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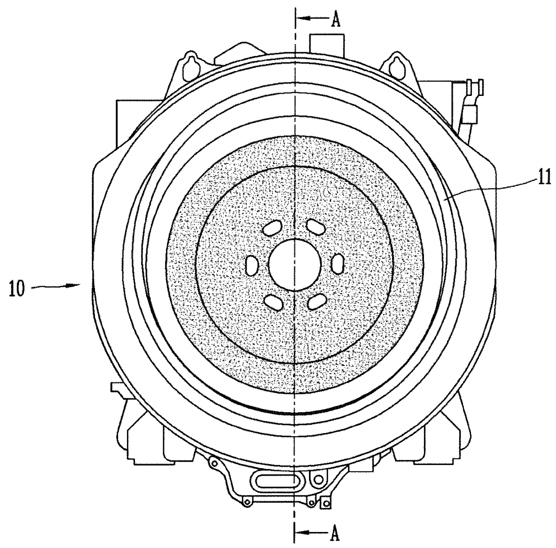
(54) **WASHING MACHINE**

(57) The present invention relates to a washing machine comprising: a tub provided inside a cabinet and storing washing water therein; and a plurality of super-hydrophobic micro-protrusions formed on the inner surface of the tub to remove residual water within the tub. Accordingly, since the plurality of super-hydrophobic micro-protrusions are formed on the inner surface of the tub, the residual water remaining inside the tub can be cleanly removed using the lotus effect, thereby maintaining a clean state of the washing machine.

FIG. 1



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Description

FIELD

[0001] The present disclosure relates to a washing machine with improved drainage performance.

BACKGROUND

[0002] In general, a washing machine is a device for cleaning washing objects through processes such as washing, rinsing, dehydrating, and drying to remove contaminants adhering to clothes or the like (hereinafter, referred to as a washing object) accommodated in a drum using the action of water and detergent.

[0003] The washing machine may be classified into a pulsator type washing machine that performs washing by water flow according to the operation of a pulsator, and a drum type washing machine that uses the falling of washing objects by the rotation of the drum itself.

[0004] The drum type washing machine includes a tub provided inside a cabinet to store wash water therein, a drum rotatably installed in the tub, a water supply device that supplies wash water to the tub, and a drain device for discharging the wash water of the tub to the outside of the cabinet.

[0005] The drain device may include a drain hose and a drain pump.

[0006] The drain hose guides the wash water of the tub to the outside of the cabinet, and the drain pump discharges wash water flowing along the drain hose.

[0007] However, when contaminated wash water inside the tub remains inside the tub without being discharged to the outside of the cabinet, the following problems occur.

[0008] First, when clean wash water supplied to rinse wash water is mixed with contaminated wash water remaining inside the tub, the efficiency of the rinsing cycle is reduced to increase the amount of wash water required for proper rinsing and the washing time.

[0009] Second, the inside of the tub is very humid even after the operation of the drain pump is completed, and the contaminated wash water of the tub is not drained through the drain hose but remains in the form of water droplets on the inner surface of the tub. At this time, the residual water remaining on the inner surface of the tub causes malodor due to the generation of bacteria such as mold, and contaminates water that is newly supplied when the washing machine is used subsequently.

SUMMARY

[0010] Therefore, a first object of the present disclosure is to provide a washing machine capable of discharging wash water remaining on the inner surface of the tub to the outside.

[0011] Furthermore, a second object of the present disclosure is to provide a washing machine capable of directing the flow of residual water remaining on the inner surface (front and rear surface, circular surface, sump) of the tub.

[0012] In addition, a third object of the present disclosure is to provide a washing machine capable of preventing an undercut of an injection mold after injection molding of the tub with the injection mold.

[0013] The first object of the present disclosure may be achieved by providing super-hydrophobic micro-protrusions in a place where water can reach the inside of the washing machine to remove residual water inside the washing machine using the lotus effect of the super-hydrophobic micro-protrusions.

[0014] The second object of the present disclosure may be achieved by forming an asymmetrical slope on both inclined surfaces of the super-hydrophobic micro-protrusions to allow water to flow toward the drain port.

[0015] The third object of the present disclosure may be achieved by providing directionality to the super-hydrophobic micro-protrusions in a direction in which the injection mold is separated to prevent the undercut of the injection mold.

[0016] According to an example associated with the present disclosure, a washing machine may include a tub provided inside a cabinet to store wash water therein; and a plurality of super-hydrophobic micro-protrusions formed on an inner surface of the tub to remove residual water in the tub.

[0017] According to an embodiment of the present disclosure, the plurality of super-hydrophobic micro-protrusions may be injection molded by an injection mold together with the tub, and integrally formed on an inner surface of the tub.

[0018] According to an embodiment of the present disclosure, the tub may include a tub cover formed with an inlet port for putting washing objects therein on a front side of the tub to form a front portion of the tub when the tub is divided into the front portion and the rear portion along a circumferential surface; and a tub body coupled to a rear end of the tub cover to form the rear portion of the tub.

[0019] According to an embodiment of the present disclosure, the plurality of super-hydrophobic micro-protrusions may be formed on a front side in the tub cover and a rear side in the tub body.

[0020] According to an embodiment of the present disclosure, each of the plurality of super-hydrophobic micro-protrusions may have an upper width thereof smaller than or equal to a lower width thereof.

[0021] According to an embodiment of the present disclosure, each of the plurality of super-hydrophobic micro-protrusions may be formed in any one of a round shape, a triangular shape, and a rectangular shape.

[0022] According to an embodiment of the present disclosure, the plurality of super-hydrophobic micro-protrusions may be symmetrically formed on both sides with respect to one directional center lines spaced apart in parallel from each other along an inner surface of the tub.

[0023] According to an embodiment of the present disclosure, the plurality of super-hydrophobic micro-protrusions may be formed symmetrically on both sides with respect to first directional center lines spaced apart in parallel from each other along an inner surface of the tub and second directional center lines spaced apart in parallel from each other in a direction intersecting the first directional center line.

[0024] According to an embodiment of the present disclosure, the first directional center line and the second directional centerline are formed in a lattice shape.

[0025] According to another embodiment of the present disclosure, the plurality of super-hydrophobic micro-protrusions may be formed on a circumferential surface in the tub.

[0026] According to another embodiment of the present disclosure, the plurality of super-hydrophobic micro-protrusions may be protruded along a longitudinal direction of the tub in a direction in which an injection mold is separated to prevent an undercut of the injection mold after injection molding.

[0027] According to another embodiment of the present disclosure, the plurality of super-hydrophobic micro-protrusions may be arranged to be spaced apart from each other in a circumferential direction of the tub.

[0028] According to another embodiment of the present disclosure, the plurality of super-hydrophobic micro-protrusions may be symmetrically formed on both sides with respect to longitudinal center lines of a circumferential surface of the tub spaced apart in parallel from each other along the circumferential surface.

[0029] According to another embodiment of the present disclosure, the plurality of super-hydrophobic micro-protrusions may be formed asymmetrically on both sides with respect to longitudinal center lines of the circumferential surface spaced apart in parallel from each other along the circumferential surface of the tub to allow residual water in the tub to flow in a circumferential direction.

[0030] According to still another embodiment of the present disclosure, the washing machine may further include a sump formed on a bottom surface in the tub, and provided with a drain port for discharging wash water in the tub to the outside, wherein the plurality of super-hydrophobic micro-protrusions are formed on a surface of the sump.

[0031] According to still another embodiment of the present disclosure, the sump may be recessed along the longitudinal direction of the tub toward a front side of the tub at a rear lower-end portion of the tub, and the plurality of super-hydrophobic micro-protrusions may be protruded along a longitudinal direction of the sump in a direction in which the injection mold is separated to prevent an undercut of the injection mold after injection molding.

[0032] According to still another embodiment of the present disclosure, the sump may be formed at a lower position than a circumferential surface of the tub, and inclined downward toward a front side of the tub.

[0033] According to still another embodiment of the present disclosure, the drain port may be spaced apart from a longitudinal center line of the sump in one direction, and the sump may further include a residual water guide passage portion one side of which is communicated with the drain port, and spaced apart from a longitudinal center line of the sump to guide residual water in the sump to the drain port.

[0034] According to still another embodiment of the present disclosure, the plurality of super-hydrophobic micro-protrusions are formed asymmetrically on both sides with respect to longitudinal center lines of the sump spaced apart in parallel from each other along the bottom surface of the sump to allow residual water in the sump to flow toward the residual water guide passage portion, and provided with a first inclined portion having a small slope on one side toward the residual water guide passage portion and a second inclined portion having a relatively large slope on another side toward a direction opposite to the residual water guide passage.

[0035] According to the present disclosure having the foregoing configuration, the following effects can be obtained.

[0036] First, a plurality of super-hydrophobic micro-protrusions may be formed on the inner surface of the tub to remove residual water remaining inside the tub using the lotus effect, thereby maintaining the cleanliness of the washing machine.

[0037] Second, the super-hydrophobic micro-protrusions may be formed to have directionality, thereby preventing the occurrence of an undercut (referred to being interfered between the micro molding protrusions of the mold and the micro-protrusions of the tub) when the mold is separated after the completion of injection molding.

[0038] Third, a slope may be formed in the super-hydrophobic micro-protrusions, thereby allowing water flowing along the micro-protrusions to flow toward a predetermined direction, for example, the drain port.

[0039] Fourth, wash water containing contaminants may be rolled by the super-hydrophobic micro-protrusions and flowed to the drain port not to remain inside the tub, thereby preventing clean rinsing water from being mixed with the contaminated wash water.

[0040] Fifth, malodor caused due to the residual water in the tub may be removed, and foreign matter inside the tub may move to the drain port along the micro-protrusions together with spherical water droplets, thereby maintaining clean hygiene inside the tub due to the self-cleaning of the inside of the tub.

BRIEF DESCRIPTION OF THE DRAWINGS

[0041] The embodiments will be described in detail with reference to the following drawings in which like reference numerals refer to like elements wherein:

FIG. 1 is a front view of a tub according to the present disclosure.

FIG. 2 is a cross-sectional view taken along line A-A in FIG. 1.

FIG. 3A is a view showing a shape in which a water droplet is falling from a lotus leaf.

FIG. 3B is a conceptual view for explaining the lotus effect of super-hydrophobic micro-protrusions applied to the inside of a washing machine according to the present disclosure.

FIG. 3C is a conceptual view for explaining a correlation between a water-surface contact angle and a water-repellent property.

FIG. 4 is a view showing an example in which super-hydrophobic micro-protrusions according to the present disclosure are applied to a tub cover.

FIG. 5 is a view showing an example in which super-hydrophobic micro-protrusions according to the present disclosure are applied to a tub body.

FIGS. 6A and 6B are schematic views for explaining a method of fabricating a tub by a plastic injection mold according to the present disclosure, wherein FIG. 6A illustrates a case where the injection mold is closed, and FIG. 6B illustrates a case where the injection mold is open.

FIG. 7A is a schematic view showing a first embodiment of super-hydrophobic micro-protrusions according to the present disclosure.

FIG. 7B is a plan view in which the super-hydrophobic micro-protrusions of FIG. 7A are seen from above.

FIG. 8A is a schematic view showing a second embodiment of super-hydrophobic micro-protrusions according to the present disclosure.

FIG. 8B is a plan view in which the super-hydrophobic micro-protrusions of FIG. 8A are seen from above.

FIG. 9A is a schematic view showing a third embodiment of super-hydrophobic micro-protrusions according to the present disclosure.

FIG. 9B is a plan view in which the super-hydrophobic micro-protrusions of FIG. 9A are seen from above.

FIG. 10A is a schematic view showing a fourth embodiment of super-hydrophobic micro-protrusions according to the present disclosure.

FIG. 10B is a plan view in which the super-hydrophobic micro-protrusions of FIG. 10A are seen from above.

FIG. 11A is a schematic view showing a fifth embodiment of super-hydrophobic micro-protrusions according to the present disclosure.

FIG. 11B is a plan view in which the super-hydrophobic micro-protrusions of FIG. 11A are seen from above.

FIG. 12A is a schematic view showing a sixth embodiment of super-hydrophobic micro-protrusions according to the present disclosure, and FIG. 12B is a plan view in which the super-hydrophobic micro-protrusions of FIG. 12A are seen from above.

FIG. 13A is a schematic view showing a seventh embodiment of super-hydrophobic micro-protrusions according to the present disclosure.

FIG. 13B is a plan view in which the super-hydrophobic micro-protrusions of FIG. 13A are seen from above.

FIG. 14 is a view showing an example in which super-hydrophobic micro-protrusions according to the present disclosure are applied to a circumferential surface of a tub cover.

FIG. 15 is a view showing an example in which super-hydrophobic micro-protrusions according to the present disclosure are applied to a circumferential surface of a tub body.

FIG. 16 is a schematic view showing a structure in which super-hydrophobic micro-protrusions according to the present disclosure have an asymmetric slope.

FIGS. 17A and 17B are schematic views for explaining a method of manufacturing a tub by a plastic injection mold according to the present disclosure, wherein FIG. 17A shows a case where the injection mold is in a closed state, FIG. 17B shows a case where the injection mold is in an open state, and FIG. 17C is a side view showing a shape when viewed in direction D-D in FIG. 17B.

FIG. 18A, as a partially enlarged view of "C" in FIG. 14, is a plan view showing an example of super-hydrophobic micro-protrusions having directionality.

FIG. 18B is a cross-sectional view showing a cross-sectional shape of the super-hydrophobic micro-protrusions viewed in direction E-E in FIG. 18A.

FIG. 19A is a plan view showing another example of super-hydrophobic micro-protrusions having directionality according to the present disclosure.

FIG. 19B is a cross-sectional view showing a cross-sectional shape of the super-hydrophobic micro-protrusions in FIG. 19A.

FIG. 20 is a front view of a tub according to the present disclosure.

FIG. 21 is a cross-sectional view taken along line I-I in FIG. 20.

FIG. 22A is a G-G sectional view showing an example of a sump in FIG. 21.

FIG. 22B is a perspective view showing super-hydrophobic micro-protrusions applied to the sump in FIG. 22A.

FIG. 23A is a perspective view showing another example of a sump in FIG. 21.

FIG. 23B is a plan view in which the sump in FIG. 23A is seen from above.

FIG. 23C is a H-H cross-sectional view of residual water in FIG. 23A.

FIGS. 24A and 24B are schematic views for explaining a method of manufacturing a tub by a plastic injection mold according to the present disclosure, wherein FIG. 24A shows a case where the injection mold is in a closed state, FIG. 24B shows a case where the injection mold is in an open state, and FIG. 24C is a side view in which the injection mold is seen in direction I-I in FIG. 24B.

FIG. 25A, as an enlarged view of portion "X" in FIG. 22B, is a plan view showing an example of super-hydrophobic micro-protrusions having directionality.

FIG. 25B is a cross-sectional view showing a cross-sectional shape of the super-hydrophobic micro-protrusions viewed in direction J-J in FIG. 25A.

FIG. 26A is a plan view showing another example of super-hydrophobic micro-protrusions having directionality according to the present disclosure.

FIG. 26B is a cross-sectional view showing a cross-sectional shape of the super-hydrophobic micro-protrusions viewed in direction K-K in FIG. 26A.

DETAILED DESCRIPTION

[0042] Hereinafter, a washing machine associated with the present disclosure will be described in more detail with reference to the accompanying drawings. Even in different embodiments according to the present disclosure, the same or similar reference numerals are designated to the same or similar configurations, and the description thereof will be substituted by the earlier description. Unless clearly used otherwise, expressions in the singular number used in the present disclosure may include a plural meaning.

[0043] FIG. 1 is a front view of a tub 10 according to the present disclosure, and FIG. 2 is a cross-sectional view taken along line A-A in FIG. 1.

[0044] The tub 10 provides a storage space for storing wash water therein. The tub 10 is provided inside a cabinet. The tub 10 is fixedly supported inside the cabinet by a supporting member such as a damper, a spring, or the like.

[0045] The tub 10 is formed in a cylindrical shape and a front surface 10a' of the tub 10 may be provided with an inlet port for putting washing objects therein.

[0046] In order to prevent wash water in the tub 10 from leaking to the outside of the tub 10, a rubber gasket 11 may be formed in a circumferential direction along the circumference of the inlet port of the tub 10.

[0047] A driving unit for rotating the drum may be provided on a rear surface 10b' of the tub 10. A drive motor may include a stator and a rotor for rotating the drum. The rotor generates a rotational force by electromagnetic interaction with the stator. The rotor can be connected to the rear surface 10b' of the drum through a rotation shaft to drive the drum. A rotation shaft support portion 10b1 may be formed on the rear surface 10b' of the tub 10 to allow the rotation shaft to pass therethrough.

[0048] The cabinet constitutes the external shape and skeleton of the washing machine. An opening portion for putting washing objects therein is formed on the front surface 10a' of the cabinet. Furthermore, a door for opening and closing the opening portion may be rotatably installed.

[0049] A water supply hose is provided inside the cabinet. One side of the water supply hose is connected to an external water pipe through an external water supply hose and the other side thereof is connected to the tub 10 to supply wash water to the inside of the tub 10 along the water supply hose.

[0050] A drum may be rotatably installed inside the tub 10.

[0051] The drum has an accommodation space for putting washing objects therein. A plurality of through holes are formed in the drum, and the wash water of the tub 10 may be introduced into the drum through the through holes.

[0052] A plurality of lifters may be provided inside the drum. The lifter may obtain an effect of lifting the washing objects in the drum to an upper portion of the drum, and tapping and washing the washing object using falling by gravity.

[0053] A detergent dispensing unit may be provided in the cabinet, and detergent may be stored inside the detergent dispensing unit. The detergent dispensing unit is connected to the water supply hose to receive wash water from the outside and mix the wash water and the detergent and then the detergent together with the wash water may be supplied to the inside of the tub 10.

[0054] A drain port 10b2 is formed on a bottom surface of the tub 10 to discharge the contaminated wash water to the outside of the cabinet. One side of the drain hose is connected to the drain port 10b2 to discharge wash water to the outside of the cabinet, and the other side thereof is formed to communicate with the outside of the cabinet.

[0055] A pump casing and a drain pump may be provided under the tub 10. One side of the pump casing may be connected to the drain port 10b2 through the drain hose and the other side thereof may be connected to the drain pump. Wash water discharged from the tub 10 may be pumped by the drain pump and discharged to the outside of the cabinet through the drain hose.

[0056] The tub 10 may be formed to be inclined upward toward the front of the cabinet so that the front surface 10a' is located higher than the rear surface 10b'. A rotation center line of the drum passing through the longitudinal center of the tub 10 may be inclined at a predetermined angle with respect to the horizontal plane.

[0057] The tub 10 may be injection molded by an injection mold 20 using polymer resin.

[0058] The tub 10 may be divided into two parts along the circumferential surface for injection molding. For example, the tub 10 may be composed of a tub cover 10a disposed on the front side of the drum in a rotational shaft direction and a tub body 10b disposed on the rear side thereof. Here, the front side (forward direction) denotes a direction facing the front surface 10a' of the cabinet formed with an inlet port for washing objects. The rear side denotes a direction facing the rear surface 10b' of the cabinet in an opposite direction to the inlet port.

[0059] The tub cover 10a may form a front portion of the tub 10 and the tub body 10b may form a rear portion of the tub 10. The tub cover 10a forms a front surface 10a' of the tub 10 and a part of the circumferential surface, that is, a front circumferential surface in the longitudinal direction of the tub 10. The tub body 10b forms a rear surface 10b' of the tub 10 and a part of the circumferential surface, that is, a rear circumferential surface in the longitudinal direction of the tub 10.

[0060] The rear surface 10b' of the tub cover 10a is open toward the tub body 10b, and the front surface 10a' of the tub body 10b is open toward the tub cover 10a, and thus the cover 10a and the tub body 10b may communicate with each other. Flange-shaped coupling portions are protruded along the circumferential surfaces of a rear-end portion of the tub cover 10a and a front-end portion of the tub body 10b to face each other, and the coupling portions may be fastened by fastening members such as bolts. Furthermore, a sealing member is coupled between the rear surface 10b' of the tub cover 10a and the front surface 10a' of the tub body 10b to maintain an airtight seal between the tub cover 10a and the tub body 10b.

[0061] The inlet port is formed on the front surface 10a' of the tub cover 10a. Washing objects are put into the drum through the inlet port. The drum has an opening portion on the front surface 10a' to communicate with the inlet port of the tub cover 10a. The inlet port of the tub cover 10a may be formed smaller than the diameter of the tub cover 10a.

[0062] The sump 12 may be recessed on the bottom surface of the tub body 10b. The sump 12 is positioned lower than the lowermost end of the circumferential surface in the tub body 10b. Thereby, wash water in the tub 10 may be introduced into the sump 12 by gravity.

[0063] The sump 12 is provided with a drain port 10b2 on one side for draining wash water to the outside. The drain port 10b2 is connected to the drain hose described above, and wash water may be drained to the outside.

[0064] FIG. 3A is a view showing a shape in which a water droplet 3 is falling from a lotus leaf 1, and FIG. 3B is a conceptual view for explaining the lotus effect of super-hydrophobic micro-protrusions 13 applied to the inside of a washing machine according to the present disclosure, and FIG. 3C is a conceptual view for explaining a correlation between a water-surface contact angle and a water-repellent property.

[0065] As shown in FIG. 3A, on a surface of the lotus leaf 1 there are a lot of nano-protrusions 2 (one protrusion having a diameter of about 1 nanometer) having hydrophobicity so that water does not infiltrate even when it rains, and droplets 3 are formed and flow down along the surface. Due to the protrusions having hydrophobicity, the water droplets 3 are not adhered to the lotus leaf 1 and fall off. At this time, dust and dirt adhered to the micro-protrusions also fall together, and the lotus leaf 1 may be always kept clean. As described above, the long leaf effect includes not only the effect of water droplets (3) being rolled out but also the self-cleaning (keeping itself clean) effect of the lotus leaf 1.

[0066] A water droplet 3 illustrated in FIG. 3B has a small contact area when brought into contact with the nano-protrusions 2 having a size smaller than that of itself, but has a contact angle larger than 100°, and thus that the lotus leaf 1 has hydrophobicity. As a result, the water droplet 3 comes across another water droplet 3 without infiltrating through the micro-protrusions to make a larger water droplet 3 while floating on the micro-protrusions, and the larger water droplet 3 flows and rolls while becoming heavier, and falls down.

[0067] An angle of water illustrated in FIG. 3C being brought into contact with a surface of a contact object is referred to as a contact angle, and the water is hydrophilic when the contact angle between the water and the surface is less than 90°, water repellent (hydrophobic) when the contact angle is above 90° but less than 150°, and super hydrophobic when the contact angle is above 150°.

[0068] In the present disclosure, super-hydrophobic micro-protrusions 13 may be applied to a place where water is in contact with the inside of the washing machine to improve drainage performance inside the washing machine and remove residual water inside the washing machine using the effect of the lotus leaf 1.

[0069] FIG. 4 is a view showing an example in which the super-hydrophobic micro-protrusions 13 according to the present disclosure are applied to a tub cover 10a, and FIG. 5 is a view showing an example in which the super-hydrophobic micro-protrusions 13 according to the present disclosure are applied to a tub body 10b.

[0070] The super-hydrophobic micro-protrusions 13 may be applied to an inner surface of the tub 10.

[0071] The super-hydrophobic micro-protrusions 13 may be applied to an inner surface of the tub cover 10a or the tub body 10b.

[0072] FIG. 4 shows a view in which a front side 10a' of the tub cover 10a is seen. The super-hydrophobic micro-protrusions 13 may be integrally formed to be covered with a predetermined pattern on the front side 10a' of the tub cover 10a shown in FIG. 4. Although not shown, the super-hydrophobic micro-protrusions 13 may be formed on an inner circumferential surface of the tub cover 10a.

[0073] FIG. 5 shows a view in which a rear side 10b' of the tub body 10b is seen. The super-hydrophobic micro-protrusions 13 may be integrally formed to be covered with a predetermined pattern on the rear side 10b' of the tub body 10b shown in FIG. 5. Although not shown, the super-hydrophobic micro-protrusions 13 may be formed on an inner circumferential surface of the tub body 10b.

[0074] The super-hydrophobic micro-protrusions 13 have a size ranging from 0.2 mm through 0.4 mm in order to exhibit super hydrophobic performance with a contact angle between the water and the surface above 150°. Furthermore, the super-hydrophobic micro-protrusions 13 preferably have a size of 0.2 mm or less (or 0.25 mm or less). This is because, when the size of the micro-protrusions is larger than the upper limit value of 0.25 mm, foreign substances may be trapped between the micro-protrusions. Therefore, it is preferable that the micro-protrusions have a size smaller than the upper limit value.

[0075] In case where the water-repellent micro-protrusions 13 cover an inner surface of the tub 10, when the water droplet 3 is formed on the surface of the tub 10, the water droplet 3 rolls along the micro-protrusions while maintaining a round ball or sphere shape without getting wet on the surface of the tub 10. The water droplet 3 slips and rolls toward the sump 12 in the tub 10 by gravity. Here, the ball-shaped droplet 3 does not touch the inner surface of the tub 10 by the super-hydrophobic micro-protrusions 13, and the super-hydrophobic micro-protrusions 13 support the water droplet 3. Furthermore, the water droplet 3 merges with another water droplet 3 to form a larger water droplet 3 while moving along the surface of the tub 10 and moves to the sump 12 and the drain port 10b2 by gravity to be discharged to the outside.

[0076] As a result, residual water is drained without remaining in the tub 10, and thus the cleanliness of the inside of the tub 10 may be kept clean.

[0077] In addition, the water droplet 3 may be rolled and drained together with the foreign substances adhering to the inside of the tub 10 to obtain the self-cleaning effect.

[0078] FIGS. 6A and 6B are schematic views for explaining a method of fabricating a tub 10 by a plastic injection mold according to the present disclosure, wherein FIG. 6A illustrates a case where the injection mold is closed, and FIG. 6B illustrates a case where the injection mold is open.

[0079] Referring to FIG. 6A, the injection mold is divided into a fixed portion and a movable portion. A first molding portion 211 having the same shape as that of an outer surface of the tub cover 10a or the tub body 10b is provided on an inner side of the fixed portion. The movable portion is provided with a second molding portion 221 having the same shape as that of an outer surface of the tub cover 10a or the tub body 10b on one side of an outer portion thereof.

[0080] The first molding portion 211 and the second molding portion 221 are formed to face each other, and the second molding portion 221 may be inserted into the fixed portion 211 toward the first molding portion 211. An injection machine is provided at one side of the fixed portion, and molten resin of plastic is injected from the injection machine into a space between the first molding portion 211 and the second molding portion 221.

[0081] The micro molding protrusions 23 are formed on a surface of the second molding portion 221, and the super-hydrophobic micro-protrusions 13 are formed integrally with the tub 10 by the micro molding protrusions 23.

[0082] Referring to FIG. 6B, the micro molding protrusions 23 are formed on a right-side surface of the movable portion. However, the super-hydrophobic micro-protrusions 13 may be formed on a circumferential surface of the tub cover 10a or the tub body 10b to form the micro molding protrusions 23 on an outer circumferential surface of the second molding portion 221.

[0083] After the injection molding is completed, the movable portion is separated from the fixed portion to take out the injection product. The movable portion is separated in the longitudinal direction of the tub cover 10a or the tub body 10b. The longitudinal direction of the tub cover 10a or the tub body 10b denotes a direction parallel to a circumferential surface of the tub body 10b of the tub cover 10a.

[0084] Hereinafter, various embodiments of the super-hydrophobic micro-protrusions 13 according to the present disclosure will be described.

[0085] FIG. 7A is a schematic view showing a first embodiment of super-hydrophobic micro-protrusions according to the present disclosure, and FIG. 7B is a plan view in which the super-hydrophobic micro-protrusions of FIG. 7A are seen from above.

[0086] The super-hydrophobic micro-protrusions 13 according to the first embodiment are formed in a brick (rectangular) shape. The upper and lower widths of the micro-protrusions are the same, and the height of the micro-protrusions may be a size of 2/10, a half compared to the horizontal and vertical lengths of the micro-protrusions of 4/10.

[0087] Furthermore, the super-hydrophobic micro-protrusions 13 may be spaced apart from each other by a size of 1/10. The super-hydrophobic micro-protrusions 13 may be formed to be spaced apart in different directions (two directions, transverse direction and longitudinal direction).

[0088] FIG. 8A is a schematic view showing a second embodiment of super-hydrophobic micro-protrusions 113 according to the present disclosure, and FIG. 8B is a plan view in which the super-hydrophobic micro-protrusions 113 of FIG. 8A are seen from above.

[0089] The super-hydrophobic micro-protrusions 113 according to the second embodiment are formed in a brick (rectangular) shape. The top and bottom widths of the micro-protrusions are the same, and the width, height, and height of the micro-protrusions are all equal to 2/10, and the micro-protrusions may be formed to be spaced apart from each other by a size of 5/100.

[0090] Furthermore, the super-hydrophobic micro-protrusions 113 may be spaced apart in different directions.

[0091] FIG. 9A is a schematic view showing a third embodiment of super-hydrophobic micro-protrusions 213 according to the present disclosure, and FIG. 9B is a plan view in which the super-hydrophobic micro-protrusions 213 of FIG. 9A are seen from above.

[0092] The super-hydrophobic micro-protrusions 213 according to the third embodiment are formed in an upward convexly rounded shape. The round shaped micro-protrusions may not be spaced apart, and formed without being continuously spaced apart in different directions. At this time, a pitch between the micro-protrusions may be the same ratio (5/100) in the horizontal and vertical directions, respectively. A spacing between the depressions (valleys) of the micro-protrusions may be formed at the same ratio in the horizontal and vertical directions.

[0093] FIG. 10A is a schematic view showing a fourth embodiment of super-hydrophobic micro-protrusions 313 according to the present disclosure, and FIG. 10B is a plan view in which the super-hydrophobic micro-protrusions 313 of FIG. 10A are seen from above.

[0094] The super-hydrophobic micro-protrusions 313 according to the fourth embodiment are formed in a protrusion shape having a pointed end. The depressions between the pointed protrusions may be formed in a downward rounded shape. The pointed protrusions and depressions may be alternately formed in succession.

[0095] At this time, a pitch between the pointed protrusions may be the same ratio (5/100) in the horizontal and vertical directions, respectively.

[0096] FIG. 11A is a schematic view showing a fifth embodiment of super-hydrophobic micro-protrusions 413 according to the present disclosure, and FIG. 11B is a plan view in which the super-hydrophobic micro-protrusions 413 of FIG. 11A are seen from above.

[0097] The super-hydrophobic micro-protrusions 413 according to the fifth embodiment may be formed in a trapezoidal shape. The trapezoidal shaped micro-protrusions are narrower in the upper width than the lower width. For example, the upper width of the micro-protrusions may be 1/10 and the lower width thereof may be 3/10. Furthermore, the height of the micro-protrusions may be greater than the upper width. For example, the height of the micro-protrusions may be 2/10 and the upper width thereof may be 1/10.

[0098] In addition, the trapezoidal shaped micro-protrusions 413 may be spaced apart in one direction.

[0099] FIG. 12A is a schematic view showing a sixth embodiment of super-hydrophobic micro-protrusions 513 according to the present disclosure, and FIG. 11B is a plan view in which the super-hydrophobic micro-protrusions 513 of FIG. 12A are seen from above.

[0100] The super-hydrophobic micro-protrusions 513 according to the sixth embodiment may be formed in a triangular or quadrangular shape. The quadrangular shaped micro-protrusions 513 have a pointed end to form four triangular surfaces along the circumferential surface. The height of the micro-protrusions 513 is 2/10 and the horizontal and vertical lengths of the bottom rectangle may be 4/10 each.

[0101] FIG. 13A is a schematic view showing a seventh embodiment of super-hydrophobic micro-protrusions 613 according to the present disclosure, and FIG. 13B is a plan view in which the super-hydrophobic micro-protrusions 613 of FIG. 13A are seen from above.

[0102] The super-hydrophobic micro-protrusions 613 according to the seventh embodiment may be formed in a triangular or quadrangular shape. However, the height of the micro-protrusions 613 according to the seventh embodiment and the horizontal and vertical lengths of the bottom rectangle may all be the same in a ratio of 2/10.

[0103] The super-hydrophobic micro-protrusions 613 may have unidirectionality or bidirectionality, as in the foregoing embodiments.

[0104] The micro-protrusions 13,113, 213, 313, 513, 613 in the remaining FIGS. 7A, 7B, 8A, 8B, 9A, 9B, 10A, 10B, 12A, 12B, 13A and 13B, excluding FIGS. 11A and 11B, have bidirectionality.

[0105] The micro-protrusions 413 in FIGS. 11A and 11B have unidirectionality.

[0106] Here, the micro-protrusions having directionality denotes that the micro-protrusion forms a predetermined pattern in any direction.

[0107] For example, the micro-protrusions 413 in FIGS. 11A and 11B are protruded in a trapezoidal shape along one direction. The trapezoidal shaped micro-protrusions 413 may be spaced apart at regular intervals in a direction intersecting the one direction.

[0108] Furthermore, the micro-protrusions 413 having unidirectionality may be spaced apart from each other in a direction intersecting one direction, and the micro-protrusions 413 having unidirectionality may be formed in a horizontally symmetrical manner with respect to the center line of the one direction spaced apart in parallel to each other. The center line of the one direction is a line connecting the centers of the upper widths in the case of the protrusions 413 having a trapezoidal shape. Furthermore, a first inclined surface 413a and a second inclined surface 413b may be formed symmetrically on both sides with respect to the unidirectional center line of the micro-protrusions 413. In addition, in the case where the micro-protrusions 413 having unidirectionality is triangular, the center line in one direction denotes a line connecting the upper vertices.

[0109] The micro-protrusions 13, 113, 213, 313, 513, 613 in FIGS. 7A through 10B and 12A through 13B except for FIGS. 11A and 11B have bidirectionality. For example, the micro-protrusions 13, 113, 213, 313, 513, 613 in the remaining drawings may be formed in a predetermined pattern along two directions, i.e., the transverse direction and the longitudinal direction.

[0110] Furthermore, the micro-protrusions 13, 113, 213, 313, 513, 613 having bidirectionality may be formed in a predetermined pattern in two directions, i.e., the transverse direction and the longitudinal direction intersecting each other, and the micro-protrusions 13, 113, 213, 313, 513, 613 having bidirectionality may be formed symmetrically with respect to the center lines in the transverse direction and the longitudinal direction arranged to be spaced apart parallel to each other. The transverse center line and the longitudinal center line may be formed in a lattice shape.

[0111] The micro-protrusions 13, 113, 213, 313, 513, 613 having bidirectionality may further improve super hydrophobic performance compared to the micro-protrusions 413 having unidirectionality.

[0112] FIG. 14 is a view showing an example in which the super-hydrophobic micro-protrusions 130 according to the present disclosure are applied to a circumferential surface 100a' of a tub cover 100a, and FIG. 15 is a view showing an example in which the super-hydrophobic micro-protrusions 130 according to the present disclosure are applied to a circumferential surface 100b' a tub body 100b.

[0113] The super-hydrophobic micro-protrusions 130 may be applied to an inner surface of the tub 100 to improve the drainage performance of wash water.

[0114] The super-hydrophobic micro-protrusions 130 may be applied to an inner surface of the tub cover 100a or the tub body 100b.

[0115] FIG. 14 shows a view in which the tub cover 100a is seen from the rear side. The super-hydrophobic micro-protrusions 130 may be integrally formed to be covered with a predetermined pattern on a circumferential surface 100a' in the tub cover 100a illustrated in FIG. 14.

[0116] FIG. 15 shows a view in which the tub body 100b is seen from the front side. The super-hydrophobic micro-protrusions 130 may be integrally formed to be covered with a predetermined pattern on a circumferential surface 100b' in the tub body 100b illustrated in FIG. 15.

[0117] The super-hydrophobic micro-protrusions 130 have a size ranging from 0.2 mm through 0.4 mm in order to exhibit super hydrophobic performance with a contact angle (θ) between the water and the surface above 150°. Furthermore, the super-hydrophobic micro-protrusions 130 preferably have a size of 0.2 mm or less (or 0.25 mm or less). This is because, when the size of the micro-protrusions is larger than the upper limit value of 0.25 mm, foreign substances may be trapped between the micro-protrusions. Therefore, it is preferable that the micro-protrusions have a size smaller than the upper limit value.

[0118] In case where the water-repellent micro-protrusions 130 cover an inner surface of the tub 100, when the water droplet 2 is formed on the surface of the tub 100, the water droplet 2 rolls along the micro-protrusions while maintaining a round ball or sphere shape without getting wet on the surface of the tub 100. The water droplet 2 slips and rolls toward the sump 120 in the tub 100 by gravity. Here, the ball-shaped droplet 2 does not touch the inner surface of the tub 100 by the super-hydrophobic micro-protrusions 130, and the super-hydrophobic micro-protrusions 130 support the water droplet 2. Furthermore, the water droplet 2 merges with another water droplet 2 to form a larger water droplet 2 while moving along the surface of the tub 100 and moves to the sump 120 and the drain port 100b2 by gravity to be discharged to the outside through the drain hose.

[0119] As a result, residual water is drained without remaining in the tub 100, and thus the cleanliness of the inside of the tub 100 may be kept clean.

[0120] In addition, the water droplet 2 may be rolled and fallen together with the foreign substances adhering to an inner surface of the tub 100 to obtain the self-cleaning effect.

[0121] Here, the super-hydrophobic micro-protrusions 13 formed on the inner surface of the tub 100 may be integrally formed with the tub 100 by injection molding.

[0122] The super-hydrophobic micro-protrusions 130 formed on the circumferential surfaces 100a', 100b' of the tub 100 may have directionality for smooth separation of the injection mold. In other words, the super-hydrophobic micro-protrusions 130 formed on the circumferential surfaces 100a', 100b' of the tub 100 have directionality in a direction in which the injection mold 200 is separated after molding. As the super-hydrophobic micro-protrusions 130 have a directionality in a specific direction, it is possible to remove the undercut of the injection mold, which is an element that hinders the smooth separation of the mold. Although a separate core may be provided to remove the undercut of the injection mold, there is a problem that the manufacturing cost increases in this case.

[0123] In the present disclosure, the super-hydrophobic micro-protrusions 130 may have directionality in a direction in which the mold is separated to remove the undercut of the injection mold without an additional core, and prevent the deterioration of physical performance due to the undercut of the water-repellent surface.

[0124] Furthermore, the super-hydrophobic micro-protrusions 130 formed on the circumferential surfaces 100a', 100b' of the tub 100 may be formed to have an inclined surface with a predetermined slope to guide the flow of residual water in a predetermined direction.

[0125] FIG. 16 is a schematic view showing a structure in which the super-hydrophobic micro-protrusions 130 according to the present disclosure have an asymmetric slope.

[0126] The super-hydrophobic micro-protrusions 130 may be formed in a a triangular cross-sectional shape, for example. However, the cross-sectional shape is not limited thereto.

[0127] The two super-hydrophobic micro-protrusions 130 illustrated in FIG. 16 are formed adjacent to each other. The super-hydrophobic micro-protrusions 130 may include a first inclined surface 130a inclined downwardly in one direction from a top vertex and a second inclined surface 130b inclined downwardly in an opposite direction from the top vertex. The slope (gradient) of the first inclined surface 130a (a right inclined surface with respect to an upper vertex in FIG. 6) is smaller (smoother) than that of the second inclined surface 130b. In the drawing, if a vertical line passing through an upper vertex intersects a horizontal line positioned at a lower portion of the upper vertex, a length of a horizontal extension line extended from an intersection of the vertical line and the horizontal line to a right vertex is "a", a length of a horizontal extension line extended from the intersection to a left vertex is "b", and a height of a vertical extension line connecting the upper vertex and the intersection is "h", then h/a is a slope of the first inclined surface 130a, and h/b is a slope of the second inclined surface 130b.

[0128] The first and second inclined surfaces 130a, 130b of the super-hydrophobic micro-protrusions 130 are formed in different slopes ($h/a < h/b$) with respect to the upper apex and thus the super-hydrophobic micro-protrusions 130 are asymmetric.

[0129] The super-hydrophobic micro-protrusions 130 have a super hydrophobic property with a contact angle (θ) above 150 degrees with respect to the water droplet 2. In addition, the water droplet 2 has directionality on the super-hydrophobic micro-protrusions 130 and may move in one direction due to the characteristics of a surface structure of the super-hydrophobic micro-protrusions 130 having an asymmetric inclined surface. In other words, the flow of the water droplet 2 is directed from the second inclined surface 130b of the super-hydrophobic micro-protrusion 130 toward the first inclined surface 130a.

[0130] Here, the first inclined surface 130a and the second inclined surface 130b of the super-hydrophobic micro-protrusions 130 may be alternately arranged in a circumferential direction of the tub 100 to allow residual water formed on the circumferential surfaces 100a', 100b' of the tub 100 to flow toward the sump 120. The first inclined surface 130a is formed to be inclined downward toward the drain port 100b2 or the sump 120 from the upper vertex of the micro-protrusion, and the second inclined surface 130b is formed to be inclined downward in an opposite direction to the drain port 100b2 or the sump 120 from the upper vertex of the micro-protrusion. However, the first inclined surface 130a and the second inclined surface 130b have different inclination angles, and the slope h/a of the first inclined surface 130a is smaller than the slope h/b of the second inclined surface 130b.

[0131] A driving force (F) that provides the directionality of the water droplet 2 is generated by the following equation.

$$\mathrm{F} = \int_{Left}^{Right} r_{lv}\left(\cos(\theta_A + w_1) - \cos(\theta_R + w_2)\right) dl$$

[0132] r_{lv}: water surface tension, θ_A: water forward angle, θ_B: water backward angle, w_1: internal angle of right vertex, w_2: internal angle of left vertex.

[0133] FIGS. 17A and 17B are schematic views for explaining a method of fabricating a tub by a plastic injection mold according to the present disclosure, wherein FIG. 17A illustrates a case where the injection mold is closed, and FIG. 17B illustrates a case where the injection mold is open. FIG. 17C is a side view showing a shape when viewed in direction D-D in FIG. 17B.

[0134] Referring to FIG. 17A, the injection mold is divided into a fixed portion and a movable portion. A first molding portion 211 having the same shape as that of an outer surface of the tub cover 100a or the tub body 100b is provided on an inner side of the fixed portion. The movable portion is provided with a second molding portion 2201 having the same shape as that of an outer surface of the tub cover 100a or the tub body 100b on one side of an outer portion thereof.

[0135] The first molding portion 2101 and the second molding portion 2201 are formed to face each other, and the second molding portion 2201 may be inserted into the fixed portion 2101 toward the first molding portion 211. An injection machine is provided at one side of the fixed portion, and molten resin of plastic is injected from the injection machine into a space between the first molding portion 2101 and the second molding portion 2201.

[0136] The micro molding protrusions 230 are formed on a surface of the second molding portion 2201, and the super-hydrophobic micro-protrusions 130 are formed integrally with the tub 100 by the micro molding protrusions 230.

[0137] Referring to FIG. 17B, the micro molding protrusions 230 are formed on a circumferential surface of the movable portion. The super-hydrophobic micro-protrusions 130 may be injection molded on the circumferential surfaces 10a' and 10b' in the tub cover 100a or the tub body 100b.

[0138] After the injection molding is completed, the movable portion is separated from the fixed portion to take out the injection product. The movable portion is separated in the longitudinal direction of the tub cover 100a or the tub body 100b. The longitudinal direction of the tub cover 100a or the tub body 100b denotes a direction parallel to a circumferential surface 100b of the tub body 100b of the tub cover 100a.

[0139] The super-hydrophobic micro-protrusions 130 formed on the circumferential surfaces 100a', 100b' of the tub cover 100a or the tub body 100b have directionality in a direction in which the movable portion or movable mold 220 is separated from the fixed portion after the injection molding is completed.

[0140] Here, the super-hydrophobic micro-protrusions 130 having directionality denote that the super-hydrophobic micro-protrusions 130 are protruded along the separating direction of the movable mold 220 so as not to interfere with the micro molding protrusions 230 of the movable mold when the mold is separated after molding is completed by the injection mold 200.

[0141] FIG. 18A, as a partially enlarged view of "C" in FIG. 14, is a plan view showing an example of the super-hydrophobic micro-protrusions 1310 having directionality, and FIG. 18B is a cross-sectional view showing a cross-sectional shape of the super-hydrophobic micro-protrusions 1310 viewed in direction E-E in FIG. 18A.

[0142] The separating direction of the movable mold 220 may be the longitudinal direction of the tub 100. For example, the movable mold 220 is separated or removed from the fixed mold 210 along the longitudinal center line of the tub cover 100a from the front surface of the tub cover 100a toward the opening portion on the rear side.

[0143] The super-hydrophobic micro-protrusions 1310 may have directionality in the longitudinal direction of the tub 100, the longitudinal direction of the tub cover 100a, or the longitudinal direction of the tub body 100b. Furthermore, the super-hydrophobic micro-protrusions 130 may have directionality in a direction parallel to the circumferential surfaces 100a',100b' of the tub 100, the circumferential surface 100a' of the tub cover 100a, or the circumferential surface 100b' of the tub body 100b.

[0144] The super-hydrophobic micro-protrusions 1310 have a predetermined cross-sectional shape along the longitudinal direction of the tub cover 100a or the tub body 100b to have directionality in the separating direction of the mold, that is, the longitudinal direction of the tub 100, the longitudinal direction of the tub cover 100a, or the tub body 100b.

[0145] The super-hydrophobic micro-protrusions 1310 illustrated in FIG. 18A have a triangular cross-sectional shape. The super-hydrophobic micro-protrusions 1310 are formed to constantly maintain the triangular cross-sectional shape along the longitudinal direction of the tub cover 100a or the tub body 100b. In particular, for the super-hydrophobic micro-protrusions 1310, triangular vertices may be continuously extended along the longitudinal direction of the tub 100 to form a straight line. Both sides may be formed symmetrically with the same length and inclination angle with respect to the vertex of the triangle or a straight line extending the vertex. Both side surfaces of the super-hydrophobic micro-protrusions 1310 are symmetrical to each other and have the same length and inclined surface. The super-hydrophobic micro-protrusions 1310 may have an isosceles triangular cross-sectional shape. At this time, the base (P) and the height (h) of the isosceles triangle may be the same length.

[0146] Furthermore, the plurality of super-hydrophobic micro-protrusions 1310 may be formed such that the triangular cross-sectional shapes are successively formed adjacent to each other or spaced apart at regular intervals in the circumferential direction of the tub 100. The plurality of super-hydrophobic micro-protrusions 1310 illustrated in FIG. 18A are successively formed adjacent to each other. Being successively formed adjacent to each other denotes that the mutually facing inclined surfaces of the two adjacent micro-protrusions are in contact with each other to form a straight valley.

[0147] FIG. 19A is a plan view showing another example of the super-hydrophobic micro-protrusions 2310 having directionality according to the present disclosure, and FIG. 19B is a cross-sectional view showing a cross-sectional shape of the super-hydrophobic micro-protrusions 2310 in FIG. 19A.

[0148] The super-water-repellent micro-protrusion 2310 illustrated in FIGS. 19A and 19B have the following differences compared to the super-hydrophobic micro-protrusions 1310 in FIGS. 18A and 18B, and the remaining configurations thereof are the same as or similar to the super-hydrophobic micro-protrusions 1310 in FIGS. 18A and 18B Water repellent micro-protrusions 1310, and thus, the detailed description thereof will be omitted.

[0149] The super-hydrophobic micro-protrusions 2310 illustrated in FIGS. 19A and 19B may be formed in a trapezoidal shape.

[0150] The upper side (w) and the lower side (P) of the trapezoid may be made parallel to each other. Furthermore, the upper side (w) may have a length of about 1/3 of the lower side (P). The inclined surfaces symmetrical to each other may be formed on both sides with respect to the center line of the upper side (w) of the trapezoid. When viewing the trapezoid from above, the width (P) of the trapezoid (including the upper surface and both inclined surfaces) may be 3/2 of the height (h) of the trapezoidal cross section.

[0151] The super-hydrophobic micro-protrusions 2310 may be constantly maintained along the longitudinal direction of the tub 100 such that the cross-sectional shape of the trapezoid has constant directivity in the separating direction of the mold, that is, the longitudinal direction of the tub 100.

[0152] Furthermore, for the super-hydrophobic micro-protrusions 2310, trapezoidal cross-sectional shapes may be spaced apart or continuously formed in a circumferential direction of the tub 100. The super-hydrophobic micro-protrusions 2310 illustrated in FIG. 9B are spaced apart in the circumferential direction of the tub 100.

[0153] FIG. 20 is a front view of a tub 200 according to the present disclosure, and FIG. 21 is a cross-sectional view taken along line I-I in FIG. 20.

[0154] An upper portion of the sump 210 is opened to communicate with the inside of the tub body 200b so that wash water in the tub body 200b flows down and gets collected into the sump 210.

[0155] An overflow preventing member 210a may be provided at an upper side edge portion of the sump 210. The overflow preventing member 210a is provided to prevent wash water from flowing into the inside of the sump 210 due to an acceleration force of the wash water flowing down along one circumferential surface of the tub body 200b while at the same time part of the wash water inside the sump 210 from flowing over a circumferential surface opposite to the tub 200 through the sump 210. For this purpose, the overflow preventing member 210a may be formed to protrude along the longitudinal direction of the sump 210 at a side edge portion of the sump 210.

[0156] The overflow preventing members 210a may be protruded in directions facing each other from both upper side ends of the sump 210.

[0157] The sump 210 may be formed to have a larger width toward the front side from the rear side of the tub body 200b. Furthermore, the overflow preventing member 210a may be formed to have a larger width toward the front side from the rear side of the tub body 200b. However, an overflow preventing member located above the drain port 200b2 of the two overflow preventing members 210a may be partially cut not to cover the upper portion of the drain port 200b2.

[0158] The sump 210 has a drain port 200b2 on one side to drain wash water stored in the tub 200 to the outside. The drain port 200b2 is connected to the drain hose described above to drain wash water to the outside.

[0159] The drain port 200b2 may be formed to be spaced apart from the sump 210 to the longitudinal center line (G-G) of the tub 200 or in one direction from the rotational center line of the drum, for example, toward a right-side panel of the cabinet.

[0160] The sump 210 may be formed at a lower portion of the tub body 200b to be inclined to the longitudinal center line (G-G) of the tub 200 or one direction from the rotational center line of the drum, for example, toward the right-side panel of the cabinet. In other words, the longitudinal center line of the sump 210 is spaced apart in one direction without coinciding with the longitudinal center line (G-G) of the tub body 200b.

[0161] The drain port 200b2 is further spaced apart from the longitudinal center line of the sump 210 in one direction.

[0162] FIG. 22A is a G-G cross-sectional view showing an example of the sump 210 in FIG. 21, and FIG. 22B is a perspective view showing the super-hydrophobic micro-protrusions 2130 applied to the sump in FIG. 22A.

[0163] The tub cover 200a illustrated in FIG. 22A is disposed on a front side in the longitudinal direction of the tub 200, and the tub body 200b is disposed on a rear side of the tub 200, and the tub cover 200a and the tub body 200b are coupled to each other. A front surface of the tub cover 200a is positioned higher than a rear surface of the tub body 200b. The inlet port of washing objects is formed on the front surface of the tub cover 200a.

[0164] The tub cover 200a may be formed to be inclined downward in a range of, for example, 5 to 15° from the front side toward the rear side. In other words, a rear side of the tub cover 200a may be positioned lower than a front side thereof.

[0165] The tub body 200b may be formed to be inclined upward from the rear side toward the front side. In other words, a front side of the tub body 200b may be positioned higher than a rear side thereof.

[0166] However, the sump 210 may be formed to be inclined downward from the rear side of the tub body 200b toward the front side. A front bottom surface of the sump 210 is positioned lower than a rear bottom surface thereof. The reason is that the drain port 200b2 is spaced apart from the rear side of the tub body 200b toward the front side to allow wash water in the sump 210 to flow to the drain port 200b2.

[0167] For example, the bottom surface of the sump 210 may be formed to be inclined at an angular range (α) of 0.5 to 1° with respect to the horizontal plane.

[0168] A plurality of super-hydrophobic micro-protrusions 2130 are integrally formed on an inner surface of the tub 200 to remove residual water inside the tub 200.

[0169] The super-hydrophobic micro-protrusions 2130 have a size ranging from 0.2 mm through 0.4 mm in order to exhibit super hydrophobic performance with a contact angle between the water and the surface above 150°. Furthermore, the super-hydrophobic micro-protrusions 2130 preferably have a size of 0.2 mm or less (or 0.25 mm or less). This is because, when the size of the micro-protrusions is larger than the upper limit value of 0.25 mm, foreign substances may be trapped between the micro-protrusions. Therefore, it is preferable that the micro-protrusions have a size smaller than the upper limit value.

[0170] In case where the water-repellent micro-protrusions 2130 cover an inner surface of the tub 200, when the water droplet 3 is formed on the surface of the tub 200, the water droplet 3 rolls along the micro-protrusions while maintaining a round ball or sphere shape without getting wet on the surface of the tub 200. The water droplet 3 slips and rolls toward the sump 210 in the tub 200 by gravity. Here, the ball-shaped droplet 3 does not touch the inner surface of the tub 200 by the super-hydrophobic micro-protrusions 2130, and the super-hydrophobic micro-protrusions 2130 support the water droplet 3. Furthermore, the water droplet 3 merges with another water droplet 3 to form a larger water droplet 3 while moving along the surface of the tub 200 and moves to the sump 210 and the drain port 200b2 by gravity to be discharged to the outside through the drain hose.

[0171] As a result, residual water is drained without remaining in the tub 200, and thus the cleanliness of the inside of the tub 200 may be kept clean.

[0172] In particular, a plurality of super-hydrophobic micro-protrusions 2130 may be formed on an inner surface of the sump 210.

[0173] Small water droplets 3 in the sump 210 are rolled down along the super-hydrophobic micro-protrusions 2130 to form a large water droplet 3 and move to the drain port 200b2.

[0174] In addition, the water droplets 3 may be rolled and fallen together with the foreign substances adhering to an inner surface of the sump 100 to obtain the self-cleaning effect.

[0175] FIG. 23A is a perspective view showing another example of the sump 2110 in FIG. 21, and FIG. 23B is a plan view in which the sump 2110 in FIG. 23A is seen from above, and FIG. 23C is a H-H cross-sectional view of residual water in FIG. 23A.

[0176] The sump 2110 shown in FIGS. 23A through 23C has the following differences from the sump 210 in FIGS. 22A and 22B. The remaining configurations thereof are the same as or similar to those shown in FIGS. 22A and 22B, and thus, the detailed description thereof will be omitted.

[0177] The sump 2110 illustrated in FIGS. 23A through 23C further includes a residual water guide passage portion 220.

[0178] The residual water guide passage portion 220 is provided to guide residual water in the sump 2110 to the drain port 200b2. The residual water guide passage portion 220 is formed to be spaced apart from the longitudinal center line of the sump 2110 in one direction. The residual water guide passage portion 220 has a narrow passage width and a long length in the longitudinal direction of the sump 2110.

[0179] In addition, the residual water guide passage portion 220 is formed to be inclined downward from the rear portion of the sump 2110 toward the front portion. Since the drain port 200b2 is formed at a front-end portion of the residual water guide passage portion 220, the front-end portion of the residual water guide passage portion 220 is preferably positioned lower than the rear portion thereof to allow residual water to flow to the drain port 200b2 under the influence of gravity. Here, the residual water guide passage portion 220 is formed to have a larger inclination than the bottom surface of the sump 210. For example, the inclination angle of the bottom surface of the sump 2110 may be 0.5° through 1°, whereas the inclination angle of the residual water guide passage portion 220 may be formed within a range of 2° through 4°.

[0180] Accordingly, the residual water guide passage portion 220 may further improve the drainage performance of residual water by the drain port 200b2 than residual water in the sump 2110.

[0181] The super-hydrophobic micro-protrusions 2130 formed on the sump 2110 may be formed to have an inclined surface with a predetermined slope to guide the flow of residual water in a predetermined direction in order to more effectively remove residual water in the sump 2110.

[0182] For example, the super-hydrophobic micro-protrusions 2130 of the sump 2110 may guide residual water to flow toward the residual water guide passage portion 220.

[0183] Here, the first inclined surface and the second inclined surface of the super-hydrophobic micro-protrusions 2130 may be alternatively arranged toward the drain port 200b2 or the residual water guide passage portion 220 in the width direction of the sump 2110 to allow residual water in the sump 2110 to flow toward the residual water guide passage portion 220 or the drain port 200b2. The first inclined surface is formed to be inclined downward from the upper vertex of the micro-protrusions toward the drain port 200b2 or the residual water guide passage portion 220, and the second inclined surface is formed to be inclined downward in a direction opposite to the drain port 200b2 or the residual water guide passage portion 220 from an upper end point of the micro-protrusions 2130. However, the first inclined surface and the second inclined surface have different inclination angles, and the slope h/a of the first inclined surface is smaller than the slope h/b of the second inclined surface.

[0184] FIGS. 24A and 24B are schematic views for explaining a method of fabricating a tub 200 by a plastic injection mold according to the present disclosure, wherein FIG. 24A illustrates a case where the injection mold is closed, and FIG. 24B illustrates a case where the injection mold is open. FIG. 24C is a side view in which the injection mold is seen in direction I-I in FIG. 24B.

[0185] Referring to FIG. 24A, the injection mold is divided into a fixed portion and a movable portion. A first molding portion 3110 having the same shape as that of an outer surface of the tub cover 200a or the tub body 200b is provided on an inner side of the fixed portion. The movable portion is provided with a second molding portion 3210 having the same shape as that of an outer surface of the tub cover 200a or the tub body 200b on one side of an outer portion thereof.

[0186] The first molding portion 3110 and the second molding portion 3210 are formed to face each other, and the second molding portion 3210 may be inserted into the fixed portion 3110 toward the first molding portion 211. An injection machine is provided at one side of the fixed portion, and molten resin of plastic is injected from the injection machine into a space between the first molding portion 3110 and the second molding portion 3210.

[0187] The micro molding protrusions 330 are formed on a surface of the second molding portion 3210, and the super-hydrophobic micro-protrusions 2130 are formed integrally with the tub 200 by the micro molding protrusions 330.

[0188] Referring to FIG. 24C, the micro molding protrusions 330 are formed at a lower portion of the circumferential surface of the movable portion (a portion facing the sump 2110). As a result, the super-hydrophobic micro-protrusions 2130 may be injection molded into the sump 2110 in the tub body 200b.

[0189] After the injection molding is completed, the movable portion is separated from the fixed portion to take out the injection product. The movable portion is separated in the longitudinal direction of the tub cover 200a or the tub body 200b. The longitudinal direction of the tub cover 200a or the tub body 200b denotes a direction parallel to a circumferential surface of the tub body 200b of the tub cover 200a.

[0190] The super-hydrophobic micro-protrusions 2130 formed on an inner surface of the sump 2110 of the tub body 200b have directionality in a direction in which the movable portion or movable mold 320 is separated from the fixed portion after the injection molding is completed.

[0191] Here, the super-hydrophobic micro-protrusions 2130 having directionality denote that the super-hydrophobic micro-protrusions 2130 are protruded along the separating direction of the movable mold 320 so as not to interfere with the micro molding protrusions 330 of the movable mold 320 when the mold is separated after molding is completed by the injection mold 300.

[0192] FIG. 25A, as an enlarged view of portion "X" in FIG. 22B, is a plan view showing an example of the super-hydrophobic micro-protrusions 2130 having directionality, and FIG. 25B is a cross-sectional view showing a cross-sectional shape of the super-hydrophobic micro-protrusions 2130 viewed in direction J-J in FIG. 25A.

[0193] The separating direction of the movable mold 320 may be the longitudinal direction of the tub 200. For example, the movable mold 320 is separated or removed from the fixed mold 310 along the longitudinal center line of the tub cover 200a from the front surface of the tub cover 200a toward the opening portion on the rear side.

[0194] The super-hydrophobic micro-protrusions 2130 may have directionality in the longitudinal direction of the tub 200, the longitudinal direction of the tub cover 200a, the longitudinal direction of the tub body 200b, or the longitudinal direction of the sump 2110. The super-hydrophobic micro-protrusions 2130 may have directionality in a direction parallel to the circumferential surface of the tub 200, the circumferential surface of the tub cover 200a, the circumferential surface of the tub body 200b, or the inner surface of the sump 2110.

[0195] The super-hydrophobic micro-protrusions 2130 have a predetermined cross-sectional shape along the longitudinal direction of the tub cover 200a or the tub body 200b or the longitudinal direction of the sump 2110 to have directionality in the separating direction of the mold, that is, the longitudinal direction of the tub 200, the longitudinal direction of the tub cover 200a or the tub body 200b or the longitudinal direction of the sump 2110.

[0196] The super-hydrophobic micro-protrusions 2130 illustrated in FIG. 25A have a triangular cross-sectional shape. The super-hydrophobic micro-protrusions 2130 are formed to constantly maintain the triangular cross-sectional shape along the longitudinal direction of the tub cover 200a or the tub body 200b or the longitudinal direction of the sump 2110. In particular, for the super-hydrophobic micro-protrusions 2130, triangular vertices may be continuously extended along the longitudinal direction of the tub 200 or the longitudinal direction of the sump 2110 to form a straight line. Both sides may be formed symmetrically with the same length and inclination angle with respect to the vertex of the triangle or a straight line extending the vertex. Both side surfaces of the super-hydrophobic micro-protrusions 2130 are symmetrical to each other and have the same length and inclined surface. The super-hydrophobic micro-protrusions 2130 may have an isosceles triangular cross-sectional shape. At this time, the base (p) and the height (h) of the isosceles triangle may be the same length.

[0197] Furthermore, the plurality of super-hydrophobic micro-protrusions 2130 may be formed such that the triangular cross-sectional shapes are successively formed adjacent to each other or spaced apart at regular intervals in the circumferential direction of the tub 200 or the width direction of the sump 2110. The plurality of super-hydrophobic micro-protrusions 2130 illustrated in FIG. 25A are successively formed adjacent to each other. Being successively formed adjacent to each other denotes that the mutually facing inclined surfaces of the two adjacent micro-protrusions are in contact with each other to form a straight valley.

[0198] FIG. 26A is a plan view showing another example of the super-hydrophobic micro-protrusions 3130 having directionality according to the present disclosure, and FIG. 26B is a cross-sectional view showing a cross-sectional shape of the super-hydrophobic micro-protrusions 3130 viewed in direction K-K in FIG. 26A.

[0199] The super-hydrophobic micro-protrusions 3130 illustrated in FIGS. 26A and 26B have the following differences, and the remaining configurations thereof are the same as or similar to the super-hydrophobic micro-protrusions 3130 in FIGS. 25A and 25B, and thus, the detailed description thereof will be omitted.

[0200] The super-hydrophobic micro-protrusions 3130 illustrated in FIGS. 26A and 26B may be formed in a trapezoidal shape.

[0201] The upper side (w) and the lower side (p) of the trapezoid may be made parallel to each other. Furthermore, the upper side (w) may have a length of about 1/3 of the lower side (p). The inclined surfaces symmetrical to each other may be formed on both sides with respect to the center line of the upper side (w) of the trapezoid. When viewing the trapezoid from above, the width of the trapezoid (including the upper surface and both inclined surfaces) may be 3/2 of the height (h) of the trapezoidal cross section.

[0202] The super-hydrophobic micro-protrusions 3130 may be constantly maintained along the longitudinal direction of the tub 200 such that the cross-sectional shape of the trapezoid has directivity in the separating direction of the mold, that is, the longitudinal direction of the tub 200.

[0203] Furthermore, for the super-hydrophobic micro-protrusions 3130, trapezoidal cross-sectional shapes may be spaced apart or continuously formed in a circumferential direction of the tub 200. The super-hydrophobic micro-protrusions 3130 illustrated in FIG. 26B are formed to be spaced apart in the circumferential direction of the tub 200 or the width direction of the sump 2110.

[0204] Therefore, according to the present disclosure, residual water inside the washing machine may be removed using the lotus effect of the super-hydrophobic micro-protrusions, and the cleanliness of the inside of the washing machine may be kept clean. For example, mold odor and the like caused by residual water may be removed.

[0205] Furthermore, the super-hydrophobic micro-protrusions may be formed to have directionality in a predetermined direction, that is, a direction in which the mold separated, thereby preventing the occurrence of undercuts when the mold is separated after injection molding.

[0206] In addition, asymmetrical slopes may be formed on both inclined surfaces of the super-hydrophobic micro-protrusions to allow water falling down along the super-hydrophobic micro-protrusions to flow in a predetermined direction, thereby allowing residual water in the tub to flow downward along the circumferential surface toward the drain port.

[0207] The configurations and methods according to the above-described embodiments will not be limited to the foregoing washing machine and all or part of each embodiment may be selectively combined and configured to make various modifications thereto.

Claims

1. A washing machine, comprising:

   a tub provided inside a cabinet to store wash water therein; and
   a plurality of super-hydrophobic micro-protrusions formed on an inner surface of the tub to remove residual water in the tub.

2. The washing machine of claim 1, wherein the plurality of super-hydrophobic micro-protrusions are injection molded by an injection mold together with the tub, and integrally formed on an inner surface of the tub.

3. The washing machine of claim 2, wherein the tub comprises:

   a tub cover formed with an inlet port for putting washing objects therein on a front side of the tub to form a front portion of the tub when the tub is divided into the front portion and the rear portion along a circumferential surface; and
   a tub body coupled to a rear end of the tub cover to form the rear portion of the tub.

4. The washing machine of claim 3, wherein the plurality of super-hydrophobic micro-protrusions are formed on a front side in the tub cover and a rear side in the tub body.

5. The washing machine of claim 1, wherein each of the plurality of super-hydrophobic micro-protrusions has an upper width thereof smaller than or equal to a lower width thereof.

6. The washing machine of claim 1, wherein each of the plurality of super-hydrophobic micro-protrusions is formed in any one of a round shape, a triangular shape, and a rectangular shape.

7. The washing machine of claim 1, wherein the plurality of super-hydrophobic micro-protrusions are symmetrically formed on both sides with respect to one directional center lines spaced apart in parallel from each other along an inner surface of the tub.

8. The washing machine of claim 1, wherein the plurality of super-hydrophobic micro-protrusions are formed symmetrically on both sides with respect to first directional center lines spaced apart in parallel from each other along an inner surface of the tub and second directional center lines spaced apart in parallel from each other in a direction intersecting the first directional center line.

9. The washing machine of claim 8, wherein the first directional center line and the second directional centerline are formed in a lattice shape.

10. The washing machine of claim 1, wherein the plurality of super-hydrophobic micro-protrusions are formed on a circumferential surface in the tub.

11. The washing machine of claim 10, wherein the plurality of super-hydrophobic micro-protrusions are protruded along a longitudinal direction of the tub in a direction in which an injection mold is separated to prevent an undercut of the injection mold after injection molding.

12. The washing machine of claim 10, wherein the plurality of super-hydrophobic micro-protrusions are arranged to be spaced apart from each other in a circumferential direction of the tub.

13. The washing machine of claim 1, wherein the plurality of super-hydrophobic micro-protrusions are symmetrically formed on both sides with respect to longitudinal center lines of a circumferential surface of the tub spaced apart in parallel from each other along the circumferential surface.

14. The washing machine of claim 10, wherein the plurality of super-hydrophobic micro-protrusions are formed asymmetrically on both sides with respect to longitudinal center lines of the circumferential surface spaced apart in parallel from each other along the circumferential surface of the tub to allow residual water in the tub to flow in a circumferential direction.

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

a sump formed on a bottom surface in the tub, and provided with a drain port for discharging wash water in the tub to the outside,
wherein the plurality of super-hydrophobic micro-protrusions are formed on a surface of the sump.

16. The washing machine of claim 15, wherein the sump is recessed along the longitudinal direction of the tub toward a front side of the tub at a rear lower-end portion of the tub, and the plurality of super-hydrophobic micro-protrusions are protruded along a longitudinal direction of the sump in a direction in which the injection mold is separated to prevent an undercut of the injection mold after injection molding.

17. The washing machine of claim 15, wherein the sump is formed at a lower position than a circumferential surface of the tub, and inclined downward toward a front side of the tub.

18. The washing machine of claim 15, wherein the drain port is spaced apart from a longitudinal center line of the sump in one direction.

19. The washing machine of claim 15, wherein the sump further comprises a residual water guide passage portion one side of which is communicated with the drain port, and spaced apart from a longitudinal center line of the sump to guide residual water in the sump to the drain port.

20. The washing machine of claim 19, wherein the plurality of super-hydrophobic micro-protrusions are formed asymmetrically on both sides with respect to longitudinal center lines of the sump spaced apart in parallel from each other along the bottom surface of the sump to allow residual water in the sump to flow toward the residual water guide passage portion, and provided with a first inclined portion having a small slope on one side toward the residual water guide passage portion and a second inclined portion having a relatively large slope on another side toward a direction opposite to the residual water guide passage.

FIG. 1

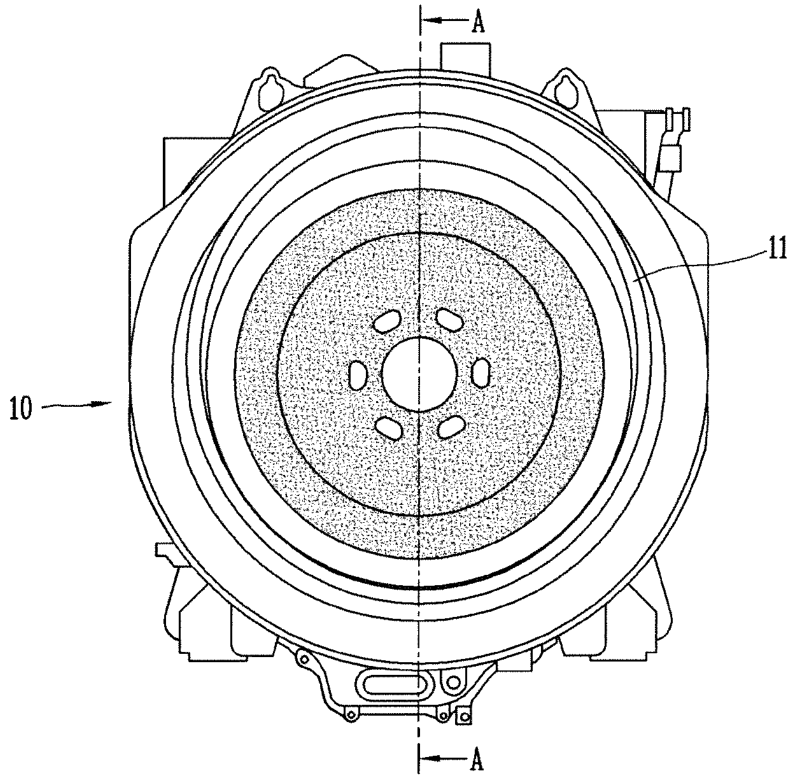

FIG. 2

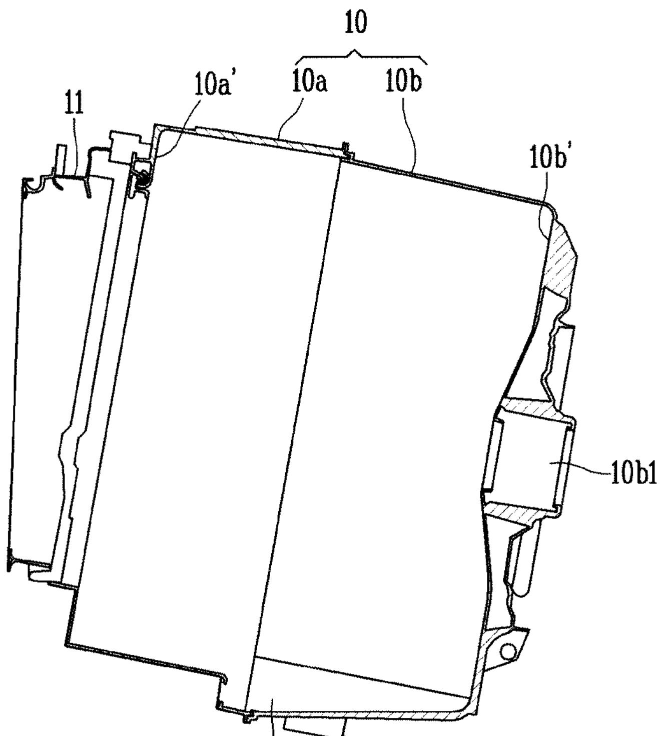

FIG. 3A

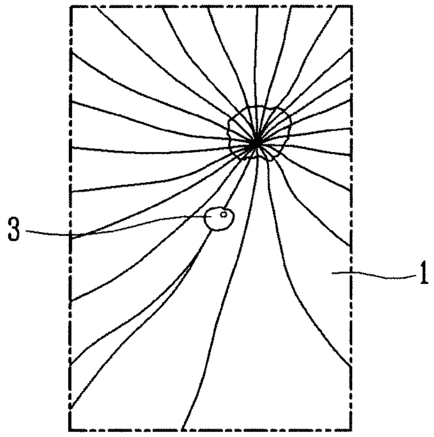

FIG. 3B

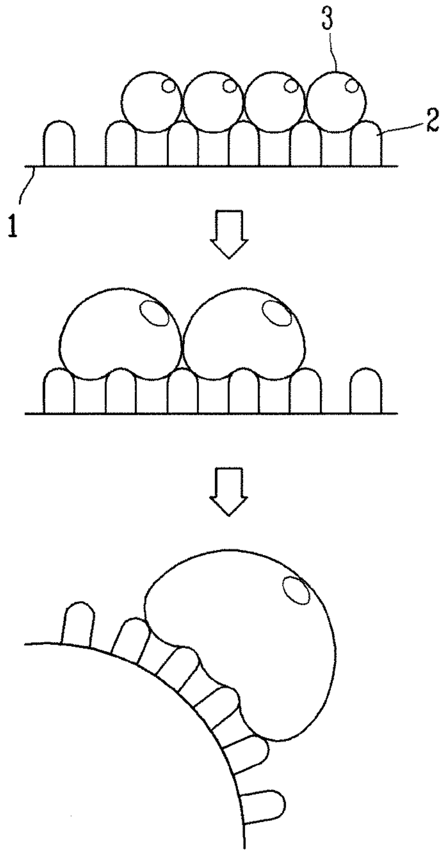

FIG. 3C

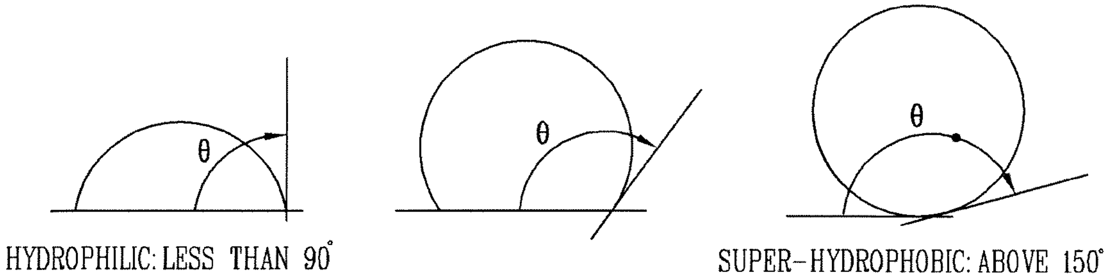
θ
θ
θ
HYDROPHILIC: LESS THAN 90°
SUPER-HYDROPHOBIC: ABOVE 150°

FIG. 4

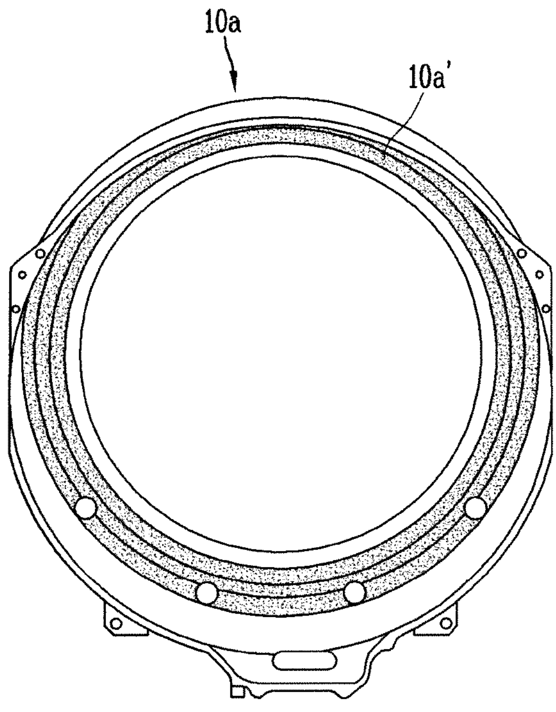
10a
10a'

FIG. 5

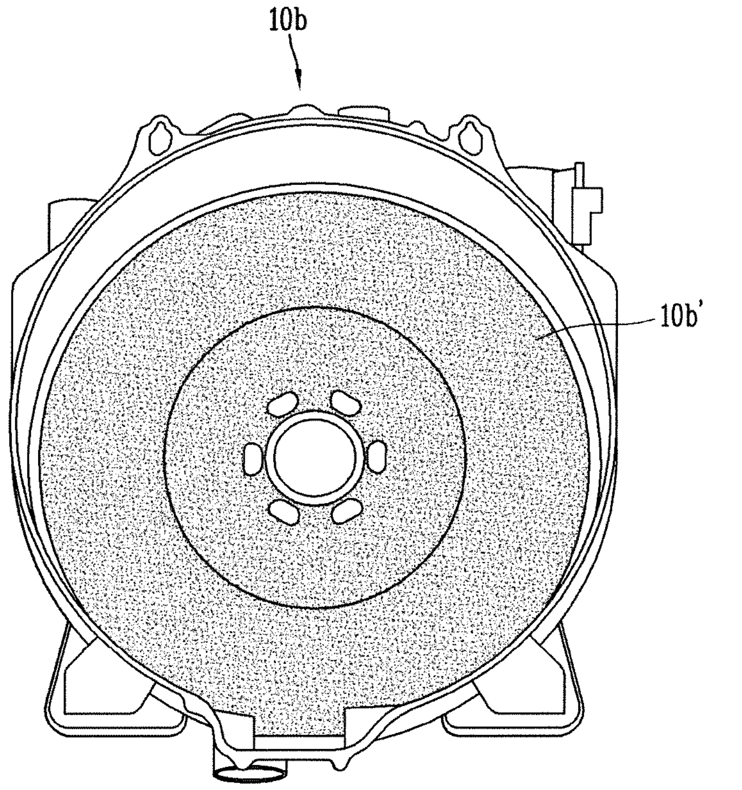

FIG. 6A

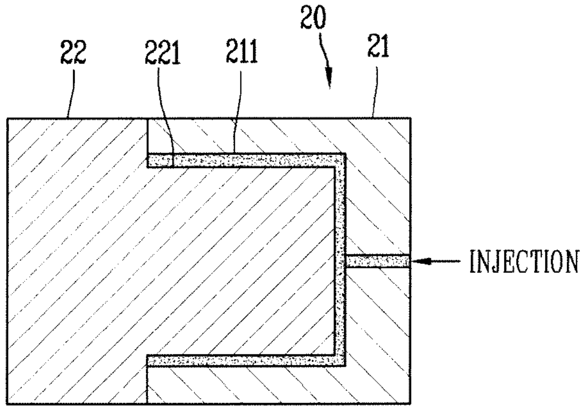

FIG. 6B

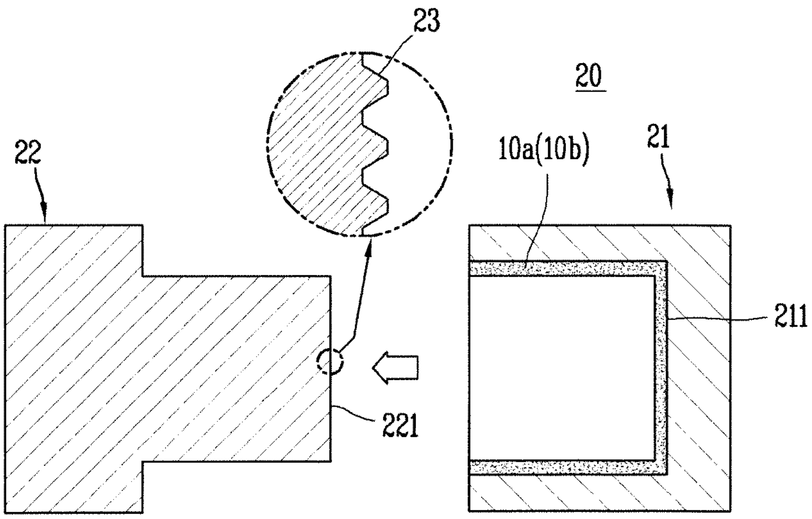

FIG. 7A

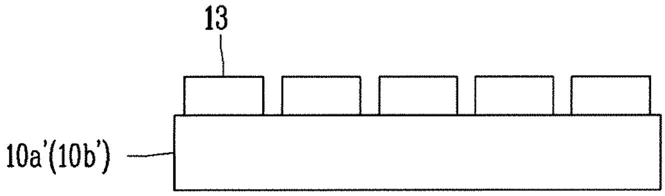

FIG. 7B

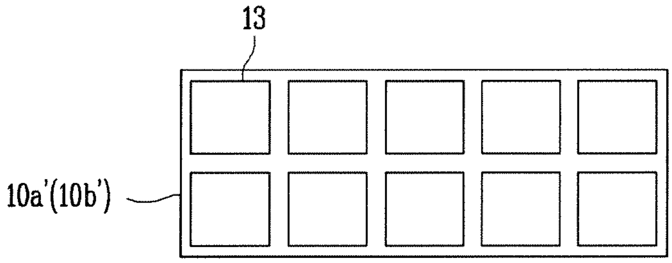

FIG. 8A

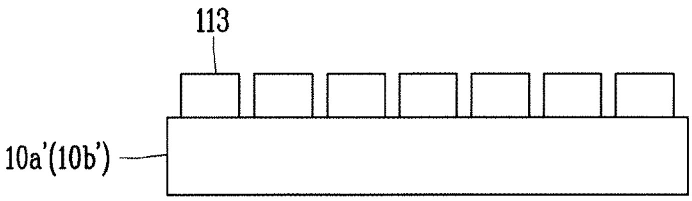

FIG. 8B

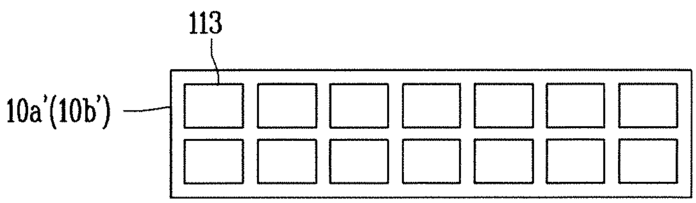

FIG. 9A

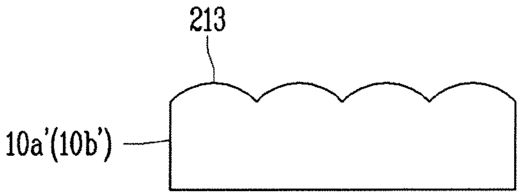

FIG. 9B

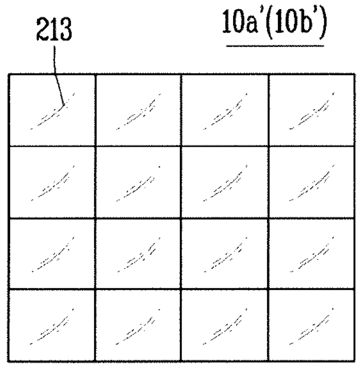

FIG. 10A

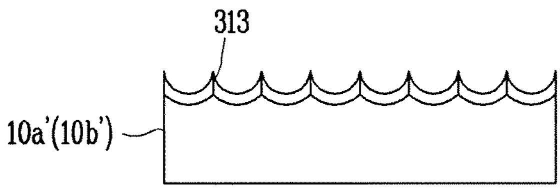

FIG. 10B

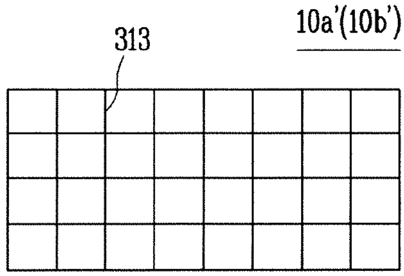

FIG. 11A

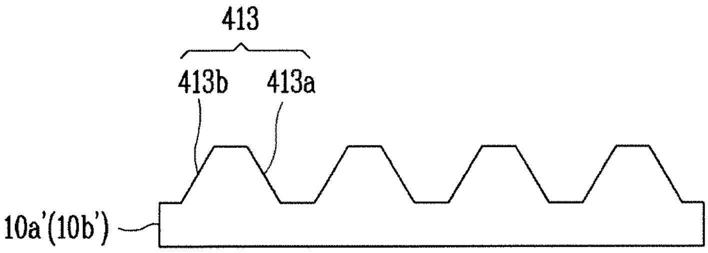

FIG. 11B

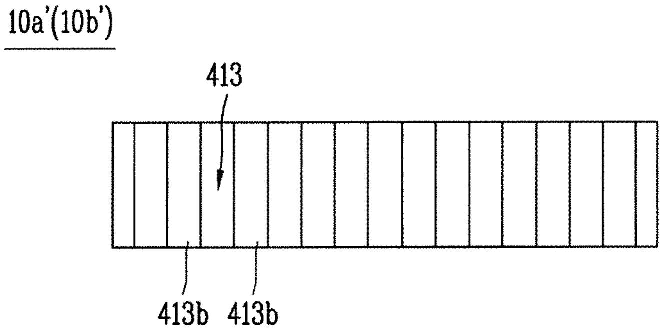

FIG. 12A

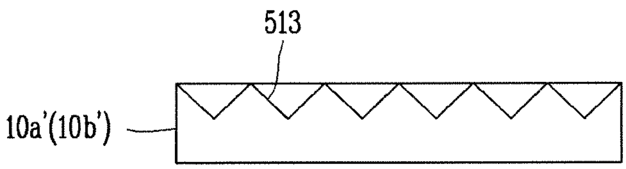

FIG. 12B

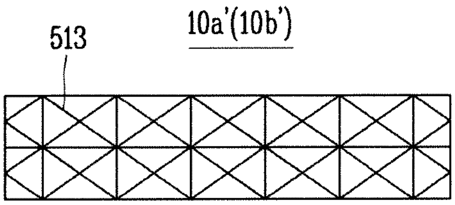

FIG. 13A

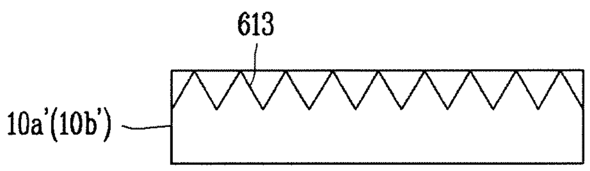

FIG. 13B

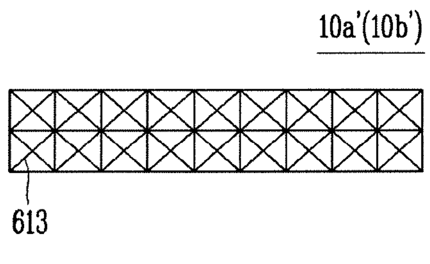

FIG. 14

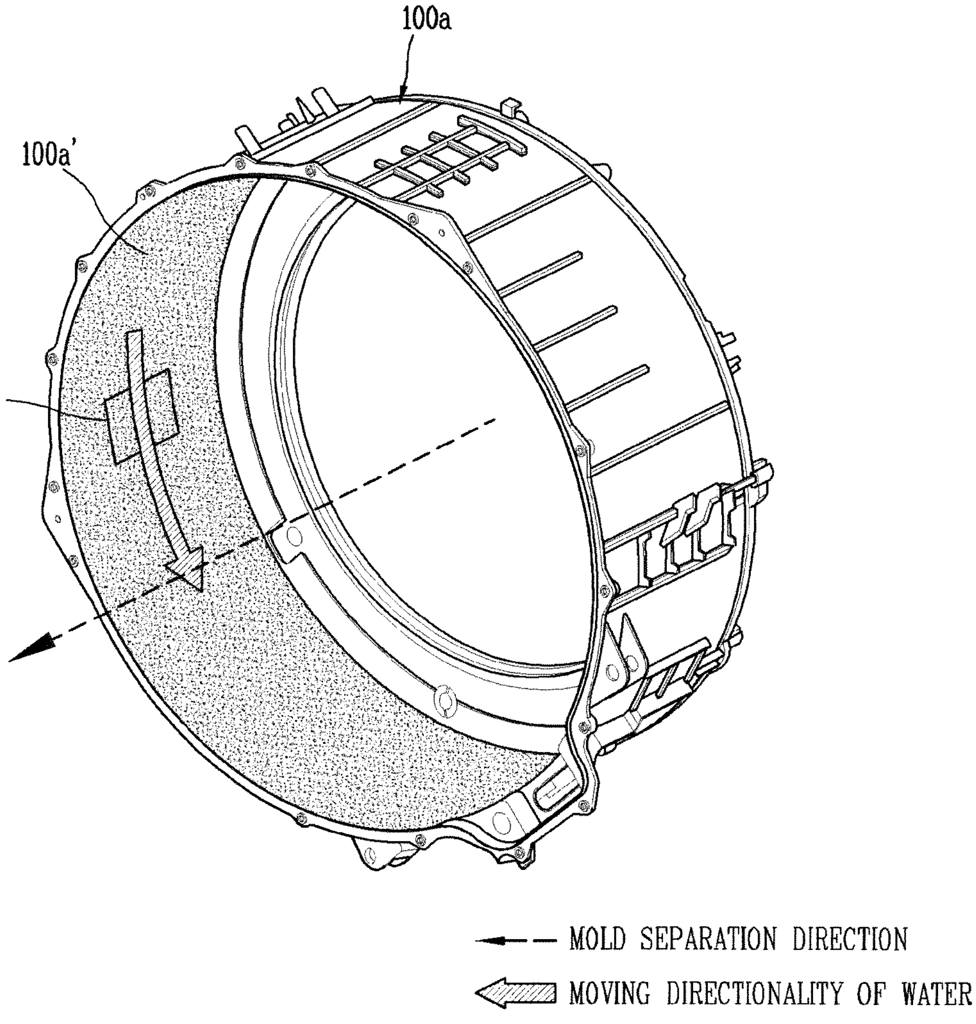
100a
100a'
"B"
MOLD SEPARATION DIRECTION
MOVING DIRECTIONALITY OF WATER

FIG. 15

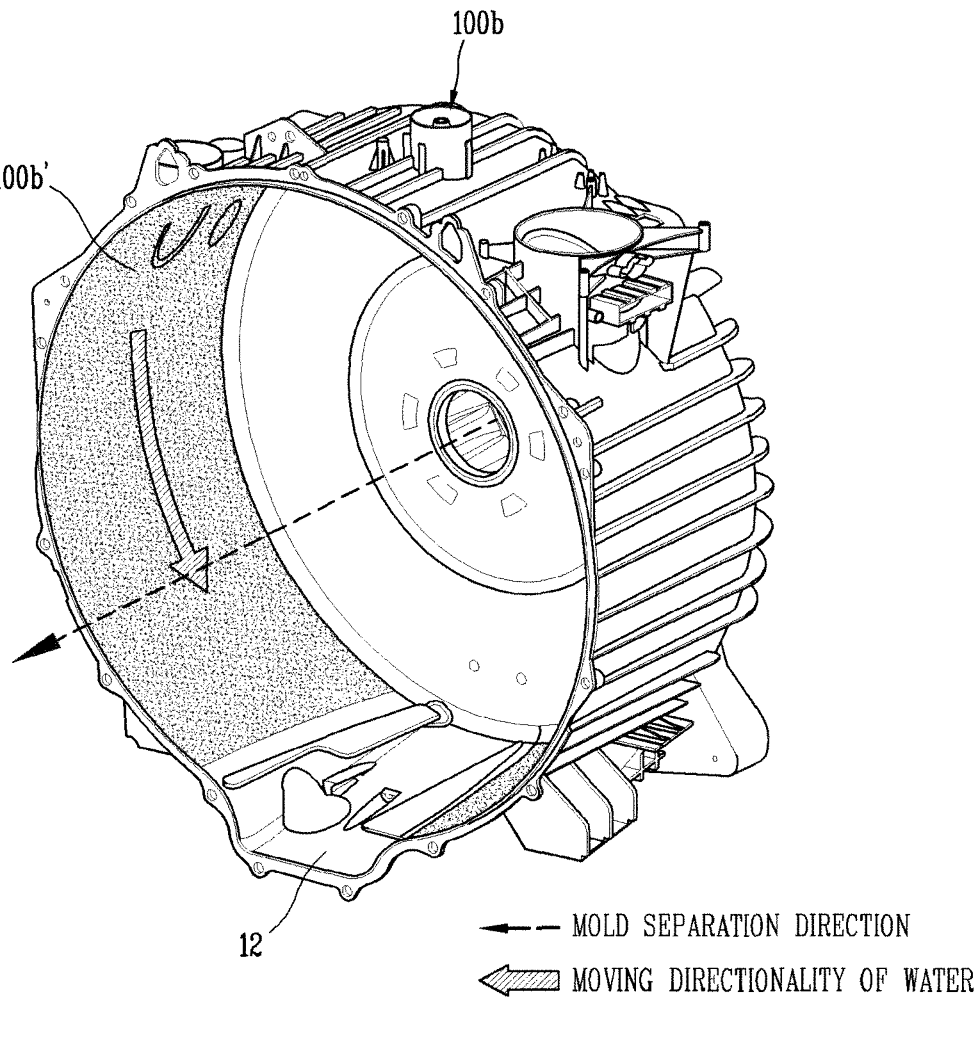
100b
100b'
12
MOLD SEPARATION DIRECTION
MOVING DIRECTIONALITY OF WATER

FIG. 16

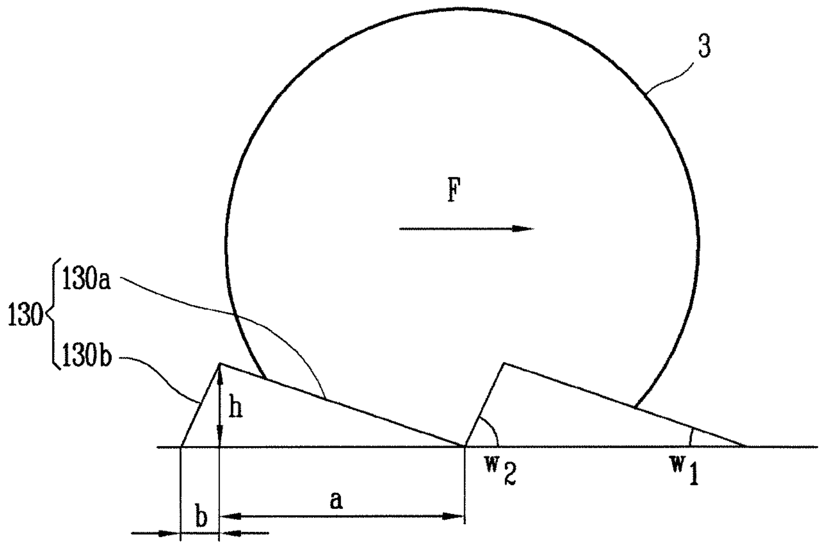

FIG. 17A

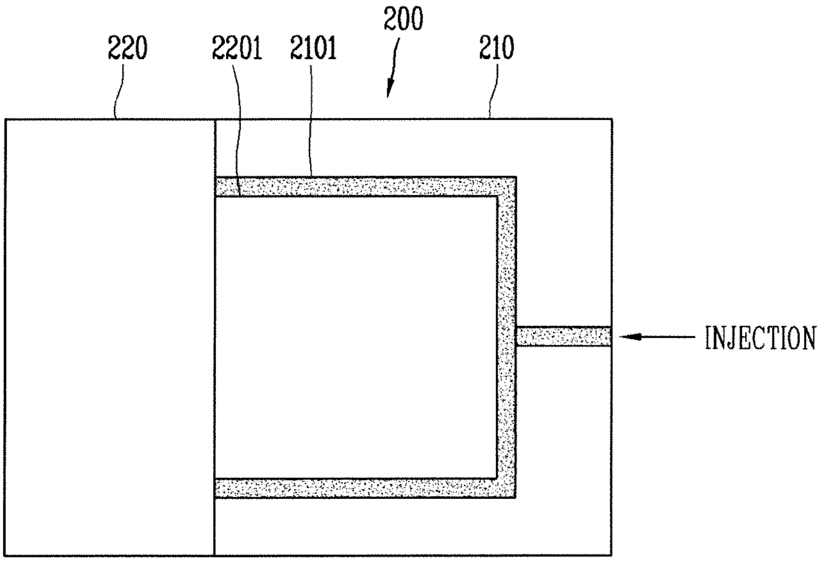

FIG. 17B

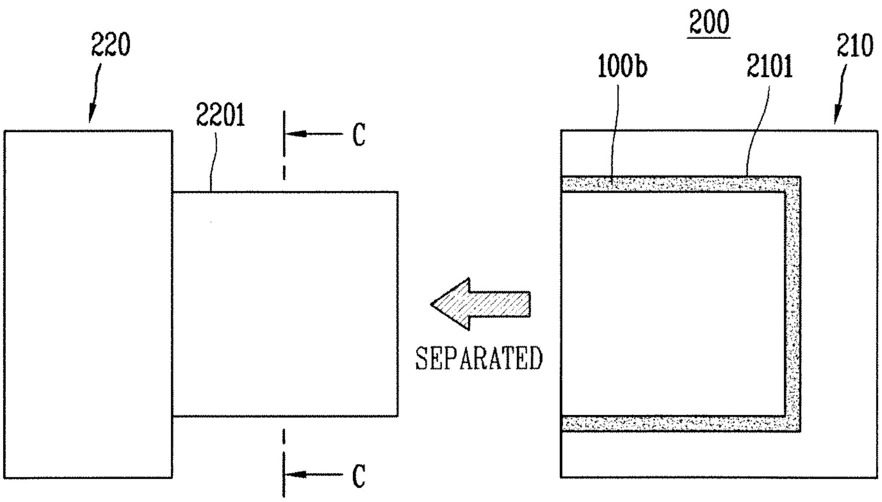

FIG. 17C

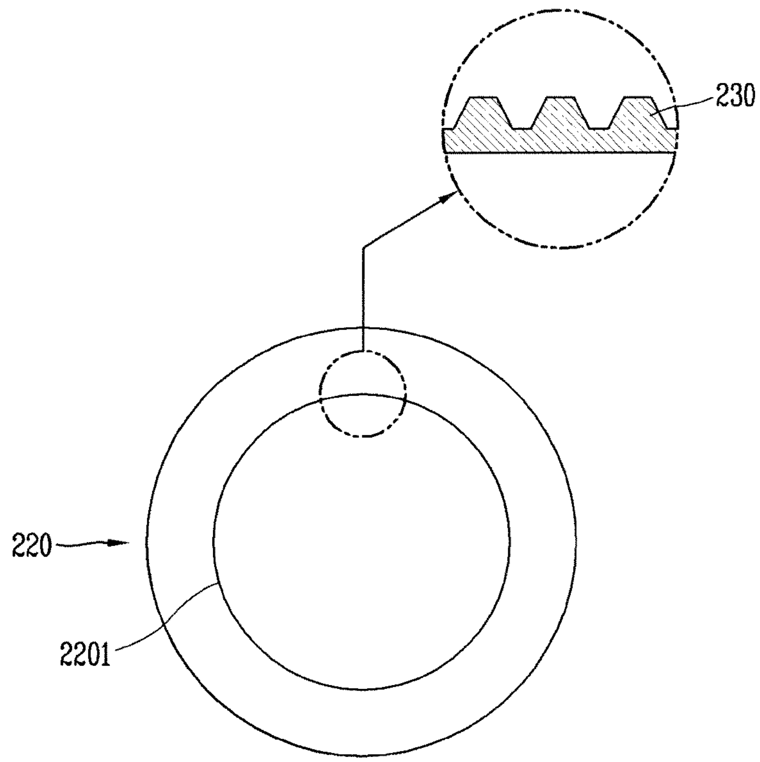

FIG. 18A

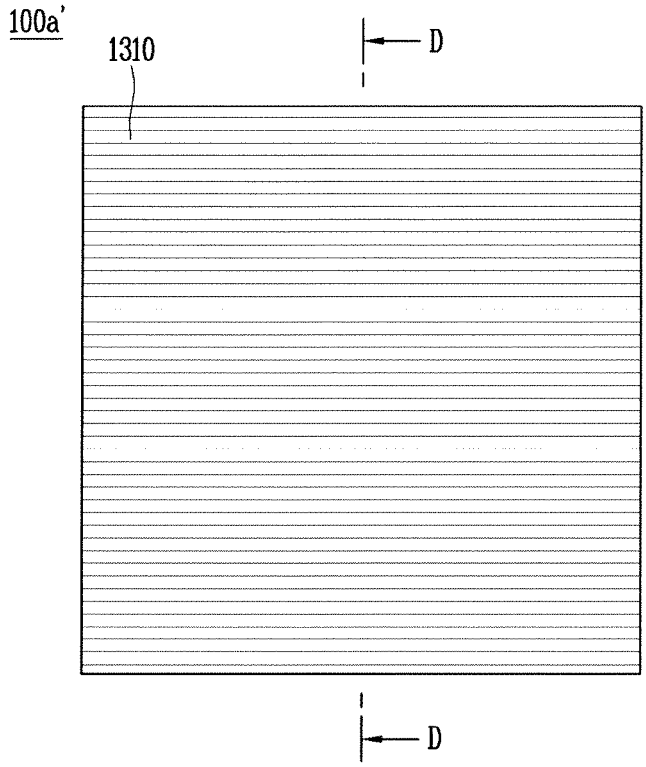

FIG. 18B

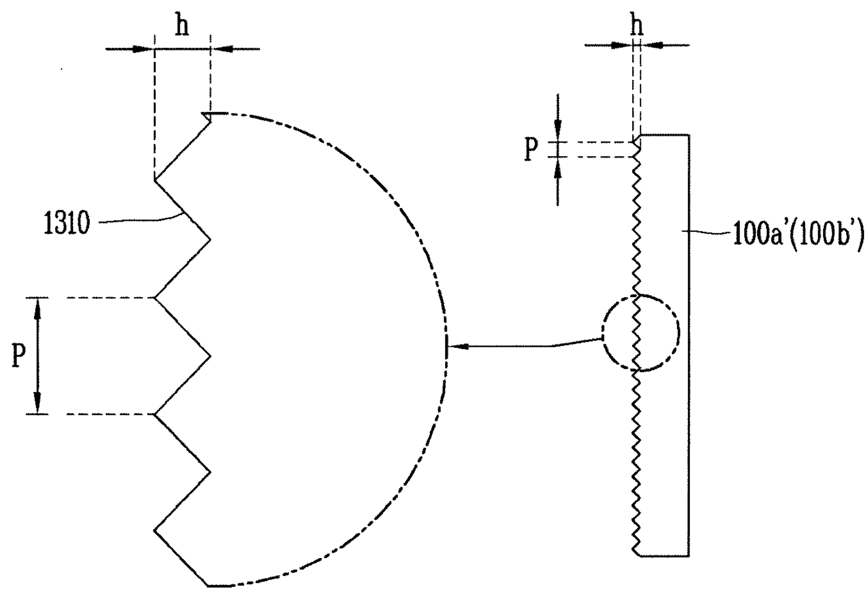

FIG. 19A

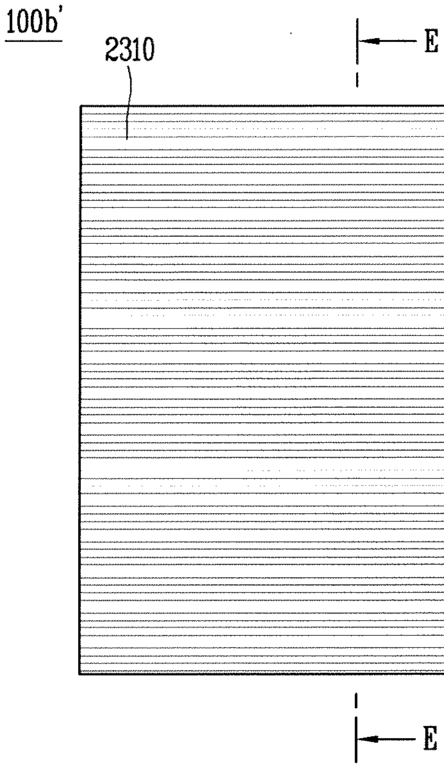

FIG. 19B

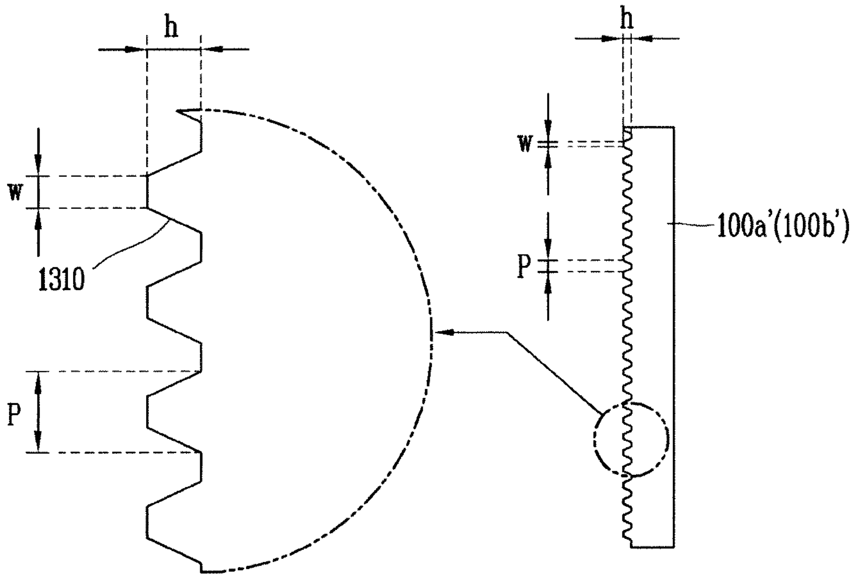

FIG. 20

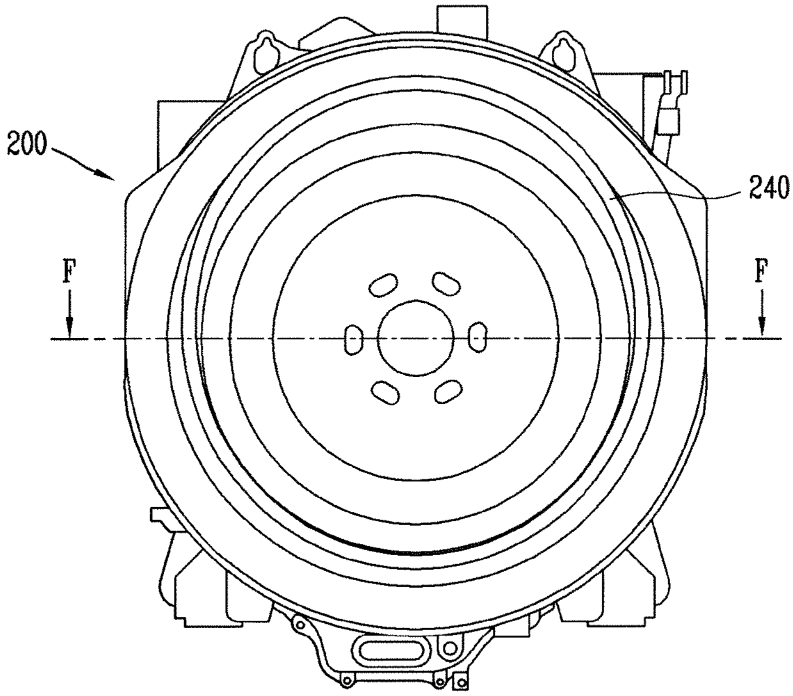

FIG. 21

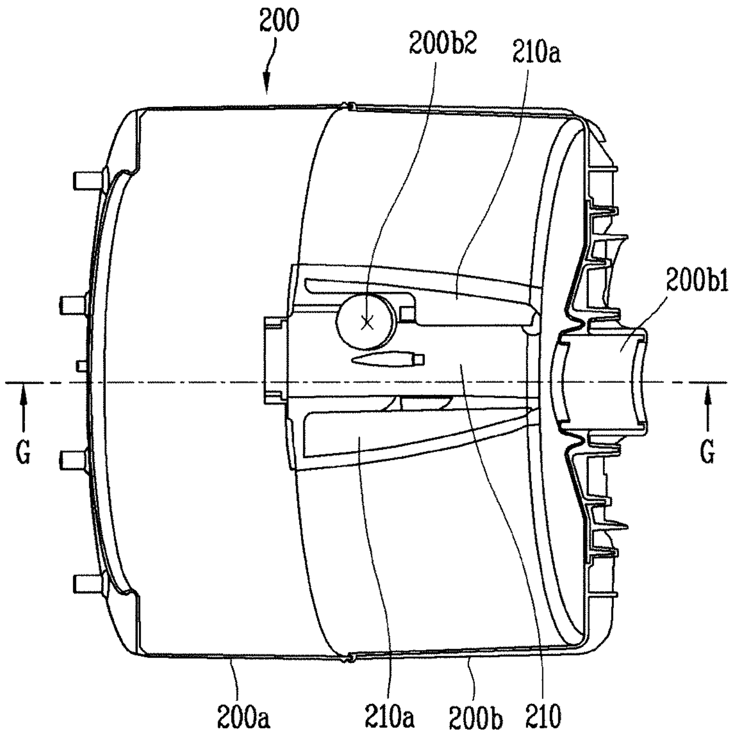

FIG. 22A

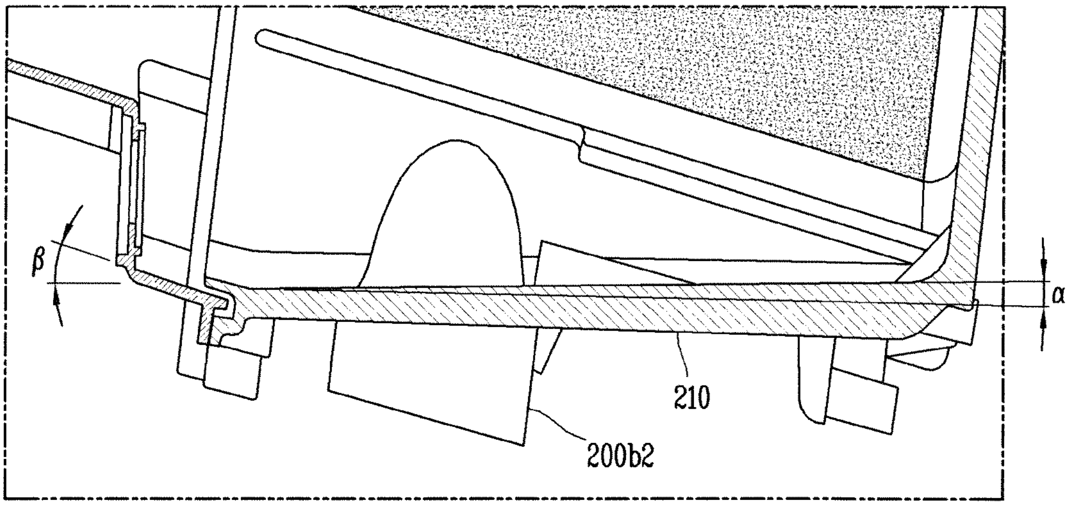

FIG. 22B

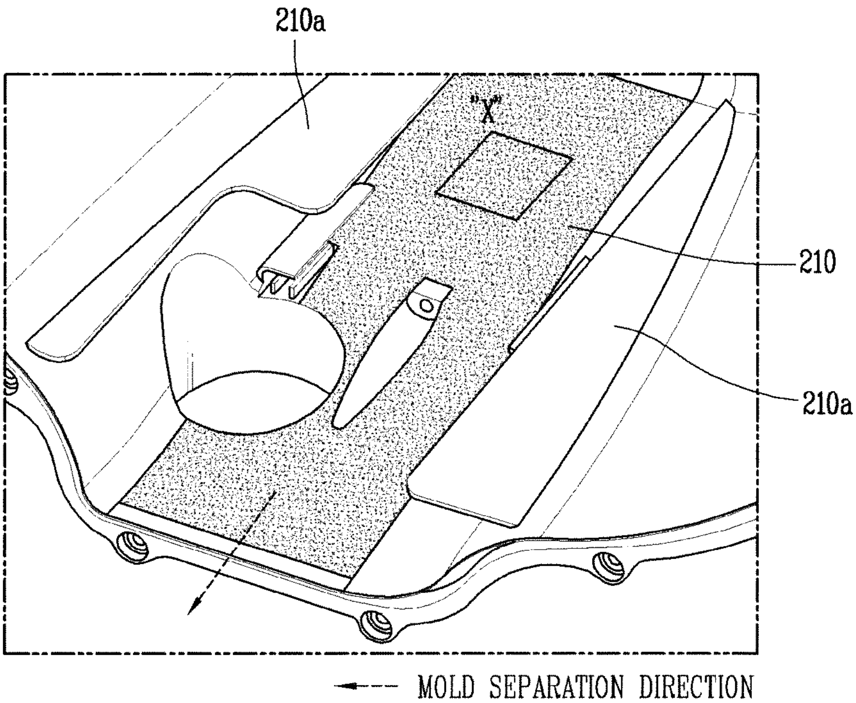

FIG. 23A

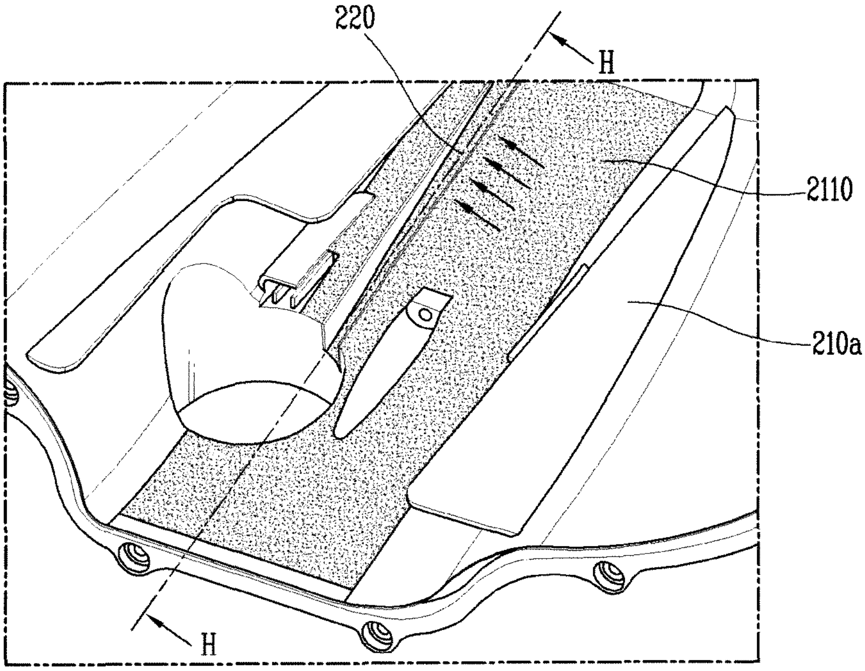

FIG. 23B

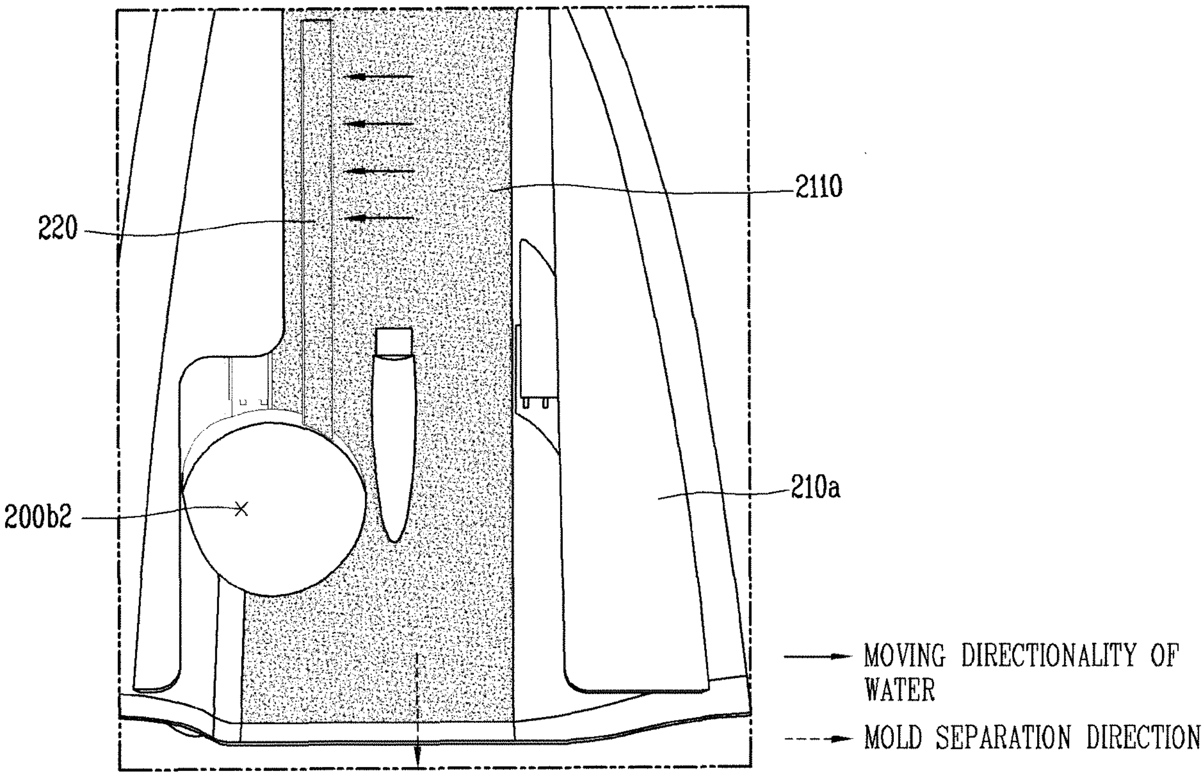

FIG. 23C

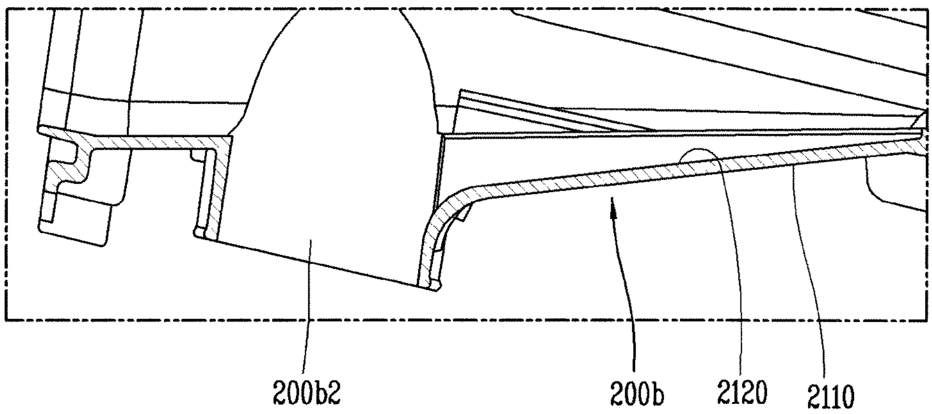

FIG. 24A

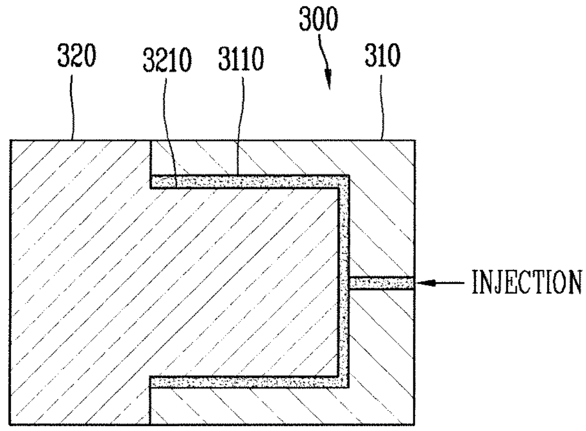

FIG. 24B

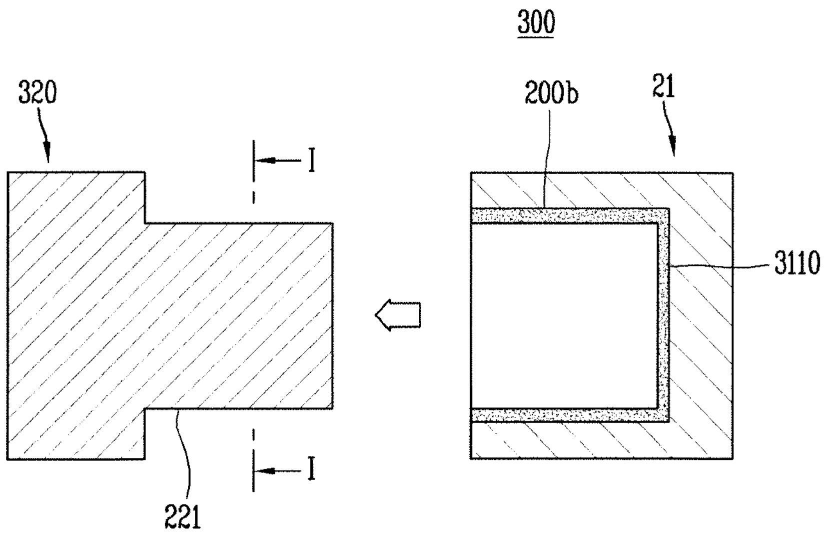

FIG. 24C

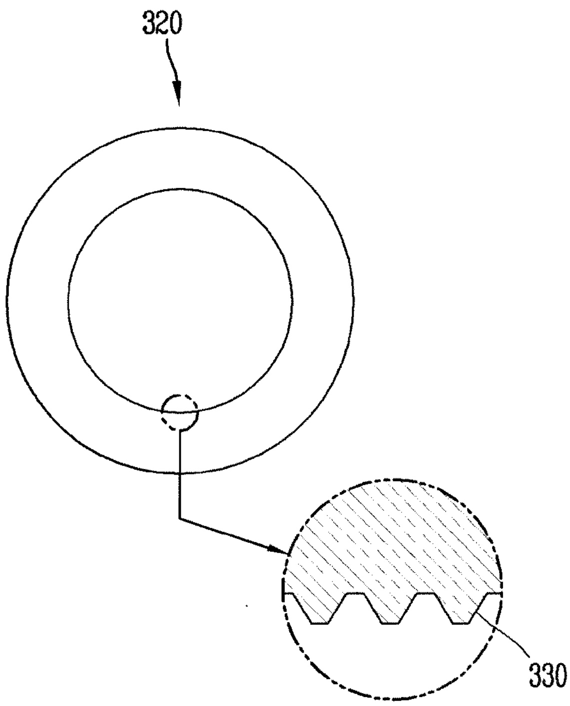

FIG. 25A

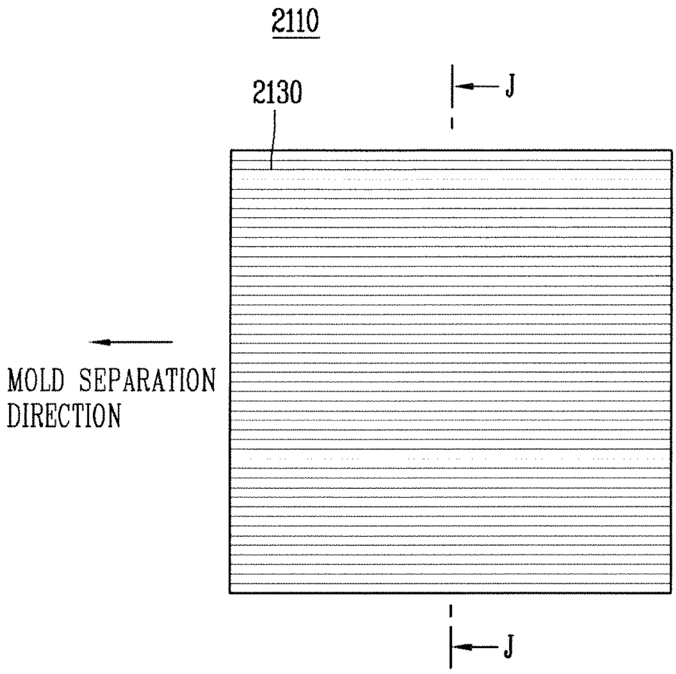

FIG. 25B

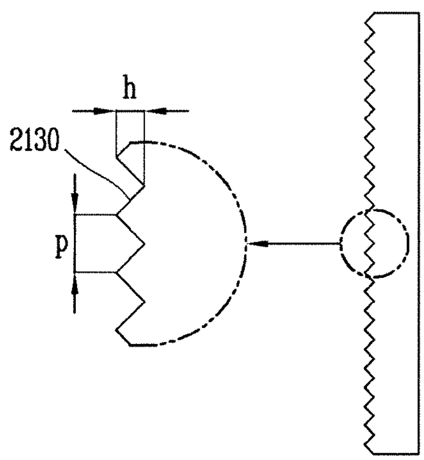

FIG. 26A

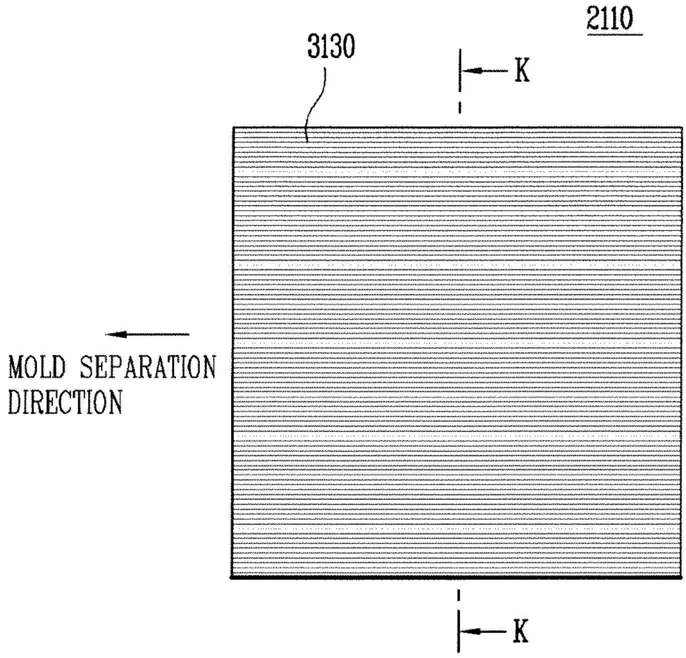

FIG. 26B