view of a bottom side of the rotating blade panel 4. As shown in FIG. 6, the rotating blade panel 4 is provided on the back surface (lower surface) thereof with a back blade 71. The back blade 71 has a plurality of radial blades 71a extending in the radial direction from the rotation center, and a plurality of circumferential blades 71b extending in the circumferential direction.

[0046] The radial blades 71a are each formed in a plate shape such that those on the back sides of the raised sectors 4a are formed to project relatively longer, while those on the back sides of the trough sectors 4b are formed to project relatively shorter. The circumferential blades 71b are concentrically formed such that those on the back sides of the raised sectors 4a are formed to project relatively longer. Additionally, the circumferential blades 71b are arranged so as to intersect the radial blades 71a.

[0047] When the rotating blade panel 4 as configured above rotates, the back blade 71 works as a centrifugal pump to cause the pressure around the center of the bottom surface of the rotating blade panel 4 to decrease,

thereby sucking the washing water in the gap between the outer tub 2 (see FIG. 1) and the washing and dewatering tub 3 (see FIG. 1) through the through-holes 3b provided in the bottom surface of the washing and dewatering tub 3. The washing water sucked through the through-holes 3b flows through the circulation water channels 51a, 51b (see FIG. 1) and the lint filter 33 (see FIG. 1), and also flows through the circulation water channels 61a, 61b and the discharge port 61c (see FIG. 1), so as to be sprayed and poured into the washing and dewatering tub 3.

[0048] FIG. 7 is a cross-sectional view of the rotating blade panel, taken along a line C-C in FIG. 3. Note that FIG. 7 shows a scene where the trough sector 4b is sectioned at the bottommost portion 4b2. As shown in FIG. 7, the bottommost portion 4b2 of the trough sector 4b has a radially inner slope 4b3 and a radially outer slope 4b4 so that a portion radially closer to an inner end thereof and a portion radially closer to an outer end thereof are higher than the rest thereof. The radially outer slope 4b4 is formed to be steeper than the radially inner slope 4b3. In addition, the radially outer slope 4b4 has an upper end thereof positioned higher than that of the radially inner slope 4b3. Further, the radially outer slope 4b4 has the same height as the flange surface 4s of the rotating blade panel 4. Furthermore, the bottommost portion 4b2 has an intermediate slope 4b5 declining from the radially inner slope 4b3 toward the radially outer slope 4b4. As described above, the bottommost portion 4b2 between the two ridges 4d has a gently curved surface from the outer circumferential end 4d2 toward the inner circumferential end 4d3. The gently curved surface is in a concave shape with a concave surface facing upward.

[0049] When dry air is taken in from above the outer circumferential end 4d2 of the rotating blade panel 4, the loss to the dry air is reduced because the radially outer slope 4b4 is formed to be steeper than the radially inner slope 4b3.

[0050] Additionally, the dry air flowing from the intermediate slope 4b5 to the radially inner slope 4b3 can smoothly flow toward the radially inner slope 4b3 without any large loss, because the intermediate slope 4b5 is rising toward the radially inner side. As a result, the dry air discharged through the radially inner slope 4b3 can be swiftly discharged upward, to promote a wash being turned over.

[0051] The inner circumferential end 4d3 of the ridge 4d is positioned higher than a lowermost point 4d4 of the ridge 4d, at which the outer circumferential end 4d2 of the ridge 4d is connected with the inner circumferential end 4d3. This makes an air passage to further increase the air flow velocity.

[0052] The dry air generated by the drying mechanism 9 is blown from above the rotating blade panel 4 toward the outer circumferential end of the rotating blade panel 4. Then, when blown to the trough sector 4b (bottom 4b1) between the two ridges 4d (a set of the ridges 4d), the dry air flows from the radially outer end to the radially inner end along the bottom surface of bottommost portion 4b2 (bottom 4b1), as indicated by a thick solid arrow. That is, the dry air flows in downward in the substantially vertical direction at the radially outer end of the bottommost portion 4b2, and flows out upward in the substantially vertical direction at the radially inner end of the bottommost portion 4b2.

[0053] Next, a description is given of the movement of a wash during washing / drying when the rotating blade panel 4 of the present embodiment is used. In a washing step (cleaning step), water is supplied so as to be pooled in a bottom portion of the outer tub 2 at a level of not exceeding or slightly exceeding the upper surface of the rotating blade panel 4. Then, a detergent such as washing powder is dissolved in said water, to generate washing water having a high detergent concentration in the bottom portion of the outer tub 2. Subsequently, the rotating blade panel 4 is rotated in the forward and reverse directions to repeatedly apply an upward force to a wash while the washing water is circulating so as to be showered over a wash, so that a wash is pressed and washed. In a rinsing step (cleaning step) after washing, water is supplied so as to be pooled in the bottom portion of the outer tub 2 at a level of not exceeding or slightly exceeding the upper surface of the rotating blade panel 4, as in the washing step. Then, the rotating blade panel 4 is rotated in the forward and reverse directions to repeatedly apply an upward force to a wash while the rinsing water supplied and pooled in the bottom portion of the outer tub 2 is circulated so as to be showered over a wash. This executes rinsing of pressing out the washing water (detergent component) contained in a wash. In the drying step, the air in the outer tub 2 is circulated so as to be sucked out, water-cooled and dehumidified, and then heated and blown into the washing and dewatering tub 3, while the rotating blade panel 4 is rotated in the forward and reverse directions, to dry a wash.

[0054] When rotated in the washing step, the rotating blade panel 4 pushes up a wash due to slopes of the intermediate sectors 4c. Wash and beat effects, due to falling of a wash pushed up as described above, and wash and rub effects, due to frictional forces between the rotating blade panel 4 and a wash, improve detergency. Additionally, an inclination of the tangent line increasing from that (T1) to the intermediate sector 4c at the bottommost portion (trough boundary 4h) to that (T2) at the raised sector 4a (raised boundary 4g) (i.e., $\theta 2 > \theta 1$) causes clothes at a lower part to be flipped up by the rotation of the rotating blade panel 4, to promote vertical turnover of the clothes. The turnover of clothes reduces uneven washing of clothes.

[0055] The intermediate sector 4c has the slope angle $\theta 2$ at a portion thereof closer to the raised sector 4a which is larger than the slope angle $\theta 1$ at a portion thereof closer to the trough sector 4b. The slope angle increasing from the intermediate sector 4c to the raised sector 4a as described above causes a wash (clothes) to be applied with an upward force to promote turnover of a vertically-over-

lapped wash, thereby reducing entanglement between clothes.

[0056] In addition, the rotating blade panel 4, when rotated, vertically shakes a wash on the upper surface thereof due to the raised sectors 4a, and the shaking occurs more often due to the ridges 4d, to have an effect of improving detergency.

[0057] Even when rotated in the drying step, the rotating blade panel 4 pushes up a wash due to the slopes of the intermediate sectors 4c. Additionally, the inclination of the tangent line increasing from that (T1) to the intermediate sector 4c at the bottommost portion (trough boundary 4h) to that (T2) at the raised sector 4a (raised boundary 4g) (i.e., $\theta 2 > \theta 1$) causes clothes at a lower part to be flipped up due to the rotation of the rotating blade panel 4, to promote vertical turnover of clothes. The turnover of clothes reduces uneven drying of clothes.

[0058] Incidentally, in a case where air is blown into the washing and dewatering tub from above to dry a wash, a conventional rotating blade panel causes a wash to be entangled with each other, to have difficulty in spreading clothes by air. According to the present embodiment, the inclination of the tangent line increasing from that to the intermediate sector 4c at the bottommost portion (trough boundary 4h) to that at the raised sector 4a causes a wash to be flipped up, to reduce a wash being entangled with each other. As a result, a wash is more likely spread in the washing and dewatering tub 3 by drying air, to have fewer wrinkles with drying.

[0059] Further, the present embodiment has the raised sectors 4a and the trough sectors 4b provided symmetrically (symmetrically with respect to the rotation center P). This results in a wash being moved in the same way, even when the rotating blade panel 4 is rotated in either of clockwise and counterclockwise directions, so that clothes are less likely entangled and/or lopsided, to have less uneven washing and/or less fabric damage.

[0060] Still further, the present embodiment promotes turnover of clothes at a time of washing and stirring, so that lint between clothes comes out more likely together with washing liquid, to have lint collection performance improved.

[0061] Still further, in case where there is a large amount of a wash, the rotating blade panel 4, when rotated, causes a wash to be collided with the ridges 4d before being colliding with the raised sectors 4a, to give an upward component force to a wash. A wash has an upward velocity component due to this component force, to allow for reducing impact when a wash is flipped up due to the raised sectors 4a. This results in advantageous effects of less fabric damage and a smaller load on the driving unit (driving motor 10).

[0062] Still further, the ridge 4d has the ridge slope 4d1 gently sloping down toward the bottommost portion 4b2 of the rotating blade panel 4. Having the ridge slope 4d1 enhances an effect of giving an upward component force to a wash, and has an effect of reducing an impact, when a wash colliding with the ridge 4d, to lead to a wash having less fabric damage.

[0063] Still further, the two ridges 4d arranged in the trough sector 4b one by one on both sides in the circumferential direction of, at positions symmetrical with respect to, the bottommost portion 4b2 each extend radially at a predetermined height from the outer circumferential end 4d2 of the rotating blade panel 4 to the inner circumferential end 4d3. The ridges 4d arranged to face each other form a shape of coming closer to each other from the outer circumferential end 4d2 toward the inner circumferential end 4d3 (V-shape in plan view or inverted V-shape in plan view). This defines an air passage having air flow velocity increased from the outer circumferential end 4d2 to the inner circumferential end 4d3, when air is blown into the washing and dewatering tub 3 from above the rotating blade panel 4, to have an air flow blowing upward at the inner circumferential end 4d3. Having such an air flow allows clothes to be dried while being lifted upward from below, to have an effect of clothes having less wrinkles when dried.

[0064] Still further, the ridges 4d arranged to face each other each have the ridge slope 4d1 gently sloping down toward the bottommost portion 4b2 of the rotating blade panel 4. This causes a flow path to be limited from the ridges 4d arranged to face each other toward the bottommost portion 4b2, so that the air flow velocity from the outer circumferential end 4d2 toward the inner circumferential end 4d3 is further increased, to have the air flow blowing upward at the inner circumferential end 4d3 further increased. Having such an air flow allows clothes to be dried while being lifted upward from below, to have an effect of clothes having less wrinkles when dried. That is, a washing machine is provided that forms an air passage of an air flow lifting clothes instead of pressing the clothes down, when air is blown into the washing tub from above to dry the clothes, resulted in the clothes to have less uneven drying and to have even less wrinkles.

[0065] As described above, the washing machine S of the present embodiment includes: the washing and dewatering tub 3; the rotating blade panel 4 provided at the bottom in the washing and dewatering tub 3; the outer tub 2 configured to contain the washing and dewatering tub 3 and store washing water; the driving motor 10 configured to rotationally drive the washing and dewatering tub 3 and the rotating blade panel 4; and the discharge outlet 23a through which drying air is discharged from above the washing and dewatering tub 3 toward the rotating blade panel 4. The rotating blade panel 4 is provided, on the upper surface thereof, with the raised sectors 4a, the trough sectors 4b, and the intermediate sectors 4c each provided between the raised sector 4a and the trough sector 4b. The trough sector 4b has the two ridges 4d extending in the radial direction from the outer circumferential end 4d2 toward the inner circumferential end 4d3. The two ridges 4d form a tapered shape of circumferentially coming closer to each other from the outer circumferential end 4d2 toward the inner circumferential end 4d3 (see FIGS. 2 and 3). The bottom 4b1 between

the two ridges 4d has a gently curved surface from the outer circumferential end 4d2 toward the inner circumferential end 4d3 (see FIGS. 2 and 3). This allows the dry air discharged from the discharge port 23a provided above the rotating blade panel 4 to be discharged upward from around the center, to promote turnover of clothes so that the clothes have less uneven drying and moreover to have fewer dry wrinkles.

[0066] In addition, the present embodiment is characterized in that the two ridges 4d are respectively provided, on sides thereof facing each other, with the ridge slopes 4d1 sloping down toward the bottom 4b1 (see FIG. 2). This allows for giving an upward force to clothes, to promote turnover of the clothes.

[0067] Further, the present embodiment is characterized in that the height of the inner circumferential end 4d3 of the ridge 4d is higher than the lowermost point 4d4 of the ridge 4d connecting the outer circumferential end 4d2 with the inner circumferential end 4d3 (see FIG. 7).

[0068] Still further, the present embodiment is characterized in that the raised sector 4a is formed at a position higher than the highest position of the intermediate sector 4c, and the trough sector 4b is formed at a position lower than the lowest position of the intermediate sector 4c. The raised sector 4a has the convex slope 4a2, and the trough sector 4b has the bottom 4b1 (concave slope). The intermediate sector 4c has the slope 4c1 and is continuously connected to the trough sector 4b and the raised sector 4a. The slope 4c1 of the intermediate sector 4c is formed to have the slope angle $\theta 2$ at a portion thereof closer to the raised sector 4a being greater than the slope angle $\theta 1$ at a portion thereof closer to the trough sector 4b (see FIG. 4). In the drying step, this causes a lower part of clothes to be flipped up due to the rotation of the rotating blade panel 4, to promote vertical turnover of clothes so that the clothes have less uneven drying. Likewise, in the washing step, the inclination of the intermediate sector 4c causes a wash to be pushed up, to improve detergency with wash and beat effects, due to falling of a wash pushed up as described above, and wash and rub effects, due to frictional forces between the rotating blade panel 4 and a wash. Additionally, the rotation of the rotating blade panel 4 causes a lower part of clothes to be flipped up, to promote vertical turnover of the clothes so that the clothes have less uneven washing due to the turnover.

[0069] Still further, the present embodiment is characterized in that the slope 4c1 of the intermediate sector 4c has the slope angle $\theta 1$ at a portion thereof closer to the trough sector 4b to satisfy a relational expression of $30° \leq \theta 1 < 40°$, and has the slope angle $\theta 2$ at a portion thereof closer to the raised sector 4a to satisfy a relational expression of $40° < \theta 2 \leq 60°$ (see FIG. 4). This promotes vertical turnover of clothes, so that the clothes have less uneven drying.

[0070] Still further, the present embodiment is characterized in that the rotating blade panel 4 is a rotating blade panel for the washing machine S to have dry air discharged from above the washing and dewatering tub 3, and has, on the upper surface thereof, the raised sectors 4a, the trough sectors 4b, and the intermediate sectors 4c each provided between the raised sector 4a and the trough sector 4b. The trough sector 4b has the two ridges 4d extending in the radial direction from the outer circumferential end 4d2 toward the inner circumferential end 4d3. The two ridges 4d form a tapered shape of circumferentially coming closer to each other from the outer circumferential end 4d2 toward the inner circumferential end 4d3 (see FIGS. 2 and 3). The bottom 4b1 between the two ridges 4d has a gently curved surface from the outer circumferential end 4d2 toward the inner circumferential end 4d3 (see FIGS. 2 and 3). This allows the dry air discharged from the discharge port 23a provided above the rotating blade panel 4 to be discharged upward from around the center, to promote turnover of clothes so that the clothes have less uneven drying and moreover to have fewer dry wrinkles.

[0071] Still further, the present embodiment is characterized in that the ridge of the convex slope 4a2 has such a height gradually increasing from the rotation center P of the rotating blade panel 4 toward a radially outer side thereof (see FIG. 5). This causes clothes to be moved radially outward due to the centrifugal force, when agitated during washing operation, and the larger the height difference between the raised sector 4a and the trough sector 4b is, the more the vertical movement of the clothes is promoted, to improve detergency. Likewise, even during drying operation, the vertical turnover of the clothes is promoted, so that the clothes have less uneven drying.

[0072] Still further, the present embodiment is characterized in that the through-holes 4f are formed in the trough sector 4b and the intermediate sector 4c, but no through-holes are formed in the raised sector 4a (see FIGS. 2 and 3). This causes the raised sector 4a having no through-holes to provide a protection. As a result, engagement with a wash is suppressed to lead to a wash having less fabric damage.

[0073] Still further, the present embodiment is characterized in that the trough sector 4b has the ridges 4d. This causes clothes to be lifted in advance by the ridges 4d, when the rotating blade panel 4 is rotated, before the clothes are lifted in the intermediate sectors 4c. As a result, a wash has less fabric damage, and the motor has a smaller load.

[0074] The present invention is not limited to the above-described embodiment, and includes various modifications. For example, the raised boundary 4g, the trough boundary 4h, and the ridge 4d are each formed in a straight line in the present embodiment, when viewed from above, but may be curved to have a bow shape.

[0075] In addition, the present embodiment can also be applied to an electric washing machine having no drying mechanism.

LEGEND FOR REFERENCE NUMERALS

[0076] 1: outer frame, 2: outer tub, 3: washing and dewatering tub (washing tub), 4: rotating blade panel, 4a: raised sector, 4a1: ridge line, 4a2: convex slope, 4b: trough sector, 4b1: bottom (concave slope), 4b2: bottommost portion, 4c: intermediate sector, 4c1: slope, 4d: ridge, 4d1: ridge slope (slope), 4d2: outer circumferential end, 4d3: inner circumferential end, 4d4: lowermost point, 4e: curved projection, 4f: through-hole, 4g: raised boundary, 4h: trough boundary, 10: driving motor (driving unit), 23a: discharge outlet, 71: back blade, S: washing machine, θ1: slope angle at a portion closer to trough sector, and θ2: slope angle at a portion closer to raised sector.

Claims

1. A washing machine comprising:

a washing tub;
a rotating blade panel provided at a bottom in the washing tub;
an outer tub configured to contain the washing tub and store washing water;
a driving unit configured to rotate the washing tub and the rotating blade panel; and
a discharge outlet through which drying air is discharged from above the washing tub toward the rotating blade panel,
wherein the rotating blade panel is provided on an upper surface thereof with raised sectors, trough sectors, and intermediate sectors between the raised sectors and the trough sectors,
the trough sectors each have at least two ridges radially extending from an outer circumferential end toward an inner circumferential end,
the two ridges of the at least two ridges form a tapered shape of circumferentially coming closer to each other from the outer circumferential end toward the inner circumferential end, and
a bottom of the rotating blade panel between the two ridges is formed to have a gently curved surface.

2. The washing machine according to claim 1, wherein the two ridges are respectively provided, on side surfaces thereof facing each other, with slopes gently sloping toward the bottom.

3. The washing machine according to claim 1, wherein the inner circumferential end of the ridge is positioned higher than a lowermost point of the ridge, the point connecting the outer circumferential end with the inner circumferential end.

4. The washing machine according to claim 1, wherein
the raised sector is formed at a position higher than a highest position of the intermediate sector,
the trough sector is formed at a position lower than a lowest position of the intermediate sector,
the raised sector has a convex slope,
the trough sector has a concave slope,
the intermediate sector has a slope and is continuously connected to the trough sector and the raised sector, and
the slope of the intermediate sector is formed to have a slope angle at a portion thereof closer to the raised sector being greater than a slope angle at a portion thereof closer to the trough sector.

5. A washing machine comprising:

a washing tub;
a rotating blade panel provided at a bottom in the washing tub;
an outer tub configured to contain the washing tub and store washing water; and
a driving unit configured to rotate the washing tub and the rotating blade panel,
wherein the rotating blade panel has an intermediate sector, a trough sector positioned lower than the lowest position of the intermediate sector, and a raised sector positioned higher than the highest position of the intermediate sector,
the raised sector has a convex slope,
the trough sector has a concave slope,
the intermediate sector has a slope and is continuously connected to the trough sector and the raised sector, and
the slope of the intermediate sector is formed to have a slope angle at a portion thereof closer to the raised sector being greater than that at a portion thereof closer to the trough sector.

6. The washing machine according to claim 5, wherein a ridge of the convex slope has such a height gradually increasing from a rotation center of the rotating blade panel toward a radially outer side thereof.

7. The washing machine according to claim 5, wherein

through-holes are formed in the trough sector and the intermediate sector, but
no through-holes are formed in the raised sector.

8. The washing machine according to claim 5, wherein the trough sector has ridges.

9. The washing machine according to claim 1 or 5, wherein
the slope of the intermediate sector has a slope angle θ1 at a portion thereof closer to the trough sector to

satisfy a relational expression of $30° \leq \theta 1 < 40°$, and has a slope angle $\theta 2$ at a portion thereof closer to the raised sector to satisfy a relational expression of $40° < \theta 2 \leq 60°$.

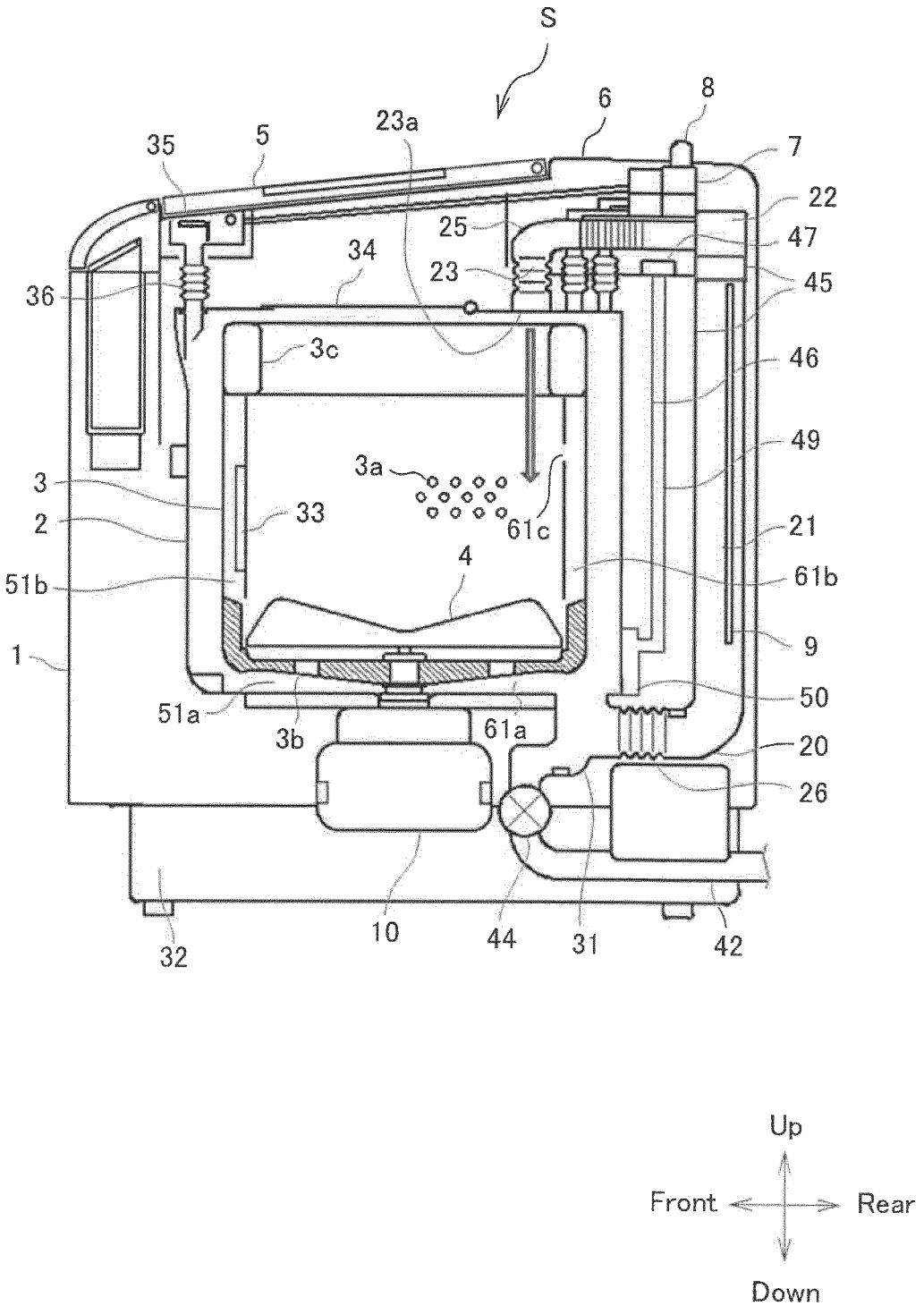
10. A rotating blade panel used for a washing machine to have dry air discharged from above a washing tub, the rotating blade panel comprising on an upper surface thereof: raised sectors; trough sectors; and intermediate sectors each provided between the raised sector and the trough sector, wherein

the trough sector has at least two ridges extending in a radial direction of the rotating blade panel from an outer circumferential end of the rotating blade panel toward an inner circumferential end of the rotating blade panel,
the two ridges of the at least two ridges form a tapered shape of circumferentially coming closer to each other from the outer circumferential end toward the inner circumferential end, and
a bottom between the two ridges of the at least two ridges has a gently curved surface from the outer circumferential end toward the inner circumferential end.

11. A rotating blade panel comprising: an intermediate sector; a trough sector positioned lower than the lowest position of the intermediate sector; and a raised sector positioned higher than the highest position of the intermediate sector, wherein

the raised sector has a convex slope,
the trough sector has a concave slope,
the intermediate sector has a slope and is continuously connected to the trough sector and the raised sector, and
the slope of the intermediate sector is formed to have a slope angle at a portion thereof closer to the raised sector being greater than that at a portion thereof closer to the trough sector.

FIG. 1


S
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23a
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7
22
25
47
34
23
45
36
3c
46
49
3a
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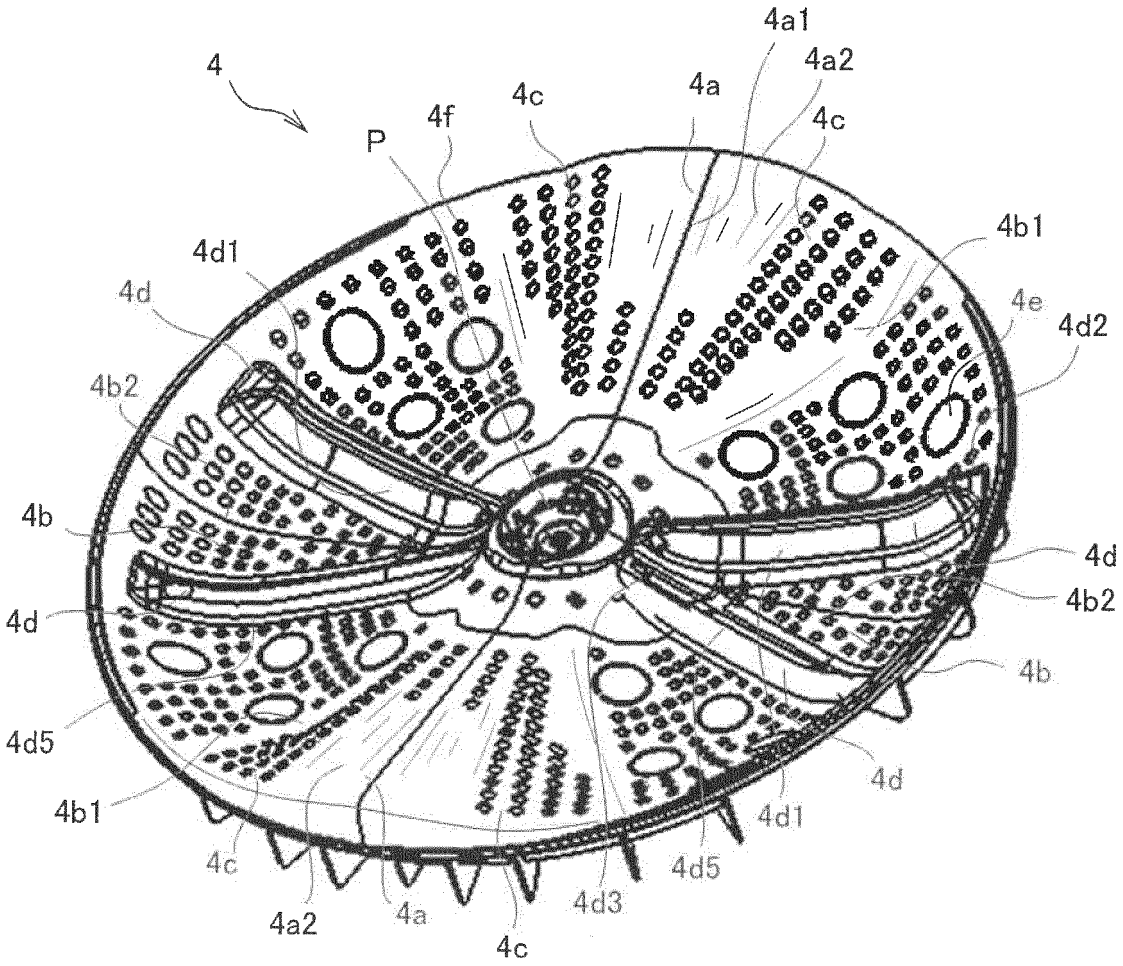
33
61c
2
21
4
51b
61b
1
9
50
51a
3b
61a
20
26
10
44
31
42
32
Up
Front
Rear
Down

FIG. 2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4a2
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4d
4d
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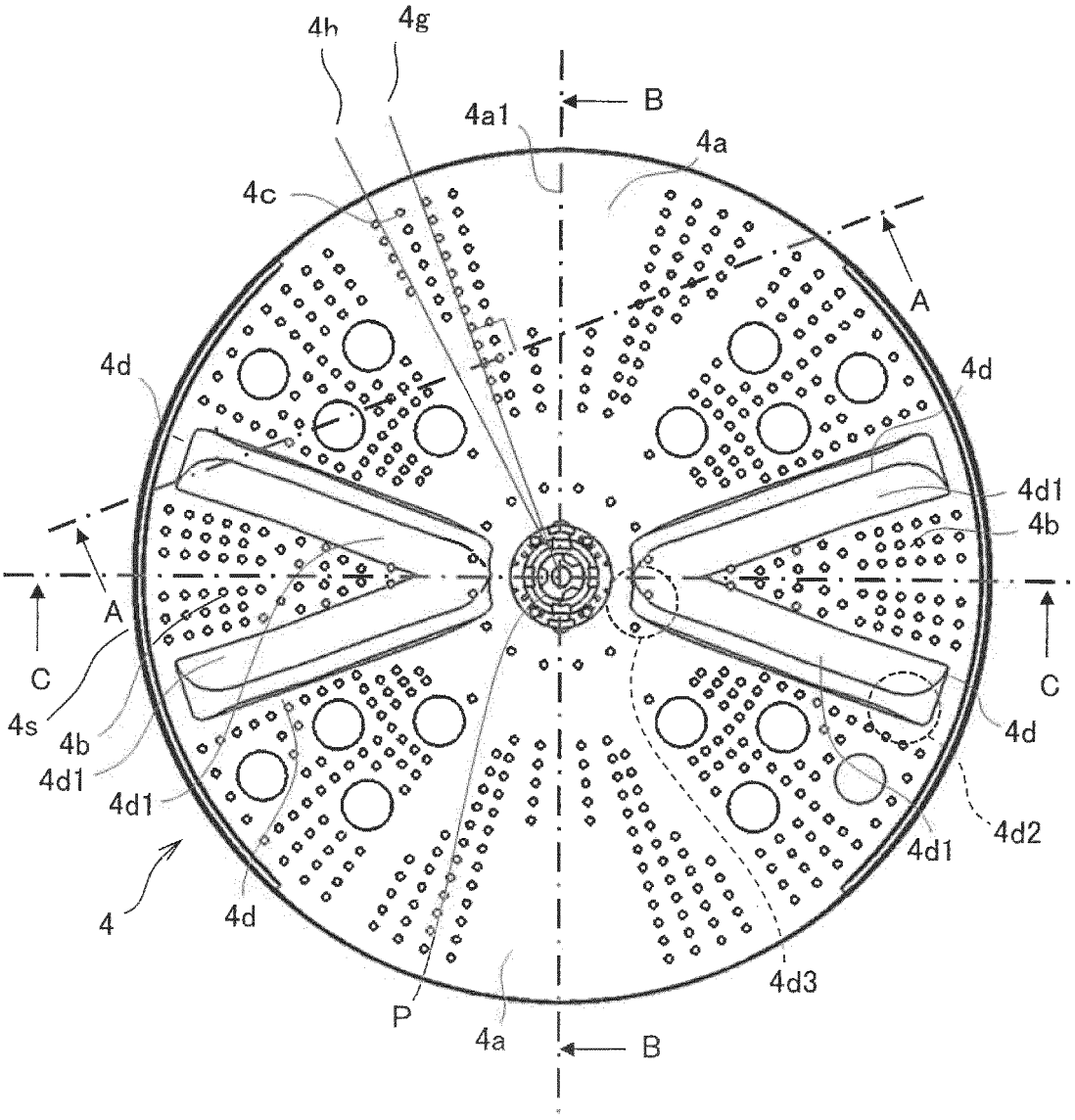
4a
4d3
4c

FIG. 3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4g
4a1
B
4a
4c
A
4d
4d
4d1
4b
A
C
C
4s
4b
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4d1
4d
4d2
4d1
4
4d
4d3
P
4a
B

FIG. 4

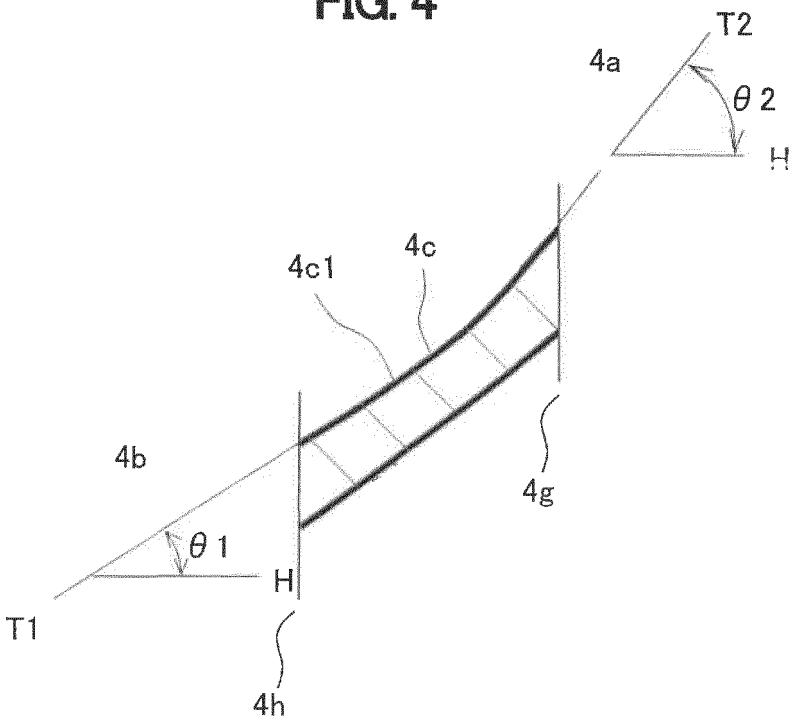


FIG. 5

Cross Section taken along line B-B

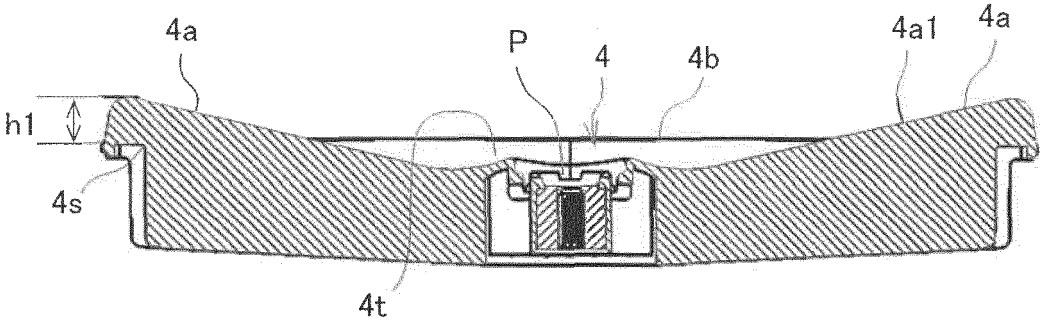


FIG. 6

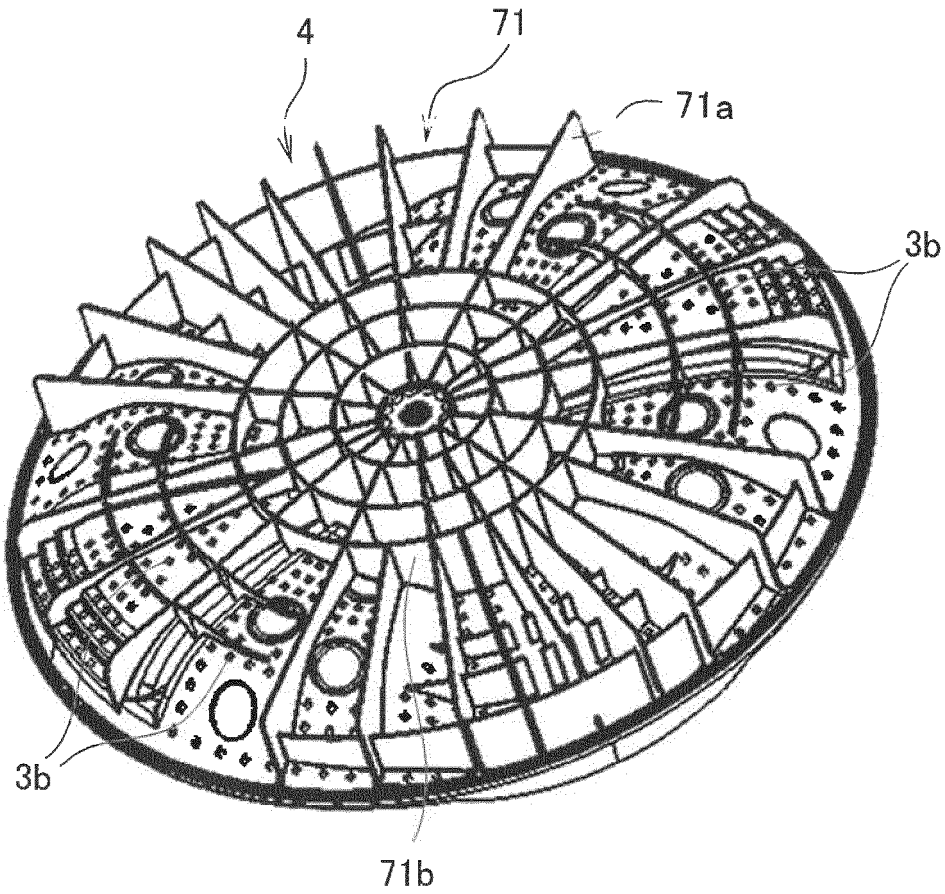
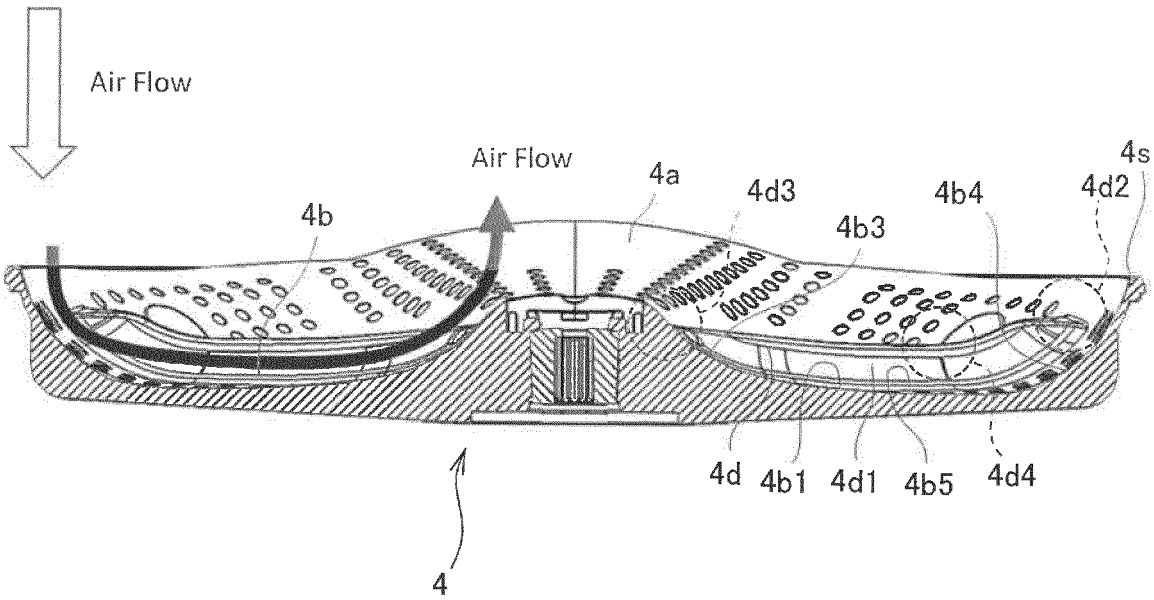

4
71
71a
3b
3b
71b

FIG. 7


Air Flow
Air Flow
4a
4d3
4b4
4s
4d2
4b
4b3
4d
4b1
4d1
4b5
4d4
4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2021/007846

A. CLASSIFICATION OF SUBJECT MATTER
D06F 13/02(2006.01)i; D06F 17/10(2006.01)i; D06F 23/04(2006.01)i; D06F 25/00(2006.01)i
FI: D06F13/02 A; D06F23/04; D06F25/00 Z; D06F17/10 A
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)
D06F13/02; D06F17/10; D06F23/04; D06F25/00

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

Published examined utility model applications of Japan	1922–1996
Published unexamined utility model applications of Japan	1971–2021
Registered utility model specifications of Japan	1996–2021
Published registered utility model applications of Japan	1994–2021

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	JP 2015-204932 A (HITACHI APPLIANCES, INC.) 19 November 2015 (2015-11-19) paragraphs [0015]-[0044], fig. 1-7	1-11
X	JP 2014-230554 A (HITACHI APPLIANCES, INC.) 11 December 2014 (2014-12-11) paragraphs [0016]-[0059], fig. 1-7	1-11
A	JP 2005-87579 A (HITACHI HOME & LIFE SOLUTION, INC.) 07 April 2005 (2005-04-07) entire text, all drawings	1-11

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

* Special categories of cited documents:
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"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
08 April 2021 (08.04.2021)	20 April 2021 (20.04.2021)

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Telephone No.

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

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2021/007846

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
JP 2015-204932 A	19 Nov. 2015	CN 105040346 A paragraphs [0026]-[0063], fig. 1-7 TW 201544648 A	
JP 2014-230554 A	11 Dec. 2014	(Family: none)	
JP 2005-87579 A	07 Apr. 2005	WO 2005/028735 A1 entire text, all drawings CN 1826445 A	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2015204932 A **[0003]**