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(54) **WASHING MACHINE AND CONTROLLING METHOD THEREOF**

WASCHMASCHINE UND STEUERUNGSVERFAHREN DAFÜR
MACHINE À LAVER ET SON PROCÉDÉ DE COMMANDE

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- **KANG, Min Hee**
Suwon-si Gyeonggi-do 16677 (KR)
- **KIM, Zoo Hyeong**
Suwon-si Gyeonggi-do 16677 (KR)

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(74) Representative: **Gulde & Partner**
Patent- und Rechtsanwaltskanzlei mbB
Wallstraße 58/59
10179 Berlin (DE)

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(73) Proprietor: **Samsung Electronics Co., Ltd.**
Suwon-si, Gyeonggi-do 16677 (KR)

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(72) Inventors:
• **HAHM, Jung Yoon**
Suwon-si Gyeonggi-do 16677 (KR)

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Description

[Technical Field]

[0001] Embodiments of the present invention relate to a washing machine capable of drying laundry and a controlling method thereof.

[Background Art]

[0002] In general, a washing machine is an apparatus configured to wash laundry inside of a tub retaining water by rotating a drum rotatably installed in the tub to accommodate the laundry. The washing machine may perform a washing cycle using water to separate pollutants from the laundry, a rinsing cycle rinsing the laundry, a spin-dry cycle removing water from the wet laundry, and a drying cycle drying the laundry.

[0003] In particular, the drying cycle may use a heat-drying method which dries the laundry by heating the air inside of the tub and the drum. To perform the drying cycle as mentioned above, the washing machine requires a drying duct configured to heat the air inside of the tub and the drum.

[0004] Typically, the drying duct is located above the tub. In addition, the drying duct is connected to the front upper part of the tub and the rear upper part of the tub, and can suck in wet air from the rear upper part of the tub and discharge the heated and dried air to the front upper part of the tub.

[0005] As such, as the drying duct is connected to the top of the tub, the flow of air is mainly generated at the top of the tub. Thereby, the drying time of the washing machine can be increased.

[0006] US 20150059202 A1 discloses a washing machine including a condensing duct and a heating duct.

[Disclosure]

[Technical Problem]

[0007] In order to overcome this problem, one aspect of the present invention is to provide a washing machine that can shorten the drying time by improving the drying efficiency of the washing machine.

[0008] One aspect of the present invention is to provide a washing machine capable of improving the drying efficiency by heating air inside a tub during a drying stroke and at the same time rotating a drum at high speed.

[0009] One aspect of the present invention is to provide a washing machine that can improve the drying efficiency by providing a condensing duct extending from the bottom to the top of the rear of the tub and connecting the condensing duct with a drying duct.

[Technical Solution]

[0010] In accordance with an aspect of the present in-

vention, a washing machine is provided as defined in claim 1.

[0011] In accordance with an aspect of the present disclosure, a controlling method of a washing machine is provided as defined in the method independent claim.

[0012] Further embodiments are defined in the dependent claims.

[Advantageous Effects]

[0013] According to the embodiments of the invention, a washing machine that can shorten the drying time by improving the drying efficiency of the washing machine is provided.

[0014] According to the embodiments of the invention, a washing machine capable of improving the drying efficiency by heating the air inside the tub during the drying stroke and at the same time rotating the drum at high speed is provided.

[0015] According to the embodiments of the invention, a washing machine that can improve the drying efficiency by providing a condensing duct extending from the bottom to the top of the rear of the tub and connecting the condensing duct with the drying duct is provided.

[Description of Drawings]

[0016]

FIG. 1 illustrates an appearance of a washing machine in accordance with an embodiment of the present invention.

FIG. 2 is a side cross-sectional view of a configuration of a washing machine in accordance with an embodiment of the present invention.

FIG. 3 is an exploded perspective view of a drying duct of a washing machine in accordance with an embodiment of the present invention.

FIG. 4 is a perspective view of a tub rear part of a washing machine in accordance with an embodiment of the present invention.

FIG. 5 shows a cross-sectional view along line AA' shown in FIG. 4.

FIG. 6 shows a cross-sectional view along line BB' shown in FIG. 4.

FIG. 7 shows a cross-sectional view along line C-C' shown in FIG. 4.

FIG. 8 shows a rear outer side of a tub of a washing machine in accordance with an embodiment of the present invention.

FIG. 9 shows a cross-sectional view along line DD ' shown in FIG. 8.

FIG. 10 shows a flow of water and air in a condensing duct according to one embodiment.

FIG. 11 shows a flow of water and air in a condensing duct according to another embodiment.

FIG. 12 shows a configuration of a washing machine in accordance with an embodiment of the present invention.

FIG. 13 shows an operation of a washing machine according to one embodiment.

FIG. 14 shows a drying cycle performed by a washing machine according to one embodiment.

FIG. 15 shows operations of each of the components of a washing machine by the drying cycle shown in FIG. 14.

FIGS. 16 and 17 show residual moisture by a heating / dehydration operation shown in FIG. 14.

FIG. 18 shows the drying time according to a tub temperature.

FIG. 19 illustrates a filter cleaning operation of a washing machine according to one embodiment.

FIG. 20 shows the amount of water entering a drum during filter cleaning according to a rotational speed of the drum.

FIG. 21 is a side cross-sectional view of a washing machine according to one embodiment.

FIG. 22 illustrates a configuration of a washing machine according to one embodiment.

[Best Mode]

[0017] The following detailed description is provided to assist the reader in gaining a comprehensive understanding of the methods, apparatuses, and/or systems described herein. Accordingly, various changes, modifications, and equivalents of the methods, apparatuses, and/or systems described herein will be suggested to those of ordinary skill in the art. The progression of processing operations described is an example; however, the sequence of and/or operations is not limited to that set forth herein and may be changed as is known in the art, with the exception of operations necessarily occurring in a particular order. In addition, respective descriptions of well-known functions and constructions may be omitted for increased clarity and conciseness.

[0018] Additionally, exemplary embodiments will now be described more fully hereinafter with reference to the accompanying drawings. The exemplary embodiments may, however, be embodied in many different forms and should not be construed as being limited to the embodiments set forth herein. These embodiments are provided so that this disclosure will be thorough and complete and will fully convey the exemplary embodiments to those of ordinary skill in the art. Like numerals denote like elements throughout.

[0019] It will be understood that, although the terms first, second, etc. may be used herein to describe various elements, these elements should not be limited by these terms. These terms are only used to distinguish one element from another. As used herein, the term "and/or," includes any and all combinations of one or more of the associated listed items.

[0020] It will be understood that when an element is referred to as being "connected," or "coupled," to another element, it can be directly connected or coupled to the other element or intervening elements may be present. In contrast, when an element is referred to as being "directly connected," or "directly coupled," to another element, there are no intervening elements present.

[0021] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting. As used herein, the singular forms "a," "an," and "the," are intended to include the plural forms as well, unless the context clearly indicates otherwise.

[0022] Reference will now be made in detail to the exemplary embodiments of the present disclosure, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to like elements throughout.

[0023] The expression, "at least one of a, b, and c," should be understood as including only a, only b, only c, both a and b, both a and c, both b and c, or all of a, b, and c.

[0024] Reference will now be made in detail to embodiments of the present disclosure, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to like components throughout.

[0025] FIG. 1 illustrates an appearance of a washing machine in accordance with an embodiment of the present disclosure. FIG. 2 is a side cross-sectional view of a configuration of a washing machine in accordance with an embodiment of the present disclosure. FIG. 3 is an exploded perspective view of a drying duct of a washing machine in accordance with an embodiment of the present disclosure.

[0026] Referring to FIGS. 1, 2 and 3, a washing machine 100 includes a cabinet 101, a tub 110, a drum 120, a drum motor 130, a water supplier 140, a water drain 150, a detergent supplier 160, and a drying duct (dryer) 200.

[0027] The cabinet 101 may accommodate components included in the washing machine 100. For example, the cabinet 101 includes the tub 110, the drum 120, the

drum motor 130, the water supplier 140, the water drain 150, the detergent supplier 160, and the drying duct 200.

[0028] At the center of the front surface of the cabinet 101, an inlet 101a is formed to which laundry is put into or taken out of.

[0029] The tub 110 includes a tub front part 111 having an opening 111a formed at a front surface thereof, and a tub rear part 112 having a cylindrical shape with a closed rear surface thereof.

[0030] The front of the tub front part 111 is provided with the opening 111a for injecting laundry into the drum 120 provided in the tub 110 or withdrawing laundry from the drum 120.

[0031] A diaphragm 113 is provided in the opening 111a of the tub front part 111, and the diaphragm 113 connects the opening 111a with the inlet 101a of the cabinet 101. In the upper portion of the diaphragm 113, a discharge port 113a is provided for discharging air dried by the drying duct 200 into the tub 110 / the drum 120 during a drying cycle.

[0032] The lower portion of the tub front part 111 is connected with a drain conduit 151 extending to a drain pump 152.

[0033] A rear wall 112a of the tub rear part 112 is provided with a bearing 112d and a bearing housing 112e for rotatably fixing the drum motor 130.

[0034] A tub heater 114 is provided below the tub rear part 112. The tub heater 114 may heat water accommodated in the tub 110. The tub heater 114 may be operated so that the temperature of the water accommodated in the tub 110 is heated to a temperature set by a user.

[0035] An upper side of the tub rear part 112 is provided with a suction port 112c for suctioning air inside the tub 110 / the drum 120 into the drying duct 200 during the drying cycle. A sidewall 112b is formed with a condensing duct 240 which guides air inside the tub 110 / the drum 120 to the suction port 112c during the drying cycle.

[0036] The condensing duct 240 is described in more detail below.

[0037] The drum 120 is rotatably provided in the tub 110 and may accommodate laundry.

[0038] The drum 120 includes a cylindrical drum body 121, a drum front part 122 provided at the front of the drum body 121, and a drum rear part 123 provided at the rear of the drum body 121.

[0039] The inner surface of the drum body 121 provides a through hole 121a connecting the inside of the drum 120 and the inside of the tub 110 and a lifter 121b for raising the laundry to the upper portion of the drum 120 during the rotation of the drum 120. The drum front part 122 is provided with an opening 122a for injecting laundry into the drum 120 or withdrawing laundry from the drum 120. The drum rear part 123 may be connected to the shaft 131 of the drum motor 130 that rotates the drum 120.

[0040] The drum motor 130 is provided outside the rear wall 112a of the tub 110 and is connected to the drum 120 through the shaft 131. The shaft 131 penetrates the

rear wall 112a of the tub 110 and is rotatably supported by the bearing 112d and the bearing housing 112e provided in the rear wall 112a of the tub 110.

[0041] The drum motor 130 includes a stator 132 fixed to the outside of the rear wall 112a of the tub rear part 112, and a rotor 133 rotatably provided and connected to the shaft 131. The rotor 133 may rotate through magnetic interaction with the stator 132, and the rotation of the rotor 133 may be transmitted to the drum 120 through the shaft 131.

[0042] The drum motor 130 may include, for example, a BrushLess Direct Current Motor (BLDC Motor) or a Permanent Synchronous Motor (PMSM).

[0043] The water supplier 140 is provided above the tub 110 and may supply water to the tub 110 / the drum 120.

[0044] The water supplier 140 includes a water supply conduit 141 connected to an external water supply source for supplying water to the tub 110, and a water supply valve 142 provided on the water supply conduit 141.

[0045] The water supply conduit 141 may extend from an external water supply source to a detergent compartment 161 and guide water to the tub 110 via the detergent compartment 161.

[0046] The water supply valve 142 may allow or block the water supply from the external water source to the tub 110 in response to an electrical signal. The water supply valve 142 may include, for example, a solenoid valve that opens and closes in response to the electrical signal.

[0047] The water drain 150 is provided below the tub 110 and may discharge the water contained in the tub 110 / the drum 120 to the outside.

[0048] The water drain 150 includes the drain conduit 151 extending from the tub 110 to the outside of the cabinet 101 and the drain pump 152 provided on the drain conduit 151. The drain pump 152 may pump water from the drain conduit 151 outside the cabinet 101.

[0049] The detergent supplier 160 may be provided at the upper side of the tub 110 and may supply detergent to the tub 110 / the drum 120.

[0050] The detergent supplier 160 includes the detergent compartment 161 for storing the detergent and a mixing conduit 162 connecting the detergent compartment 161 with the tub 110.

[0051] The detergent compartment 161 is connected to the water supply conduit 141 and the water supplied through the water supply conduit 141 can be mixed with the detergent in the detergent compartment 161. The mixture of the detergent and water may be supplied to the tub 110 through the mixing conduit 162.

[0052] The drying duct 200 is provided on the rear wall 112a of the tub 110 and provided above the tub 110, and may dry laundry contained in the drum 120.

[0053] The drying duct 200 includes a heating duct 210, a filter housing 220, a connecting conduit 230 and the condensing duct 240.

[0054] The heating duct 210 is provided above the tub 110, and the air sucked from the tub 110 may be heated while passing through the heating duct 210.

[0055] The heating duct 210 extends from the rear of the tub 110 to the front of the tub 110. The front of the heating duct 210 is connected to a discharge port 111b, and the rear of the heating duct 210 is connected to the filter housing 220.

[0056] The heating duct 210 has a tubular shape extending from the rear of the tub 110 to the front of the tub 110. A duct upper plate 211 and a duct lower plate 212 may be included. However, the shape of the heating duct 210 is not limited to that shown in FIG. 3.

[0057] A fan 213, a fan motor 214, and a duct heater 215 are provided inside the heating duct 210, that is, between the duct upper plate 211 and the duct lower plate 212.

[0058] The fan motor 214 may be connected to the fan 213 through a rotation shaft, and may provide rotation to the fan 213.

[0059] The fan 213 may be provided in an opening 212a of the duct lower plate 212, and the fan 213 may circulate air between the tub 110 and the heating duct 210 by rotation. For example, the fan 213 sucks the internal air of the tub 110 / the drum 120 from the rear of the tub 110 to the heating duct 210 and exhausts the air of the heating duct 210 to the front of the tub 110.

[0060] The duct heater 215 may heat air passing through the heating duct 210. The air of the tub 110 is sucked into the heating duct 210 by the fan 213 and may flow into the heating duct 210. The duct heater 215 may heat the air flowing through the heating duct 210. The heated air may be discharged to the tub 110 by the fan 213.

[0061] The filter housing 220 is provided between the heating duct 210 and the tub 110, and guides air sucked from the tub 110 to the heating duct 210 through the connecting conduit 230.

[0062] The filter housing 220 is connected to the heating duct 210. In addition, the filter housing 220 is connected to the tub 110 through the connecting conduit 230.

[0063] The filter housing 220 has a shape in which two cylinders are combined. The upper cylinder is connected to the heating duct 210, and the lower cylinder is connected to the connecting conduit 230. The upper cylinder and the lower cylinder have different diameters. The central axis of the upper cylinder does not coincide with the central axis of the lower cylinder, and the central axis of the upper cylinder may be disposed parallel to the central axis of the lower cylinder. However, the shape of the filter housing 220 is not limited to that shown in FIG. 3.

[0064] In the filter housing 220, a filter 221 is provided to separate dust contained in the air sucked from the tub 110. For example, the filter 221 may be provided at a portion where the upper cylinder and the lower cylinder are connected.

[0065] The filter housing 220 is provided with a washing water nozzle 222 for spraying water to clean the filter

221. The washing water nozzle 222 is connected to an external water source through a washing water conduit 223, and a washing water valve 224 is provided on the washing water conduit 223. The washing water valve 224 may allow or block the supply of water to the washing water nozzle 222 in response to the electrical signal. The washing water valve 224 may include, for example, a solenoid valve that opens and closes in response to the electrical signal.

[0066] The connecting conduit 230 may be provided between the filter housing 220 and the tub 110 to guide the air sucked from the tub 110 to the heating duct 210.

[0067] The connecting conduit 230 has one end connected to the condensing duct 240. In more detail, the connecting conduit 230 may be connected to the suction port 112c of the tub 110. The connecting conduit 230 is also connected at the other end to the filter housing 220.

[0068] The connecting conduit 230 may have a bellows shape to prevent vibration of the tub 110 from being transmitted to the filter housing 220. However, the shape of the connecting conduit 230 is not limited to that shown in FIG. 3.

[0069] Hereinafter, the condensing duct 240 will be described.

[0070] FIG. 4 is a perspective view of a tub rear part of a washing machine in accordance with an embodiment of the present disclosure. FIG. 5 shows a cross-sectional view along line A-A' shown in FIG. 4. FIG. 6 shows a cross-sectional view along line B-B' shown in FIG. 4. FIG. 7 shows a cross-sectional view along line C-C' shown in FIG. 4. FIG. 8 shows a rear outer side of a tub of a washing machine in accordance with an embodiment of the present disclosure. FIG. 9 shows a cross-sectional view along line D-D' shown in FIG. 8.

[0071] Referring to FIGS. 4, 5, 6, 7, 8 and 9, the condensing duct 240 is provided inside the rear wall 112a of the tub 110.

[0072] Water vapor contained in the air may be condensed while the air of the tub 110 passes through the condensing duct 240. Air heated from the heating duct 210 is supplied to the inside of the tub 110 and the drum 120 during the drying cycle, and the heated air may absorb the moisture of wet laundry contained in the drum 120.

[0073] When hot and humid air comes into contact with cold water, the water vapor contained in the hot and humid air may condense.

[0074] The condensing duct 240 may be provided at the rear wall 112a of the tub 110, and water for condensation may be supplied to the condensing duct 240. Therefore, the high temperature and high humidity air inside the drum 120 may contact with water flowing along the outer wall of the condensing duct 240, and the water vapor contained in the high temperature and high humidity air may be condensed.

[0075] Referring to FIGS. 4, 5, 6 and 7, the condensing duct 240 may be provided integrally with the tub rear part 112. For example, the condensing duct 240 may be pro-

vided along the sidewall 112b of the tub rear part 112 inside the rear wall 112a of the tub rear part 112.

[0076] A stepped recessed along the sidewall 112b of the tub rear part 112 may be formed at the rear wall 112a of the tub rear part 112. A part of the edge portion of the rear wall 112a of the tub rear part 112 is retracted further rearward than the center portion of the rear wall 112a of the tub 110. As a result, a rear groove 241 having a substantially horseshoe shape may be formed at the edge portion inside the rear wall 112a of the tub rear part 112. For example, the rear groove 241 is formed along the sidewall 112b of the tub rear part 112, as shown in FIG. 7, and a first center angle α of the rear groove 241 is approximately between 180 degrees 360 degrees.

[0077] As illustrated in FIG. 8, ribs 112f and 112g may be provided outside the rear wall 112a of the tub rear part 112 to improve rigidity of the tub 110.

[0078] The first rib 112f is provided at an approximately center portion of the rear wall 112a of the tub rear part 112. The second rib 112g is provided at an approximately edge portion of the rear wall of the tub rear part 112. The depth of the first rib 112f and the depth of the second rib 112g are different from each other. Specifically, since the rear groove 241 is formed at the edge portion of the rear wall 112a inside the tub rear part 112, the depth of the second rib 112g provided at the approximately edge portion of the rear wall 112a of the tub rear part 112 is shallower than the depth of the first rib 112f provided at the approximately center portion of the rear wall 112a of the tub rear part 112.

[0079] As shown in FIGS. 4 and 7, a cover 242 may be provided on the substantially horseshoeshaped rear groove 241 formed inside the rear wall 112a of the tub rear part 112.

[0080] The cover 242 has an approximately horseshoe shape to correspond to the shape of the rear groove 241. For example, the cover 242 is provided along the sidewall 112b of the tub rear part 112 at the rear wall 112a of the tub rear part 112, as shown in FIG. 7, and a second center angle β of the cover 242 may be between approximately 180 degrees and 360 degrees.

[0081] In addition, the second center angle β of the cover 242 may be smaller than the first center angle α of the rear groove 241. Therefore, at least a part of the rear groove 241 may not be covered by the cover 242, and at least a part of the rear groove 241 may be exposed to the outside.

[0082] Portions exposed to the outside due to not being covered by the cover 242 may form inlets 243a and 243b. As shown in FIG. 7, the inlets 243a and 243b may be formed at both ends of the rear groove 241. For example, the first inlet 243a may be formed at the left end of the rear groove 241, and the second inlet 243b may be formed at the right end of the rear groove 241. Water or air inside the tub 110 may be introduced into the rear groove 241 through the first inlet 243a and the second inlet 243b. For example, the first inlet 243a may be formed at the left end of the rear groove 241, and the

second inlet 243b may be formed at the right end of the rear groove 241. Water or air inside the tub 110 may be introduced into the rear groove 241 through the first inlet 243a and the second inlet 243b.

[0083] The cover 242 may be spaced apart from the rear groove 241 in front of the rear groove 241. For example, the cover 242 may be provided on the same plane as the inner surface of the rear wall 112a of the tub rear part 112.

[0084] Since the cover 242 is spaced apart from the rear groove 241, a space in which water or air can flow is formed between the cover 242 and the rear groove 241, and the space between them forms the condensing duct 240.

[0085] The condensing duct 240 is formed by the rear wall 112a and the cover 242 of the tub rear part 112. The condensing duct 240 may be provided along the sidewall 112b of the tub rear part 112 at the rear wall 112a of the tub rear part 112 having a closed cylindrical bottom surface.

[0086] The condensing duct 240 may have an approximately horseshoe shape in the same manner as the cover 242 and the rear groove 241. The first and second inlets 243a and 243b are respectively provided at both ends of the condensing duct 240 having a substantially horseshoe shape.

[0087] The cross section of the condensing duct 240 may have a substantially rectangular shape as shown in FIGS. 5 and 6.

[0088] A width w of the condensing duct 240 and a depth d of the condensing duct 240 may be determined depending on the stiffness of the tub 110 and the amount of air passing through the condensing duct 240.

[0089] As the width w of the condensing duct 240 and the depth d of the condensing duct 240 increase, the amount of air passing through the condensing duct 240 increases, and the drying efficiency of the washing machine 100 may increase.

[0090] On the other hand, as the depth d of the condensing duct 240 increases, the depth of the second rib 112g provided outside the rear wall 112a of the tub rear part 112 is reduced. In order to match with other furniture or home appliances, the overall size (horizontal, vertical and height) of the washing machine 100 may be a predetermined value. Therefore, as the depth d of the condensing duct 240 increases, the size of the second rib 112g decreases, and the rigidity of the tub 110 may decrease.

[0091] In addition, as the width w of the condensing duct 240 increases, the size of the first rib 112f provided outside the rear wall 112a of the tub rear part 112 is reduced and the size of the second rib 112g is increased. Since the depth of the second rib 112g is shallower than the depth of the first rib 112f, the rigidity of the tub 110 may decrease as the width w of the condensing duct 240 increases.

[0092] The width w and the depth d of the condensing duct 240 affect the stiffness of the tub 110 and the amount

of air passing through the condensing duct 240, and the stiffness of the tub 110 and the air passing through the condensing duct 240 can be determined depending on the amount. For example, the width w of the condensing duct 240 may be determined so that the area of the condensing duct 240 is about 20% or more of the total area of the rear wall 112a of the tub rear part 112.

[0093] The condensing duct 240 is provided with condensing nozzles 244a and 244b for injecting water for condensation of water vapor into the condensing duct 240. The first condensing nozzle 244a is provided on the left side of the condensing duct 240, and the second condensing nozzle 244b is provided on the right side of the condensing duct 240.

[0094] The first condensing nozzle 244a and the second condensing nozzle 244b are connected to an external water source through a condensate conduit 245 (see FIG. 3), and a condensation valve 246 is provided on the condensate conduit 245. The condensation valve 246 may allow or block the supply of water to the first condensing nozzle 244a and the second condensing nozzle 244b in response to an electrical signal. The condensation valve 246 may include, for example, a solenoid valve that opens and closes in response to the electrical signal.

[0095] The condensing duct 240 may extend from the first inlet 243a and the second inlet 243b formed at both ends thereof to the suction port 112c formed at the upper side of the tub 110.

[0096] In order to extend the condensing duct 240 provided inside the rear wall 112a of the tub rear part 112 to the suction port 112c, in the vicinity of the suction port 112c of the tub rear part 112, a side groove 247 in which the sidewall 112b of the tub rear part 112 is recessed outward may be formed.

[0097] The side groove 247 may be provided above the tub 110. For example, as illustrated in FIGS. 4 and 7, the tub 110 may be provided at an upper right side of the tub 110. The center of the tub 110 may be provided at approximately 1 o'clock to 2 o'clock.

[0098] The side groove 247 may have a substantially triangular pillar shape. Therefore, when viewed from the outside of the tub 110, the side groove 247 can be seen as a stepped protrusion 247a. For example, as shown in FIG. 4, the side groove 247 may be formed inside the stepped protrusion 247a formed on the sidewall of the tub rear part 112. However, the shape of the side groove 247 is not limited to this.

[0099] The side groove 247 may extend from the rear groove 241 to the suction port 112c. For example, the side groove 247 may extend from the rear surface of the rear groove 241 to the suction port 112c.

[0100] The cover 242 may include a protruding portion to cover the side groove 247. The protruding portion of the cover 242 may extend to the lower side of the suction port 112c to partition the side groove 247 from the inside of the tub 110.

[0101] As such, the condensing duct 240 may extend from the first inlet 243a and the second inlet 243b formed

inside the rear wall 112a of the tub 110 to the suction port 112c formed above the sidewall 112b of the tub rear part 112. The condensing duct 240 may be connected to the heating duct 210 through the suction port 112c. Air passing through the condensing duct 240 may be introduced into the heating duct 210 through the suction port 112c.

[0102] As such, the condensing duct 240 may be provided at the rear wall 112a of the tub rear part 112. Since the condensing duct 240 is provided, water vapor contained in the internal air of the tub 110 / the drum 120 may be condensed while passing through the condensing duct 240. In addition, the condensing duct 240 increases the time for the internal air of the tub 110 / the drum 120 to contact with the water vapor, thereby increasing the amount of water vapor condensed. Therefore, the drying efficiency of the washing machine 100 is improved.

[0103] The condensing duct 240 may be integrally formed with the tub rear part 112 inside the rear wall 112a of the tub rear part 112. Thereby, the condensing duct 240 can be provided without attachment of additional structures (e.g., conduits for forming condensation ducts) behind the tub 110.

[0104] Furthermore, the increase in the size of the washing machine due to the additional structure can be prevented, and also the decrease in the size (washing capacity) of the tub and the drum due to the additional structure can be prevented.

[0105] Since the condensing duct 240 is formed by the cover 242, the assembly structure for forming the condensing duct 240 can be simplified.

[0106] Since the condensing duct 240 is integrally formed with the tub rear part 112, leakage of the condensing duct 240 may be prevented.

[0107] The condensing duct 240 includes the first inlet 243a and the second inlet 243b, thereby forming two flow paths from the first inlet 243a and the second inlet 243b to the suction port 112c. Thereby, the resistance of the airflow passing through the condensing duct 240 can be reduced, and the amount of air passing through the condensing duct 240 can be increased.

[0108] By configuring the cover 242 to form the condensing duct 240 made of a metal material, it is possible to further improve the condensation efficiency of the condensing duct 240.

[0109] FIG. 10 illustrates a flow of water and air in a condensation duct according to one embodiment.

[0110] As shown in FIG. 10, sidewalls of the condensing duct 240 are provided with the first condensing nozzle 244a and the second condensing nozzle 244b for injecting water for condensing water vapor into the condensing duct 240.

[0111] Water sprayed from the first condensing nozzle 244a and the second condensing nozzle 244b may flow down the sidewalls of the condensing duct 240. For example, water may flow along the rear wall 112a of the tub rear part 112 forming the condensing duct 240 or

along the cover 242.

[0112] The internal air of the tub 110 / the drum 120 may be sucked into the condensing duct 240 through the first inlet 243a and the second inlet 243b formed under the rear wall 112a of the tub 110.

[0113] The air sucked through the first inlet 243a and the second inlet 243b may flow along the condensing duct 240 to the suction port 112c provided at the upper portion of the tub 110. Hot and humid air may contact water flowing along the sidewalls of the condensing duct 240 while flowing along the condensing duct 240. Water vapor contained in the hot humid air may condense while the hot humid air comes into contact with the water of the condensing duct 240.

[0114] FIG. 11 illustrates a flow of water and air in a condensation duct according to another embodiment.

[0115] In order to improve the condensation efficiency of the water vapor contained in the air, a portion of the cross-sectional area of the internal flow path of the condensing duct 240 may be reduced.

[0116] For example, to reduce the cross-sectional area of the internal flow path of the condensing duct 240, protrusions 248a and 248b are formed on the inner wall of the condensing duct 240 as shown in FIG. 11. In addition, the protrusions 248a and 248b are provided with the condensing nozzles 244a and 244b for injecting water. The first protrusion 248a and the second protrusion 248b are formed in the condensing duct 240, the first condensing nozzle 244a is provided in the first protrusion 248a, and the second condensing nozzle is provided in the second protrusion 248b.

[0117] The air flowing through the condensing duct 240 increases in flow rate at a portion where the cross-sectional area is reduced by the first protrusion 248a and the second protrusion 248b. In addition, the air may contact the water sprayed from the first condensing nozzle 244a and the second condensing nozzle 244b respectively provided in the first protrusion 248a and the second protrusion 248b. For example, water is injected into the rapidly flowing air through the first condensing nozzle 244a provided in the first protrusion 248a.

[0118] Thereby, the contact of water with the air is increased, and the amount of water vapor condensed by the water may be increased. In other words, the condensing efficiency in the condensing duct 240 can be improved and the drying time can be reduced.

[0119] FIGS. 1 to 11 describe the flow of air during the drying cycle. The internal air of the tub 110 / the drum 120 may be condensed and heated while passing through the condensing duct 240 and the heating duct 210.

[0120] After dehydration, the laundry still contains a lot of moisture, and the amount of water vapor contained in the air inside the drum 120 may increase due to the wet laundry.

[0121] The air inside the drum 120 may be sucked into the condensing duct 240 by the operation of the fan 213. For example, humid air inside the drum 120 may move

to a space between the drum 120 and the tub 110 through the through hole 121a of the drum 120. While passing through the through hole 121a of the drum 120, the air inside the drum 120 passes through the wet laundry, thereby increasing the amount of water vapor contained in the air.

[0122] The air passing through the through hole 121a may be sucked into the condensing duct 240 through the first inlet 243a and/or the second inlet 243b provided at the rear wall 112a of the tub 110. Water sprayed from the first condensing nozzle 244a and the second condensing nozzle 244b may flow on the sidewall of the condensing duct 240.

[0123] The air entering the condensing duct 240 passes through the condensing duct 240 and is sucked into the heating duct 210. While the humid air passes through the condensing duct 240, it can come into contact with water flowing through the sidewalls of the condensing duct 240, and it may condense during contact with cold water contained in the humid air. As a result, the amount of water vapor contained in the air during the passage of the condensing duct 240 may decrease.

[0124] The air which lost steam in the condensing duct 240 is sucked into the heating duct 210 through the suction port 112c by the fan 213. Air passes through the filter housing 220, and particles such as dust included in the air may be caught while passing through the filter housing 220. Air passes through the fan 213 and may be discharged to the heating duct 210 by the fan 213.

[0125] The air may be heated by the duct heater 215 while passing through the heating duct 210. Due to the heating of the air, the capacity (amount of saturated steam) in which the air can receive water vapor may increase. In other words, the amount of saturated water vapor in the air may increase.

[0126] The air heated in the heating duct 210 may be discharged into the drum 120 through the discharge port 111b.

[0127] The air inside the drum 120 may absorb water vapor from the wet laundry and circulate through the condensing duct 240 and the heating duct 210.

[0128] As such, the washing machine 100 may dry the laundry through the absorption of water vapor in the drum 120, condensation of water vapor in the condensing duct 240, and heating of air in the heating duct 210.

[0129] Hereinafter, a control configuration and a control operation of the washing machine 100 for drying laundry will be described.

[0130] FIG. 12 shows a configuration of a washing machine in accordance with an embodiment of the present disclosure. FIG. 13 shows an operation of a washing machine according to one embodiment.

[0131] Referring to FIGS. 12 and 13, the washing machine 100 includes a user input 171, a display 172, a water level sensor 173, a tub temperature sensor 174, a duct temperature sensor 175, a motor driving circuit 180, the drum motor 130, the water supply valve 142, the drain pump 152, the fan motor 214, the tub heater 114, the

duct heater 215, the washing water valve 224, the condensation valve 246 and a controller 190. In addition, the washing machine 100 may perform an amount of laundry 1010, a washing cycle 1020, a rinsing cycle 1030, a dehydration cycle 1040, and a drying cycle 1050.

[0132] The drum motor 130, the water supply valve 142, the drain pump 152, the fan motor 214, the tub heater 114, the duct heater 215, the washing water valve 224 and the condensation valve 246 shown in FIG. 3 may be the same as described.

[0133] The user input 171 is provided on the control panel 103 of the cabinet 101, and includes a dial 171a (see FIG. 1) capable of obtaining the user input by rotation and an input button 171b capable of obtaining the user input by reciprocating movement.

[0134] The user can select any one of the plurality of laundry courses by rotating the dial 171a. The washing machine 100 may include a plurality of different washing courses for washing different kinds of laundry, for example, the different washing courses may include different washing times, different rinsing times and different dehydration times.

[0135] The input button 171b may include a washing button for adjusting the washing time in which the washing machine 100 washes laundry, a rinsing button for adjusting the number of rinses of the washing machine 100 to rinse the laundry and, a dehydration button for adjusting the dehydration time for dehydrating the laundry. In addition, the input button 171b may include a power button for allowing or cutting off power supplied from an external power source, and an operation button for starting or stopping an operation of the washing machine 100.

[0136] The dial 171a and the input button 171b may transmit an electrical signal (voltage or current) corresponding to the user input to the controller 190 in response to the user input received from the user.

[0137] The display 172 is provided on the control panel 103 of the cabinet 101 and may display an operation state of the washing machine 100 and a control command of the user. For example, the display 172 may display the washing course selected by the user, and display the time remaining until the completion of the operation while the washing machine 100 is in operation.

[0138] The display 172 may include a light emitting diode (LED) panel, an organic light emitting diode (OLED) panel, a liquid crystal display (LCD) panel, or the like.

[0139] The display 172 may adopt a touch screen panel (TSP) that receives a control command from the user and displays operation information corresponding to the received control command.

[0140] As such, the display 172 may receive a display control signal from the controller 170 and display an image corresponding to the display control signal.

[0141] The water level sensor 173 may be installed at the end of a connection hose 173a (see FIG. 2) connected to the bottom of the tub 110.

[0142] The water level of the connection hose 173a

may be the same as that of the tub 110. As the water level of the connection hose 173a increases, the pressure inside the connection hose 173a increases, and as the water level of the connection hose 173a decreases, the pressure inside the connection hose 173a decreases.

[0143] The water level sensor 173 may measure the pressure inside the connection hose 173a and output an electrical signal corresponding to the measured pressure to the controller 190. The controller 190 may identify the level of the connection hose 173a, that is, the level of the tub 110, based on the pressure of the connection hose 173a measured by the water level sensor 173.

[0144] The tub temperature sensor 174 may be provided below the tub 110. For example, the tub temperature sensor 174 may be installed near the tub heater 114.

[0145] The tub temperature sensor 174 may measure the temperature of the water accommodated in the tub 110 or measure the temperature of the internal air of the tub 110 or the drum 120. For example, the tub temperature sensor 174 may measure the temperature of the water contained in the tub 110 during the wash cycle and/or the rinse cycle. In addition, the tub temperature sensor 174 may measure the temperature of the internal air of the tub 110 / the drum 120 during the drying cycle.

[0146] The tub temperature sensor 174 may include a thermistor. An electrical resistance value of the thermistor is converted according to the temperature, and the tub temperature sensor 174 may transmit an electrical signal (voltage or current) corresponding to the electrical resistance value of the thermistor to the controller 190.

[0147] The duct temperature sensor 175 may be provided inside the heating duct 210. For example, the duct temperature sensor 175 may be installed in the vicinity of the duct heater 215. Specifically, the duct temperature sensor 175 may be located downstream of the duct heater 215 based on the flow of air during the heating cycle.

[0148] The duct temperature sensor 175 may measure the internal temperature of the heating duct 210. For example, the duct temperature sensor 175 may measure the temperature of the air heated by the duct heater 215 during the drying cycle.

[0149] The duct temperature sensor 175 may include a thermistor. An electrical resistance value of the thermistor is converted according to the temperature, and the duct temperature sensor 175 may transmit an electrical signal (voltage or current) corresponding to the electrical resistance value of the thermistor to the controller 190.

[0150] The motor driving circuit 180 may be mounted on a printed circuit board installed near the drum motor 130.

[0151] The motor driving circuit 180 may supply a driving current to the drum motor 130.

[0152] The motor driving circuit 180 may convert AC power of an external power source into driving power for driving the drum motor 130.

[0153] The motor driving circuit 180 may have various topologies according to the type of the drum motor 130.

[0154] For example, when the drum motor 130 is a DC motor, the motor driving circuit 180 may convert AC power supplied from an external power source into DC power and intermittently supply DC power to the drum motor 130. When the drum motor 130 is a non-commutator DC motor, the motor driving circuit 180 converts AC power into DC power, and thereafter, the DC power may be converted into AC power in the form of a square wave, and the AC power in the form of a square wave may be supplied to the drum motor 130. When the drum motor 130 is a permanent magnet synchronous motor, the motor driving circuit 180 converts AC power into DC power, and then converts the DC power into AC power in the sine wave form, and converts the AC power in the sine wave form into a drum to supply to the motor 130. When the drum motor 130 is an induction motor, the motor driving circuit 180 may intermittently supply AC power supplied from an external power source to the drum motor 130.

[0155] In addition, the motor driving circuit 180 detects a first driving current supplied to the drum motor 130 in order to prevent damage of the drum motor 130 due to an overload, and the information about the first driving current (for example, driving current value) can be output to the controller 190.

[0156] The controller 190 may be mounted on, for example, a printed circuit board provided at the rear of the control panel 103.

[0157] The controller 190 is electrically connected to the user input 171, the tub temperature sensor 174, the duct temperature sensor 175, the display 172, the motor driving circuit 180, the water supply valve 142, the drain pump 152, the fan motor 214, the tub heater 114, the duct heater 215, the washing water valve 224, and the condensation valve 246.

[0158] The controller 190 may control the display 172, the motor driving circuit 180, the water supply valve 142, the drain pump 152, the fan motor 214, the tub heater 114, the duct heater 215, the washing water valve 224, and the condensation valve 246 based on the output of the user input 171, the tub temperature sensor 174 and the duct temperature sensor 175.

[0159] The controller 190 includes a processor 191 for generating a control signal for controlling the operation of the washing machine 100, and a memory 192 for memorizing or storing a program and data for generating a control signal for controlling the operation of the washing machine 100. The processor 191 and the memory 192 may be implemented as separate chips or as a single chip. In addition, the controller 190 may include a plurality of processors or a plurality of memories.

[0160] The processor 191 may process data and/or signals according to a program provided from the memory 192, and provide a control signal to each component of the washing machine 100 based on the processing result.

[0161] The processor 191 receives an electrical signal related to the user input from the user input 171, receives

an electrical signal related to the temperature of the tub 110 from the tub temperature sensor 174, and receives an electrical signal related to the heating duct 210 from the duct temperature sensor 175. The processor 191 may process an electrical signal related to the user input, an electrical signal related to the temperature of the tub 110, and an electrical signal related to the temperature of the heating duct 210.

[0162] The processor 191 provides an image signal to the display 172, a driving signal to the motor driving circuit 180, a water supply signal to the water supply valve 142, a drain signal to the drain pump 152, a blow signal to the fan motor 214, a tub heating signal to the tub heater 114, a duct heating signal to the duct heater 215, a filter wash signal to the washing water valve 224 and a condensation signal to the condensation valve 246, based on the user input and the temperature of the tub 110 and the temperature of the heating duct 210.

[0163] For example, the processor 191 may identify the washing course selected by the user based on the user input. The processor 191 determines the rotational speed and the operating cycle (e.g., on time and off time) of the drum 120 depending on the washing course selected by the user. According to the determined rotational speed and operation period, a motor signal for rotating the drum motor 130 may be provided to the motor driving circuit 180.

[0164] The processor 191, during the drying cycle, may provide a blowing signal to the fan motor 214 to suck the internal air of the tub 110 / the drum 120 into the drying duct 200, provide a duct heating signal to the duct heater 215 for heating the air in the heating duct 210, provide a condensation signal for injecting water into the condensing duct 240 to the condensation valve 246, and provide a driving signal for rotating the drum 120 to the motor driving circuit 180.

[0165] The processor 191 may include an operation circuit, a memory circuit, and a control circuit. The processor 191 may include one chip or may include a plurality of chips. In addition, the processor 191 may include one core or may include a plurality of cores.

[0166] The memory 192 may memorize or store a program and data for controlling the operation of the washing machine 100 according to the washing course. For example, the memory 192 may memorize or store the rotational speed of the drum 120 according to the washing course and the washing time / rinsing frequency / dehydration time according to the washing course.

[0167] The memory 192 may store a program and data for controlling the operation of the washing machine 100 according to the washing course. For example, the memory 192 may memorize or store the rotational speed of the drum 120 according to the washing course and the washing time / rinsing frequency / dehydration time according to the washing course.

[0168] The memory 192 stores the user input received through the dial 171a and the input button 171b, or information on the operation of the washing machine 100 (for

example, a cycle in progress, remaining time until the operation of the washing machine is completed).

[0169] The memory 192 may include a volatile memory such as static random access memory (S-RAM), dynamic random access memory (D-RAM), and read only memory (ROM), or a nonvolatile memory, such as Erasable Programmable Read Only Memory (EPROM).

[0170] The memory 192 may include one memory device or may include a plurality of memory devices.

[0171] As illustrated in FIG. 13, the controller 190 may control each component of the washing machine 100 to wash / rinse / dehydrate / dry laundry. The controller 190 may measure the amount of laundry 1010, sequentially perform the washing cycle 1020, the rinsing cycle 1030, the dehydration cycle 1040, and the drying cycle 1050.

[0172] The controller 190 measures the amount of laundry 1010.

[0173] By increasing the amount of laundry, the current supplied from the motor driving circuit 180 to the drum motor 130 may increase. The controller 190 controls the motor driving circuit 180 to rotate the drum 120 in the forward or reverse direction to measure the amount of laundry, and the current supplied from the motor driving circuit 180 to the drum motor 130 may be measured.

[0174] The controller 190 may estimate the amount of laundry based on the current supplied from the motor driving circuit 180 to the drum motor 130.

[0175] The controller 190 performs the washing cycle 1020.

[0176] The controller 190 may supply water and detergent to the tub 110. The controller 190 may open the water supply valve 142 to supply water to the tub 110 depending on the amount of laundry measured. By opening the water supply valve 142, water may be supplied to the tub 110 via the detergent compartment 161. Thereby, the detergent may be supplied to the tub 110 with water during the first water supply for washing.

[0177] The controller 190 may rotate the drum 120 at low speed for washing. The controller 190 may control the motor driving circuit 180 to rotate the drum 120 at low speed (e.g., rotational speed between approximately 45 rpm and 60 rpm). The controller 190 may control the motor driving circuit 180 to alternately rotate the drum 120 in a first direction and in a second direction. While the drum 120 rotates alternately in the first direction and the second direction, the laundry inside the drum 120 may be rolled along the inner wall of the drum 120 or dropped after being lifted. Foreign matter attached to the laundry can be separated from the laundry by the physical action of tumbling and falling of the laundry and the chemical action of the detergent.

[0178] The controller 190 may discharge the water from the tub 110. The controller 190 may operate the drain pump 152 to discharge the water from the tub 110. The water in the tub 110 may be pumped out by the drain pump 152.

[0179] The controller 190 may rotate the drum 120 at high speed for intermediate dehydration. The controller

190 may control the motor driving circuit 180 to rotate the drum 120 at high speed (e.g., rotational speed of approximately 1000 rpm to 1100 rpm). While the drum 120 rotates at high speed, the laundry inside the drum 120 is located along the inner wall of the drum 120, and the water absorbed by the laundry may be separated from the laundry by centrifugal force. The water separated from the laundry may be discharged to the outside through the tub 110 and the drain conduit 151 through the through hole 121a of the drum 120.

[0180] Thereafter, the controller 190 performs the rinsing cycle 1030. The controller 190 may supply water to the tub 110 and rotate the drum motor 130 at low speed for rinsing. The controller 190 may discharge the water from the tub 110 and rotate the drum 120 at high speed for intermediate dehydration.

[0181] Thereafter, the controller 190 performs the dehydration cycle 1040. The controller 190 may rotate the drum 120 at high speed.

[0182] Thereafter, the controller 190 performs the drying cycle 1050.

[0183] The controller 190 may operate the duct heater 215 to heat the air inside the tub 110 / the drum 120. When the temperature of the internal air of the tub 110 reaches a predetermined temperature, the controller 190 controls the motor driving circuit 180 to operate the duct heater 215 and to rotate the drum 120 at high speed. The controller 190 may open the condensation valve 246 to supply water to the condensing duct 240.

[0184] As described above, the controller 190 may sequentially perform the washing cycle 1020, the rinsing cycle 1030, the dehydration cycle 1040, and the drying cycle 1050 to wash laundry.

[0185] FIG. 14 shows a drying cycle performed by a washing machine according to one embodiment. FIG. 15 shows operations of each of the components of a washing machine by the drying cycle shown in FIG. 14. FIGS. 16 and 17 show residual moisture by a heating / dehydration operation shown in FIG. 14. FIG. 18 shows the drying time according to a tub temperature.

[0186] FIGS. 14, 15, 16, 17 and 18 describe the drying cycle 1050 of the washing machine 100.

[0187] After the dehydration cycle 1040 is finished, the washing machine 100 continuously heats the inside of the tub 110 / the drum 120 (1110). (Hereinafter referred to as "heating operation.")

[0188] After stopping the rotation of the drum 120 for the dehydration cycle 1040, the controller 190 may operate the duct heater 215 provided inside the heating duct 210 to heat the tub 110 / the drum 120. For example, the controller 190 may provide a duct heating signal to the duct heater 215 to turn on the duct heater 215 as shown in FIG. 15.

[0189] During the heating operation, the controller 190 may operate the fan 213 provided inside the heating duct 210 to circulate air between the tub 110 / the drum 120 and the drying duct 200. For example, the controller 190 can provide a blowing signal to the fan motor 214 for

rotating the fan 213 during continuous heating as shown in FIG. 15.

[0190] During the heating operation, the controller 190 may rotate the drum 120 at a first rotational speed (for example, 40 rpm to 100 rpm) as shown in FIG. 15. While the drum 120 rotates at the first rotational speed, the laundry inside the drum 120 may be rolled inside the drum 120 by centrifugal force and gravity. For example, while the drum 120 rotates at low speed, the laundry may be lifted along with the drum 120 to approximately the center height of the drum 120 by centrifugal force and gravity. When the laundry is lifted to approximately the center height of the drum 120, the direction of the centrifugal force is opposite to the direction of gravity and the laundry falls to the lower portion of the drum 120 by the gravity. As such, the laundry repeatedly enters the rotational direction of the drum 120 and falls to the bottom of the drum 120, and this operation is hereinafter referred to as "tumbling."

[0191] During the heating operation, the controller 190 may alternately rotate the drum 120 counterclockwise (CCW) or clockwise (CW) as shown in FIG. 15. The time for the controller 190 to rotate the drum 120 counterclockwise (CCW) may be different from the time for the controller 190 to rotate the drum 120 clockwise (CW). For example, the ratio between the time when the controller 190 rotates the drum 120 counterclockwise (CCW) and the time when the controller 190 rotates the drum 120 clockwise (CW) may be 5: 1.

[0192] During the heating operation, the controller 190 may not supply water for condensation to the condensing duct 240. For example, as shown in FIG. 15, the controller 190 may provide an off signal to the condensation valve 246 to close the condensation valve 246.

[0193] Before the internal air of the tub 110 / the drum 120 is sufficiently heated, the water condensation efficiency may be low. In addition, the rate of increase of the internal temperature of the tub 110 / the drum 120 of the condensing duct 240 is lowered, thereby increasing the drying time. For this reason, the water for condensation may not be supplied to the condensing duct 240 while heating the internal air of the tub 110 / the drum 120.

[0194] Optionally, the controller 190 may operate the tub heater 114 provided inside the tub 110 during the heating operation. For example, the controller 190 may provide a tub heating signal to the tub heater 114.

[0195] The washing machine 100 determines whether the internal temperature of the tub 110 is equal to or greater than a first reference temperature (1120).

[0196] While heating the internal air of the tub 110 / the drum 120, the controller 190 may measure the internal temperature of the tub 110. For example, the controller 190 may receive an electrical signal (voltage or current) indicating the internal temperature of the tub 110 from the tub temperature sensor 174 at every predetermined time (per sampling period).

[0197] In addition, the controller 190 may compare the internal temperature of the tub 110 with the first reference

temperature to determine whether the internal temperature of the tub 110 is greater than or equal to the first reference temperature. The first reference temperature may be set experimentally or empirically, and the first reference temperature may be, for example, approximately 90 degree Celsius.

[0198] If the internal temperature of the tub 110 is not greater than the first reference temperature (NO in 1120), the washing machine 100 continues to heat the internal air of the tub 110 / the drum 120.

[0199] If the internal temperature of the tub 110 is equal to or greater than the first reference temperature (YES in 1120), the washing machine 100 intermittently heats the internal air of the tub 110 / the drum 120 and simultaneously heats the drum 120 and rotates at high speed (1130). (Hereinafter referred to as "heating / dehydration operation.")

[0200] If the internal temperature of the tub 110 is greater than or equal to the first reference temperature, the controller 190 may intermittently operate the duct heater 215 to maintain the internal temperature of the tub 110 / the drum 120 at the first reference temperature. For example, if the internal temperature of the tub 110 is less than the first reference temperature, the controller 190 operates the duct heater 215, and when the internal temperature of the tub 110 exceeds the first reference temperature, the controller 190 may stop the duct heater.

[0201] During the heating / dehydration operation, the controller 190 may operate the fan 213 provided inside the heating duct 210 to circulate air between the tub 110 / the drum 120 and the drying duct 200. For example, the controller 190 can provide a blowing signal to the fan motor 214 for rotating the fan 213 during intermittent heating, as shown in FIG. 15.

[0202] During the heating / dehydration operation, the controller 190 may rotate the drum 120 at a second rotational speed (for example, 1000 rpm to 1600 rpm) for dehydration. While the drum 120 rotates at the second rotational speed, the laundry may be attached to the inner wall of the drum 120 by centrifugal force. In addition, the water absorbed in the laundry may be separated to the outside of the drum 120 through the through hole 121a of the drum 120.

[0203] As the temperature of the laundry absorbing water increases or decreases, the amount of water separated from the laundry may increase. Specifically, the surface tension decreases with the increasing water temperature. For example, the surface tension of water at 25 degrees Celsius may be approximately 0.0712 Nm (Newton-meter), and the surface tension of water at 55 degrees Celsius may be approximately 0.0671 Nm.

[0204] Due to the reduction in the surface tension, water can be easily separated from the laundry. For example, the residual moisture content (RMC) of laundry after rinsing is approximately 45% as shown in FIG. 16A, and the residual moisture content (RMC) of the laundry after dehydration may be approximately 38% as shown in FIG. 16B. After dehydration at the same time as heating, the

residual moisture content (RMC) of the laundry may be 33% as shown in FIG. 16C.

[0205] Further, as shown in FIG. 17, as the temperature of the laundry increases or decreases, the residual moisture content (RMC) of the laundry changes. For example, if the temperature of the laundry is approximately 65 degrees Celsius, the residual moisture content (RMC) of the laundry is approximately 35.5%. If the temperature of the laundry is approximately 75 degrees Celsius, the residual moisture content (RMC) of the laundry is approximately 34%. If the temperature of the laundry is approximately 80 degrees Celsius, the residual moisture content (RMC) of the laundry may be approximately 33%.

[0206] As such, by simultaneously performing heating and dehydration, the washing machine 100 may improve the dehydration efficiency for drying, thereby reducing the time for drying.

[0207] During the heating / dehydration operation, the controller 190 may not supply the condensing duct 240 with water for condensation. For example, as shown in FIG. 15, the controller 190 may provide an off signal to the condensation valve 246 to close the condensation valve 246.

[0208] The washing machine 100 determines whether the heating / dehydration time is greater than or equal to a first reference time (1140).

[0209] The controller 190 may determine a time when the heating / dehydration operation is performed during the heating / dehydration operation, and compare the heating / dehydration time with the first reference time (for example, any one of 5 minutes to 10 minutes). The first reference time can be set experimentally or empirically and can vary depending on the amount of laundry. For example, as the amount of laundry increases, the first reference time may increase. In other words, as the amount of laundry increases, the heating / dehydration time may increase.

[0210] If the heating / dehydration time is not greater than or equal to the first reference time (NO in 1140), the washing machine 100 may continue the heating / dehydration operation.

[0211] If the heating / dehydration time is greater than or equal to the first reference time (YES in 1140), the washing machine 100 intermittently heats the internal air of the tub 110 / the drum 120 and the interior of the tub 110 / the drum 120, and condenses water vapor contained in the air (1150). (Hereinafter referred to as "heating / condensing operation.")

[0212] After the end of the heating / dehydrating operation, the controller 190 may intermittently operate the duct heater 215 to maintain the internal temperature of the tub 110 / the drum 120 at the first reference temperature or a second reference temperature. For example, as shown in FIG. 15, the controller 190 may intermittently operate the duct heater 215 to maintain the internal temperature of the tub 110 / the drum 120 at the second reference temperature greater than the first reference temperature after completion of heating / dehydration.

As shown in FIG. 18, the internal temperature of the tub 110 / the drum 120 increases during the drying operation, thereby reducing the time of the drying cycle of the washing machine 100. Thus, in order to reduce the time of the drying cycle, the controller 190 maintains the internal temperature of the tub 110 / the drum 120 higher than the internal temperature of the tub 110 / the drum 120 during heating / dehydration during the drying operation after heating / dehydration.

[0213] However, the present invention is not limited thereto, and the controller 190 may set the internal temperature of the tub 110 / the drum 120 to be equal to the internal temperature of the tub 110 / the drum 120 during heating / dehydration after the heating / dehydration is completed. The duct heater 215 may be intermittently operated to maintain the reference temperature.

[0214] During the heating condensation operation, the controller 190 may operate the fan 213 provided inside the heating duct 210 to circulate air between the tub 110 / the drum 120 and the drying duct 200.

[0215] During the heat condensation operation, the controller 190 may rotate the drum 120 at the first rotational speed (e.g., low speed, for example, 40 rpm to 100 rpm). While the drum 120 rotates at the first rotational speed, the laundry inside the drum 120 may be tumbling inside the drum 120 by centrifugal force and gravity. The controller 190 may alternately rotate the drum 120 counterclockwise (CCW) or clockwise (CW) as shown in FIG. 15.

[0216] During the heat condensation operation, the controller 190 can supply the condensing duct 240 with water for condensation for efficient drying. For example, as shown in FIG. 15, a condensation signal may be provided to the condensation valve 246 to open the condensation valve 246. Due to the opening of the condensation valve 246, the condensing duct 240 is supplied with water for condensation and water can flow along the inner wall of the condensing duct 240.

[0217] The air heated by the heating duct 210 may absorb water vapor from the laundry passing through the tub 110 and the drum 120. Water vapor absorbed by the air may be condensed by water flowing along the inner wall of the condensing duct 240 while the air passes through the condensing duct 240. The air condensed with the water vapor may be heated again in the heating duct 210.

[0218] As such, the internal air of the tub 110 and the drum 120 may be dried by condensation in the condensing duct 240 and heating in the heating duct 210.

[0219] The washing machine 100 determines whether the condensation / heating time for drying is greater than or equal to the second reference time (1160).

[0220] The controller 190 may determine the time when the condensation / heating operation is performed during the condensation / heating operation, and compare the condensation / heating time with the second reference time. The second reference time can be set experimentally or empirically and can vary depending on

the amount of laundry.

[0221] If the condensation / heating time is not greater than or equal to the second reference time (NO in 1160), the washing machine 100 may continue the condensation / heating operation.

[0222] If the condensation / heating time is greater than or equal to the second reference time (YES in 1160), the washing machine 100 cools the interior of the tub 110 / the drum 120 (1170). (Hereinafter referred to as "cooling operation.") After the end of the condensation / heating operation, the controller 190 may stop heating the internal air of the tub 110 / the drum 120. For example, as illustrated in FIG. 15, the controller 190 may provide the duct heater 215 with an off signal for stopping the duct heater 215.

[0223] During the cooling operation, the controller 190 may operate the fan 213 provided inside the heating duct 210 to circulate air between the tub 110 / the drum 120 and the drying duct 200.

[0224] During the cooling operation, the controller 190 may rotate the drum 120 at the first rotational speed (e.g., low speed, for example, 40 rpm to 100 rpm). The controller 190 may alternately rotate the drum 120 counter-clockwise (CCW) or clockwise (CW) as shown in FIG. 15.

[0225] During the cooling operation, the controller 190 may supply water to the condensing duct 240 to cool the internal air of the tub 110 / the drum 120 more quickly. For example, as shown in FIG. 15, a condensation signal may be provided to the condensation valve 246 to open the condensation valve 246.

[0226] The internal air of the tub 110 / the drum 120 may be cooled in contact with the water of the condensing duct 240.

[0227] In addition, the washing machine 100 may discharge the water of the tub 110 to the outside intermittently during the drying cycle. For example, as shown in FIG. 15, the controller 190 may intermittently operate the drain pump 152 during the drying cycle.

[0228] As described above, the washing machine 100 may perform a heating operation, a heating / dehydrating operation, a condensation / heating operation, and a cooling operation during the drying cycle 1050. In particular, during the heating / dehydration operation, the washing machine 100 maintains the internal air of the tub 110 / the drum 120 at high temperature, the internal air of the tub 110 / the drum 120 may be intermittently heated, and at the same time, the drum 120 may be rotated at high speed for dehydration. By the heating / dehydrating operation, the residual moisture content (RMC) of the laundry can be further reduced and the drying time can be reduced.

[0229] FIG. 19 illustrates a filter cleaning operation of a washing machine according to one embodiment. FIG. 20 shows the amount of water entering a drum during filter cleaning according to a rotational speed of the drum.

[0230] Referring to FIGS. 19 and 20, a filter cleaning operation 1200 of the washing machine 100 is described.

[0231] The washing machine 100 performs the drying

cycle 1050 after the dehydration cycle 1040 (1210).

[0232] During the drying cycle 1050, the controller 190 may perform a heating operation, a heating / dehydrating operation, a condensation / heating operation, and a cooling operation.

[0233] The washing machine 100 determines whether the filter 221 is blocked during the drying cycle 1050 (1220).

[0234] Lint or dust is separated from the laundry by the rotation of the drum 120 during the drying cycle. The lint or dust can be filtered by the filter 221. As the drying cycle progresses, the amount of lint or dust filtered by the filter 221 increases, and the filter 221 may be blocked by the filtered lint or dust.

[0235] The controller 190 may determine whether the filter 221 is blocked based on the internal temperature of the tub 110 and/or the internal temperature of the heating duct 210.

[0236] For example, the controller 190 may determine whether the filter 221 is blocked based on the internal temperature of the tub 110 measured by the tub temperature sensor 174. In detail, the controller 190 may determine whether the filter 221 is blocked based on the change in the internal temperature of the tub 110.

[0237] During the drying cycle 1050, the controller 190 can intermittently run the duct heater 215 and operate the fan motor 214 to allow air to circulate through the drying duct 200 and the tub 110 / the drum 120. The internal temperature of the tub 110 may increase during the operation of the duct heater 215, and the internal temperature of the tub 110 may decrease during the stop of the duct heater 215. Therefore, the change of the internal temperature of the tub 110 measured by the tub temperature sensor 174 is large. On the other hand, if the filter 221 is blocked by lint or dust, the internal air of the tub 110 / the drum 120 does not circulate through the drying duct 200. Therefore, the change of the internal temperature of the tub 110 by the start and stop of the duct heater 215 is small.

[0238] Therefore, if the change in the internal temperature of the tub 110 measured by the tub temperature sensor 174 is greater than or equal to the reference value, the controller 190 identifies that the filter 221 is not blocked, and the change in the internal temperature of the tub 110 is determined. If it is less than the reference value, the controller 190 may identify that the filter 221 is blocked.

[0239] Accordingly, when the change in the internal temperature of the tub 110 measured by the tub temperature sensor 174 is greater than or equal to the reference value, the controller 190 identifies that the filter 221 is not blocked, and when the change in the internal temperature of the tub 110 is less than the reference value, the controller 190 may identify that the filter 221 is blocked.

[0240] As another example, the controller 190 may determine whether the filter 221 is blocked based on the difference between the internal temperature of the tub

110 measured by the tub temperature sensor 174 and the internal temperature of the heating duct 210 measured by the duct temperature sensor 175.

[0241] By the operation of the fan 213, the air circulates through the heating duct 210 and the tub 110 / the drum 120, and the difference between the internal temperature of the tub 110 and the internal temperature of the heating duct 210 measured by the duct temperature sensor 175 is small. On the other hand, if the filter 221 is blocked by lint or dust, air does not circulate through the heating duct 210 and the tub 110 / the drum 120, therefore, the difference between the internal temperature of the tub 110 and the internal temperature of the heating duct 210 measured by the duct temperature sensor 175 is large.

[0242] Therefore, when the difference between the internal temperature of the tub 110 and the internal temperature of the heating duct 210 measured by the duct temperature sensor 175 is less than the reference value, the controller 190 identifies that the filter 221 is not blocked, and when the difference between the internal temperature of the tub 110 and the internal temperature of the heating duct 210 measured by the duct temperature sensor 175 is greater than or equal to the reference value, the controller 190 may identify that the filter 221 is blocked.

[0243] If blocking of the filter 221 is identified (YES in 1220), the washing machine 100 rotates the drum 120 at a third rotational speed (1230).

[0244] Once the blockage of the filter 221 is identified, the controller 190 may spray water into the filter 221 as described below. The injected water may flow into the tub 110 through the suction port 112c and flow along the sidewall of the tub 110. Water flowing along the sidewall of the tub 110 may be introduced into the drum 120 by the rotation of the drum 120.

[0245] The controller 190 is configured to rotate the drum 120 at the third rotational speed so as to prevent water from flowing into the drum 120 to clean the filter 221. The driving current supplied to the drum motor 130 may be controlled.

[0246] As previously described with reference to FIG. 14, the controller 190 controls the driving current supplied from the motor driving circuit 180 to the drum motor 130 to rotate the drum 120 at the first rotational speed during the condensation / heating operation.

[0247] The third rotational speed during filter cleaning may be greater than the first rotational speed during the condensation / heating operation. As shown in FIG. 20, when the rotational speed of the drum 120 is approximately 120 rpm, the amount of water injected to clean the filter 221 that is introduced into the drum 120 is minimized. For example, the third rotational speed may be set to approximately 120 rpm, and the third rotational speed may be greater than the first rotational speed, which is approximately 40 rpm to 100 rpm.

[0248] The washing machine 100 washes the filter 221 (1240).

[0249] The controller 190 may control the washing wa-

ter valve 224 to spray water for washing with the filter 221 while rotating the drum 120 at the third rotational speed. For example, the controller 190 can provide a filter wash signal to the washing water valve 224 to open the washing water valve 224.

[0250] The washing machine 100 restores the rotational speed of the drum 120 (1250).

[0251] The controller 190 may restore the rotational speed of the drum 120 to the rotational speed before cleaning the filter 221. For example, when the filter 221 is cleaned during the condensation / heating operation, the controller 190 may rotate the drum 120 at the first rotational speed (for example, 40 rpm to 100 rpm).

[0252] As described above, when the filter 221 is blocked by lint or dust, the washing machine 100 may control the rotational speed of the drum 120 and inject water for washing into the filter 221. Therefore, the inflow of water for cleaning the filter 221 into the drum 120 may be minimized.

[0253] FIG. 21 is a side cross-sectional view of a washing machine according to one embodiment. FIG. 22 illustrates a configuration of a washing machine according to one embodiment.

[0254] As shown in FIG. 21, the washing machine 100 includes the cabinet 101, the tub 110, the drum 120, a pulsator 125, a first motor 130a, a second motor 130b, the water supplier 140, the water drain 150, the detergent supplier 160 and the drying duct 200.

[0255] The cabinet 101, the tub 110, the water supplier 140, the water drain 150, the detergent supplier 160, and the drying duct 200 may be the same as illustrated in FIG. 2.

[0256] The drum 120 is rotatably provided in the tub 110. The drum 120 may accommodate laundry therein.

[0257] The pulsator 125 is provided inside the rear of the drum 120 and is rotatably provided with respect to the drum 120. The pulsator 125 may be provided to be rotatable independently of the drum 120. In other words, the pulsator 125 may rotate in the same direction as the drum 120 or in a different direction from the drum 120. The rotation axis of the pulsator 125 may be provided on the same axis as the rotation axis of the drum 120.

[0258] The pulsator 125 may generate water flow in the front-rear direction inside the drum 120 during washing. The washing performance of the washing machine 100 may be improved by the pulsator 125.

[0259] The first motor 130a is connected to a first drive shaft 131a and may provide rotation to rotate the drum 120 to the first drive shaft 131a. The first drive shaft 131a may provide rotation of the first motor 130a to a first pulley 136a through a first belt 135a. The first pulley 136a may be connected to the drum 120 through a first driven shaft 137a and may provide rotation of the first motor 130a to the drum 120.

[0260] The second motor 130b is connected to a second drive shaft 131b and may provide rotation to rotate the pulsator 125 to the second drive shaft 131b. The second drive shaft 131b may provide rotation of the second

motor 130b to a second pulley 136b through a second belt 135b. The second pulley 136b is connected to the pulsator 125 through a second driven shaft 137b and may provide rotation of the second motor 130b to the pulsator 125.

[0261] The second motor 130b is connected to the second drive shaft 131b and may provide rotation to rotate the pulsator 125 to the second drive shaft 131b. The second drive shaft 131b may provide rotation of the second motor 130b to the second pulley 136b through the second belt 135b. The second pulley 136b is connected to the pulsator 125 through the second driven shaft 137b and may provide rotation of the second motor 130b to the pulsator 125.

[0262] The first driven shaft 137a is provided on the same axis as the second driven shaft 137b. For example, a hollow in which the second driven shaft 137b is inserted is formed at an approximately center of the first driven shaft 137a. Thereby, the first driven shaft 137a can rotate at a different direction and/or at a different speed than the second driven shaft 137b on the same axis as the second driven shaft 137b.

[0263] As shown in FIG. 22, the washing machine 100 includes the user input 171, the display 172, the water level sensor 173, the tub temperature sensor 174, the duct temperature sensor 175, a first driving circuit 181, the first motor 130a, a second driving circuit 182, the second motor 130b, the water supply valve 142, the drain pump 152, the fan motor 214, the tub heater 114, the duct heater 215, the washing water valve 224, the condensation valve 246 and the controller 190.

[0264] The user input 171, the display 172, the water level sensor 173, the tub temperature sensor 174, the duct temperature sensor 175, the water supply valve 142, the drain pump 152, the fan motor 214, the tub heater 114, the duct heater 215, the washing water valve 224 and the condensation valve 246 may be the same as described with reference to FIG. 12.

[0265] The first driving circuit 181 can provide the first motor 130a with the first driving current for rotating the drum 120. The second driving circuit 182 may provide a second driving current to the second motor 130b to rotate the pulsator 125. For example, each of the first driving circuit 181 and the second driving circuit 182 may convert AC power of an external power source into driving power for driving each of the first motor 130a and the second motor 130b.

[0266] The controller 190 may control the first motor 130a and the second motor 130b to rotate the drum 120 and the pulsator 125 during the washing cycle 1020, the rinsing cycle 1030, the dehydration cycle 1040, and the drying cycle 1050. In detail, the controller 190 may control the driving current supplied from the first driving circuit 181 and the second driving circuit 182 to the first motor 130a and the second motor 130b.

[0267] The controller 190 controls the driving current supplied from the first driving circuit 181 and the second driving circuit 182 to the first motor 130a and the second

motor 130b to rotate the drum 120 and the pulsator 125 during the heating operation, the heating / dehydrating operation, the heating / condensation operation, and the cooling operation of the drying cycle 1050. The driving current supplied from the first driving circuit 181 and the second driving circuit 182 to the first motor 130a and the second motor 130b may be controlled.

[0268] The controller 190 controls the first motor 130a and the second motor 130b to rotate the drum 120 and the pulsator 125 in the same direction during the heating operation, the heating / condensing operation, and the cooling operation of the drying cycle 1050.

[0269] During the heating operation, the heating / condensing operation and the cooling operation of the drying cycle 1050, the controller 190 rotates the first driving circuit 181 so that the drum 120 rotates at the first rotational speed (e.g., approximately 40 rpm to 100 rpm) to control the first motor 130a.

[0270] In addition, during the heating operation, the heating / condensing operation, and the cooling operation of the drying cycle 1050, the controller 190 controls the second motor 130b through the second driving circuit 182 to rotate the pulsator 125 at a fourth rotational speed. The fourth rotational speed may be equal to or greater than the first rotational speed. For example, the ratio of the fourth rotational speed to the first rotational speed may be approximately 1:1 to 5:1.

[0271] As such, during the heating operation, the heating / condensing operation, and the cooling operation, the pulsator 125 may rotate at a rotational speed different from that of the drum 120 in the same direction as the rotation direction of the drum 120.

[0272] As the pulsator 125 rotates in the same rotational direction as the drum 120, the twisting of the laundry may be reduced during the drying cycle 1050. In addition, the drying efficiency of the laundry may be improved because the twisting of the laundry is reduced.

[0273] A washing machine includes a tub; a drum rotatably installed inside of the tub; a condensing duct formed on an inner wall of the tub; a heating duct provided outside the tub; a duct heater provided inside the heating duct; a fan configured to circulate air in the drum, the condensing duct, and the heating duct; and a controller configured to rotate the drum at a first rotational speed so as to tumble laundry contained in the drum while controlling the duct heater to heat the air circulated by the fan. The controller may rotate the drum at a second rotational speed to separate water from the laundry contained in the drum while controlling the duct heater to heat the circulating air.

[0274] Because of this, the washing machine can perform heating and dehydration at the same time. Since the surface tension of the water is reduced by heating, the washing machine can reduce the amount of moisture contained in the laundry by simultaneously performing heating and dehydration. In addition, the washing machine can reduce the drying time for drying the laundry.

[0275] The washing machine may further include a

condensation conduit extending from an external water source to the condensing duct; and a condensation valve provided on the condensation conduit to allow or block the supply of water to the condensing duct.

[0276] For this reason, the washing machine can prevent that water in the condensation duct impedes dehydration.

[0277] The controller may control the duct heater to heat the circulating air, and may control the condensation valve to block the supply of water to the condensing duct while rotating the drum to separate the water from the laundry contained within the drum.

[0278] As a result, the washing machine may dry the laundry through heating and condensation.

[0279] The controller may rotate the drum alternately in a first direction and a second direction so that the laundry contained in the drum tumbles, and the time for rotating the drum in the first direction may differ from the time for rotating the drum in the second direction.

[0280] As a result, the washing machine can effectively guide the air inside the drum to the condensation duct, and further reduce the drying time.

[0281] The condensation duct may include a rear groove formed inside a rear wall of the tub having a cylindrical shape, and a cover for partitioning the inside of the rear groove from the inside of the tub.

[0282] As a result, the condensation duct can be integrally formed with the tub. In addition, the condensation duct can be prevented from increasing the overall size of the washing machine or decreasing the size of the drum.

[0283] The condensing duct may be formed along a portion of a sidewall of the tub having the cylindrical shape.

[0284] The condensing duct may have a horseshoe shape.

[0285] Both ends of the condensing duct may be formed with inlets for connecting the condensing duct with the inside of the tub.

[0286] The washing machine may further include a filter for filtering foreign substances contained in the air sucked into the heating duct; a washing water nozzle for spraying water on the filter; a washing water conduit extending from an external water source to the washing nozzle; and a washing water valve configured to allow or block the supply of the water to the washing nozzle provided on the washing water conduit; and the controller may rotate the drum at a third rotational speed which is faster than the first rotational speed and slower than the second rotational speed while controlling the washing water valve to allow the supply of the water to the washing nozzle.

[0287] As a result, the washing machine can minimize the inflow of water for cleaning the filter into the drum.

[0288] The washing machine may further include a pulsator provided inside the rear of the drum having a cylindrical shape and rotating independently of the drum, and the controller may rotate the drum at the first rota-

tional speed, and rotate the pulsator the same as the drum at a fourth rotational speed while controlling the duct heater and the fan to heat the air circulating in the drum and the condensing duct and the heating duct, and the fourth rotational speed may be greater than the first rotational speed.

[0289] Therefore, the washing machine can prevent the laundry inside the drum from being twisted by the pulsator.

[0290] A controlling method of the washing machine as above, the method may include rotating the drum at a first rotational speed so as to tumble laundry contained in the drum while controlling a duct heater to heat air circulated by a fan, and rotating the drum at a second rotational speed to separate water from the laundry contained in the drum while controlling the duct heater to heat the circulating air.

[0291] Because of this, the washing machine can perform heating and dehydration at the same time. Since the surface tension of the water is reduced by heating, the washing machine can reduce the amount of moisture contained in the laundry by simultaneously performing heating and dehydration. In addition, the washing machine can reduce the drying time for drying the laundry.

[0292] Rotating the drum at the first rotational speed may include allowing the supply of water to the condensing duct while heating the heating duct and circulating the air and rotating the drum at the first rotational speed so as to tumble the laundry contained within the drum.

[0293] Rotating the drum at the first rotational speed may include rotating the drum alternately in a first direction and a second direction so that the laundry contained in the drum tumbles, and wherein the time for rotating the drum in the first direction differs from the time for rotating the drum in the second direction.

[0294] As a result, the washing machine can effectively guide the air inside the drum to the condensation duct, and further reduce the drying time.

[0295] Rotating the drum at the second rotational speed may include blocking the supply of water to the condensing duct while rotating the drum at the second rotational speed to separate the water from the laundry contained within the drum.

[0296] A washing machine includes a tub; a drum rotatably installed inside of the tub; a condensing duct formed on an inner wall of the tub; a condensation conduit extending from an external water source to the condensing duct; a condensation valve provided on the condensation conduit to allow or block the supply of water to the condensing duct; a heating duct provided outside the tub; a duct heater provided inside the heating duct; a fan circulating air in the drum, the condensing duct, and the heating duct; and a controller electrically connected with the drum motor, the condensation valve, the duct heater, and the fan; and the condensing duct may include a rear groove formed inside a rear wall of the tub having a cylindrical shape, and a cover for partitioning the inside of the rear groove from the inside of the tub.

[0297] As a result, the condensation duct can be integrally formed with the tub. In addition, the condensation duct can be prevented from increasing the overall size of the washing machine or decreasing the size of the drum.

[0298] The condensing duct may be formed along a portion of a sidewall of the tub having the cylindrical shape.

[0299] Both ends of the condensing duct may be formed with inlets for connecting the condensing duct with the inside of the tub.

[0300] The controller may rotate the drum to separate water from laundry contained within the drum while controlling the condensation valve to block the supply of water to the condensing duct and controlling the duct heater to heat the air circulated by the fan.

[0301] The controller may rotate the drum to tumble laundry contained within the drum while controlling the condensation valve to block the supply of water to the condensing duct and controlling the duct heater to heat the air circulated by the fan.

[0302] Exemplary embodiments of the present disclosure have been described above. In the exemplary embodiments described above, some components may be implemented as a "module". Here, the term 'module' means, but is not limited to, a software and/or hardware component, such as a Field Programmable Gate Array (FPGA) or Application Specific Integrated Circuit (ASIC), which performs certain tasks. A module may advantageously be configured to reside on the addressable storage medium and configured to execute on one or more processors.

[0303] Thus, a module may include, by way of example, components, such as software components, object-oriented software components, class components and task components, processes, functions, attributes, procedures, subroutines, segments of program code, drivers, firmware, microcode, circuitry, data, databases, data structures, tables, arrays, and variables. The operations provided for in the components and modules may be combined into fewer components and modules or further separated into additional components and modules. In addition, the components and modules may be implemented such that they execute one or more CPUs in a device.

[0304] With that being said, and in addition to the above described exemplary embodiments, embodiments can thus be implemented through computer readable code/instructions in/on a medium, e.g., a computer readable medium, to control at least one processing element to implement any above described exemplary embodiment. The medium can correspond to any medium/media permitting the storing and/or transmission of the computer readable code.

[0305] The computer-readable code can be recorded on a medium or transmitted through the Internet. The medium may include Read Only Memory (ROM), Random Access Memory (RAM), Compact Disk-Read Only

Memories (CD-ROMs), magnetic tapes, floppy disks, and optical recording medium. Also, the medium may be a non-transitory computer-readable medium. The media may also be a distributed network, so that the computer readable code is stored or transferred and executed in a distributed fashion. Still further, as only an example, the processing element could include at least one processor or at least one computer processor, and processing elements may be distributed and/or included in a single device.

[0306] While exemplary embodiments have been described with respect to a limited number of embodiments, those skilled in the art, having the benefit of this disclosure, will appreciate that other embodiments can be devised which do not depart from the scope as disclosed herein. Accordingly, the scope should be limited only by the attached claims.

Claims

1. A washing machine, comprising:

a tub (110);
a drum (120) rotatably installed inside of the tub;
a condensing duct (240) formed on an inner wall of the tub (120);
a heating duct (210) provided outside the tub;
a duct heater (215) provided inside the heating duct;
a fan (213) configured to circulate air in the drum, the condensing duct, and the heating duct; and
a controller (190) configured to rotate the drum (120) at a first rotational speed so as to tumble laundry contained in the drum while controlling the duct heater (215) to heat the air circulated by the fan,
wherein the controller (190) is configured to rotate the drum (120) at a second rotational speed, which is higher than the first rotational speed, to separate water from the laundry contained in the drum while controlling the duct heater (215) to heat the circulating air;
wherein
the controller (190) is configured to rotate the drum at the first rotational speed alternately in a first direction and a second direction so that the laundry contained in the drum tumbles, and time for rotating the drum in the first direction differs from time for rotating the drum in the second direction.

2. The washing machine of claim 1 further comprising:

a condensation conduit to connect an external water source to the condensing duct; and
a condensation valve (246) provided on the condensation conduit to adjust supply of water to

the condensing duct.

3. The washing machine of claim 2, wherein the controller (190) is configured to control the duct heater to heat the circulating air, and controls the condensation valve to block the supply of water to the condensing duct while rotating the drum at the second rotational speed to separate the water from the laundry contained within the drum. 5
4. The washing machine of claim 2, wherein the controller (190) is configured to control the duct heater to heat the circulating air, and controls the condensation valve to allow the supply of water to the condensing duct while rotating the drum at the first rotational speed to tumble the laundry contained within the drum. 10
5. The washing machine of any one of claims 1 to 4, wherein the condensing duct (240) includes a rear groove (241) formed inside a rear wall of the tub having a cylindrical shape, and a cover for partitioning the inside of the rear groove from the inside of the tub. 20
6. The washing machine of claim 5, wherein the condensing duct (240) is formed along a portion of a sidewall of the tub (110) having the cylindrical shape. 25
7. The washing machine of claim 5, wherein the condensing duct (240) has a horseshoe shape. 30
8. The washing machine of claim 6, wherein both ends of the condensing duct (240) are formed with inlets to connect the condensing duct with the inside of the tub (110). 35
9. The washing machine of any one of claims 1 to 4, further comprising:
 - a filter (221) to filter foreign substances contained in the air sucked into the heating duct; 40
 - a washing water nozzle (222) to spray water on the filter;
 - a washing water conduit (223) to connect an external water source to the washing nozzle; and 45
 - a washing water valve (224) configured to adjust the supply of the water to the washing nozzle provided on the washing water conduit, and wherein the controller is configured to rotate the drum (120) at a third rotational speed which is higher than the first rotational speed and lower than the second rotational speed while controlling the washing water valve to allow the supply of the water to the washing nozzle. 50
10. The washing machine of any one of claims 1 to 4, further comprising: 55

a pulsator (125) provided inside the rear of the drum having a cylindrical shape and rotating independently of the drum, and wherein the controller is configured to rotate the drum (120) at the first rotational speed, and to rotate the pulsator the same as the drum at a fourth rotational speed while controlling the duct heat and the fan to heat the air circulating in the drum and the condensing duct and the heating duct, wherein the fourth rotational speed is higher than the first rotational speed.

11. A controlling method of a washing machine as claimed in claim 1, the method comprising:

rotating the drum (120) at a first rotational speed so as to tumble laundry contained in the drum while controlling a duct heater (215) to heat air circulated by a fan, and
 rotating the drum (120) at a second rotational speed, which is higher than the first rotational speed, to separate water from the laundry contained in the tub while controlling the duct heater to heat the circulating air,
 rotating the drum (120) at the first rotational speed includes rotating the drum (120) alternately in a first direction and a second direction so that the laundry contained in the drum tumbles, and wherein time for rotating the drum (120) in the first direction differs from time for rotating the drum in the second direction.

12. The method of claim 11, wherein rotating the drum (120) at the first rotational speed includes allowing supply of water to the condensing duct (240) while heating the heating duct (215) and circulating the air and rotating the drum (120) at the first rotational speed so as to tumble the laundry contained in the drum.
13. The method of claim 11, wherein rotating the drum (120) at the second rotational speed includes, blocking the supply of water to the condensing duct (240) while rotating the drum (120) at the second rotational speed to separate the water from the laundry contained within the drum.

Patentansprüche

1. Waschmaschine, umfassend:

eine Wanne (110);
 eine Trommel (120), die drehbar im Inneren der Wanne angebracht ist;
 einen an einer Innenwand der Wanne (120) ausgebildeten Kondensierkanal (240);
 einen Heizkanal (210), der außerhalb der Wan-

- ne vorgesehen ist;
 eine Kanalheizung (215), die im Inneren des Heizkanals vorgesehen ist;
 ein Gebläse (213), das so konfiguriert ist, dass es Luft in der Trommel, dem Kondensierkanal und dem Heizkanal umwälzt; und
 eine Steuerung (190), die konfiguriert ist, um die Trommel (120) mit einer ersten Drehgeschwindigkeit zu drehen, um die in der Trommel enthaltene Wäsche hin und her zu wirbeln, während sie die Kanalheizung (215) steuert, um die vom Gebläse umgewälzte Luft zu erwärmen, wobei die Steuerung (190) so konfiguriert ist, dass sie die Trommel (120) mit einer zweiten Drehgeschwindigkeit dreht, die höher ist als die erste Drehgeschwindigkeit, um Wasser von der in der Trommel enthaltenen Wäsche zu trennen, während sie die Kanalheizung (215) steuert, um die zirkulierende Luft zu erwärmen;
 wobei die Steuerung (190) konfiguriert ist, um die Trommel mit der ersten Drehgeschwindigkeit abwechselnd in einer ersten Richtung und einer zweiten Richtung zu drehen, so dass die in der Trommel enthaltene Wäsche hin und her gewirbelt wird, und die Zeit zum Drehen der Trommel in der ersten Richtung sich von der Zeit zum Drehen der Trommel in der zweiten Richtung unterscheidet.
2. Waschmaschine nach Anspruch 1, die außerdem umfasst:
- eine Kondensationsleitung zur Verbindung einer externen Wasserquelle mit dem Kondensierkanal; und
 ein Kondensationsventil (246), das an der Kondensationsleitung vorgesehen ist, um die Wasserzufuhr zur Kondensationsleitung einzustellen.
3. Waschmaschine nach Anspruch 2, wobei die Steuerung (190) so konfiguriert ist, dass sie die Kanalheizung zum Erwärmen der zirkulierenden Luft steuert und das Kondensationsventil so steuert, dass die Wasserzufuhr zum Kondensierkanal gesperrt wird, während die Trommel mit der zweiten Drehzahl gedreht wird, um das Wasser von der in der Trommel enthaltenen Wäsche zu trennen.
4. Waschmaschine nach Anspruch 2, wobei die Steuerung (190) so konfiguriert ist, dass sie die Kanalheizung zum Erwärmen der zirkulierenden Luft steuert und das Kondensationsventil steuert, um die Zufuhr von Wasser in den Kondensierkanal zu ermöglichen, während die Trommel mit der ersten Drehgeschwindigkeit gedreht wird, um die in der Trommel enthaltene Wäsche hin und her zu wirbeln.
5. Waschmaschine nach einem der Ansprüche 1 bis 4, wobei der Kondensierkanal (240) eine hintere Nut (241), die innerhalb einer Rückwand der Wanne ausgebildet ist und eine zylindrische Form hat, und eine Abdeckung zum Abtrennen des Inneren der hinteren Nut vom Inneren der Wanne aufweist.
6. Waschmaschine nach Anspruch 5, wobei der Kondensierkanal (240) entlang eines Abschnitts einer Seitenwand der Wanne (110) mit der zylindrischen Form ausgebildet ist.
7. Waschmaschine nach Anspruch 5, wobei der Kondensierkanal (240) die Form eines Hufeisens hat.
8. Waschmaschine nach Anspruch 6, wobei beide Enden des Kondensierkanals (240) mit Einlässen ausgebildet sind, um den Kondensierkanal mit dem Inneren der Wanne (110) zu verbinden.
9. Waschmaschine nach einem der Ansprüche 1 bis 4, ferner umfassend:
- einen Filter (221) zum Filtern von Fremdstoffen, die in der in den Heizkanal gesaugten Luft enthalten sind;
 eine Waschwasserdüse (222) zum Besprühen des Filters mit Wasser;
 eine Waschwasserleitung (223), um eine externe Wasserquelle mit der Waschdüse zu verbinden; und
 ein Waschwasserventil (224), das konfiguriert ist, um die Wasserzufuhr zu der an der Waschwasserleitung vorgesehenen Waschdüse einzustellen, und
 wobei die Steuerung konfiguriert ist, um die Trommel (120) mit einer dritten Drehgeschwindigkeit zu drehen, die höher als die erste Drehgeschwindigkeit und niedriger als die zweite Drehgeschwindigkeit ist, während sie das Waschwasserventil steuert, um die Zufuhr des Wassers zu der Waschdüse zu ermöglichen.
10. Waschmaschine nach einem der Ansprüche 1 bis 4, ferner umfassend:
- einen Pulsator (125), der innerhalb der Rückseite der Trommel vorgesehen ist, eine zylindrische Form hat und sich unabhängig von der Trommel dreht, und wobei
 die Steuerung so konfiguriert ist, dass sie die Trommel (120) mit der ersten Drehzahl dreht und den Pulsator mit der gleichen Drehzahl wie die Trommel mit einer vierten Drehzahl dreht, während sie die Kanalheizung und das Gebläse steuert, um die in der Trommel zirkulierende Luft sowie den Kondensierkanal und den Heizkanal zu erwärmen,

wobei die vierte Drehgeschwindigkeit höher ist als die erste Drehgeschwindigkeit.

11. Verfahren zur Steuerung einer Waschmaschine nach Anspruch 1, wobei das Verfahren umfasst:

Drehen der Trommel (120) mit einer ersten Drehgeschwindigkeit, um die in der Trommel enthaltene Wäsche zu schleudern, während eine Kanalheizung (215) gesteuert wird, um die von einem Gebläse umgewälzte Luft zu erwärmen, und

Drehen der Trommel (120) mit einer zweiten Drehzahl, die höher ist als die erste Drehzahl, um das Wasser von der in der Wanne enthaltenen Wäsche zu trennen, während die Kanalheizung zur Erwärmung der zirkulierenden Luft gesteuert wird,

wobei das Drehen der Trommel (120) mit der ersten Drehgeschwindigkeit das Drehen der Trommel (120) abwechselnd in einer ersten Richtung und einer zweiten Richtung umfasst, so dass die in der Trommel enthaltene Wäsche geschleudert wird, und wobei sich die Zeit für das Drehen der Trommel (120) in der ersten Richtung von der Zeit für das Drehen der Trommel in der zweiten Richtung unterscheidet.

12. Verfahren nach Anspruch 11, wobei das Drehen der Trommel (120) mit der ersten Drehgeschwindigkeit das Zulassen der Zufuhr von Wasser zum Kondensierkanal (240) umfasst, während der Heizkanal (215) beheizt wird und die Luft zirkuliert und die Trommel (120) mit der ersten Drehgeschwindigkeit gedreht wird, um die in der Trommel enthaltene Wäsche zu schleudern.

13. Verfahren nach Anspruch 11, wobei das Drehen der Trommel (120) mit der zweiten Drehgeschwindigkeit das Blockieren der Wasserzufuhr zum Kondensierkanal (240) umfasst, während die Trommel (120) mit der zweiten Drehgeschwindigkeit gedreht wird, um das Wasser von der in der Trommel enthaltenen Wäsche zu trennen.

Revendications

1. Machine à laver, comprenant :

une cuve (110) ;
un tambour (120) installé de manière rotative à l'intérieur de la cuve ;
un conduit de condensation (240) formé sur une paroi intérieure de la cuve (120) ;
un conduit de chauffage (210) situé à l'extérieur de la cuve ;
un chauffage de conduit (215) placé à l'intérieur

du conduit de chauffage ;

un ventilateur (213) configuré pour faire circuler l'air dans le tambour, le conduit de condensation et le conduit de chauffage ; et

une commande (190) configurée pour faire tourner le tambour (120) à une première vitesse de rotation de manière à culbutter le linge contenu dans le tambour tout en commandant le chauffage de conduit (215) pour chauffer l'air circulé par le ventilateur,

dans lequel la commande (190) est configurée pour faire tourner le tambour (120) à une deuxième vitesse de rotation, supérieure à la première vitesse de rotation, afin de séparer l'eau du linge contenu dans le tambour tout en commandant le chauffage de conduit (215) pour chauffer l'air circulant ;

dans lequel la commande (190) est configurée pour faire tourner le tambour à la première vitesse de rotation alternativement dans un premier sens et dans un deuxième sens de sorte que le linge contenu dans le tambour culbute, et que le temps de rotation du tambour dans le premier sens diffère du temps de rotation du tambour dans le deuxième sens.

2. Machine à laver de la revendication 1, comprenant en outre :

un conduit de condensation pour connecter une source d'eau externe au conduit de condensation ; et

une vanne de condensation (246) placée sur le conduit de condensation pour régler l'alimentation en eau du conduit de condensation.

3. Machine à laver de la revendication 2, dans laquelle la commande (190) est configurée pour commander le chauffage de conduit pour chauffer l'air circulant, et commande la vanne de condensation pour bloquer l'alimentation en eau du conduit de condensation tout en faisant tourner le tambour à la deuxième vitesse de rotation pour séparer l'eau du linge contenu dans le tambour.

4. Machine à laver de la revendication 2, dans laquelle la commande (190) est configurée pour commander le chauffage de conduit pour chauffer l'air circulant, et commande la vanne de condensation pour permettre l'alimentation en eau du conduit de condensation tout en faisant tourner le tambour à la première vitesse de rotation pour culbutter le linge contenu dans le tambour.

5. Machine à laver de l'une des revendications 1 à 4, dans laquelle le conduit de condensation (240) comprend une rainure arrière (241) formée à l'intérieur d'une paroi arrière de la cuve ayant une forme cy-

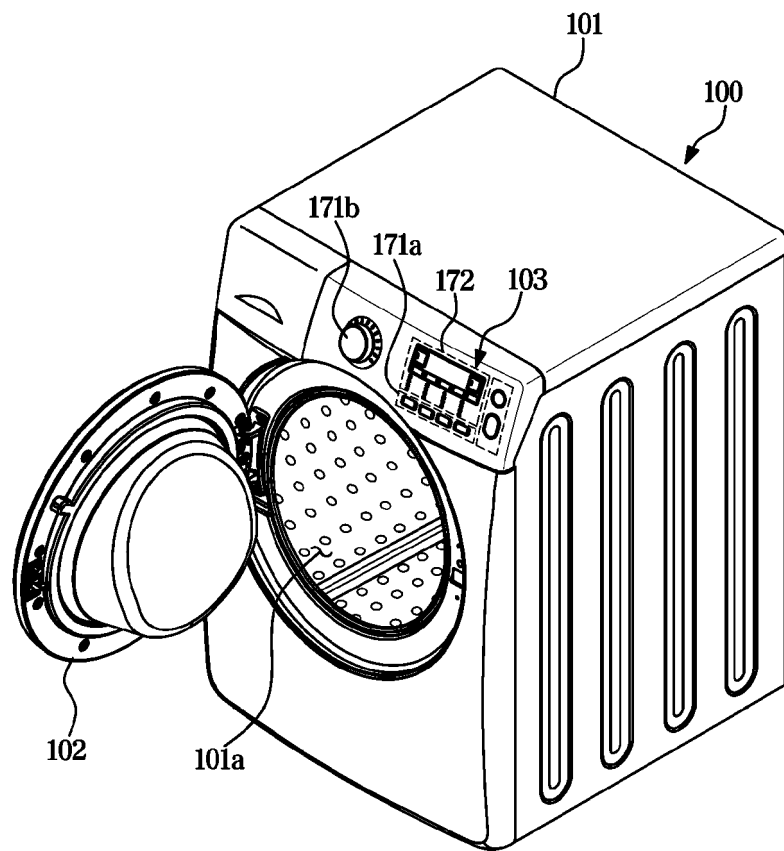
lindrique, et un couvercle pour cloisonner l'intérieur de la rainure arrière de l'intérieur de la cuve.

6. Machine à laver de la revendication 5, dans laquelle le conduit de condensation (240) est formé le long d'une partie d'une paroi latérale de la cuve (110) ayant une forme cylindrique. 5
7. Machine à laver de la revendication 5, dans laquelle le conduit de condensation (240) a une forme de fer à cheval. 10
8. Machine à laver de la revendication 6, dans laquelle les deux extrémités du conduit de condensation (240) sont formées avec des entrées pour connecter le conduit de condensation avec l'intérieur de la cuve (110). 15
9. Machine à laver de l'une quelconque des revendications 1 à 4, comprenant en outre : 20
 - un filtre (221) pour filtrer les substances étrangères contenues dans l'air aspiré dans le conduit de chauffage ;
 - une buse d'eau de lavage (222) pour pulvériser de l'eau sur le filtre ; 25
 - un conduit d'eau de lavage (223) pour connecter une source d'eau externe à la buse de lavage ; et
 - une vanne d'eau de lavage (224) configurée pour ajuster l'alimentation en eau de la buse de lavage prévue sur le conduit d'eau de lavage, et dans lequel la commande est configurée pour faire tourner le tambour (120) à une troisième vitesse de rotation supérieure à la première vitesse de rotation et inférieure à la deuxième vitesse de rotation tout en commandant la vanne d'eau de lavage pour permettre l'alimentation en eau de la buse de lavage. 30 35
10. Machine à laver de l'une quelconque des revendications 1 à 4, comprenant en outre : 40
 - un pulsateur (125) situé à l'arrière du tambour, de forme cylindrique et tournant indépendamment du tambour, et dans lequel 45
 - la commande est configurée pour faire tourner le tambour (120) à la première vitesse de rotation, et pour faire tourner le pulsateur de la même manière que le tambour à une quatrième vitesse de rotation tout en commandant la chaleur du chauffage de conduit et le ventilateur pour chauffer l'air circulant dans le tambour et le conduit de condensation et le conduit de chauffage, dans lequel la quatrième vitesse de rotation est supérieure à la première vitesse de rotation. 50 55
11. Procédé de commande d'une machine à laver selon la revendication 1, le procédé comprenant :

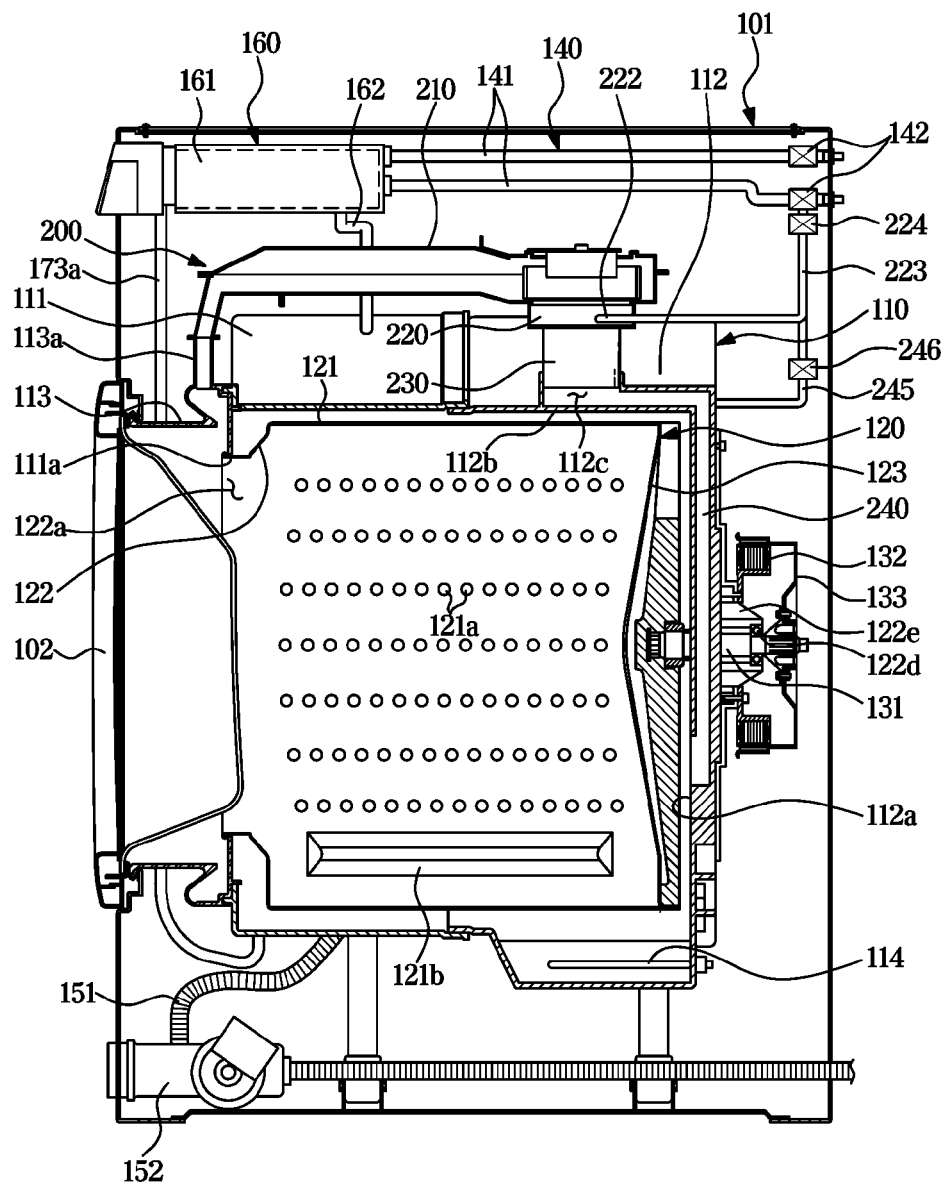
faire tourner le tambour (120) à une première vitesse de rotation de manière à culbuter le linge contenu dans le tambour tout en commandant un chauffage de conduit (215) pour chauffer l'air circulant par un ventilateur, et faire tourner le tambour (120) à une deuxième vitesse de rotation, supérieure à la première vitesse de rotation, pour séparer l'eau du linge contenu dans la cuve tout en commandant le chauffage de conduit pour chauffer l'air circulant, la rotation du tambour (120) à la première vitesse de rotation comprenant la rotation du tambour (120) alternativement dans un premier sens et dans un deuxième sens de sorte que le linge contenu dans le tambour culbute, et dans lequel le temps de rotation du tambour (120) dans le premier sens diffère du temps de rotation du tambour dans le deuxième sens.

12. Procédé de la revendication 11, dans lequel la rotation du tambour (120) à la première vitesse de rotation comprend l'alimentation en eau du conduit de condensation (240) tout en chauffant le conduit de chauffage (215) et en faisant circuler l'air et en faisant tourner le tambour (120) à la première vitesse de rotation de manière à culbuter le linge contenu dans le tambour.
13. Procédé de la revendication 11, dans lequel la rotation du tambour (120) à la deuxième vitesse de rotation comprend le blocage de l'alimentation en eau du conduit de condensation (240) pendant la rotation du tambour (120) à la deuxième vitesse de rotation pour séparer l'eau du linge contenu dans le tambour.

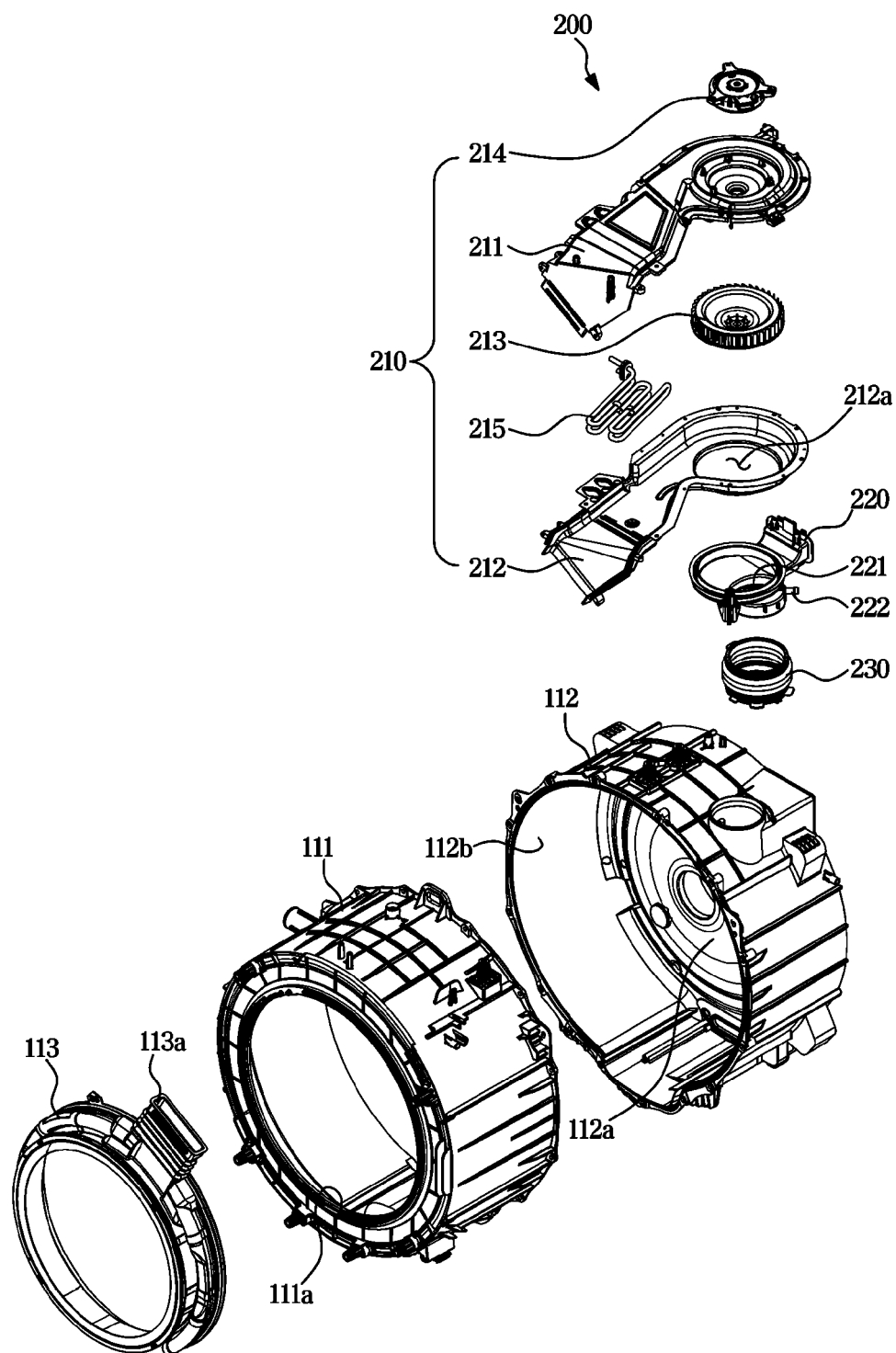
[Fig. 1]



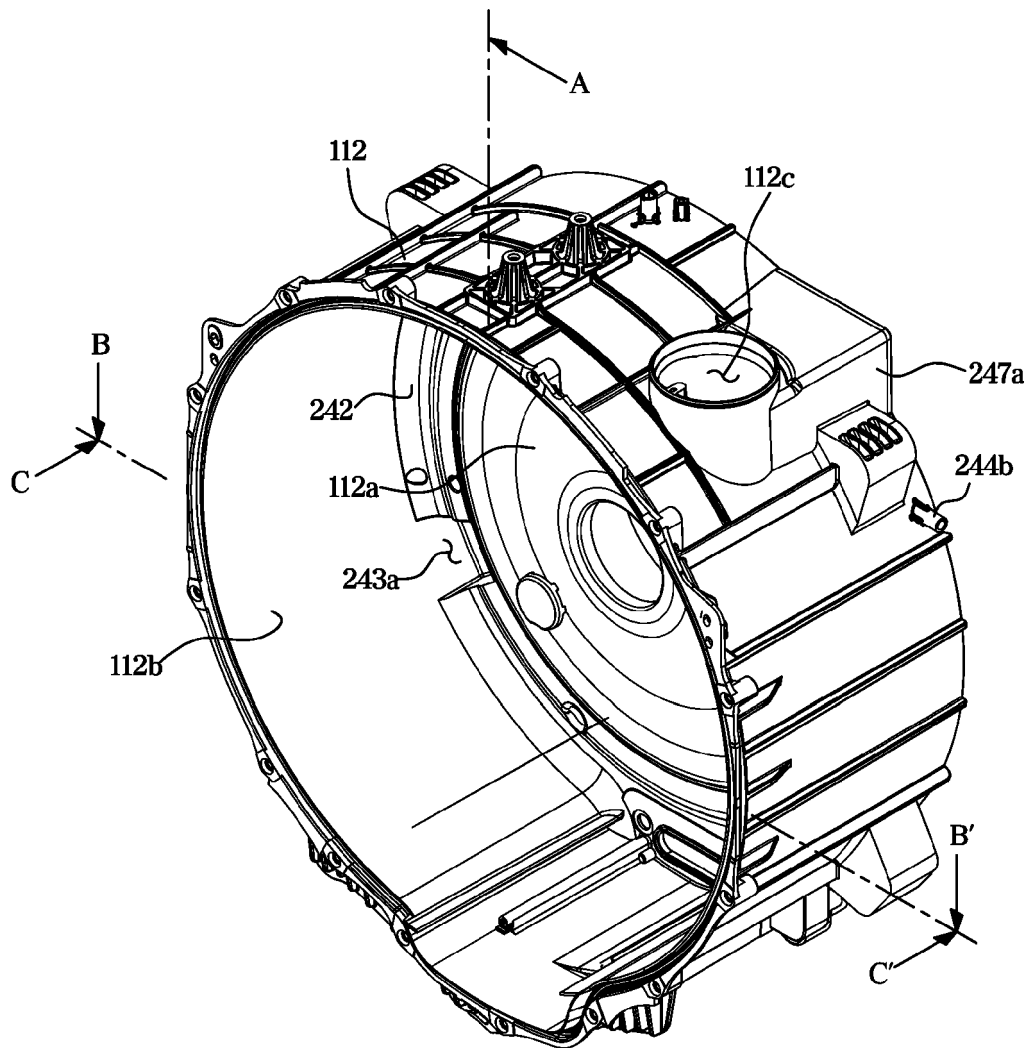
[Fig. 2]



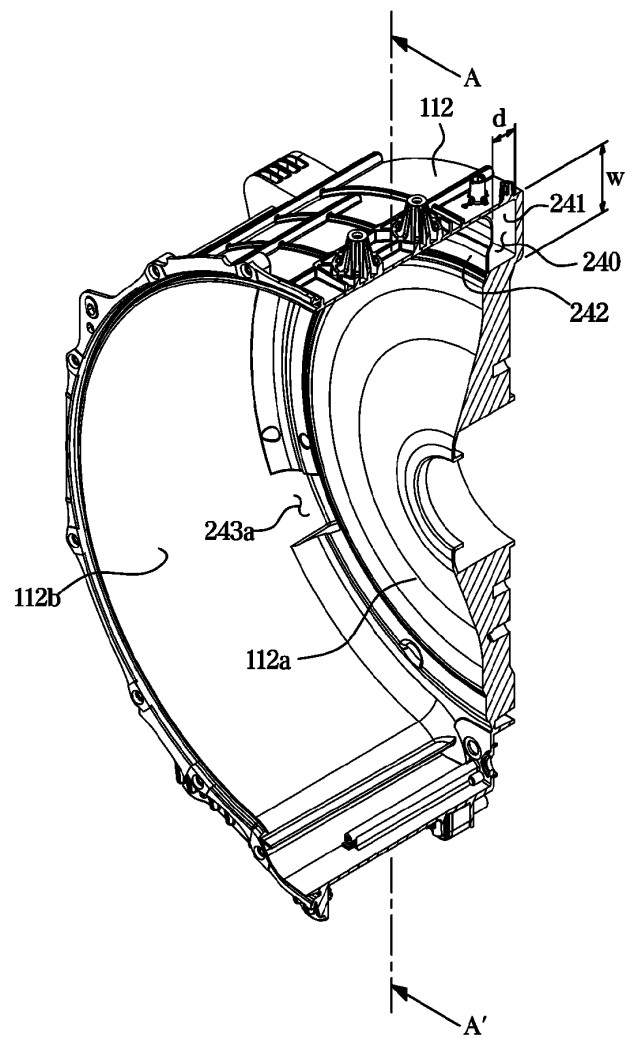
[Fig. 3]



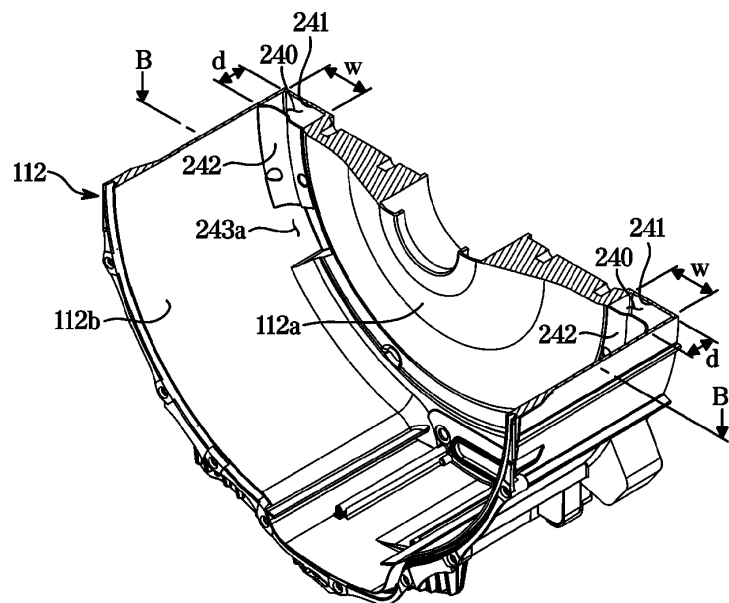
[Fig. 4]



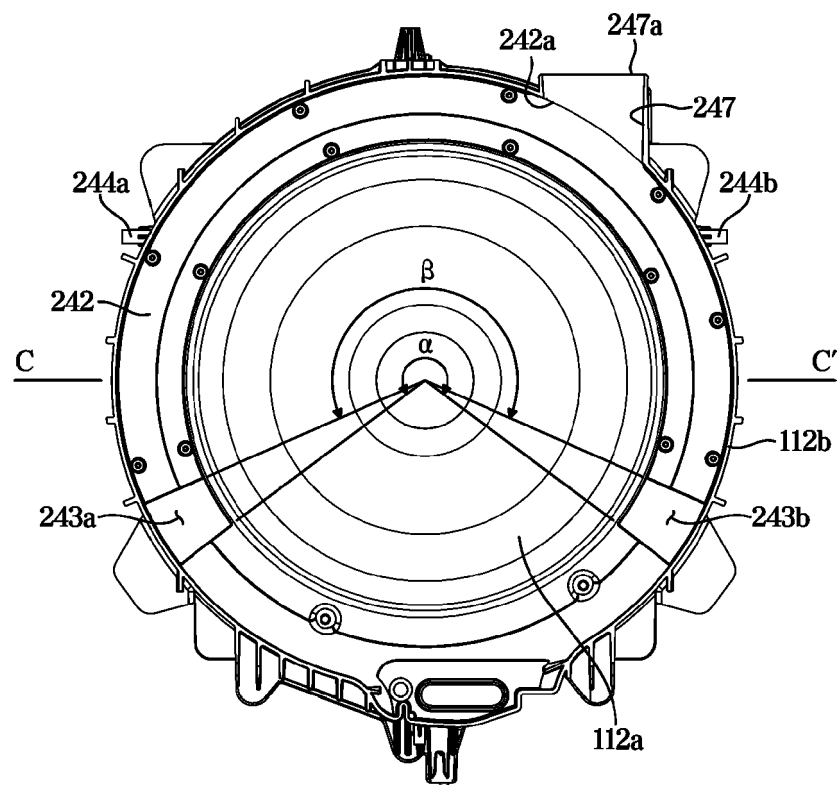
[Fig. 5]



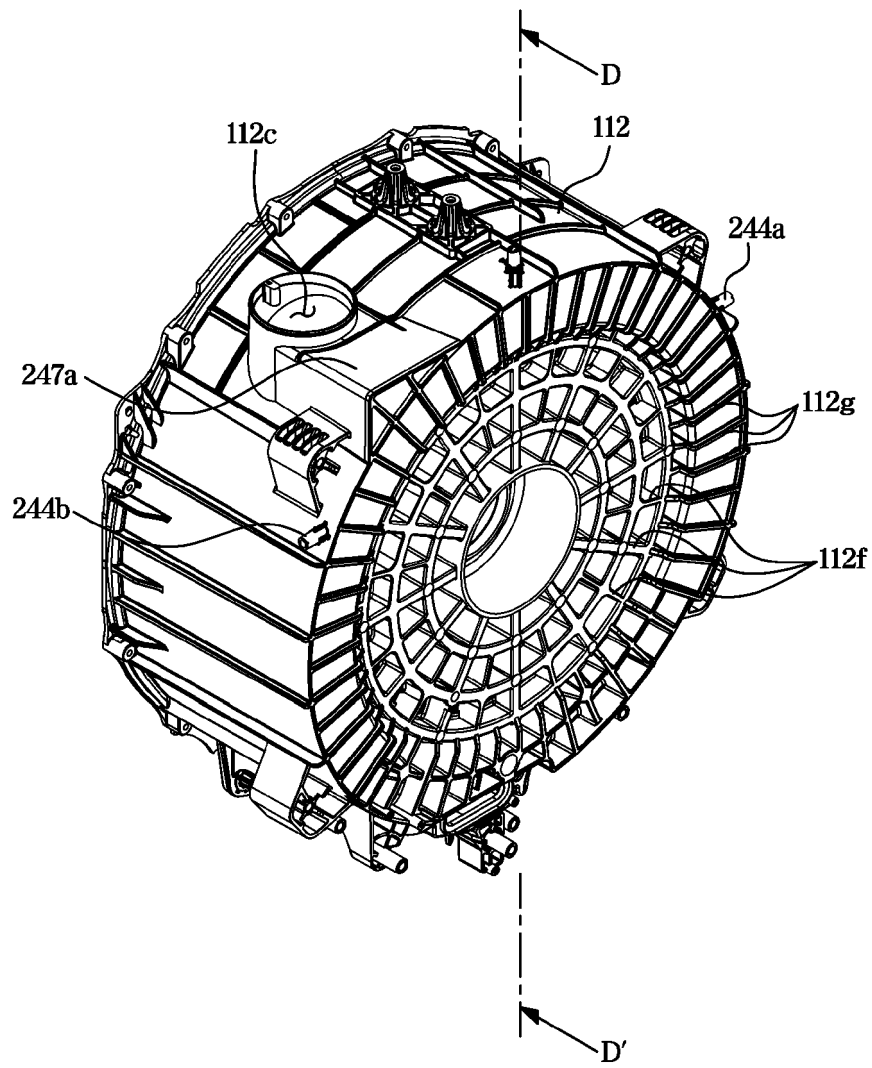
[Fig. 6]



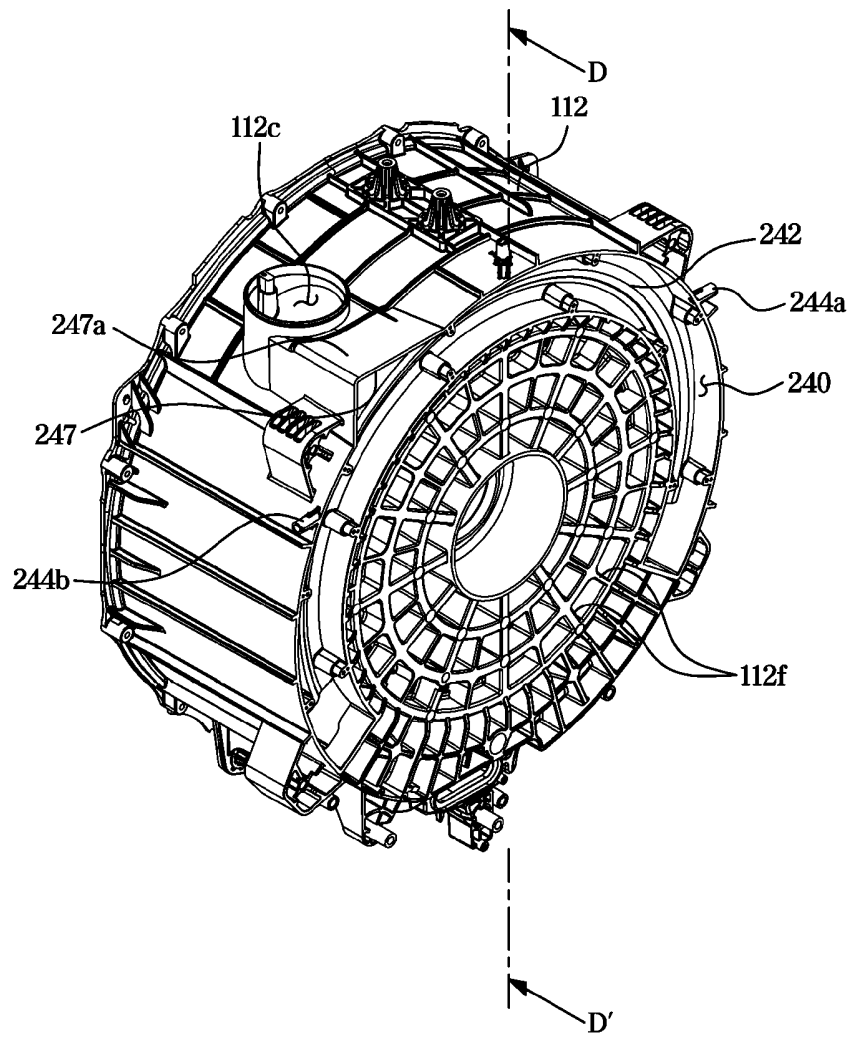
[Fig. 7]



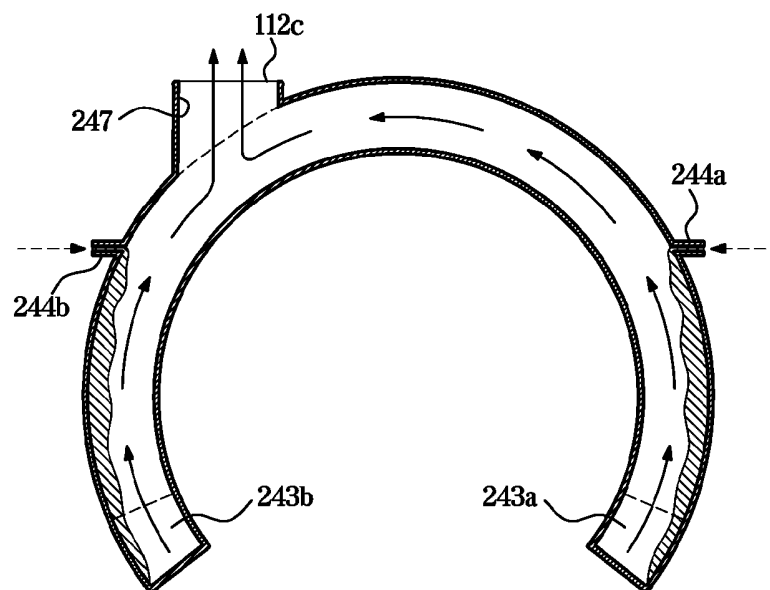
[Fig. 8]



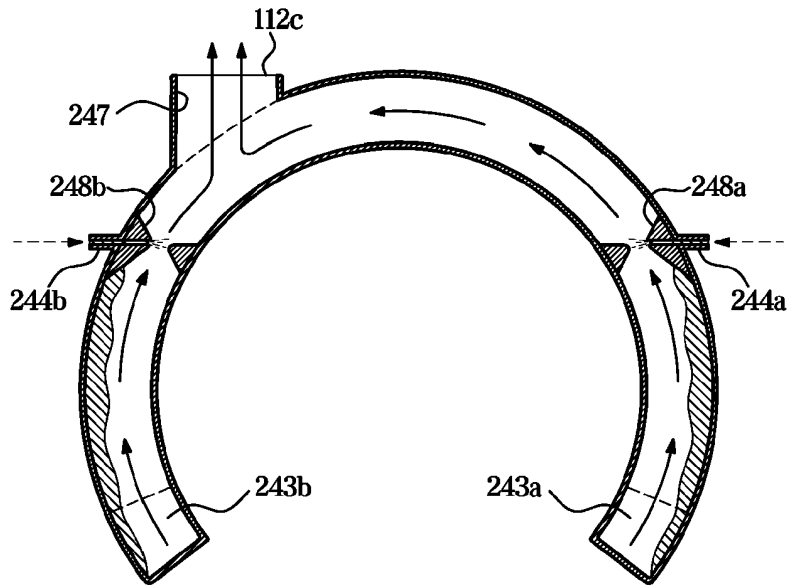
[Fig. 9]



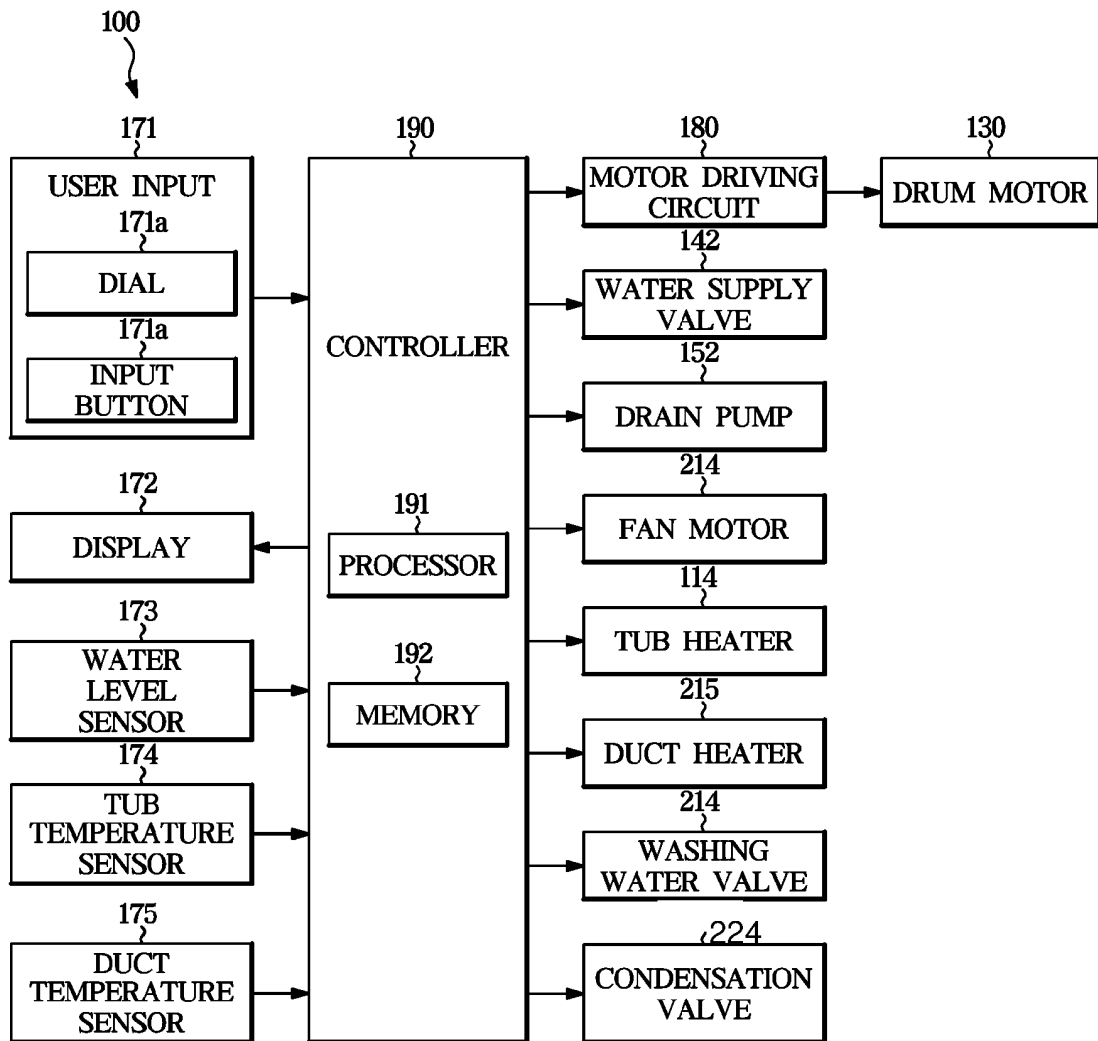
[Fig. 10]



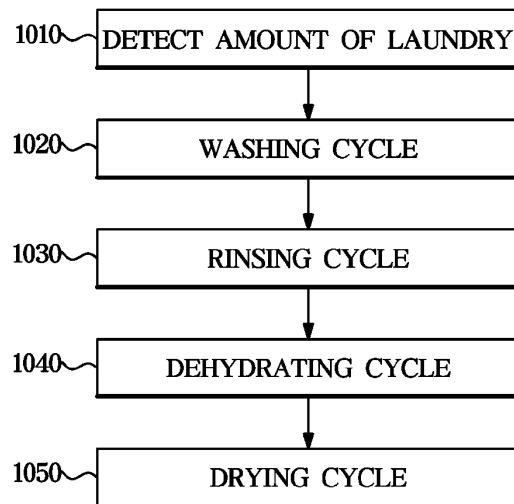
[Fig. 11]



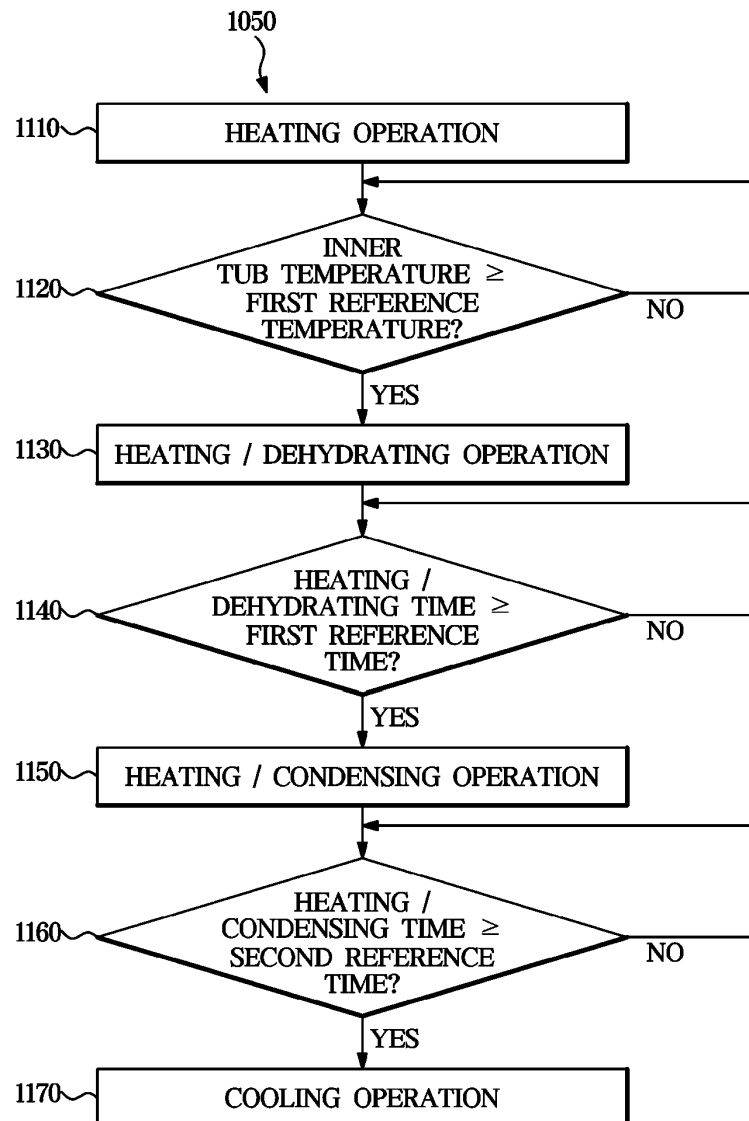
[Fig. 12]



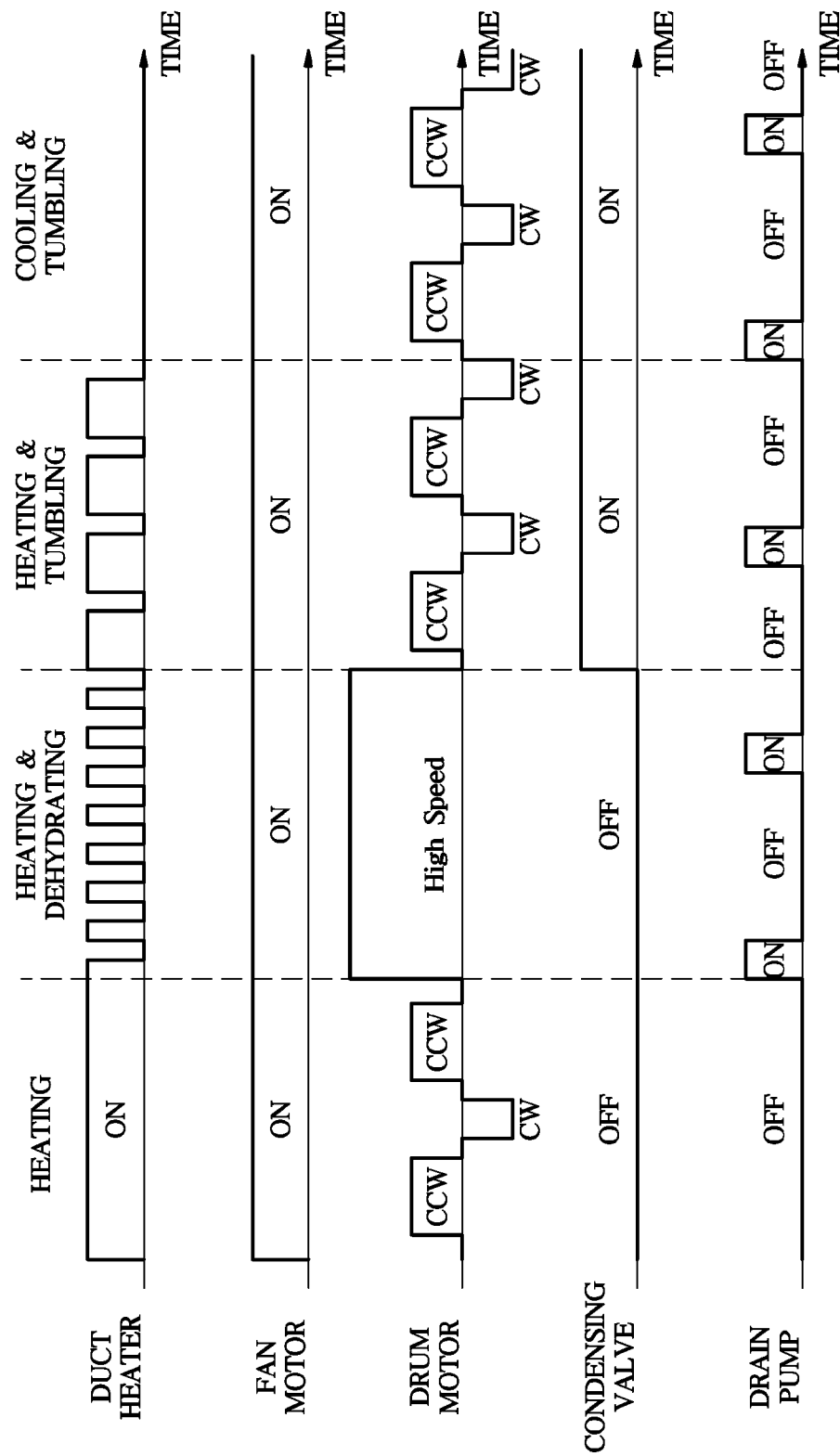
[Fig. 13]



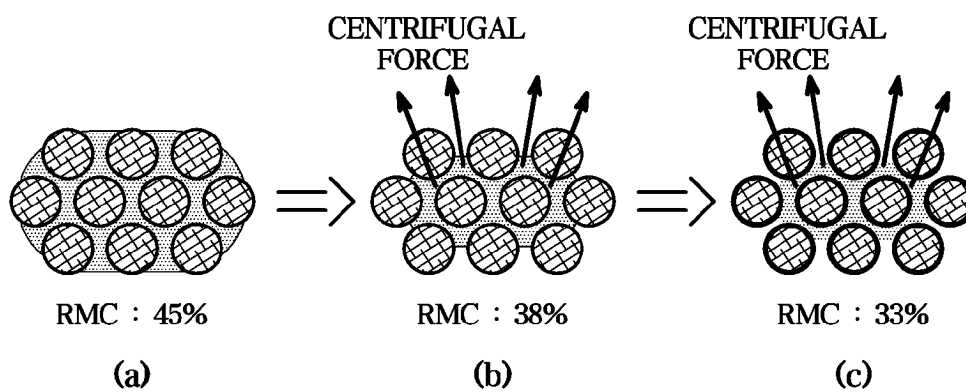
[Fig. 14]



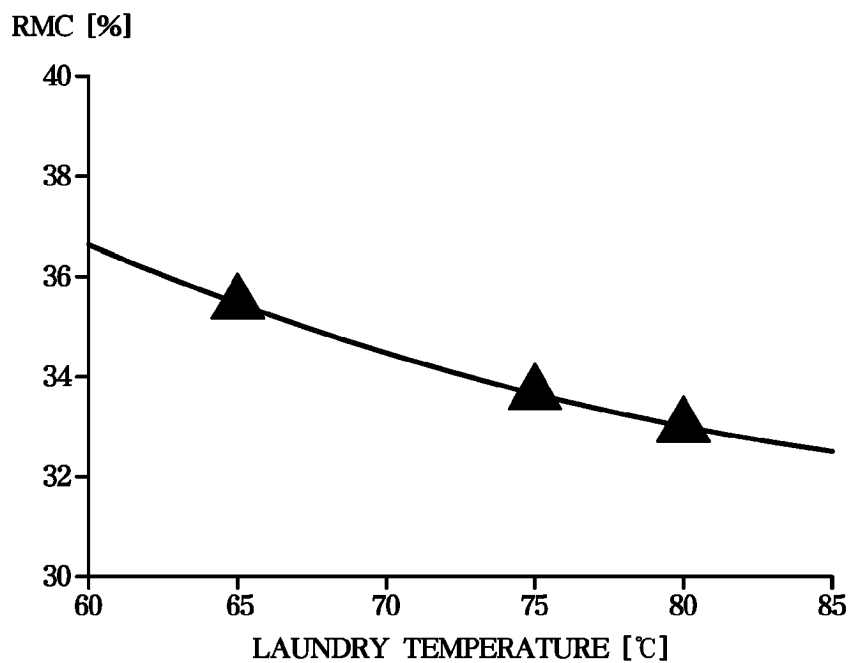
[Fig. 15]



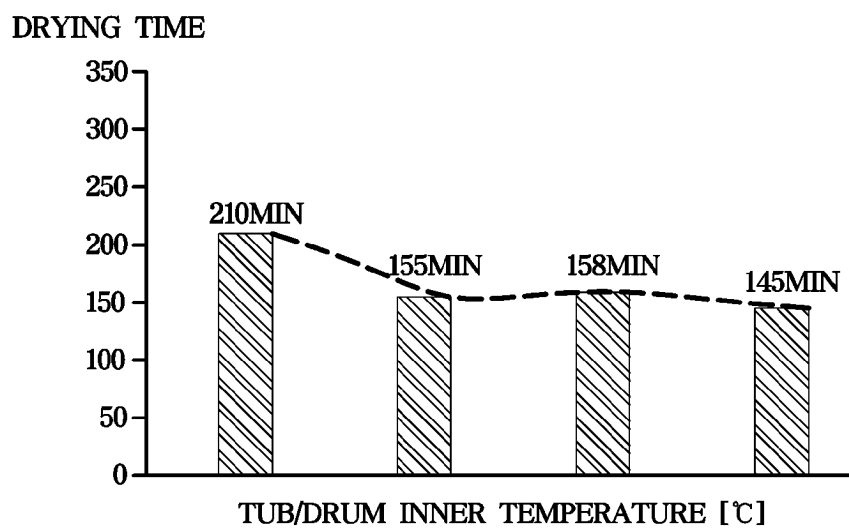
[Fig. 16]



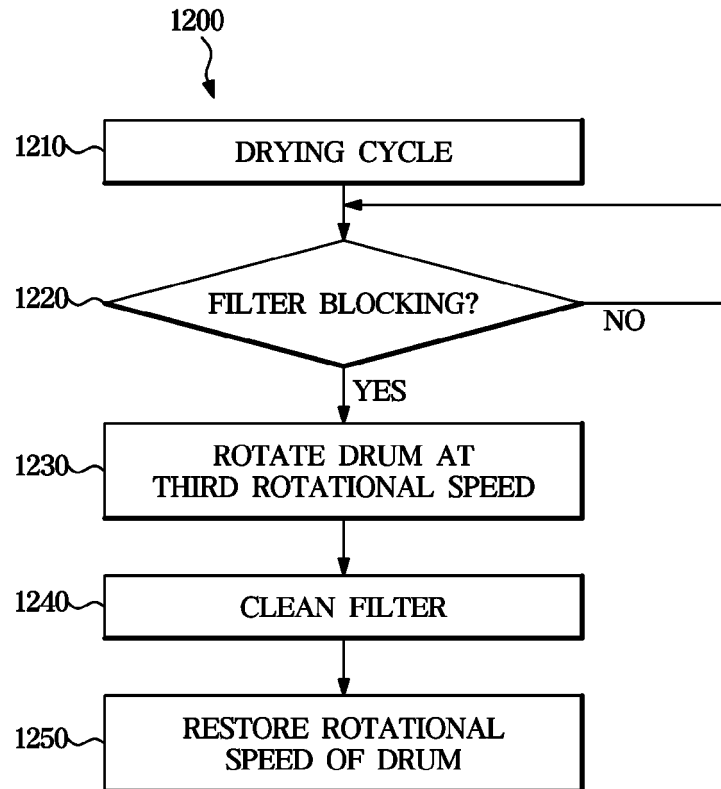
[Fig. 17]



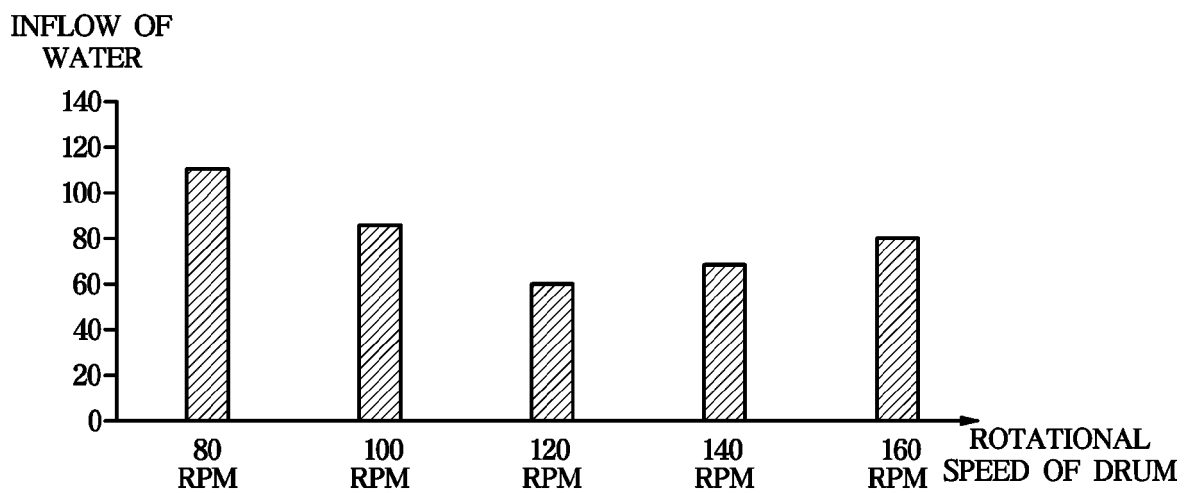
[Fig. 18]



[Fig. 19]



[Fig. 20]



[Fig. 21]

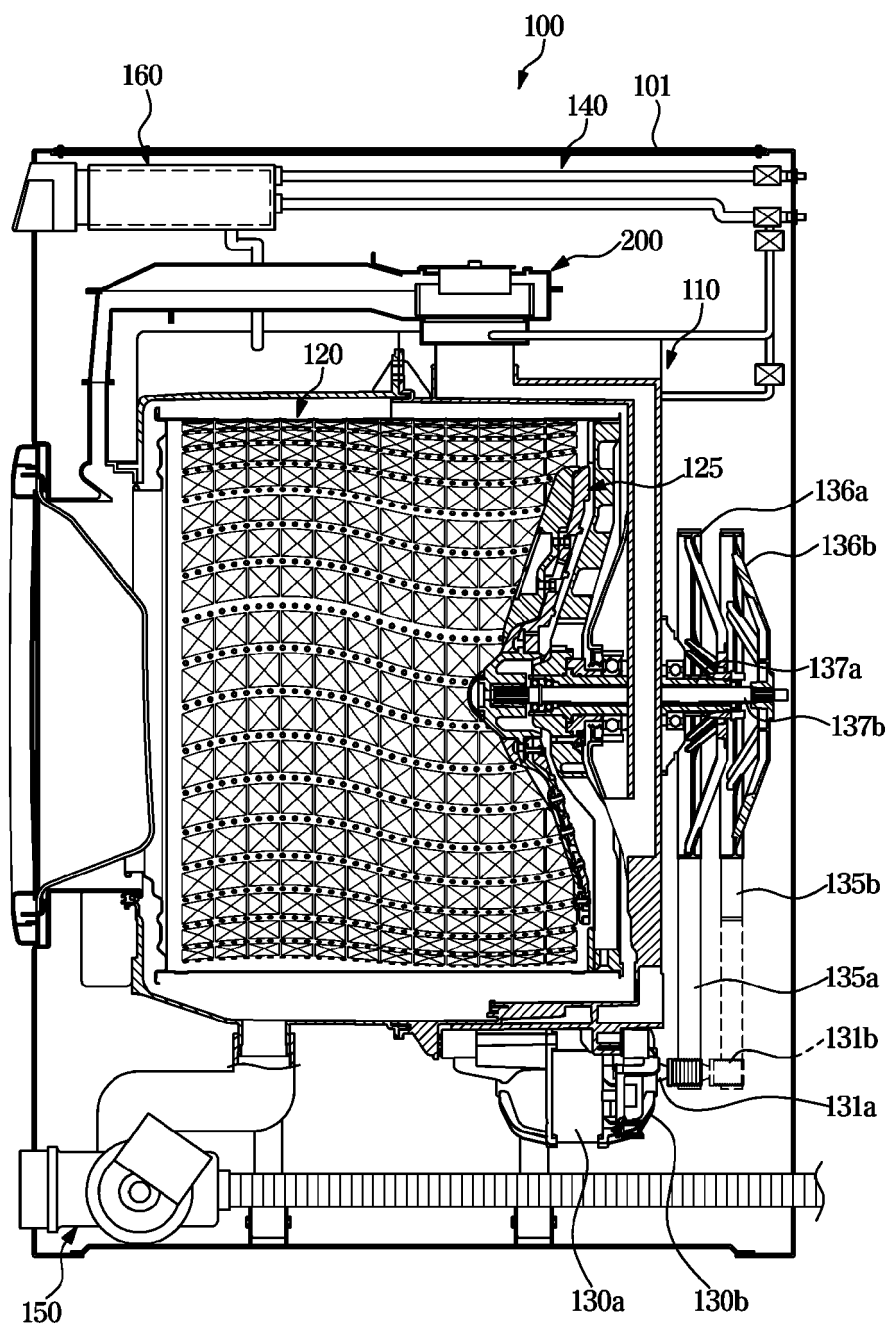
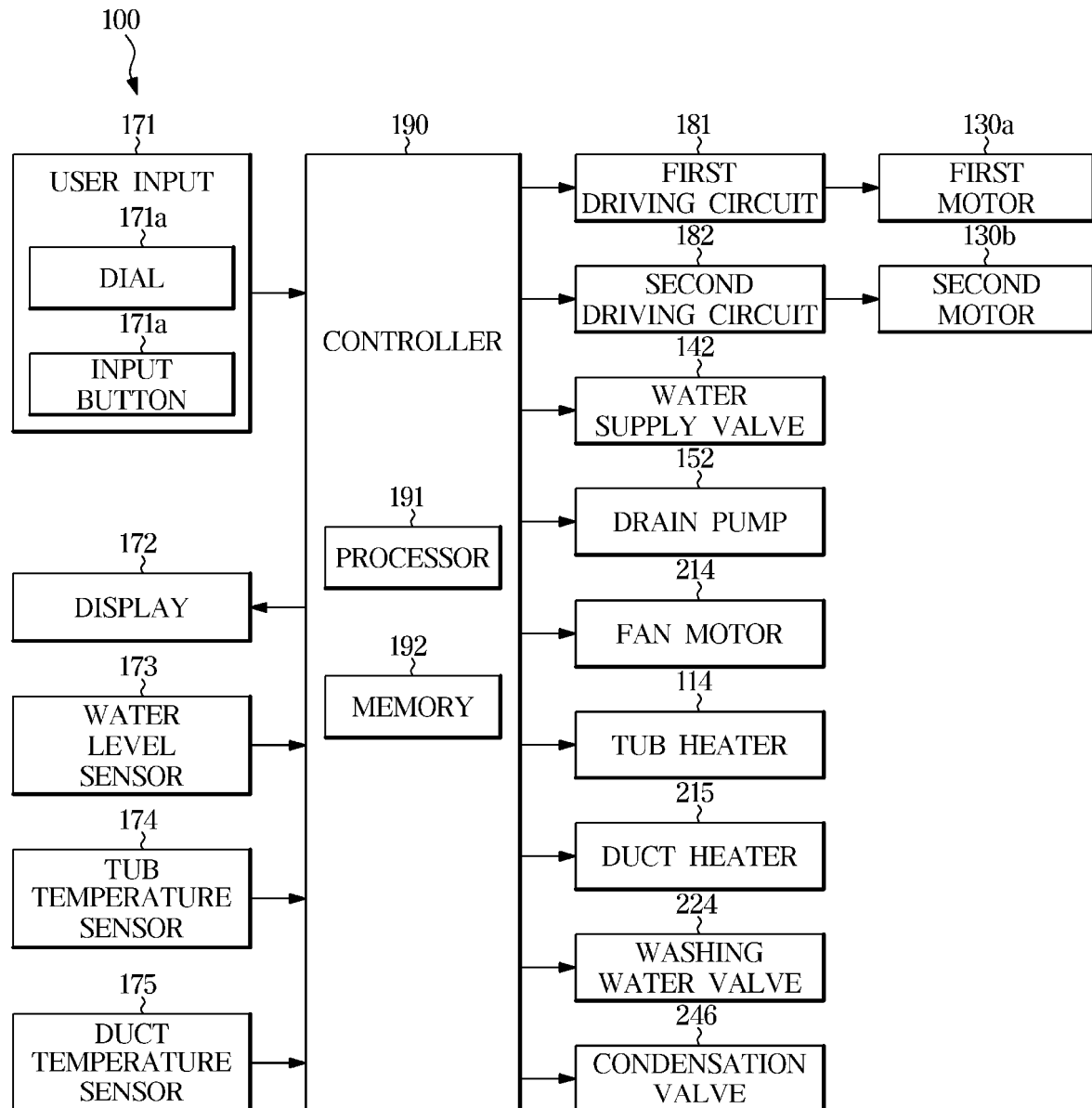


FIG. 22



REFERENCES CITED IN THE DESCRIPTION

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