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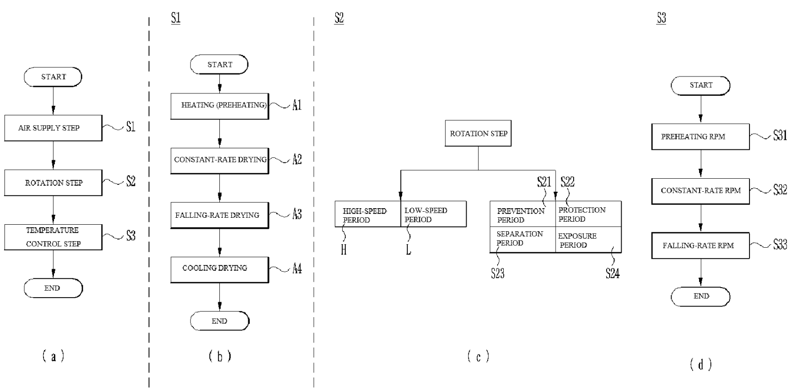
(54) **CLOTHING TREATING APPARATUS**

(57) The present invention relates to a CLOTHING TREATING APPARATUS which provides various optimized drum motion combinations capable of preventing damage to or shrinking of clothing in each of a preheating section, a constant rate drying section, a reduced rate drying section, and a cooling section.

【FIG 16】



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Description

[Technical Field]

[0001] The present disclosure relates to a laundry treating apparatus. More particularly, the present disclosure relates to a laundry treating apparatus that may dry laundry.

[Background]

[0002] A laundry treating apparatus is a concept including a washing machine, a dryer, and a dryer-washing machine as an apparatus that may wash, dry, or wash and dry laundry (an object to be washed or an object to be dried).

[0003] Recently, a laundry treating apparatus that may intensively dry the laundry using a heat pump has emerged. In such existing laundry treating apparatus, hot air generated from the heat pump was supplied to the laundry accommodated in a drum, and at the same time, the drum was rotated to evenly expose the laundry, so that the drying of the laundry was able to be performed.

[0004] FIG. 1 is a view illustrating a structure of a laundry treating apparatus that may perform an existing drying cycle.

[0005] Referring to Korean Patent Application Publication No. 10-2019-0121656, an existing dryer has a driver 3 fixed to a bottom surface of a cabinet 1.

[0006] Specifically, the dryer may include the cabinet 1 and a drum 2, and may include a circulation flow channel 5 for circulating air of the drum 2 to the outside, and a heat pump 6 accommodated in the circulation flow channel 5 to condense air and re-heat air. Water condensed by the heat pump 6 may be collected in a water storage tank 9 using a pump 8. In one example, even when the driver 3 generates a vibration or a temporary external force is transmitted via the driver 3, a bottom surface 12 of the cabinet 1 may be prevented from being deformed or inclined.

[0007] Accordingly, the existing dryer is constructed to fix the driver 3 to the bottom surface 12 of the cabinet 1, or to a base or the like fixed to the bottom surface of the cabinet 1 under the drum 2. Because the driver 3 is not disposed in parallel with a rotation shaft of the drum 2, such dryer rotates the drum 2 by additionally using a separate component.

[0008] Specifically, the driver 3 may include a motor 34 fixed to the bottom of the cabinet 1, a rotation shaft 37 rotating by the motor 34, a pulley 35 rotated by the rotation shaft 37, and a belt 36 disposed to connect an outer circumferential surface of the drum 2 with an outer circumferential surface of the pulley 35.

[0009] Accordingly, when the motor 34 rotates the rotation shaft 37, the pulley 35 rotates the belt 36, and the belt 36 is able to rotate the drum 2. In this regard, because a diameter of the pulley 35 is much smaller than a diameter of the drum 2, the dryer may omit a reducer. However, because the diameter of the pulley 35 is much smaller than the diameter of the drum 2, when the motor 34 rapidly rotates, a phenomenon in which the belt 36 slips from the drum 2 or the pulley 35 occurs in such dryer. Therefore, such dryer has a problem in that a rotational acceleration of the motor 34 is limited to a level equal to or lower than a predetermined level, and has a fundamental limit that the motor 34 should slowly accelerate or decelerate such that the belt 36 does not slip when the drum 2 is rotated.

[0010] Therefore, because the existing dryer is not able to rapidly convert a rotation direction of the drum 2, the rotation of the drum 2 may not be able to be controlled or the rotation direction of the drum 2 may not be able to be changed.

[0011] Accordingly, when the existing laundry treating apparatus has the structure in which the drum is rotated using the belt and the pulley, because it is difficult to vary a speed of the drum during the drying cycle, to prevent the laundry from being over-dried and damaged by hot air, a scheme of controlling operation of the heat pump based on dryness of the laundry was adopted.

[0012] For example, referring to Korean Patent Application Publication No. 10-2006-0023715, an existing laundry treating apparatus divides a period of the drying cycle into a preheating period, a constant-rate drying period, a falling-rate drying period, and a cooling period based on a state of the heat pump and the dryness of the laundry, and protects the laundry by controlling a temperature or an air volume of hot air supplied to the drum for each period.

[0013] FIG. 2 is a view illustrating a rotational speed of a drum when drying laundry in an existing laundry treating apparatus.

[0014] In the existing laundry treating apparatus, when the drying cycle is performed along the preheating period, the constant-rate drying period, and the falling-rate drying period, only a tumbling motion in which the laundry may be exposed to supplied hot air while ascending and then falling was performed.

[0015] The tumbling motion is a motion of rotating the drum such that the laundry ascends upwardly of a central area of the drum and then falls from an area lower than a high point of the drum to a lower portion of the drum. To this end, in the tumbling motion, the drum is rotated at a speed equal to or lower than 1G in a certain direction, and the laundry is repeatedly exposed in the greatest area size to hot air while being attached to an inner wall of the drum and then spaced apart therefrom and falling, so that the tumbling motion corresponds to a motion with the highest drying efficiency.

[0016] However, when only the tumbling motion is applied during the drying cycle, the laundry damage, such as wear and fluff, and shrinkage of the laundry, such as a fiber diameter change of the laundry, a fiber spacing change, and the like, occur.

[0017] FIG. 3 is a view illustrating a problem generated by performing a tumbling motion in an existing laundry treating apparatus.

[0018] Referring to (a) in FIG. 3, when the tumbling motion is performed, the laundry accommodated in the drum 2 may be disposed in one of a first area I where the laundry rotates while being attached to an inner wall of the drum 2, a second area II where laundry items are not in contact with the inner wall of the drum 2, but surfaces of the laundry items are rubbed against each other, and a third area III where the laundry is detached from the inner wall of the drum 2 and falls inside the drum 2.

[0019] Referring to (b) in FIG. 3, the laundry in the third area III of the drum may be in a state of being entirely separated from the inner wall of the drum 2 and be exposed to hot air as in a state 1. Thereafter, the laundry may come into contact with the inner wall of the drum 2 as in a state 2.

[0020] However, the laundry may collide with the inner wall of the drum 200 to be pressed against the inner wall of the drum 200 as in a state 3 by a self-load and an acceleration force applied during the falling.

[0021] Accordingly, a falling impact may occur as the laundry disposed in the third area III is separated from the inner wall of the drum 200 and then collides again therewith. As a result, the laundry may shrink or be deformed as the fiber itself is temporarily pressurized.

[0022] Referring to (c) in FIG. 3, a laundry item in the second area II of the drum is separated from the inner wall of the drum 2, but is in contact with another laundry item, or different portions of the same laundry item are in contact with each other. In this regard, when the drum 2 is rotated at a second speed L1, a laundry item relatively close to the inner wall of the drum 2 and a laundry item relatively far from the inner wall of the drum 2 may be rubbed against each other because of an inertial force difference. Accordingly, the laundry items in the second area II may be rubbed against each other or worn.

[0023] Referring to (d) in FIG. 3, the laundry in the first area I of the drum may be attached to the inner wall of the drum 2 at a vertical level lower than that of a center O of the drum 2. When the drum 2 is rotated at the second speed L1, the laundry in the first area I is not able to move completely simultaneously with the inner wall of the drum 2 because of the inertial force, so that the laundry in the first area I and the inner wall of the drum 2 may be rubbed against each other.

[0024] The tumbling motion may cause friction between the laundry items or between areas of the laundry item even when there is only one laundry item, and may cause friction between the laundry and the drum 200. As a result, the laundry may be damaged or worn and the fluff may occur on the laundry.

[0025] In addition, the tumbling motion may apply the falling impact on the laundry. Accordingly, the laundry may be deformed or damaged by the impact, and the laundry itself may shrink as an inner space of the laundry is contracted.

[0026] As a result, although the existing laundry treating apparatus dries the laundry using the tumbling motion which is the most favorable motion for drying the laundry, there is a fundamental limitation that there is a risk that the laundry is damaged or shrinks by performing the tumbling motion throughout the entire process of the drying cycle without considering a state of the laundry.

[0027] FIG. 4 is a view illustrating a structure of an existing laundry treating apparatus that may arbitrarily change a rotation speed and a rotation direction of a drum. Referring to Korean Patent Application Publication No. 10-2020-0065932, recently, in the laundry treating apparatus for intensively performing the drying cycle, a laundry treating apparatus in which the driver 3 is coupled to the drum 2 to change the rotation direction and the rotation speed of the drum has emerged.

[0028] However, such laundry treating apparatus also has a problem in that the damage or the shrinkage of the laundry is not able to be prevented because there are no specific hints on how to change the rotation motion of the drum and how to apply it depending on the state of the laundry during the drying cycle process.

[0029] In addition, the existing laundry treating apparatus has a limitation of not being able to be implemented as a real product because there is no specific embodiment on how to fix the driver 3 to the cabinet to rotate the drum 2.

[Summary]

[Technical Problem]

[0030] The present disclosure is to provide a laundry treating apparatus that may prevent friction or wear of laundry during a drying cycle process.

[0031] The present disclosure is to provide a laundry treating apparatus that may prevent a friction between laundry items and a friction between laundry and a drum during a drying cycle process.

[0032] The present disclosure is to provide a laundry treating apparatus that prevents a fluff from occurring on laundry during a drying cycle process.

[0033] The present disclosure is to provide a laundry treating apparatus that may protect a surface of laundry by having a period in which the laundry rotate integrally with a drum depending on dryness of the laundry or a surface state of the laundry.

[0034] The present disclosure is to provide a laundry treating apparatus that may prevent shrinkage of laundry during a drying cycle process.

[0035] The present disclosure is to provide a laundry treating apparatus that may prevent over-drying of a specific laundry item or a specific portion during a drying cycle process.

[0036] The present disclosure is to provide a laundry treating apparatus that may separately have a fabric protection course that may focus on preventing deformation and damage of laundry or preventing shrinkage.

[0037] The present disclosure is to provide a laundry treating apparatus that provides a drum rotation motion that may protect a surface of laundry and dry the laundry at the same time.

[Technical Solutions]

[0038] To solve the above-mentioned problems, the present disclosure provides a laundry treating apparatus that disposes a period in which laundry may rotate integrally with a drum by accelerating the drum during a drying cycle process.

[0039] The laundry treating apparatus according to the present disclosure may prevent the laundry from being separated or falling from an inner wall of the drum by disposing a period of rotating the drum at a speed equal to or higher than 1G during the drying cycle process.

[0040] In addition, the laundry treating apparatus according to the present disclosure may dispose a low-speed period of rotating the drum at a speed equal to or lower than 1G between periods of rotating the drum at the speed equal to or higher than 1G. As a result, even drying of a surface of the laundry may be induced between periods of protecting the laundry.

[0041] The laundry treating apparatus according to the present disclosure may minimize a time period during which a laundry item is rubbed against the drum and another laundry item by disposing a period of accelerating the drum to the speed equal to or higher than 1G in the falling-rate drying period in which most of the surface of the laundry is dried.

[0042] The laundry treating apparatus according to the present disclosure may dispose a period in which the laundry rotates integrally with the drum in the falling-rate drying period in which the surface of the laundry is prone to be rubbed. Additionally, in the falling-rate drying period, the rotation speed of the drum may be higher in a late stage than in an early stage. In addition, a period in which the drum rotates at a speed that allows the laundry to be stirred may be disposed in the falling-rate drying period. However, at the end of the falling-rate drying period, a period in which the drum accelerates and the laundry rotates integrally with the drum may always be disposed.

[0043] The laundry treating apparatus according to the present disclosure may dispose a period of rotating the drum at the speed equal to or higher than 1G even in the constant-rate drying period.

[0044] In the constant-rate drying period, the period of rotating the drum at the speed equal to or higher than 1G may be disposed closer to the late stage rather than the early stage.

[0045] The laundry treating apparatus according to the present disclosure may provide a drum rotation motion (so-called hanging motion) in which a high-speed period for rotating the drum at the speed equal to or higher than 1G and a low-speed period for rotating the drum at the speed equal to or lower than 1G are periodically repeated.

[0046] In the hanging motion, a duration of the high-speed period and the low-speed period may be set longer than a time period for the drum to rotate once or more.

[0047] In the hanging motion, a duration of the high-speed period may be set to be longer than or equal to a duration of the low-speed period.

[Advantageous Effects]

[0048] The laundry treating apparatus according to the present disclosure may prevent the friction or the wear of the laundry during the drying cycle process.

[0049] The laundry treating apparatus according to the present disclosure may prevent the friction between the laundry items and the friction between the laundry and the drum during the drying cycle process.

[0050] The laundry treating apparatus according to the present disclosure may prevent the fluff from occurring on the laundry during the drying cycle process.

[0051] The present disclosure may protect the surface of the laundry by having the period in which the laundry rotates integrally with the drum depending on the dryness of the laundry or the surface state of the laundry.

[0052] The present disclosure may achieve both the drying and the protection of the laundry by protecting the surface of the laundry and drying the laundry at the same time.

[Brief Description of the Drawings]

[0053]

FIG. 1 is a view illustrating a structure of an existing laundry treating apparatus.

FIG. 2 is a view illustrating a drying cycle scheme of an existing laundry treating apparatus.

FIG. 3 is a view illustrating a problem of an existing laundry treating apparatus.

FIG. 4 is a view illustrating another structure of an existing laundry treating apparatus.

FIG. 5 is a view illustrating an outer appearance of a laundry treating apparatus according to the present disclosure.

FIG. 6 is a view simply illustrating the inside of a laundry treating apparatus according to the present disclosure.

FIG. 7 is an exploded perspective view illustrating internal components constituting the laundry treating apparatus separated from each other;

FIG. 8 is a view illustrating an outer appearance of a reducer according to an embodiment of the present disclosure.

FIG. 9 is an enlarged cross-sectional view of a driver.

FIG. 10 is a view illustrating a base and a rear plate according to an embodiment of the present disclosure.

FIG. 11 is a view illustrating a coupling structure of a rear plate, a reducer, and a motor according to an embodiment of the present disclosure.

FIG. 12 is a rear view illustrating a coupling structure of a reducer and a stator according to an embodiment of the present disclosure.
FIG. 13 is a view illustrating coupling of a reducer and a motor according to an embodiment of the present disclosure.
FIG. 14 is a view illustrating a situation in which the laundry may be damaged or shrink during a drying cycle process.
FIG. 15 is a view illustrating a change in volume of laundry based on a change in a diameter of fiber L.
FIG. 16 is a view illustrating an embodiment in which a laundry treating apparatus according to the present disclosure performs a drying cycle.
FIG. 17 illustrates internal states of a heat exchanger 900 and a drum 200 when an air supply step S 1 is performed.
FIG. 18 illustrates that a rotation step of a laundry treating apparatus according to the present disclosure includes a tumbling motion.
FIG. 19 is a view illustrating a state of laundry in a tumbling motion.
FIG. 20 illustrates that a rotation step includes a pulling motion.
FIG. 21 is a view illustrating a state of laundry when a laundry treating apparatus according to the present disclosure performs a pulling motion.
FIG. 22 illustrates that a rotation step includes a flipping motion.
FIG. 23 is a view illustrating a state of laundry when a rotation step performs a flipping motion.
FIG. 24 illustrates that a rotation step includes a hanging motion.
FIG. 25 is a view illustrating a state of laundry when a rotation step performs a hanging motion.
FIG. 26 illustrates that a rotation step includes a shaking motion.
FIG. 27 is a view illustrating a state of laundry when a rotation step performs a shaking motion.
FIG. 28 illustrates that a rotation step includes a rolling motion.
FIG. 29 is a view illustrating a state of laundry when a rotation step performs a rolling motion.
FIG. 30 illustrates that a rotation step includes a stop motion.
FIG. 31 illustrates a rotation step S2 that may be applied in a preheating period in an air supply step S1.
FIG. 32 is a view illustrating a rotation step S2 that may be applied in a constant-rate drying period A2 in an air supply step S 1.
FIG. 33 is a view illustrating a rotation step S2 that may be applied in a falling-rate drying period in an air supply step S1.
FIG. 34 illustrates a rotation step S2 that may be applied in a cooling period in an air supply step S1.

[Detailed Description]

[0054] Hereinafter, an embodiment of the present disclosure will be described in detail with reference to the accompanying drawings such that a person having ordinary knowledge in the technical field to which the present disclosure belongs may easily implement the embodiment.

[0055] However, the present disclosure is able to be implemented in various different forms and is not limited to the embodiment described herein. In addition, to clearly describe the present disclosure, components irrelevant to the description are omitted in the drawings. Further, similar reference numerals are assigned to similar components throughout the present document.

[0056] Duplicate descriptions of the same components are omitted herein.

[0057] In addition, it will be understood that when a component is referred to as being ‘connected to’ or ‘coupled to’ another component herein, it may be directly connected to or coupled to the other component, or one or more intervening components may be present. On the other hand, it will be understood that when a component is referred to as being ’directly connected to’ or ‘directly coupled to’ another component herein, there are no other intervening components.

[0058] Furthermore, the terminology used herein is for the purpose of describing the specific embodiment of the present disclosure only and is not intended to be limiting of the present disclosure.

[0059] As used herein, the singular forms ’a’ and ’an’ are intended to include the plural forms as well, unless the context clearly indicates otherwise.

[0060] It should be understood that the terms ‘comprises’, ’comprising’, ’includes’, and ’including’ when used herein, specify the presence of the features, numbers, steps, operations, components, parts, or combinations thereof described herein, but do not preclude the presence or addition of one or more other features, numbers, steps, operations, components, or combinations thereof.

[0061] In addition, herein, the term ’and/or’ includes a combination of a plurality of listed items or any of the plurality of listed items. Herein, ‘A or B’ may include ’A’, ’B’, or ‘both A and B’.

[0062] FIG. 5 is a view illustrating an outer appearance of a laundry treating apparatus according to the present disclosure.

[0063] The laundry treating apparatus according to an embodiment of the present disclosure may include a cabinet 100 that forms an outer appearance of the laundry treating apparatus.

[0064] The cabinet 100 may include a front panel 110 that forms a front surface of the laundry treating apparatus, an upper panel 150 that forms an upper surface, and a side panel 140 that forms a side surface. The side panel 140 may include a left panel 141 that forms a left side surface. The front panel 110 may include an opening 111 defined to be in communication with the inside of the cabinet 100, and a door 130 that is pivotably coupled to the cabinet 100 to open and close the opening 111.

[0065] A manipulation panel 117 may be installed on the front panel 110. The manipulation panel 117 may include an input unit 118 that receives a control command from a user, and a display 119 that outputs information such as the control command selectable by the user. The control command may include a drying course or a drying option that may perform a series of drying cycles. A control panel that controls an internal component to perform the control command input via the input unit 118 may be installed in the cabinet 100. The control panel may be connected to the components inside the laundry treating apparatus to control the corresponding components to perform the input command.

[0066] The input unit 118 may include a power supply request unit that requests power supply of the laundry treating apparatus, a course input unit that enables the user to select a desired course among multiple courses, and an execution request unit that requests initiation of the course selected by the user.

[0067] The display 119 may include at least one of a display panel that may output text and a figure, and a speaker that may output a voice signal and sound.

[0068] In one example, the laundry treating apparatus according to the present disclosure may include a water storage tank 120 constructed to separately store moisture generated in a process of drying the laundry. The water storage tank 120 may include a handle extendable from one side of the front panel 110 to the outside. The water storage tank 120 may collect condensate water generated during the drying cycle. Accordingly, the user may extend the water storage tank 120 from the cabinet 100 to remove the condensed water, and then may retract the water storage tank 120 in the cabinet 100 again. Accordingly, the laundry treating apparatus according to the present disclosure may be disposed at a place where a sewer or the like is not installed.

[0069] In one example, the water storage tank 120 may be disposed above the door 130. Accordingly, when the user extends the water storage tank 120 from the front panel 110, the user may bend the waist relatively less, and thus, user convenience may be increased.

[0070] FIG. 6 is a view simply illustrating the inside of a laundry treating apparatus according to the present disclosure. The laundry treating apparatus according to the present disclosure may include a drum 200 that is accommodated in the cabinet 100 and accommodates the laundry therein, a driver that rotates the drum 200, a heat exchanger assembly 900 that supplies hot air to the drum 200, and a base 800 having a circulation flow channel 820. The circulation flow channel 820 is in communication with the drum 200. Air discharged from the drum 200 may be supplied to the circulation flow channel 820. In addition, air discharged from the circulation flow channel 820 may be supplied again to the drum 200.

[0071] The driver may include a motor 500 that provides power to rotate the drum 200. The driver may be directly connected to the drum 200 to rotate the drum 200. For example, the driver may be of a direct drive Unit (DD) type. Accordingly, the driver may control a rotation direction of the drum 200 or a rotation speed of the drum 200 by directly rotating the drum 200 by omitting components such as a belt and a pulley.

[0072] The motor 500 may rotate at a high RPM. For example, the motor 500 may rotate at an RPM much greater than an RPM at which the laundry inside the drum 200 may be rotated while being attached to the inner wall of the drum 200.

[0073] However, when the laundry inside the drum 200 rotates while being continuously attached to the inner wall of the drum 200, a portion thereof attached to the inner wall of the drum is not exposed to hot air, thereby reducing a drying efficiency.

[0074] When a rotor 520 is rotated at a low RPM to roll or stir the laundry in the drum 200 so as not to be attached to the inner wall of the drum 200, an output or a torque generated by the driver may not be properly utilized.

[0075] Therefore, the driver of the laundry treating apparatus according to the present disclosure may further include a reducer 600 that may increase the torque while utilizing a maximum output of the motor 500 by reducing the RPM.

[0076] The driver may include a drum rotating shaft 6341 connected to the drum 200 to rotate the drum 200.

[0077] The drum 200 may be formed in a cylindrical shape to accommodate the laundry therein. In addition, unlike the drum used for washing, there is no need to inject water into the drum 200 used only for drying, and water in a condensed liquid state inside the drum 200 needs not be discharged to the outside of the drum 200. Accordingly, a through-hole defined along a circumferential surface of the drum 200 may be omitted. That is, the drum 200 used only for the drying may be formed differently from the drum 200 used for the washing.

[0078] The drum 200 may be formed in an integral cylindrical shape, but may be manufactured in a form in which a drum body 210 including the circumferential surface and a drum rear surface 220 forming a rear surface are coupled to each other.

[0079] An inlet 211 through which the laundry enters and exits may be defined in front of the drum body 210. The driver that rotates the drum may be connected to the drum rear surface 220 from the rear. The drum body 210 and the drum rear surface 220 may be coupled to each other by a fastening member such as a bolt, but may not be limited thereto, and may be coupled to each other using various methods as long as the drum body 210 and the drum rear surface 220 may rotate together.

[0080] The drum body 210 may have a lift 213 that lifts the laundry inside upward such that the laundry items accommodated therein may be mixed with each other based on the rotation. When the drum 200 rotates, the laundry accommodated therein may repeat a process of ascending and falling by the lift 213. The laundry accommodated in the drum 200 may be evenly in contact with hot air while repeatedly ascending and falling. Accordingly, the drying efficiency is increased, and a drying time is shortened.

[0081] A reinforcing bead 212 may be formed on the circumferential surface of the drum body 210. The reinforcing bead 212 may be recessed or protrude inside/outside the drum along the circumferential surface of the drum 200. The reinforcing bead may include a plurality of reinforcing beads spaced apart from each other. The reinforcing beads may form a certain pattern and may be disposed on an inner surface/outer surface of the circumferential surface.

[0082] A strength of the drum body 210 may be increased by the reinforcing bead 212. Accordingly, even when a large amount of laundry is accommodated in the drum body 210 or a sudden rotational force is received via the driver, the drum body 210 may be prevented from being twisted. In addition, when the reinforcing bead 212 is disposed, a gap between the laundry and the inner circumferential surface may be increased compared to when the circumferential surface of the drum body 210 is formed as a flat surface, so that hot air supplied to the drum 200 may be more effectively introduced to a space between the laundry and the drum 200. Durability of the drum may be increased by the reinforcing bead, and the drying efficiency of the laundry treating apparatus may be increased.

[0083] In the case of the DD-type washing machine, generally, the driver may be coupled to and fixed to a tub accommodating the drum 200 therein, and the drum 200 may be coupled to the driver to be supported by the tub. However, because the laundry treating apparatus according to the present disclosure is constructed to intensively perform the drying cycle, the tub fixed to the cabinet 100 to accommodate the drum 200 therein is omitted.

[0084] Accordingly, the laundry treating apparatus according to the present disclosure may further include a support 400 that fixes or supports the drum 200 or the driver inside the cabinet 100.

[0085] The support 400 may include a front plate 410 disposed in front of the drum 200 and a rear plate 420 disposed at the rear of the drum 200. The front plate 410 and the rear plate 420 may be formed in a plate shape to respectively face the front surface and the rear surface of the drum 200. A distance between the front plate 410 and the rear plate 420 may be equal to a length of the drum 200 or greater than the length of the drum 200. The front plate 410 and the rear plate 420 may be fixed to and supported by a bottom surface of the cabinet 100 or the base 800.

[0086] The front plate 410 may be disposed between the front panel that forms the front surface of the cabinet and the drum 200. Furrhter, an input communication hole 412 in communication with the inlet 211 may be defined in the front plate 410. Because the input communication hole 412 is defined in the front plate 410, the laundry may be put into or withdrawn from the drum 200 while the front surface of the drum 200 is supported.

[0087] The front plate 410 may include a duct connection portion 416 disposed under the input communication hole 412. The duct connection portion 416 may form a lower surface of the front plate 410.

[0088] The front plate 410 may include a duct communication hole 417 extending through the duct connection portion 416. The duct communication hole 417 may be formed in a hollow shape to guide air discharged via the inlet 211 of the drum to a space under the drum 200. In addition, air discharged via the drum 211 may be guided to the circulation flow channel 820 located under the drum 200.

[0089] A filter (not shown) may be installed in the duct communication hole 417 to filter lint or foreign substances with large particles generated from the laundry. The filter may filter air discharged from the drum 200 to prevent the foreign substances from being accumulated in the laundry treating apparatus, and may prevent the foreign substances from being accumulated to prevent air circulation.

[0090] Because the inlet 211 is disposed at the front, the driver may be installed on the rear plate 420 rather than on the front plate 410. The driver may be mounted on and supported by the rear plate 420. Accordingly, the driver may rotate the drum 200 in a state in which a location thereof is stably fixed via the rear plate 420.

[0091] At least one of the front plate 410 and the rear plate 420 may rotatably support the drum 200. At least one of the front plate 410 and the rear plate 420 may rotatably accommodate a front end or a rear end of the drum 200.

[0092] For example, a front portion of the drum 200 may be rotatably supported by the front plate 410, and a rear portion of the drum 200 may be spaced apart from the rear plate 420, but connected to the motor 500 mounted on the rear plate 420 to be indirectly supported by the rear plate 420. Accordingly, an area in which the drum 200 is in contact with or rubbed against the support 400 may be minimized, and unnecessary noise or vibration may be prevented from occurring.

[0093] In one example, the drum 200 may be rotatably supported by both the front plate 410 and the rear plate 420.

[0094] One or more support wheels 415 that support the front portion of the drum 200 may be disposed at a lower portion of the front plate 410. The support wheel 415 may be rotatably disposed on a rear surface of the front plate 410. The support wheel 415 may be rotated while being in contact with a lower portion of the drum 200.

[0095] When the drum 200 is rotated by the driver, the drum 200 may be supported by the drum rotating shaft 6341 connected thereto from the rear. When the laundry is accommodated in the drum 200, a load imposed on the drum rotating shaft 6341 by the laundry may be increased. Accordingly, the drum rotating shaft 6341 may be at a risk of being bent by the load.

[0096] When the support wheel 415 supports a front lower portion of the drum 200, the load applied to the drum rotating shaft 6341 may be reduced. Accordingly, the drum rotating shaft 6341 may be prevented from being bent, and noise may be prevented from occurring due to vibration.

[0097] The support wheels 415 may be disposed at locations symmetrical to each other with respect to a center of rotation of the drum 200 to support the load of the drum 200. It is preferable that the support wheels 415 are respectively disposed at left and right lower portions of the drum 200 to support the drum 200. However, the present disclosure may not be limited thereto, and a greater number of support wheels 415 may be disposed depending on an operating environment of the drum 200.

[0098] The circulation flow channel 820 disposed in the base 800 may form a flow channel for circulating air inside the drum 200 and then injecting air into the drum 200.

[0099] The circulation flow channel 820 may include an inlet duct 821 through which air discharged from the drum 200 is introduced, a discharge duct 823 for supplying air to the drum 200, and a flow duct 822 for connecting the inlet duct 821 with the discharge duct 823.

[0100] When air is discharged from the front side of the drum 200, the flow duct 822 may be located at a front side of the circulation flow channel 820. The discharge duct 823 may be positioned at a rear side of the circulation flow channel 820.

[0101] The discharge duct 823 may further include a blower 8231 for discharging air to the outside of the circulation flow channel 820. The blower 8231 may be disposed at a rear side of the discharge duct 823. Air discharged via the blower 8231 may flow to the drum 200.

[0102] A duct cover 830 may be coupled onto the circulation flow channel 820 to partially shield an opened upper surface of the circulation flow channel 820. The duct cover 830 may prevent air from leaking to the outside of the circulation flow channel 820. In other words, the duct cover 830 may form one surface of the flow channel through which air circulates.

[0103] In addition, the heat exchanger assembly 900 disposed in the base 800 may include a first heat exchanger 910 disposed inside the circulation flow channel 820 to cool air, and a second heat exchanger 920 disposed inside the circulation flow channel 820 to heat air cooled by the first heat exchanger 910.

[0104] The first heat exchanger 910 may dehumidify air discharged from the drum 200, and the second heat exchanger 920 may heat dehumidified air. Heated air may be supplied again to the drum 200 to dry the laundry accommodated in the drum 200.

[0105] The first heat exchanger 910 and the second heat exchanger 920 may be constructed as heat exchangers through which a refrigerant flows. When they are constructed as the heat exchanges through which the refrigerant flows, the first heat exchanger 910 may be constructed as an evaporator and the second heat exchanger 920 may be constructed as a condenser. The refrigerant flowing along the first heat exchanger 910 and the second heat exchanger 920 may heat-exchange with air discharged from the drum 200.

[0106] The heat exchanger assembly 900 may include a circulation flow channel fan 950 installed in the circulation flow channel 820 to generate an internal air flow of the circulation flow channel 820. In addition, the heat exchanger assembly 900 may further include a circulation flow channel fan motor 951 for rotating the circulation flow channel fan 950. The circulation flow channel fan 950 may be rotated by receiving rotational power by the circulation flow channel fan motor 951. When the circulation flow channel fan 950 is operated, air dehumidified by the first heat exchanger 910 and heated by the second heat exchanger 920 may flow to the rear of the drum 200.

[0107] The circulation flow channel fan 950 may be installed in one of the inlet duct 821, the flow duct 822, and the discharge duct 823. Because the circulation flow channel fan 950 is constructed to rotate, noise may be generated when the circulation flow channel fan 950 operates. Therefore, it is preferable that the circulation flow channel fan 950 is disposed at a rear portion of the circulation flow channel 820.

[0108] The circulation flow channel fan 950 may be installed in the blower 8231. In addition, the circulation flow channel fan motor 951 may be disposed at a rear portion of the blower 8231. When the circulation flow channel fan 950 is rotated by the circulation flow channel fan motor 951, air in the circulation flow channel 820 may be discharged to the outside of the circulation flow channel 820 via the blower 8231.

[0109] Because the inlet 211 of the drum 200 is preferably disposed at a relatively high location to easily withdraw the laundry located inside the drum 200, the circulation flow channel 820 and the heat exchanger assembly 900 may be disposed under the drum 200.

[0110] The rear plate 420 that guides air discharged from the circulation flow channel 820 to the drum 200 may be disposed at the rear of the drum 200 . The rear plate 420 may be spaced apart from the drum rear surface 220. The circulation flow channel 820 may receive air in the drum 200 via the front plate 410 and supply air to the drum 200 via the rear plate 420. Air discharged from the circulation flow channel 820 may be guided to the drum 200 through the rear plate 420.

[0111] The base 800 may further include a connector 850 for guiding air discharged from the circulation flow channel 820 to the rear plate 420. The connector 850 may induce the discharged air to be evenly spread throughout the rear plate 420.

[0112] The connector 850 may be installed in the blower 8231. That is, the connector 850 may guide air discharged from the blower 8231 to the rear plate 420. Hot air supplied to the rear plate 420 may be introduced into the drum 200 via the drum rear surface 220.

[0113] The drum 200 of the laundry treating apparatus according to the present disclosure may not be indirectly rotated by being coupled to a belt or the like, but may be directly connected to the driver located at the rear of the drum 200 to be rotated. Accordingly, unlike the drum of the existing dryer is formed in a cylindrical shape with open front and rear surfaces, the rear surface of the drum of the laundry treating apparatus according to the present disclosure may be shielded and directly coupled to the driver.

[0114] As described above, the drum 200 may include the drum body 210 formed in the cylindrical shape to accommodate the laundry therein and the drum rear surface 220 coupled to the drum body 210 from the rear to form the rear surface of the drum.

[0115] The drum rear surface 220 may shield the rear surface of the drum body 210 to provide a coupling surface directly coupled to the driver. That is, the drum rear surface 220 may be connected to the driver and receive the rotational power to rotate the entire drum 200. As a result, the inlet 211 through which the laundry is input may be defined in the front surface of the drum body 210 and the rear surface of the drum body may be shielded by the drum rear surface 220.

[0116] The drum rear surface 220 may have a bushing 300 that connects the driver with the drum rear surface 220. The bushing 300 may be disposed on the drum rear surface 220 to form a rotational center of the drum 200. The bushing 300 may be integrally formed with the drum rear surface 220, but may be made of a material having greater rigidity or durability than the drum rear surface 220 to be firmly coupled to a rotating shaft transmitting the power. The bushing 300 may be seated on and coupled to the drum rear surface 220 to be coaxial with the rotational center of the drum rear surface 220.

[0117] The drum rear surface 220 may include a circumferential portion 221 coupled to the outer circumferential surface of the drum body 210 and a mounting plate 222 disposed inwardly of the circumferential portion 221 to be coupled to the driver. The bushing 300 may be seated on and coupled to the mounting plate 222. The rotating shaft rotating the drum may be coupled to the mounting plate 222 via the bushing 300 to be more firmly coupled to the mounting plate 222. In addition, deformation of the drum rear surface 220 may be prevented.

[0118] The drum rear surface 220 may include a suction hole 224 defined between the circumferential portion 221 and the mounting plate 222 and allowing spaces in front of and at the rear of the drum rear surface 220 to be in communication with each other. Hot air supplied via the circulation flow channel 820 may be introduced into the drum body 210 via the suction hole 224. The suction hole 224 may be defined as a plurality of holes extending through the drum rear surface 220 or may be formed as a mesh.

[0119] The driver for rotating the drum 200 may be positioned at the rear of the rear plate 420. The driver may include the motor 500 that generates the rotational power and the reducer 600 that reduces the rotational force of the motor 500 and transmits the reduced rotational force to the drum 200.

[0120] The motor 500 may be disposed at the rear of the rear plate 420. In addition, the motor 500 may be coupled to a rear surface of the rear plate 420 via the reducer 600.

[0121] The reducer 600 may be fixed to the rear surface of the rear plate 420, and the motor 500 may be coupled to a rear surface of the reducer 600. That is, the rear plate 420 may provide a support surface on which the reducer 600 or the motor 500 is supported. However, the present disclosure may not be limited thereto, and the motor 500 may be coupled to the rear plate 420.

[0122] FIG. 7 is an exploded perspective view illustrating internal components constituting the laundry treating apparatus separated from each other.

[0123] The laundry treating apparatus according to one embodiment of the present disclosure may include the drum 200 that accommodates the laundry therein, the front plate 410 that supports the front surface of the drum, the rear plate 420 positioned at the rear of the drum, the base 800 that is disposed under the drum to provide a space in which air inside the drum is circulated or moisture contained in the air is condensed, the motor 510, 520, and 540 that is positioned at the rear of the drum and provides the rotational power to the drum, the reducer 600 that decelerates the rotation of the motor and transmits the same to the drum, and a rear cover 430 that is coupled to the rear plate 420 to prevent the motor from being exposed to the outside.

[0124] The base 800 may include the circulation flow channel 820 in communication with the drum 200 to receive air introduced from the drum or discharge air to the drum.

[0125] The front plate 410 may include a front panel 411 that forms a front surface thereof, and the input communication hole 412 defined to extend through the front panel 411 to be in communication with the drum 200. The front plate 410 may have a front gasket 413 that is disposed on a rear surface of the front panel 411, and surrounds an outer side of the input communication hole 412 in a radial direction to accommodate a portion of the drum body 210 therein.

[0126] The front gasket 413 may rotatably support the drum body 210, and may be in contact with an outer circumferential surface or an inner circumferential surface of the inlet 211. The front gasket 413 may prevent hot air inside the drum 200 from leaking to a space between the drum body 210 and the front plate 410. The front gasket 413 may be made of a plastic resin-based or elastic body, and a separate sealing member may be additionally coupled to the front gasket 413 to prevent the laundry or hot air in the drum body 210 from escaping to the front plate 410.

[0127] In one example, the front plate 410 may include the duct communication hole 417 defined to extend through an inner circumferential surface of the input communication hole 412. In addition, the front plate 410 may include the duct connection portion 416 extending downwardly of the duct communication hole 417 to form a flow channel that allows the drum body 210 and the circulation flow channel 820 to be in communication with each other.

[0128] The duct connection portion 416 may be in communication with the drum body 210 via the duct communication hole 417, and air discharged from the drum body 210 may be introduced into the duct connection portion 416 via the duct communication hole 417 and be guided to the circulation flow channel 820. Because air discharged from the drum body 210 is guided to the circulation flow channel 820 by the duct connection portion 416, air inside the drum may be prevented from leaking.

[0129] The duct connection portion 416 may have the filter (not shown) installed therein for filtering the foreign substances or the lint from air discharged from the drum 200 to prevent the foreign substances from entering the circulation flow channel 820.

[0130] The front plate 410 may have the support wheel 415 installed thereon that is rotatably installed on the rear surface of the front panel 411 to support the lower portion of the drum 200. The support wheel 415 may support the front side of the drum 200 to prevent the rotating shaft connected to the drum from being bent.

[0131] The front plate 410 may have a water storage tank support hole 414 that extends through the front panel 411 and through which the water storage tank 120 (see FIG. 1) for storing condensate water generated during the drying process may be extended or supported. When the water storage tank support hole 414 is defined at an upper side, the user does not need to bend the waist when the user extends the water storage tank, thereby increasing user convenience.

[0132] The drum 200 accommodating the laundry therein may include the drum body 210 having the inlet 211 defined therein through which the laundry enters and exits, and the drum rear surface 220 forming the rear surface.

[0133] The drum rear surface 220 may include the circumferential portion 221 connected to the drum body 210, the suction hole 224 defined inwardly of the circumferential portion 221 to extend through the drum rear surface 220, and the mounting plate 222 disposed at the rotational center of the drum rear surface 220 and coupled to the rotating shaft. Air may be introduced into the rear side of the drum via the suction hole 224.

[0134] The drum rear surface 220 may further include a reinforcing rib 225 extending from the circumferential portion 221 toward the center of rotation. The reinforcing rib 225 may extend to avoid the suction hole 224. The reinforcing rib 225 may prevent the rigidity of the drum rear surface 220 from decreasing because of the suction hole 224. The reinforcing rib 225 may extend radially from an outer circumferential surface of the mounting plate 222 toward an inner circumferential surface of the circumferential portion 221.

[0135] In addition, the drum rear surface 220 may further include a circumferential rib 227 extending in a circumferential direction of the drum rear surface 220 to connect the reinforcing ribs 225 to each other. each suction hole 224 may be defined between each reinforcing rib 225, each circumferential rib 227, and each circumferential portion 221. The reinforcing rib 225 and the circumferential rib 227 may prevent the drum rear surface 220 from being deformed even when the drum rear surface 220 receives the rotational force from the motor 500.

[0136] The inlet duct 821 may be in communication with the duct communication hole 417 of the front plate 410 to be in communication with the flow channel installed inside the front plate 410. The flow duct 822 may extend from a distal end of the inlet duct 821 toward the rear side of the drum 200, and the discharge duct 823 may be disposed at a distal end of the flow duct 822 to guide air to the drum 200.

[0137] The blower 8231 may be positioned downstream of the discharge duct 823, and the blower 8231 may provide a space in which the circulation flow channel fan is installed. When the circulation fan flow fan is operated, air introduced into the inflow duct 821 may be discharged to an upper portion of the blower 8231.

[0138] In one example, the base 800 may have the heat exchanger 900 that may cool and heat air circulating in the drum 200. The heat exchanger assembly 900 may include a compressor 930 connected to the first heat exchanger and the second heat exchanger to supply the compressed refrigerant. The compressor 930 may not directly exchange heat with circulated air, and thus, may be located outside the circulation flow channel 820.

[0139] In addition, the heat exchanger assembly may include the circulation flow channel fan motor 951 supported at the rear of the blower 8231 to rotate the circulation flow channel fan. The circulation flow channel fan motor 951 may be coupled to a rear side of the blower 8231.

[0140] In one example, the laundry treating apparatus according to an embodiment of the present disclosure may further include the connector 850 that is coupled to the circulation flow channel 820 to guide hot air discharged from the circulation flow channel 820 rearwardly of the drum 200 or to the rear plate 420.

[0141] The connector 850 may be disposed on the discharge duct 823 to guide hot air heated by passing through the second heat exchanger 920 upwardly of the discharge duct 823. In addition, the connector 850 may be coupled to the opening defined at an upper side of the blower 8231.

[0142] The connector 850 may form a flow channel therein. The connector 850 may evenly guide a flow of air generated by the circulation flow channel fan to the rear plate 420. That is, the connector 850 may increase an area of the flow channel as a distance from the blower 8231 increases.

[0143] The rear plate 420 may be coupled to the base 800 or may be supported by the base 800 to be positioned at the rear of the drum 200. The rear plate 420 may include a rear panel 421 positioned to face the front plate 410, and a duct 423 formed to be recessed from the rear panel 421 to form a flow channel through which air flows and to guide air discharged from the circulation flow channel 820 to the drum.

[0144] The rear plate 420 may include a mounting portion 425 to which the driver is coupled or supported. The mounting portion 425 may extend through the rear panel 421, and may be disposed in an inner circumferential surface of the duct 423. The mounting portion 425 may be spaced inwardly in the radial direction from the inner circumferential surface of the duct 423.

[0145] Here, the driver may refer to a combination of the reducer 600 and the motor 500 as described above. In addition, the driver may refer to only the motor 500. That is, a component that generates the power and transmits the rotational power to the drum may be referred to as the driver.

[0146] The driver may be mounted in the mounting portion 425. The mounting portion 425 may support a load of the driver. The driver may be connected to the drum 200 while being supported by the mounting unit 425.

[0147] The duct 423 may accommodate therein a portion of the drum rear surface 220. The duct 423 may form the flow channel through which air flows together with the drum rear surface 220.

[0148] The driver may be installed in the mounting portion 425 so as not to interfere with the duct 423. That is. The driver may be disposed to be spaced inwardly in the radial direction from the inner circumferential surface of the duct 423. The driver may be installed in the mounting unit 425, and may be installed such that a rear portion thereof is exposed to the outside and cooled by external air.

[0149] The driver may include the motor 500 that provides the power for rotating the drum 200. The motor 500 may include the stator 510 for generating a rotating magnetic field and the rotor 520 rotated by the stator 510.

[0150] The rotor 520 may be of an outer rotor type that accommodates the stator 510 therein and rotates along a circumference of the stator 510. In this case, a driving shaft may be coupled to the rotor 520 and extend through the stator 510 and the mounting portion 425 to be directly connected to the drum 200. In this case, the rotor 520 may directly transmit the power for rotating the drum 200.

[0151] The rotor 520 may be coupled to the driving shaft via the washer 540. The washer 540 may connect the driving shaft with the rotor 520. Because a contact area between the rotor 520 and the driving shaft may be increased by the washer 540, the rotation of the rotor 520 may be more effectively transmitted.

[0152] The reducer 600 may connect the motor 500 with the drum 200. The reducer 600 may convert the power of the motor 500 to rotate the drum 200. The reducer 600 may be disposed between the motor 500 and the drum 200 to receive the power from the motor 500, convert the power, and transfer the converted power to the drum 200. The reducer 600 may convert an RPM of the rotor to a low RPM, increase a torque value, and transmit the torque value to the drum 200.

[0153] Specifically, the reducer 600 may be coupled to the rotor 520 to be coupled to the driving shaft rotating together with the rotor 520. The reducer 600 may include therein a gear assembly that rotates in engagement with the driving shaft to convert an RPM of the driving shaft and increase a torque, and the gear assembly may be connected to the drum rotating shaft that is coupled to the drum 200 to rotate the drum. Accordingly, when the driving shaft 530 rotates, the drum rotating shaft 530 may rotate at a lower RPM than the drum rotating shaft but may rotate with a greater torque.

[0154] A performance of the reducer 600 may depend on whether the driving shaft and the drum rotating shaft are able to remain coaxial with each other. That is, when the driving shaft and the drum rotating shaft are misaligned to each other, there is a risk that coupling of components constituting the gear assembly inside the reducer 600 to at least one of the driving shaft and the drum rotating shaft may be loosened or released. Accordingly, the power of the driving shaft may not be properly transmitted to the drum rotating shaft or the driving shaft may idle.

[0155] In addition, when the driving shaft and the drum rotating shaft are misaligned with each other even temporarily, gears inside the reducer 600 may be misaligned or collide with each other, thereby generating unnecessary vibration or noise.

[0156] In addition, when an angle at which the driving shaft and the drum rotating shaft are misaligned with each other is great, the reducer 600 may completely deviate from a correct location or may be damaged.

[0157] To prevent such problem, it is preferable that the laundry treating apparatuses having the reducer fix the reducer 600 and the motor 500 to a support body maintaining an original state without deformation even when an external force is generated.

[0158] For example, in the case of the washing machine, a scheme of primarily fixing the tub accommodating the drum therein to the cabinet and then secondarily fixing the motor and the reducer to a bearing housing made of a rigid body embedded in the tub by injection molding. Accordingly, even when a significant vibration occurs in the tub, the reducer and the driver may be inclined or vibrate together with the bearing housing or a fixing steel plate. As a result, the reducer and the driver themselves may always be maintained in the coupled state, and the state in which the driving shaft and the rotating shaft are coaxial with each other may be maintained.

[0159] However, because the laundry treating apparatus according to the present disclosure is constructed as the dryer, the tub fixed inside the cabinet is omitted. In addition, the rear panel of the cabinet is formed as a relatively thin plate, so that even when the stator 510 is fixed, the rear panel may easily vibrate or bend because of a repulsive force when the rotor 520 rotates. When the rear panel vibrates or bends even temporarily, the reducer 600 coupled to the drum 200 and the rotation center of the motor 500 may be misaligned with each other.

[0160] In addition, because the rear panel is formed as the thin steel plate, it may be difficult to support both the reducer 600 and the motor 500. For example, when the reducer 600 and the motor 500 are coupled to the rear panel side by side, a rotation moment may be generated because of entire lengths and self-loads of the reducer 600 and the motor 500, and thus, the reducer 600 may sag downward. As a result, the drum rotating shaft itself coupled to the drum may be misaligned with the reducer 600 and thus may not be able to remain coaxial with the driving shaft.

[0161] In one example, a case in which the stator 510 is coupled to the rear plate 420 to support the motor 500 may be considered. When a large among of laundry is accommodated or eccentricity occurs in the drum 200, whenever the drum 200 rotates, the drum rotating shaft may be misaligned along arrangement of the laundry. In this case, because the stator 510 is separated from the drum 200 and is fixed to the rear plate 420, the drum rotating shaft may vibrate with a vibration amplitude different from that of the stator 510 or may be inclined at a different angle. Accordingly, the drum rotating shaft and the driving shaft may not be able to remain coaxial with each other.

[0162] In another aspect, the drum 200 may be supported by the front plate 410 and the rear plate 420 and an installation location thereof may fixed at a predetermined level. Accordingly, a location of the drum rotating shaft coupled to the drum 200 may also be fixed at a predetermined level. Accordingly, even when the vibration occurs in the drum 200, the vibration may be buffered by at least one of the front plate 410 and the rear plate 420.

[0163] However, when the vibration occurred in the drum 200 is transmitted to the motor 500, even when the reducer 600 and the motor 500 are fixed to the rear plate 420, a vibration amplitude at which the motor 500 and the rear plate 420 vibrate may be greater than a vibration amplitude at which the drum rotating shaft vibrates. Even in this case, the drum rotating shaft and the driving shaft may not be able to remain coaxial with each other.

[0164] To solve such problem, the laundry treating apparatus according to the present disclosure may couple the motor 500 to the reducer 600 to fix the same. In other words, the reducer 600 itself may serve as a reference of the entire driver. That is, the reducer 600 may serve as a reference for the vibration and an inclined angle of the entire driver.

[0165] Because the motor 500 is fixed only to the reducer 600 without being fixed to another component of the laundry treating apparatus, when the vibration or the external force is transmitted to the driver, the motor 500 may always be inclined or vibrate simultaneously with the reducer 600 when the reducer 600 is inclinded or vibrates.

[0166] As a result, the reducer 600 and the motor 500 may form one vibration system, and the reducer 600 and the motor 500 may be maintained in a fixed state without performing a relative movement with respect to each other.

[0167] The stator 510 of the motor 500 may be directly coupled and fixed to the reducer 600. Accordingly, the location at which the driving shaft 530 is installed with respect to the reducer 600 may not be changed. A center of the driving shaft 530 and a center of the reducer 600 may be coincident with each other, the driving shaft 530 may rotate while remaining coaxial with the center of the reducer 600.

[0168] A first axis M1 may refer to a virtual line extending in a front and rear direction along the center of rotation of the drum 200. That is, the first axis M1 may be in parallel with an X-axis.

[0169] A second axis M2 and a third axis M3 may refer to virtual lines extending rearwards and upwards of the laundry treating apparatus. That is, the second axis M2 and the third axis M3 may be in parallel with an XZ plane or perpendicular to a Y-axis.

[0170] The first axis M1 and the second axis M2 may cross each other at the reducer 600. In addition, the first axis M1 and the third axis M3 may cross each other at the mounting portion 425.

[0171] The reducer 600 and the motor 500 may be designed to be disposed along the first axis M1 parallel to the ground when no load is applied to the drum 200 or the motor 500 is not operated.

[0172] However, when the vibration occurs in the drum 200 or the motor 500, the vibration is transmitted to the reducer 600 and the reducer 600 is inclined, so that the reducer 600 may be temporarily inclined along the second axis M2.

[0173] In this regard, because the motor 500 is coupled to the reducer 600, the motor 500 may vibrate or be inclined together with the reducer 600. Accordingly, the motor 500 may be disposed in parallel with the reducer 600 on the second axis M2. Accordingly, the driving shaft and the drum rotating shaft may also be disposed in parallel along the second axis M2.

[0174] As a result, even when the reducer 600 is inclined, the motor 500 may move integrally with the reducer 600, and the driving shaft and the drum rotating shaft may remain coaxial with each other.

[0175] The reducer 600 may be coupled to and fixed to the rear plate 420. In this case, because the reducer 600 will be inclined or vibrate while being coupled to the rear plate 420, it may be seen that the rear plate 420 serves as a center of a vibration system including the reducer 600, the motor 500, and the drum 200. In this case, the motor 500 may also not be directly coupled to the rear plate 420 but may be coupled only to the reducer 600 and fixed.

[0176] The reducer 600, the motor 500, and the drum 200 may be arranged in parallel along the first axis M1, and then the reducer 600 may be inclined parallel to the third axis M3 because of the vibration of the drum 200 or the motor 500. The third axis M3 may pass through the reducer 600 coupled to the rear plate 420. Because the reducer 600 and the motor 500 are coupled to each other, the motor 500 may also be inclined in parallel with the third axis M3 in the same manner as the reducer 600.

[0177] As a result, the motor 500 and the drum 200 are coupled to the reducer 600, so that the motor 500 and the drum 200 may be inclined in parallel with each other with respect to the reducer 600 or vibrate simultaneously.

[0178] The terms "coaxial" and "coincident" described above are not intended to mean physically perfect coaxiality and coincidence, but are concepts allowing a range of error that may be permitted in mechanical engineering or a range that a person skilled in the art may permit as being coaxial or consistent. For example, a range in which the driving shaft 530 and the drum rotating shaft 6341 are misaligned with each other within 5 degrees may be defined to be coaxial or coincident. However, such an angle value is merely an example, and an allowable error may be changed.

[0179] Because the driving shaft 530 rotates with respect to the reducer 600, but is fixed so as not to be inclined, and the stator 510 is also fixed to the reducer 600, a distance between the stator 510 and the rotor 520 may always be maintained. As a result, a collision between the stator 510 and the rotor 520 may be prevented, and noise or vibration, which may occur as the rotor 520 rotates around the stator 510 and a center or rotation changes, may be fundamentally blocked.

[0180] The drum rotating shaft 6341 may extend from the inside of the reducer 600 toward the drum 200, may vibrate together with the reducer 600, and may be inclined together with the reducer 600. That is, the drum rotating shaft 6341 may rotate in the reducer 600, but may be fixed in the installation location. As a result, the drum rotating shaft 6341 and the driving shaft 530 may always be disposed in parallel to each other and may be coaxial with each other. In other words, the center of the drum rotating shaft 6341 and the center of the driving shaft 530 may remain coincident with each other.

[0181] A seal 450 may be disposed between the drum rear surface 220 and the rear plate 420. The seal 450 may seal a space between the drum rear surface 220 and the rear plate 420 such that air introduced into the duct 423 of the rear plate 420 is not discharged to the outside and flows into the suction hole 224.

[0182] The seals 450 may be disposed on the outer surface and the inner surface of the duct 423, respectively. A first seal 451 may be disposed on an outer side in the radial direction of the duct 423, and a second seal 452 may be disposed on an inner side in the radial direction of the duct 423. The first seal 451 may prevent hot air from leaking outward in the radial direction at a location between the drum rear surface 220 and the duct 423, and the second seal 452 may prevent hot air from leaking radially inward in the radial direction at a location between the drum rear surface 220 and the duct 423.

[0183] In other words, the seals 450 may be disposed on an outer side and an inner side in the radial direction of the suction hole 224, respectively. The first seal 451 may be disposed on the outer side in the radial direction of the suction hole 224, and the second seal 452 may be disposed on the inner side in the radial direction of the suction hole 224.

[0184] To prevent hot air from leaking out of the seal 450, it is preferable that the seal 450 is in contact with both the drum rear surface 220 and the rear plate 420. Because the drum 200 rotates during the operation of the laundry treating apparatus, continuous friction is applied to the seal 450 by the drum rear surface 220. Therefore, it is preferable that the seal 450 is made of a material that may seal the space between the drum rear surface 220 and the duct 423 without deteriorating in performance with the presence of a frictional force and a frictional heat generated based on the rotation.

[0185] In one example, the motor 500 or the reducer 600 may be coupled to the rear plate 420 from the rear. Because the rear plate 420 may be made of the thin steel plate material, the rear plate 420 may be bent or deformed by the load transferred to the reducer 600 because of the reducer 600 and the drum 200. That is, the rigidity of the rear plate 420 needs to be secured to install the reducer 600, the motor 500, and the like.

[0186] To this end, the rear plate 420 may further include a bracket 700 for reinforcing coupling rigidity. The bracket 700 may be additionally coupled to the rear plate 420, and the reducer 600 and the motor 500 may be coupled to the rear plate 420 by the bracket 700.

[0187] The reducer 600 may be coupled to the bracket 700 and the rear plate 420 at the same time. A fastening member may simultaneously extend through the reducer 600, the rear plate 420, and the bracket 700 and couple them to each other. The rear plate 420 may be coupled to the bracket 700 to ensure the rigidity. The reducer 600, the motor 500, and the like may be coupled to the rear plate 420 whose rigidity is secured.

[0188] The components may be fastened to each other as the reducer 600 is coupled to the bracket 700 first, and the bracket 700 is coupled to the rear plate 420. That is, the reducer may be fixed to the rear plate 420 via the bracket 700 without being directly coupled to the rear plate 420.

[0189] In one example, when the motor 500 or the reducer 600 is coupled to the rear plate 420 from the rear, the motor 500 and the reducer 600 may be exposed to the outside. Therefore, it is necessary to prevent the motor 500 from being exposed by being coupled to the rear portion of the rear plate 420. In addition, the duct 423 may be heated by hot air. Therefore, it may be necessary to insulate the rear surface of the duct 423.

[0190] The rear cover 430 may be coupled to the rear plate 420 from the rear to prevent the duct 423 and the motor 500 or the reducer 600 from being exposed to the outside. The rear cover 430 may be spaced apart from the duct 423 and the driver.

[0191] The rear cover 430 may prevent the motor 500 from being damaged by external interference or prevent the decrease in the drying efficiency caused by heat loss occurred via the duct 423.

[0192] FIG. 8 is a view illustrating an outer appearance of a reducer according to an embodiment of the present disclosure.

[0193] The reducer 600 may include a reducer housing 610 and 620 forming an outer appearance thereof. The reducer housing may include a first housing 610 facing the drum and a second housing 620 facing the motor.

[0194] The reducer 600 may include a gear box. The gear box may receive the power from the motor, convert the RPM of the motor to the lower RPM, and increase the torque value to transfer the torque value to the drum. Most of the gear box may be accommodated in the second housing 620, and the first housing 610 may shield the inside of the reducer 600. Accordingly, an overall thickness of the reducer 600 may be reduced. A detailed configuration of the gear box will be described later.

[0195] The first housing 610 may include a first housing blocking body 611 that shields the second housing 620 and a first housing shaft receiving portion 612 extending from the first housing blocking body 611 in a direction away from the second housing 620. The first housing shaft receiving portion 612 may receive the drum rotating shaft 6341 therein and rotatably support the drum rotating shaft 6341.

[0196] The first housing 610 may include a stator coupling portion 613 that supports the motor. The stator coupling portion 613 may extend from a circumferential surface of the first housing blocking body 611 in the direction away from the first housing shaft receiving portion 612.

[0197] The stator coupling portion 613 may include a stator fastening hole 615 to which the motor may be fastened. The stator fastening hole 615 may be recessed from the stator coupling portion 613. A separate fastening member may be inserted into the stator fastening hole 615. The stator coupling portion 613 and the motor may be coupled to each other using the fastening member.

[0198] The first housing 610 may further include a coupling guide 614 for guiding the coupling of the motor. The coupling guide 614 may extend from a circumferential surface of the first housing blocking body 611 in a direction away from the first housing shaft receiving portion 612. The coupling guide 614 may extend from the first housing blocking body 611 to be connected to the stator coupling portion 613. When the stator 510 is coupled to the stator coupling portion 613, the coupling guide 614 may guide the location of the stator 510. Accordingly, ease of assembly may be improved.

[0199] Referring to FIG. 8, the second housing 620 may accommodate the gear assembly therein. Generally, the gearbox coupled to the reducer 600 may include a sun gear, a planetary gear revolving the sun gear, and a ring gear receiving the planetary gear therein and inducing the planetary gear to rotate. The second housing 620 may include a second housing coupling body 621 coupled to the first housing 610, a second housing blocking body 622 extending from the second housing coupling body 621 in a direction away from the first housing 610 to define a space in which the gear box is accommodated, and a second housing shaft receiving portion extending away from the first housing 610 from an inner circumferential surface of the second housing blocking body 622 to support the driving shaft 530.

[0200] A center of the first housing 610 and a center of the second housing 620 may be designed to be coaxial with each other. It is favorable in terms of power transmission that the driving shaft 540 is coaxial with the drum rotating shaft 6341. Therefore, it is preferable that the first housing shaft receiving portion 612 for rotatably supporting the drum rotating shaft 6341 and the second housing shaft receiving portion for rotatably supporting the driving shaft 540 are coupled to each other to be coaxial with each other.

[0201] The driving shaft 530 may be inserted into the second housing 620 and rotatably supported inside the second housing 620. The washer 540 rotatably supporting the rotor 520 may be coupled to the driving shaft 530. The washer 540 may include an accommodating body 542 having a shaft support hole 543 defined at a center thereof in which the driving shaft 530 is accommodated, and a washer coupling body 541 extending from an outer circumferential surface of the accommodating body in the radial direction to form a surface to which the rotor is coupled. The shaft support hole 543 may be defined in a groove shape corresponding to a protrusion to allow the protrusion formed on an outer circumferential surface of the driving shaft 530 to be coupled thereto.

[0202] The washer 540 may include at least one washer coupling protrusion 5411 protruding from the washer coupling body 541 in a direction away from the reducer. In addition, the washer 540 may include at least one washer coupling hole 5412 extending through the washer coupling body 541.

[0203] The washer coupling protrusion 5411 may be coupled to an accommodating groove defined in the rotor. A fastening member extending through the rotor may be inserted into the washer coupling hole 5412 to couple the rotor with the washer 540.

[0204] The washer coupling protrusion 5411 and the washer coupling hole 5412 may be disposed alternately with each other along the circumferential direction on a surface of the washer coupling body 541 and may include a plurality of washer coupling protrusions and a plurality of washer coupling holes, respectively.

[0205] FIG. 9 is an enlarged cross-sectional view of a driver.

[0206] The driver may include the motor 500 for generating the rotational power and the reducer for reducing the rotation speed of the motor 500 and transmitting the reduced rotation speed to the drum. The reducer 600 may include the drum rotating shaft 6341 for rotating the drum.

[0207] The motor 500 may include the stator 510 for receiving the external power and generating the rotating magnetic field, and the rotor 520 surrounding the outer circumferential surface of the stator 510. A permanent magnet may be disposed on the inner circumferential surface of the rotor 520.

[0208] The permanent magnet positioned on the inner circumferential surface of the rotor 520 may move in a specific direction by rotating magnetism generated by the stator 510, and the permanent magnet may be fixed to the inner circumferential surface of the rotor 520. Accordingly, the rotor 520 may be rotated by the rotating magnetic field of the stator 510.

[0209] The driving shaft 530 that rotates with the rotor 520 and transmits the rotational power of the rotor 520 may be coupled to the rotation center of the rotor 520. The driving shaft 530 may rotate together with the rotor 540. The driving shaft 530 may be coupled to the rotor 540 via the washer 540.

[0210] The driving shaft 530 may be directly connected to the rotor 520, but when connected thereto via the washer 540, the driving shaft 530 may be more firmly coupled to the rotor 520, thereby more effectively transmitting the rotational force of the rotor 520. In addition, a load may be prevented from being intensively applied to the driving shaft 530, thereby increasing the durability of the driving shaft 530.

[0211] The driving shaft 530 may be directly connected to the drum, but because the driving shaft 530 rotates at the same speed as the rotation speed of the rotor 520, deceleration may be needed. Accordingly, the driving shaft 530 may be connected to the reducer, and the reducer may be connected to the drum. That is, the reducer may rotate the drum by decelerating the rotation of the driving shaft 530.

[0212] The reducer 600 may include the first housing 610 and the second housing 620 that form the outer appearance thereof, and the gear box 630 that reduces the power of the driving shaft 530. The second housing 620 may provide a space for accommodating the gear box 630, and the first housing 610 may shield the accommodation space provided by the second housing 620.

[0213] The second housing 620 may be composed of the second housing coupling body 621 coupled to the first housing 610, the second housing blocking body 622 extending rearward from an inner circumferential surface of the second housing coupling body 621 to define the accommodation space and accommodating the gear box 630, and the second housing shaft receiving portion 623 extending rearward from the second housing blocking body 622 to accommodate the driving shaft 530 therein.

[0214] The gear box 630 may include a ring gear 633 installed along an inner circumferential surface of the second housing blocking body 622. One or more planetary gears 632 gear-coupled to the ring gear 633 may be disposed on an inner circumferential surface of the ring gear 633, and a sun gear 631 gear-coupled to the planetary gear 632 and rotating together with the driving shaft 530 may be disposed inside the ring gear 633.

[0215] The sun gear 631 may be coupled to the driving shaft 530 to rotate. The sun gear 631 may be formed as a separate member from the driving shaft 530, but may not be limited thereto, and the sun gear 631 may be integrally formed with the driving shaft 530.

[0216] The sun gear 631, the planetary gear 632, and the ring gear 633 may be formed as helical gears. When each gear is formed as the helical gear, noise may be reduced and a power transmission efficiency may be increased. However, the present disclosure may not be limited thereto, and the sun gear 631, the planetary gear 632, and the ring gear 633 may be formed as flat gears.

[0217] As an example of operation of the gear box 630, as the rotor rotates, when the sun gear 631 connected to the driving shaft 530 and the driving shaft 530 rotate, the planetary gear 632 gear-coupled to an outer circumferential surface of the sun gear 631 may rotate by being gear-coupled to and located between the ring gear 633 and the sun gear 631.

[0218] The planetary gear 632 may include a planetary gear shaft 6323 inserted at a spinning center of the planetary gear 632. The planetary gear shaft 6323 may rotatably support the planetary gear 632.

[0219] The reducer may further include a first carrier 6342 and a second carrier 6343 supporting the planetary gear shaft 6323. The planetary gear shaft 6323 may be supported by the second carrier 6343 at the front, and may be supported by the first carrier 6342 at the rear.

[0220] The drum rotating shaft 6341 may extend in a direction away from the motor from a rotation center of the second carrier 6343. The drum rotating shaft 6341 may be constructed as a separate component from the second carrier 6343 and may be coupled thereto to rotate together. On the other hand, the drum rotating shaft 6341 may extend from the second carrier 6343 to be integrally formed with the second carrier 6343.

[0221] The drum rotating shaft 6341 may be coupled to the drum to rotate the drum. As described above, the drum rotating shaft 6341 may be coupled to the drum via a connection body such as the bushing or may be directly coupled to the drum without the separate connector.

[0222] The drum rotating shaft 6341 may be supported by the first housing 610. The first housing 610 may include the first housing blocking body 611 for shielding the accommodation space of the second housing 620 and the first housing shaft receiving portion 612 extending from the first housing blocking body 611 in the direction away from the second housing 620 and accommodating the drum rotating shaft 6341 therein. The first bearing 660 and the second bearing 670 may be press-fitted to an inner circumferential surface of the first housing shaft receiving portion 612 to rotatably support the drum rotating shaft 6341.

[0223] The first housing 610 and the second housing 620 may be coupled to each other via a reducer fastening member 681. In addition, the reducer fastening member 681 may simultaneously extend through the first housing 610 and the second housing 620 and couple them to each other. In addition, the reducer fastening member 681 may simultaneously extend through the first housing 610, the second housing 620, and the rear plate 420 to couple the first housing 610 with the second housing 620, and at the same time, fix the reducer 600 to the rear plate 420.

[0224] The rear plate 420 may be formed as the thin steel plate. Accordingly, it may be difficult to secure rigidity for supporting all of the reducer 600, the motor 500 coupled to the reducer 600, and the drum 200 connected to the reducer 600. Therefore, the bracket 700 may be used to secure the rigidity of the rear plate 420 when the reducer 600 is coupled to the rear plate 420. The bracket 700 may be made of a material having a greater rigidity than the rear plate 420 and be coupled to the front surface or the rear surface of the rear plate 420.

[0225] The bracket 700 may be coupled to the front surface of the rear plate 420 to secure the rigidity for the reducer 600 to be coupled, and the reducer 600 may be coupled to the rear plate 420 and the bracket 700 at the same time. A fastening member such as a bolt may be used to couple the rear plate 420, the bracket 700, and the reducer to each other.

[0226] Further, to fix the reducer 600 to the rear plate 420, the reducer fastening member 681 used to couple the first housing 610 with the second housing 620 may be used. That is, the reducer fastening member 681 may extend through and be coupled to the second housing 620, the first housing, the rear plate 420, and the bracket 700 at a stroke. When the reducer fastening member 681 is coupled as such, because the rear plate 420 may be supported by the bracket 700 at the front and by the first housing 610 at the rear, the rear plate 420 may secure the rigidity even with the coupling of the reducer 600. However, the present disclosure may not be limited thereto, and first, only the first housing 610 and the second housing 620 may be coupled to each other using the reducer fastening member 681, and then the reducer 600 may be coupled to the rear plate 420 using a separate fastening member.

[0227] Further, the stator coupling portion 613 to which the motor 500 may be coupled may be formed at an outer side in the radial direction of the first housing 610. The stator coupling portion 613 may include a coupling groove recessed therein.

[0228] The stator 510 may be directly coupled to the rear plate 420, but may be coupled to the stator coupling portion 613. The stator 510 may include a fixing rib 512 disposed on an inner circumferential surface thereof to support the stator. The fixing rib 512 may be coupled to the stator coupling portion 613. The fixing rib 512 and the stator coupling portion 613 may be coupled to each other by a stator coupling pin 617.

[0229] Because the motor 500 is coupled to the reducer 600 while being spaced apart from the rear plate 420, the motor 500 and the reducer 600 may form one vibrating body. Therefore, even when the vibration is applied from the outside, the driving shaft 530 coupled to the rotor 520 and the drum rotating shaft 6341 connected to the reducer 600 may easily remain coaxial with each other.

[0230] The drum rotating shaft 6341 may have a risk that a direction of the shaft is biased by the vibration of the drum 200. However, because the motor 500 is coupled to the first housing 610 supporting the drum rotating shaft 6341, even when the axial direction of the drum rotating shaft 6341 is biased, an axial direction of the driving shaft 530 may also be similarly biased by the first housing 610. That is, the motor 500 may integrally move with the reducer 600, so that the drum rotating shaft 6341 and the driving shaft 530 may remain coaxial with each other even when a force is applied from the outside.

[0231] By the above-described coupling structure, efficiency and reliability of transmission of the power generated by the motor 500 to the drum 200 may be increased, and wear of the gear box 630, the reduction in the power transmission efficiency, the reduction in the durability and the reliability, and the like caused by the shaft misalignment between the drum rotating shaft 6341 and the driving shaft 530 may be prevented.

[0232] FIG. 10 is a view illustrating a base and a rear plate according to an embodiment of the present disclosure.

[0233] Referring to FIG. 10, the rear plate 420 may be positioned at the rear of the drum. The rear plate 420 may guide hot air discharged from the circulation flow channel 820 to the drum. That is, the rear plate 420 may be positioned at the rear of the drum to form the flow channel such that hot air is evenly supplied to the entire drum.

[0234] The rear plate 420 may include the rear panel 421 facing the drum rear surface, and the duct 423 recessed rearward from the rear panel 421 to form the flow channel. The duct 423 may be pressed rearward from the rear panel 421. The duct 423 may partially accommodate the rear surface of the drum therein.

[0235] The duct 423 may include an inlet portion 4233 positioned at the rear of the circulation flow channel and a flow portion 4231 positioned at the rear of the drum. The flow portion 4231 may accommodate a portion of the drum therein. The flow portion 4231 may accommodate the portion of the drum therein to form a flow channel disposed at the rear of the drum.

[0236] The flow portion 4231 may be formed in an annular shape to face the suction hole defined in the rear surface of the drum. The flow portion 4231 may be recessed from the rear panel 421. That is, a front portion of the flow portion 4231 may be opened and may form the flow channel together with the rear surface of the drum.

[0237] When the front portion of the flow portion 4231 is opened, hot air that as flowed to the flow portion 4231 may directly flow to the drum without passing through a separate component. Accordingly, heat loss may be prevented from occurring while hot air passes through the separate component. That is, the drying efficiency may be increased by reducing the heat loss of hot air.

[0238] The rear plate 420 may include the mounting portion 425 disposed radially inward of the flow portion

4231. The mounting portion 425 may provide a space in which the reducer 600 or the motor 500 is coupled. That is, the rear plate 420 may include the mounting portion 425 disposed on an inner side, and the flow portion 4231 formed in the annular shape on a radially outer side of the mounting portion 425.

[0239] Specifically, the flow portion 4231 may include a flow outer circumferential portion 4231a surrounding an inner space through which hot air flows from the outside. In addition, the flow portion 4231 may include a flow inner circumferential portion 4231b surrounding the inner space through which hot air flows from the inside. That is, the flow outer circumferential portion 4231a may form an outer circumference of the flow portion 4231 and the flow inner circumferential portion 4231b may form an inner circumference of the flow portion 4231.

[0240] In addition, the flow portion 4231 may include a flow recessed surface 4232 forming a rear surface of the flow channel through which hot air flows. The flow recessed surface 4232 may be disposed to connect the flow outer circumferential portion 4231a with the flow inner circumferential portion 4231b. That is, the space through which hot air discharged from the circulation flow channel 820 flows may be defined by the flow inner circumferential portion 4231b, the flow outer circumferential portion 4231a, and the flow recessed surface 4232.

[0241] In addition, because of the flow recessed surface 4232, hot air may be prevented from leaking rearward and may be guided toward the drum. That is, the flow recessed surface 4232 may refer to a recessed surface of the flow portion 4231.

[0242] The inlet portion 4233 may be positioned to face the circulation flow channel 820. The inlet portion may be positioned to face the blower 8231. The inlet portion 4233 may be recessed rearward from the rear panel 421 to prevent interference with the blower 8231. An upper side of the inflow portion 4233 may be connected to the flow portion 4231.

[0243] The laundry treating apparatus according to one embodiment of the present disclosure may include the connector 850 connected to the blower 8231. The connector 850 may guide hot air discharged from the blower 8231 to the flow portion 4231. The connector 850 may have a flow channel formed therein to guide hot air discharged from the blower 4231 to the flow portion 4231. That is, the connector 850 may form the flow channel connecting the blower 8231 with the flow portion 4231. A cross-sectional area of the flow channel formed inside the connector 850 may increase in a direction away from the blower 8231.

[0244] The connector 850 may be positioned to face the inlet portion 4233. The inlet portion 4233 may be formed to be recessed rearward to prevent interference with the connector 850. Further, an upper end of the connector 850 may partition the movable part 4231 from the inflow portion 4233. That is, hot air discharged from the connector 850 may be introduced into the flow portion 4231, but may be prevented from flowing into the inlet portion 4233.

[0245] The connector 850 may evenly supply hot air to the flow portion 4231. The connector 850 may be formed such that a width thereof increases as a distance from the blower 8231 increases. The upper end of the connector 850 may be positioned along a circumferential extension line of the flow outer circumferential portion 4231a.

[0246] Accordingly, hot air discharged from the connector 850 may be supplied throughout the flow portion 4231 without flowing to the inlet portion 4233. The connector 850 may prevent hot air from being concentrated at one side of the flow portion 4231 to evenly supply hot air into the drum. Therefore, the drying efficiency of the laundry is increased.

[0247] The connector 850 may be formed such that the width thereof gradually increases toward an upstream such that a speed of hot air flowing along the connector 850 may be reduced in a flow direction. That is, the connector 850 may function as a diffuser for adjusting the speed of hot air. The connector 850 may prevent hot air from being intensively supplied only to a specific portion of the drum by reducing the speed of hot air.

[0248] Because of the shape of the connector 850 described above, the inlet portion 4233 disposed to face the connector 850 and prevented from interfering with the connector 850 may also be formed such that a width thereof increases in a direction away from the blower 8231. Because of the shape of the inlet portion 4233, the duct 423 may have an overall shape like '9' when viewed from the front.

[0249] Because the drum is constructed to rotate during the drying cycle, the drum may be spaced apart from the flow portion 4231 by a predetermined distance. Hot air may leak through the separation space.

[0250] Accordingly, the laundry treating apparatus may further include the seal 450 for preventing hot air from leaking into the separation space between the drum and the flow portion 4231. The seal 450 may be positioned along a circumference of the flow portion 4231.

[0251] The seal 450 may include the first seal 451 disposed along an outer circumference of the flow portion 4231. The first seal 451 may be disposed between the drum and the outer circumference of the flow portion 4231. In addition, the first seal 451 may be disposed to be in contact with both the drum rear surface 220 and the rear plate 420, thereby more effectively preventing the leakage.

[0252] In one example, the first seal 451 may be disposed to be in contact with a front surface of the connector 850. In addition, the first seal 451 may be in contact with the upper end of the connector 850. The connector 850 may form the flow channel through which hot air flows together with the flow portion 4231. Accordingly, the first seal 451 may be disposed to be in contact with the connector 850 to prevent hot air from leaking between the drum and the connector 850.

[0253] The seal 450 may include the second seal 452 disposed along an inner circumference of the flow portion 4231. The second seal 452 may be disposed between the drum and the inner circumference of the flow portion 4231. In addition, the second seal 452 may be disposed to be in contact with both the drum rear surface 220 and the rear plate 420. The second seal 452 may prevent hot air flowing along the flow portion 4231 from leaking toward the mounting portion 425.

[0254] Because the drum 200 rotates during the operation of the laundry treating apparatus, continuous friction is applied to the seal 450 by the drum rear surface 220. Therefore, it is preferable that the seal 450 is made of a material that may seal the space between the drum rear surface 220 and the flow portion 4231 without deteriorating in performance even with the frictional force and the frictional heat generated based on the rotation.

[0255] FIG. 11 is a view illustrating a coupling structure of a rear plate, a reducer, and a motor according to an embodiment of the present disclosure.

[0256] Referring to FIG. 11, the reducer 600 may be supported by the rear plate 420, and the motor 500 may be coupled to the reducer 600. That is, the rear plate 420 may support both the reducer 600 and the motor 500.

[0257] The motor 500 that provides the rotational power and the reducer 600 that reduces the power of the motor and transmits the reduced power to the drum may be positioned at the rear of the rear plate 420.

[0258] The reducer 600 may be installed in the rear plate 420 to be positioned inside the duct 423. The reducer 600 may be positioned radially inward of the flow portion 4231 so as to prevent interference with the flow portion 4231.

[0259] The gear device inside the reducer 600 may be damaged by heat of hot air flowing along the flow portion 4231. Accordingly, the flow portion 4231 and the reducer 600 may be spaced apart from each other by a predetermined distance.

[0260] The reducer 600 may be coupled to extend through the rear plate 420. Therefore, the reducer 600 may be connected to the drum positioned in front of the rear plate 420.

[0261] The stator 510 may be coupled to the reducer 600. The stator 510 may be coupled to the reducer 600 to be installed to be spaced apart from the rear plate 420. In this regard, the reducer 600 may be positioned between the drum and the motor to support the drum and the motor to be spaced apart from the rear plate 420. That is, the reducer 600 may be a center supporting the drum and the motor.

[0262] In one example, the stator 510 may include a main body 511 formed in a ring shape, the fixing rib 512 extending from an inner circumferential surface of the main body 511 and coupled to the stator coupling portion 613 of the reducer, teeth 514 extending from an outer circumferential surface along a circumference of the main body 511 to wind a coil, and a pole shoe 515 disposed at a free end of each of the teeth 514 to prevent the coil from deviating.

[0263] The rotor 520 may include a rotor body 521 formed in a hollow cylindrical shape. In addition, the rotor 520 may include an installation body 522 recessed forward from a rear surface of the rotor body 521. The rotor 520 may have the permanent magnet disposed along an inner circumferential surface of the rotor body 521.

[0264] The rotor 520 may be coupled to the driving shaft 530 to transmit the rotational power of the rotor 520 to the outside via the driving shaft 530. The driving shaft 530 may be connected to the rotor 520 via the washer 540.

[0265] In addition, the motor 500 may include the washer 540 supporting the driving shaft 530. The washer 540 may include a washer coupling body 541 coupled to the rotor. The washer coupling body 541 may be formed in a disk shape.

[0266] The washer 540 may include an accommodating body 542 accommodated in the rotor. The accommodating body 542 may protrude rearward from the washer coupling body 541. The washer 540 may include the shaft support hole 543 extending through a center of the accommodating body 542. The driving shaft 530 may be inserted into the shaft support hole 543 to be supported by the washer 540.

[0267] In addition, the washer 540 may include the washer coupling hole 5412 defined to extend through the washer coupling body 541. In addition, the installation body 522 may include a rotor coupling hole 526 defined at a location corresponding to the washer coupling hole 5412. That is, the washer 540 and the rotor 520 may be coupled to each other by a coupling member that simultaneously extends through the washer coupling hole 5412 and the rotor coupling hole 526 to couple them to each other. That is, the washer 540 and the rotor 520 may be coupled to each other to rotate together.

[0268] In addition, the washer 540 may include the washer coupling protrusion 5411 protruding rearward from the washer coupling body 541. In addition, the installation body 522 may include a washer protrusion accommodating hole 525 defined to correspond to the washer coupling protrusion 5411. The washer coupling protrusion 5411 may be inserted into the washer protrusion accommodating hole 525 to support the coupling between the washer 540 and the rotor 520.

[0269] In addition, the rotor 520 may include a rotor installation hole 524 defined at a center of the installation body 522. The rotor installation hole 524 may accommodate the accommodating body 542 therein. Accordingly, the washer 540 may rotate together with the driving shaft 530 by the rotor 520 and may firmly support the coupling between the driving shaft 530 and the rotor 520. Accordingly, durability and reliability of the entire motor 500 may be secured.

[0270] FIG. 12 is a rear view illustrating a coupling structure of a reducer and a stator according to an embodiment of the present disclosure.

[0271] The stator 510 may include the main body 511 fixed to the reducer 600 and formed in the ring shape, the fixing rib 512 extending from the inner circumferential surface of the main body 511 and coupled to the stator fastening hole 615 of the reducer, the teeth 514 extending from the outer circumferential surface along the circumference of the main body 511 to wind the coil, the pole shoe 515 disposed at the free end of each of the teeth 514 to prevent the coil from deviating, and a terminal (not shown) for controlling a current to be supplied to the coil.

[0272] The stator 510 may include an accommodation space 513 defined inside the main body 511 by extending through the main body 511. The fixing rib 512 may include a plurality of fixing ribs spaced apart from each other at a predetermined angle with respect to the accommodation space 513 inside the main body 511, and a fixing rib hole 5121 in which a fixing member is installed may be defined inside the fixing rib 512, so that the fixing rib hole 5121 and the stator fastening hole 615 of the reducer may be coupled to each other using the fixing member such as a pin.

[0273] When the stator 510 is directly coupled to the reducer 600, a portion of the reducer 600 may be accommodated in the stator 510. In particular, when the reducer 600 is accommodated in the stator 510, an overall thickness of the driver including both the reducer and the motor may be reduced to further expand a volume of the drum.

[0274] To this end, the reducer 600 may have a diameter smaller than a diameter of the main body 511. That is, the greatest diameter of the first housing 610 and the second housing 620 may be smaller than the diameter of the main body 511. Accordingly, at least a portion of the reducer 600 may be accommodated in the main body 511. However, the stator coupling portion 613 may extend to overlap the fixing rib 512 in the housing of the reducer. Accordingly, the stator coupling portion 613 may be coupled to the fixing rib 512, and portions of the first housing and the second housing 620 may be positioned inside the main body 511.

[0275] FIG. 13 is a view illustrating coupling of a reducer and a motor according to an embodiment of the present disclosure.

[0276] The stator 510 may be coupled to the reducer 600. At least a portion of the reducer may be accommodated in the main body 511 by being coupled to the stator coupling portion 613 protruding outward from the housing of the reducer 600. Accordingly, a center of the main body 511 and centers of the driving shaft 530 and the reducer 600 may always remain coaxial with each other.

[0277] In one example, the rotor 520 may be disposed to accommodate the stator 510 therein while being spaced apart from the pole shoe 515 by a predetermined distance. Because the driving shaft 530 is fixed to the reducer 600 accommodated in the main body 511, a gap G1 between the rotor 520 and the stator 510 may always be maintained.

[0278] Therefore, the rotor 520 and the stator 510 may be prevented from colliding with each other or the stator 510 may be prevented from rotating while being temporarily misaligned, thereby preventing noise or unnecessary vibration from occurring.

[0279] In one example, all of a virtual first diameter line K1 extending through the center of the reducer 600 and the center of the driving shaft 530, a virtual second diameter line K2 extending through the center of the main body 511, and a virtual third diameter line K3 extending through the center of the rotor 520 may be disposed at the center of rotation of the reducer 600.

[0280] Accordingly, because the reducer 600 itself becomes the rotational center of the driving shaft 530 and the stator 510 is directly fixed to the reducer 600, the driving shaft 530 may be blocked from being misaligned with respect to the reducer 600. As a result, the reliability of the reducer 600 may be guaranteed.

[0281] FIG. 14 illustrates a situation in which the laundry may be damaged or shrink during a drying cycle process.

[0282] Referring to (a) in FIG. 14, the fiber L forming the laundry may have a predetermined thickness. For example, when the fiber L is in a dry state, a diameter of the fiber L may be a first diameter D 1.

[0283] Because the fiber L is made of a material that may be expanded or compressed, an air gap C that may contain air may be defined in the fiber L.

[0284] When the laundry is submerged in water W while performing the washing cycle, the fiber L itself may stay water, but water may be filled in the air gap C).

[0285] Referring to (b) in FIG. 14, even when the laundry is taken out of water W, water may remain in the air gap C. In particular, because the fiber L itself serves as a capillary tube, even when the fiber L is disposed in the air, the air gap C may be filled with water W.

[0286] In one example, when the laundry is withdrawn while being immersed in water W, the laundry may partially shrink by a surface tension of the water or the like. Accordingly, when the fiber L is immersed in water W and then taken out, the diameter of the fiber may be reduced to a second diameter D2 smaller than the first diameter D 1.

[0287] Referring to (c) in FIG. 14, when the drying cycle is performed in the state in which the diameter of the fiber L is reduced, water contained in the air gap C may be evaporated to define an empty space inside the air gap C.

[0288] A contractile force and a restoring force for filling the suddenly recreated air gap C may occur on the fiber L. As a result, the fiber L may shrink inwards.

[0289] Referring to (d) in FIG. 14, when an external force F is applied to the fiber L by the rotation of the drum in the state in which the air gap C is recreated inside the fiber L, the air gap C may be removed. In other words, when the fiber L is applied with the contractile force for filling the air gap C or the falling impact F, the air gap C may be removed.

[0290] Referring to (e) in FIG. 14, when the air gap C is removed, the fiber L may further shrink to that extent, and the diameter of the fiber L may become a third diameter D3 smaller than the second diameter D2.

[0291] As a result, the diameter of the fiber L of the laundry may be reduced from the first diameter D1 to the third diameter D3 in the process of drying the laundry with the laundry treating apparatus according to the present disclosure.

[0292] FIG. 15 illustrates a change in volume of laundry based on a change in the diameter of the fiber L.

[0293] Referring to (a) in FIG. 15, a length of a portion of the laundry in which the fibers L are combined may be a first length T1, and a thickness of the portion of the laundry may be a first diameter D1.

[0294] Referring to (b) in FIG. 15, when the fiber L shrinks as the air gap C inside is removed, the length of the portion of the laundry may be reduced to a second length T2 smaller than the first length, and the thickness of the portion of the laundry may also become reduced to a third diameter D2 smaller than the first diameter D1.

[0295] As a result, both the length and the thickness of the entire laundry may be reduced during the drying cycle process compared to those in a state before the drying.

[0296] Furthermore, as the laundry is dried to be closer to a dry laundry state, fluff or the like may occur on a surface of the laundry even by small friction.

[0297] In addition, when the laundry is not dried and close to a wet laundry state, and thus has a weight greater than an original weight thereof, the frictional force may be further increased when the laundry items are rubbed against each other or the laundry is rubbed against the drum, so that the surface of the laundry may be worn out.

[0298] To prevent such problem, the laundry treating apparatus according to the present disclosure may perform the drying cycle to prevent not only the shrinkage of the laundry but also the wear of the laundry.

[0299] FIG. 16 illustrates an embodiment in which a laundry treating apparatus according to the present disclosure performs a drying cycle.

[0300] (a) in FIG. 16 illustrates a control step constituting the drying cycle.

[0301] The control panel of the laundry treating apparatus according to the present disclosure may execute arbitrary drying course and option for performing the drying cycle for removing moisture from the laundry accommodated in the drum 200.

[0302] The control panel receives a selection command for selecting one of arbitrary drying courses and options via the input unit 118, and an execution command for executing the selected course and option.

[0303] The arbitrary drying course and option may include an algorithm that operates the driver and the heat exchanger assembly 900 to supply hot air into the drum 200 while rotating the drum 200, thereby performing the drying cycle.

[0304] For example, the arbitrary drying courses and options may commonly include an air supply step S1 of supplying air to the drum 200, a rotation step S2 of rotating the drum 200 during the air supply step S1 to expose air to the laundry, and a temperature control step S3 of controlling the temperature inside the drum 200 or the temperature of the refrigerant.

[0305] The air supply step S1, the rotation step S2, and the temperature control step S3 may be simultaneously performed during the drying cycle.

[0306] The air supply step S1 may include supplying hot air to the drum 200 by operating the heat exchanger assembly 900 and the circulation flow channel fan 950. In addition, the air supply step S1 may include supplying relatively low-temperature air into the drum 200 by operating only the circulation flow channel fan 950 without operating the heat exchanger assembly 900.

[0307] In one example, the rotation step S2 and the temperature control step S3 may be performed to protect the laundry.

[0308] Specifically, the rotation step S2 and the temperature control step S3 may be performed to perform the arbitrary drying course and option for performing the drying cycle. In addition, the rotation step S2 and the temperature control step S3 may be performed to protect the laundry such as prevention of the damage to laundry, prevention of the shrinkage of laundry, and the like.

[0309] For example, when the arbitrary drying course and option have functions of preventing the damage to the laundry and preventing the shrinkage of the laundry, the rotation step S2 and the temperature control step S3 for protecting the laundry may be performed.

[0310] In addition, when there is a fabric protection course for protecting the laundry, when the fabric protection course is performed, the rotation step S2 and the temperature control step S3 for protecting the laundry may be performed.

[0311] Hereinafter, the air supply step S1, the rotation step S2, and the temperature control step S3 for protecting the laundry will be described.

[0312] The air supply step S 1, the rotation step S2, and the temperature controlling step S3 may be performed when the arbitrary drying course and option are performed, or when there is the fabric protection course, may be performed when the fabric protection course is performed.

[0313] (b) in FIG. 16 illustrates a control method of the air supply step S 1.

[0314] In addition, the air supply step S1 may include stopping the circulation flow fan 950 and operating the pump 861 when the first heat exchanger 910 is washed with water collected in the water collector 860. As a result, the air supply step S1 may include a period in which air is not temporarily supplied to the drum 200.

[0315] In one example, because the driver is directly connected to the drum 200, the rotation speed and the rotation direction of the drum 200 may be changed in the rotation step S2. That is, when the air supply step S1 is performed, the control panel may drive the motor 500 to rotate the drum 200 via the reducer 600. The motor 500 may change the rotation speed and the rotation direction of the drum 200 based on the algorithm set in the arbitrary drying course and option.

[0316] Generally, the air supply step S1 may be divided into a preheating period A1, a constant-rate drying period A2, a falling-rate drying period A3, and a cooling period A4 based on at least one of a state of the heat exchanger assembly 900, an operation time of the heat exchanger assembly 900, the temperature of air discharged to the circulation flow channel 820, the dryness of the laundry, and an operation time of the motor 500.

[0317] (c) in FIG. 16 illustrates a control method of the rotation step S2.

[0318] The rotation step S2 may include a high-speed period H for rotating the drum 200 at the first speed at which the laundry may rotate while being attached to the inner wall of the drum 200, and a low-speed period L for rotating the drum 200 at the second speed lower than the first speed such that the laundry items are separated from the inner wall of the drum 200 and stirred whenever the drum 200 rotates.

[0319] The first speed may correspond to a speed of rotating the drum 200 to generate a centrifugal force of 1G or greater on the laundry or a higher speed, and the second speed may correspond to a speed of rotating the drum 200 to generate the centrifugal force of 1G or smaller.

[0320] In the rotation step S2, all of the preheating period A1, the constant-rate drying period A2, the falling-rate drying period A3, and the cooling period A4 may be performed.

[0321] In addition, the rotation step S2 may be interrupted for a predetermined time in at least one of the preheating period A1, the constant-rate drying period A2, the falling-rate drying period A3, and the cooling period A4, but the air supply step S 1 may not be interrupted in an entirety of one of the preheating period A1, the constant-rate drying period A2, the falling-rate drying period A3, and the cooling period A4.

[0322] The rotation step S2 may place various combinations of the high-speed period H and the low-speed period L for at least one of the prevention of the damage to the laundry, the prevention of the shrinkage of the laundry, or the drying of the laundry in the preheating period A1, the constant-rate drying period A2, the falling-rate drying period A3, and the cooling period A4.

[0323] Accordingly, the rotation step S2 may prevent the friction or the wear of the laundry by attaching the laundry to the drum 200 via the high-speed period H, may perform the drying of the laundry via the low-speed period L, and may reduce the mechanical force applied to the laundry to prevent the shrinkage of the laundry when rotating the drum at a speed lower than the second speed.

[0324] In addition, the rotation step S2 may be divided into a prevention period S21, a protection period S22, a separation period S23, and an exposure period S24 based on the function of protecting the fabric.

[0325] The prevention step S21 may include the high-speed period H for rotating the drum at the speed equal to or higher than the first speed H1 at which the laundry rotates while being attached to the inner wall of the drum. That is, in the prevention step, the laundry rotates while being attached to the drum 200, thereby preventing the friction between the laundry items and the friction between the laundry and the drum 200.

[0326] In addition, the prevention step S21 may further include the low-speed period L for rotating the drum at the speed lower than the first speed H1. Accordingly, in the prevention step S21, the high-speed period H and the low-speed period L may be periodically disposed. Accordingly, the prevention step S21 may stir the laundry via the low-speed period L, thereby preventing over-drying of only a specific area of the laundry in the high-speed period H and inducing the laundry to be evenly dried.

[0327] That is, in the prevention step S21, the low-speed period L of the laundry may be included to not only protect the laundry, but also dry the laundry.

[0328] In the prevention step S21, one of a pulling motion and a hanging motion to be described later may be performed.

[0329] The prevention step S21 may be performed in at least one of the preheating period A1, the constant-rate drying period A2, and the falling-rate drying period A3. Because all of the preheating period A1, the constant-rate drying period A2, and the falling-rate drying period A3 need not only the drying of the laundry but also the protection of the laundry, the prevention step S21 may be performed at least once in each of the preheating period A1, the constant-rate drying period A2, and the falling-rate drying period A3.

[0330] The preheating period A1 ends when the temperature of the refrigerant reaches a specific temperature TC from a start temperature, the constant-rate drying period A2 ends when the dryness level reaches a set value c or a duration of the constant-rate drying period A2 reaches a reference duration, and the falling-rate drying period A3 ends when the dryness level reaches a completion value e.

[0331] In one example, in the prevention step S21 performed in the preheating period A1, a ratio of the high-speed period H to the low-speed period L may be set to be longer than in the prevention step S22 performed in the constant-rate drying period A2 or the falling-rate drying period A3. Because the laundry is in the wet laundry state and thus is shrinking relatively much in the preheating period A1, it is necessary to expand the laundry as much as possible by arranging a lot of the high-speed periods H.

[0332] In addition, the prevention step S22 performed in the constant-rate drying period A2 or the falling-rate drying period A3 may further increase the efficiency of drying the laundry because a ratio of the low-speed period L is higher than in the preheating period A1.

[0333] In one example, the rotation step S2 may perform the exposure step S24 of exposing the laundry to air by rotating the drum 200 at a speed higher than a limit speed and lower than the first speed H1.

[0334] The exposure step S24 may be regarded as a step for drying the laundry regardless of the protection of the laundry. For example, the exposure step S24 may be regarded as a step in which a tumbling motion, a flipping motion, and the like are performed.

[0335] In one example, the prevention step S21 may be performed after the completion of the exposure step S24 in the constant-rate drying period A2 or the falling-rate drying period A3. As the laundry is dried in the exposure step S24 and becomes closer to the dry laundry state, the fluff is generated on the surface of the laundry or the laundry is easy to be damaged by the friction, so that the prevention step S21 may be performed after the exposure step S24 to minimize the friction between the laundry items and the friction between the laundry and the drum.

[0336] The protection step S22 may be regarded as a step including the low-speed period L for rotating the drum at the speed equal to or lower than the second speed L1. Specifically, the protection step S22 may include a limit period of rotating the drum at a limit speed L3 at which the laundry is blocked from ascending higher than the drum center O.

[0337] That is, the protection step S22 may correspond to reducing the falling impact applied to the laundry and also preventing the friction between the drum and the laundry.

[0338] The protection step S22 may prevent the shrinkage of the laundry by maintaining the air gap C in the fiber inside the laundry by minimizing the falling impact of the laundry. In addition, the protection step S22 may perform the drying of the laundry by allowing the laundry items to be stirred in the drum 200 while preventing the shrinkage of the laundry.

[0339] The protection step S22 may correspond to performing a rolling motion.

[0340] In addition, because the protection step S22 is performed to maintain the air gap C of the laundry, the protection step S22 may be performed in the falling-rate drying period A3 in which drying has been considerably performed.

[0341] In one example, the rotation step S2 may further include a separation step S23 of periodically repeating a process of rotating the drum at the first speed H1 or the second speed L1, then rotating the drum at the increased speed, and then rotating the drum at the decreased speed.

[0342] The separation step S23 may separate the wet laundry and the dry laundry from each other using an inertial force difference of the laundry items based on the dryness. Therefore, when the separation step S23 is performed in the constant-rate drying period A2, the wet laundry may be separated from the dry laundry and be intensively dried, and the dry laundry may be prevented from being over-dried.

[0343] The separation step S23 may correspond to performing a shaking motion.

[0344] Because the drying of the laundry has progressed to a significant extent, the laundry drying period A3 is a period in which it is more important that the laundry is dried evenly. Therefore, the separation step S23 may be performed before entering the falling-rate drying period A3 to allow the laundry items to be separated for each dryness level, thereby significantly reducing the duration of the falling-rate drying period A3.

[0345] In the falling-rate drying period A3, the protection step S22 may be performed, and then the prevention step S21 may be performed. This is because, when the dryness of the laundry is increased in the protection step S22, the friction between the laundry and the drum may need to be prevented, the stirring and the drying of the laundry may be performed in the low-speed period L also in the prevention step S21, and an area of the laundry that is not attached to the inner wall of the drum 200 may also be dried in the high-speed period H.

[0346] In the falling-rate drying period A3, when the dryness level reaches a specific value d, the prevention step S21 may be performed.

[0347] As a result, the laundry treating apparatus according to the present disclosure may appropriately select or combine the prevention step S21, the protection step S22, and the separation step S23 in each period of the air supply step S1, thereby preventing the wear of the laundry, preventing the shrinkage of the laundry, and uniformly drying the laundry.

[0348] For example, in the preheating period A1, the pulling motion may be performed to prevent the shrinkage of the wet laundry, the laundry may be dried by the tumbling motion in the constant-rate drying period A2, the wear of the laundry may be prevented by the hanging motion, the laundry may be evenly dried by performing the shaking motion, which will be described later, the rolling motion may be performed to prevent the shrinkage of the laundry, and the hanging motion may be performed to prevent the fluff from being generated on the laundry.

[0349] For each period of the air supply step S 1, based on a type of the course and the option, the rotation step S2 may appropriately select and perform the pulling motion, the hanging motion, the tumbling motion, the flipping motion, the rolling motion, and a stop motion, which will be described later.

[0350] In addition, the laundry treating apparatus according to the present disclosure may apply all of the motions when performing the rotation step S2 in the air supply period S 1.

[0351] Alternatively, the laundry treating apparatus according to the present disclosure may selectively perform only a specific motion among the drum motions in a specific period.

[0352] For example, in the laundry treating apparatus according to the present disclosure, when specific drying course and option are performed, only a few of performing the pulling motion in the preheating period A1, performing the tumbling motion, and the hanging motion or the shaking motion in the constant-rate drying period A2, performing the rolling motion and the hanging motion in the falling-rate drying period A3, and performing the stop motion in the cooling period A4 may be selected and performed. That is, the laundry treating apparatus according to the present disclosure may perform the pulling motion in the preheating period A1 and perform the tumbling motion in the remaining periods when the rotation step S2 is performed.

[0353] (d) in FIG. 16 shows a control method of the temperature control step S3.

[0354] The temperature control step S3 is a step of controlling the operation of the compressor 930 to control the temperature inside the drum 200 or the temperature of hot air supplied to the drum 200. The temperature control step S3 may control the compressor 930 differently in the preheating period A1, the constant-rate drying period A2, the falling-rate drying period A3, and the cooling period A4.

[0355] The temperature control step S3 may be a step of controlling the temperature inside the drum 200 not to exceed a limit temperature T_limit at which the laundry may be damaged. To this end, the temperature control step S3 may include a first step S31 of rotating the compressor 930 at a heating RPM rpm_h, a second step S32 of rotating the compressor 930 at a constant-rate RPM rpm_cr lower than the heating RPM, and a third step S33 of rotating the compressor 930 at a falling-rate RPM rpm-fr lower than the constant-rate RPM (see FIG. 17).

[0356] In other words, the temperature control step S3 may sequentially reduce the operating RPM of the compressor 930 while performing the air supply step S1 to adjust the temperature of the refrigerant, thereby controlling the temperature inside the drum 200 not to exceed the limit temperature T_limit. Accordingly, the laundry may be prevented from being over-heated and damaged by hot air.

[0357] FIG. 17 illustrates internal states of the heat exchanger assembly 900 and the drum 200 when the air supply step S1 is performed.

[0358] The preheating period A1 may be divided based on an operation time or an operation condition of the compressor 930. Specifically, when the drying cycle starts, the compressor 930 may start operating to compress the refrigerant and discharge the refrigerant to the second heat exchanger 920. In this regard, a period for the temperature of the refrigerant discharged from the compressor 930 to reach a specific temperature TC from a start temperature T0 may be set as the preheating period A1.

[0359] The specific temperature TC may correspond to a maximum temperature of the refrigerant that may be discharged from the compressor 930 during the drying cycle. For example, it may correspond to 90°C.

[0360] Alternatively, the specific temperature TC may correspond to a temperature at which the refrigerant discharged from the compressor 930 may be heated by the second heat exchanger 920 to maximum.

[0361] Alternatively, a period until an operating HZ of the compressor 930 reaches one of a heating HZ or a maximum HZ may be set as the preheating period A1.

[0362] Alternatively, a period until reaching an initial duration after the compressor 930 is operated may be set as the preheating period A1.

[0363] In one example, the preheating period A1 may be set to a period until a temperature air flowing through the circulation flow channel 930 reaches a heating temperature.

[0364] The heating temperature may correspond to 40°C as a temperature at which the moisture of the laundry may be dried more than a naturally dried amount. That is, a period until air discharged to the circulation flow channel 930 as the heat exchanger assembly 900 operates reaches the heating temperature may be firmly determined as the preheating period A1.

[0365] As a result, the preheating period A1, as the initial period of the drying cycle, may be referred to as a period in which, as the compressor 930 starts operating to heat the second heat exchanger 920 to a specific temperature, the temperature inside the drum 200 or the temperature of air flowing through the circulation flow channel section 930 is increased and prepared until sufficiently drying the moisture in the laundry.

[0366] In the preheating period A1, continuously heated air may be introduced into the drum 200 because of the operation of the compressor 930 and the circulation flow fan 950. As a result, the temperature inside the drum 200 may gradually increase and the moisture may be evaporated from the laundry.

[0367] In addition, because the rotation step S2 is performed in the preheating period A1 and the laundry rotates in the drum 200, air may be evenly exposed to the surface of the laundry. As a result, the laundry may be dried also in the preheating period A1.

[0368] After the preheating period A1, the constant-rate drying period A2 may start.

[0369] The preheating period A1 and the constant-rate drying period A2 may be divided from each other based on the dryness level of the laundry.

[0370] Specifically, the laundry treating apparatus according to the present disclosure may include a dryness sensor capable of measuring the dryness of the laundry. The dryness sensor may be in contact with the laundry inside the drum 200. The dryness sensor may be mounted on the front plate 410, and may be disposed under the inner circumferential surface of the front gasket 413.

[0371] The dryness sensor may be constructed as an electrode sensor that is in contact with the laundry and measures a resistance value or the like of the laundry to calculate the dryness of the laundry.

[0372] In one example, the dryness sensor may be formed in any shape as long as the dryness of the laundry may be measured.

[0373] When the dryness of the laundry reaches a reference value a, it may be set that the preheating period A1 is terminated and the constant-rate drying period A2 is entered. For example, the reference value a may correspond to 20%.

[0374] The constant-rate drying period A2 may be a period in which hot air is sufficiently introduced into the drum 200 and the moisture is dried from the laundry in a full-scale.

[0375] In the constant-rate drying period A2, as the moisture is continuously evaporated in a large amount from the laundry, evaporation heat may be absorbed by hot air. Accordingly, the internal temperature of the drum 200 may be increased to a smaller extent than in the preheating period A1 or may be maintained at a predetermined level in the constant-rate drying period A2.

[0376] The internal temperature of the drum 200 or the temperature of air discharged to the circulation flow channel 930 may be maintained at a drying temperature level, and the drying temperature may correspond to the specific temperature TC that is an end temperature of the preheating period A1.

[0377] That is, although hot air with the temperature higher than the specific temperature TC is supplied into the drum 200 in the constant-rate drying period A2, the temperature inside the drum 200 may be maintained at the temperature equal to or lower than the specific temperature TC.

[0378] Also in the constant-rate drying period A2, the rotation step S2 may be performed to continuously vary the location of the laundry disposed in the drum 200, so that the laundry may be evenly exposed to hot air. Accordingly, a greater amount of moisture may be vaporized from the laundry 200 than when the drum 200 is stopped.

[0379] After the constant-rate drying period A2, the falling-rate drying period A3 may be performed.

[0380] In the process of performing the constant-rate drying period A2, the evaporation amount of moisture in the laundry may gradually decrease. Accordingly, as the amount of moisture contained in the laundry decreases, the temperature of hot air introduced into the drum 200 may not be sufficiently lowered. As a result, the temperature inside the drum 200 may become higher than the drying temperature by the supplied hot air. Accordingly, the falling-rate drying period A3 may be set to be entered from a time point when the temperature inside the drum 200 becomes higher than the drying temperature.

[0381] The falling-rate drying period A3 may be set to be entered when the dryness of the laundry reaches the set value c while the constant-rate drying period A2 is in progress. When the dryness calculated as the laundry comes into contact with the dryness sensor that is constructed as the electrode sensor reaches the set value c, the falling-rate drying period A3 may be entered.

[0382] The setting value c may be set to 50% or greater, and may be, for example, set to 80%. This is because, when the dryness of the laundry is 50% or greater, because the amount of moisture discharged from the laundry becomes smaller, the evaporation heat is also reduced, and thus the temperature of hot air is not lowered.

[0383] The rotation step S2 may also be performed in the falling-rate drying period A3, so that the laundry that has not been dried completely in the drum 200 is exposed to hot air. Accordingly, a portion that has been completely dried in the laundry is covered by the inner wall of the drum 200 or other laundry items by the rotation of the drum 200, and thus is prevented from being over-dried.

[0384] In addition, a portion that has not been dried completely in the laundry may be exposed inside the drum 200 by the rotation of the drum 200, and thus may be prevented from not being dried.

[0385] After the falling-rate drying period A3, the cooling period A4 may be performed. The cooling period A4 may correspond to a period in which although the drying of the laundry is completed, the inside of the drum 200 is not yet cooled, and thus the user may be injured or the like.

[0386] When the dryness of the laundry reaches the completion value e while the falling-rate drying period A3 is in progress, it may be set to activate the cooling period A4. For example, the completion value e may correspond to a value equal to or greater than 90%.

[0387] The compressor 930 may not operate and the motor 500 and the circulation flow channel fan 950 may operate in the cooling period A4. Accordingly, cold air having a temperature lower than that of the hot air may be supplied to the drum 200, and the cold air may evenly come into contact with the laundry rotating inside the drum 200 and thus the laundry may be cooled.

[0388] The cooling period A4 may be terminated when the temperature inside the drum 200 reaches a safe temperature. The safe temperature may correspond to 20 degrees as a temperature at which hot air is not exposed to the user.

[0389] The rotation step S2 may also be performed in the cooling period A4 to expose all areas of the laundry to cold air. Accordingly, the laundry may not only be cooled, but also air inside the drum 200 may be mixed with cold air to be cooled by the movement of the laundry.

[0390] In one example, a waiting step of waiting as it is for a predetermined time after the rotation step S2 ends may be further performed in the cooling period A4. That is, in a last period of the cooling period A4, only the circulation flow channel fan 950 may operate without the rotation of the drum 200 to allow only cold air to flow into the drum 200 or the circulation flow channel fan 950 may also not operate and the laundry may be left to be naturally cooled.

[0391] In one example, the laundry treating apparatus according to the present disclosure may further perform the temperature control step S3 during the air supply step S1 and the rotation step S2.

[0392] The temperature control step S3 is a step of preventing the temperature inside the drum 200 from rising to a temperature equal to or higher than a maximum temperature Tmax. The maximum temperature may be a temperature at which the drying and sterilization of the laundry are performed, but the laundry is prevented from being damaged and deformed by high heat.

[0393] For example, the maximum temperature Tmax may be set to a temperature equal to or lower than 60°C.

[0394] The temperature control step S3 may be performed in an entire period of the air supply step S1.

[0395] The temperature control step S3 may control the operating RPM of the compressor 930 and the temperature of the refrigerant discharged from the compressor 930 such that a temperature of one of air discharged from the inside of the drum 200 or air introduced does not exceed the maximum temperature Tmax.

[0396] In the temperature control step S3, the temperature of the refrigerant discharged from the compressor 930 may be controlled not to exceed the limit temperature set to be reduced by a certain temperature over time from the highest temperature Th of the refrigerant.

[0397] The limit temperature T_limit of the refrigerant is set to decrease during an entire period from the preheating period A1 to the cooling period A4. As a result, because the temperature of the refrigerant is lowered for each section, the temperature of the drum 200 may be controlled not to exceed the maximum temperature Tmax.

[0398] The limit temperature T_limit of the refrigerant may vary over time, and may decrease as time elapses.

[0399] In the temperature control step S3, the compressor 930 may be controlled such that the temperature of the discharged refrigerant does not exceed the limit temperature set at each moment.

[0400] In the temperature control step S3, the limit temperature T_limit of the falling-rate drying period may be lower than the limit temperature T_limit of the constant-rate drying period, and the limit temperature T_limit of the constant-rate drying period may be set to be lower than the limit temperature T_LIMIT of the falling-rate drying period.

[0401] In the temperature control step S3, the compressor 930 may be controlled in the RPM to control the temperature of the refrigerant, thereby controlling the temperature of the drum.

[0402] Specifically, when the preheating period A1 proceeds, the first step S31 may be performed. The compressor 930 may operate by accelerating to the heating RPM rpm_H, and the heating RPM may correspond to a maximum RPM that the compressor 930 may reach during the drying cycle. Accordingly, the temperature of the refrigerant may be rapidly increased in the preheating period A1.

[0403] When the preheating period A1 is terminated or the constant-rate drying period A2 is entered, the second step S32 is performed. Accordingly, the operating RPM of the compressor 930 may be controlled to be reduced. In the constant-rate drying period A2, the compressor 930 may be controlled to operate at the constant-rate RPM rpm_CR lower than the heating RPM.

[0404] Accordingly, the temperature of the drum 200 may be prevented from rising in the constant-rate drying period A2.

[0405] In the falling-rate drying period A3, the third step S33 may be performed. The compressor 930 may be controlled to operate at the falling-rate RPM rpm_FR lower than the constant-rate RPM.

[0406] Thereafter, in the cooling period A4, the compressor 930 may stop operating, and the temperature of the drum 200 may be lowered.

[0407] As a result, because the compressor 930 operates in the temperature control step S3, the temperature of the refrigerant may rise and the temperature of the drum may increase or be maintained.

[0408] In addition, because the RPM of the compressor 930 is lowered in each period in the temperature control step S3, the temperature of the drum 200 may not exceed the maximum temperature Tmax.

[0409] In addition, in the temperature control step S3, the compressor 930 continuously operates without stopping even when the operating RPM is lowered, so that the refrigerant may be compressed to heat air introduced into the drum 200. Accordingly, the temperature of the drum 200 may be maintained below the maximum temperature Tmax without falling to a temperature equal to or lower than a predetermined temperature.

[0410] As a result, the laundry treating apparatus according to the present disclosure may prevent the laundry from being damaged via the temperature control step S3 as well as the rotation step S2.

[0411] FIG. 18 illustrates that a rotation step of a laundry treating apparatus according to the present disclosure includes a tumbling motion.

[0412] The rotation step S2 may include the tumbling motion for rotating the drum 200 in one direction at the second speed L1 that is lower than the first speed H1 capable of providing the acceleration force equal to or greater than 1G.

[0413] For example, when the diameter of the drum 200 is 24 inches or 27 inches, the first speed H1 may correspond to an RPM equal to or greater than 50RPM, and the second speed L1 may correspond to an RPM equal to or smaller than 50RPM,

[0414] The first speed H1 may be defined as a speed at which the laundry accommodated in the drum 200 rotates while being attached to the inner wall of the drum when the drum 200 rotates. In the tumbling motion in which the drum 200 rotates at the second speed L1 lower than the first speed H1, the laundry accommodated in the drum 200 rotates while being separated from the inner wall of the drum 200. Accordingly, whenever the drum 200 rotates, the laundry accommodated in the drum 200 may be separated from the inner wall of the drum 200 and fall, and thus may be evenly exposed to hot air.

[0415] In the tumbling motion, the drum 200 may rotate in either a clockwise direction or a counterclockwise direction as long as the drum 200 rotates at the second speed L1. However, in the tumbling motion, the rotation direction of the drum 200 may be maintained without changing, thereby reducing the load applied to the motor 500 and preventing the laundry from being suddenly twisted or agglomerated.

[0416] FIG. 19 is a view illustrating a state of laundry in the tumbling motion.

[0417] Referring to (a) in FIG. 19, the laundry accommodated in the drum 200 may be disposed at a lower portion of the drum 200 by the self-load.

[0418] Referring to (b) in FIG. 19, when the tumbling motion is performed and the drum 200 rotates in the clockwise direction, the laundry accommodated in the drum 200 may ascend upward while being attached to the inner wall of the drum 200 because of the frictional force with the drum 200 and the centrifugal force generated while the drum 200 rotates at the second speed L1.

[0419] The laundry may ascend while being attached to the inner wall of the drum 200 up to the rotation center O or the portion higher than the center of the drum 200.

[0420] Referring to (c) in FIG. 19, because the drum 200 rotates at the second speed L1 providing the centrifugal force smaller than 1G, the laundry may move upwardly of the center of the drum 200, but may be separated from the inner wall of the drum 200 at a location lower than the high point of the drum 200 to fall toward the lower portion of the drum 200.

[0421] That is, the laundry accommodated in the drum 200 may ascend while being attached to the inner wall of the drum 200 from the lower portion of the drum 200 by a radius R of the drum 200 or more in the tumbling motion, but may be separated from the inner wall of the drum 200 without being able to ascend as much as a diameter 2R of the drum 200 from the lower portion of the drum 200.

[0422] In other words, because the laundry has the self-load greater than the centrifugal force provided by the drum 200 in the tumbling motion, the laundry is separated from the inner wall of the drum 200 at a location between the center O of the drum 200 and the high point of the drum 200 and fall toward a low point of the drum 200.

[0423] In addition, when the laundry is separated from the inner wall of the drum 200 by the inertial force of rotating together with the drum 200, the laundry may fall while being more biased to one side than the low point of the drum 200. For example, when the drum 200 rotates clockwise, the laundry may fall to a location on a right side of the low point of the drum 200, and when the drum 200 rotates counterclockwise, the laundry may fall to a location on a left side of the low point of the drum 200.

[0424] As a result, the laundry may move by a distance close to the diameter 2R of the drum 200 as much as possible while falling from an upper portion of one side higher than the center O of the drum to a lower portion of the other side lower than the center O of the drum, and an area or a time the laundry is exposed to hot air supplied to the drum 200 may increase.

[0425] In addition, while the laundry is repeatedly attached to and separated from the inner wall of the drum 200, an exposed surface thereof facing the center of the drum 200 may be changed, and thus the entire surface of the laundry may be evenly exposed to hot air.

[0426] As a result, the laundry may be most effectively dried in the tumbling motion. However, as described above, when only the tumbling motion is continued, the shrinkage or the wear of the laundry may occur.

[0427] To prevent such problem, the laundry treating apparatus according to the present disclosure further provides an additional drum motion in addition to the tumbling motion to prevent the wear of the laundry and the shrinkage of the laundry as described above. In addition, the laundry treating apparatus according to the present disclosure may vary the drum motion applied in each period or may apply various combinations.

[0428] In other words, in the laundry treating apparatus according to the present disclosure, the rotation step S2 may variously change the rotation speed of the drum 200, the rotation direction of the drum 200, and the duration of the drum 200, and the like in each period of the air supply step S1. That is, the rotation step S2 of the laundry treating apparatus according to the present disclosure may perform various motions of expanding the shrunk laundry, reducing the external force such as the mechanical force and the frictional force applied to the laundry, and minimizing the friction between the laundry and the drum.

[0429] Because the motor 500 is directly coupled to the drum 200 or is coupled to the drum 200 via the reducer 600 in the laundry treating apparatus according to the present disclosure, the motor 500 may freely change the rotation direction and the rotation speed of the drum 200.

[0430] Therefore, the laundry treating apparatus according to the present disclosure may vary at least one of the rotation speed of the drum 200, the rotation direction of the drum 200,and a rotation speed maintaining time of the drum 200 based on the state of the laundry and the internal state of the drum 200 in the air supply step S1, thereby preventing all of the shrinkage, the wear, and the damage of the laundry.

[0431] Hereinafter, various motions that the laundry treating apparatus according to the present disclosure may perform in the rotation step S2 will be described.

[0432] The rotation step S2 may include the high-speed period H for rotating the drum such that the laundry rotates in the state of being attached to the inner wall of the drum, and the low-speed period L for rotating the drum such that the laundry rotates while falling from the inner wall of the drum.

[0433] The high-speed period H is the period in which the drum 200 rotates at the speed equal to or higher than the first speed H1 that generates the acceleration force equal to or greater than 1G, and the low-speed period L corresponds to the period in which the drum 200 rotates at the second speed L1 lower than the first speed H1 to generate the acceleration force equal to or smaller than 1G.

[0434] For example, the laundry treating apparatus according to the present disclosure may to a speed equal to or lower than 50RPM, and the first speed H1 may correspond to a speed exceeding 50RPM.

[0435] FIG. 20 illustrates that the rotation step includes a pulling motion.

[0436] In the rotation step S2, the pulling motion of periodically repeating the process of rotating the drum 200 at the second speed L1 for a preparation time and then rotating the drum 200 at the first speed H1 for an expansion time may be performed.

[0437] Accordingly, the laundry may be stirred inside the drum 200 while being separated from the inner wall of the drum 200 during the preparation time, and may be attached to the inner wall of the drum 200 and receive the acceleration force equal to or greater than 1G during the expansion time.

[0438] The expansion time may be set to be longer than the preparation time. Therefore, the laundry may be subjected to the acceleration force equal to or greater than 1G for a time longer than the time during which the laundry is stirred.

[0439] Because the laundry is attached to the inner wall of the drum 200 by the acceleration force equal to or greater than 1G during the expansion time, the laundry may be expanded along the inner circumferential surface of the drum 200. In addition, because the laundry is separated from the inner wall of the drum 200 during the preparation time after the expansion time, another area of the laundry may be attached to the inner wall of the drum 200 during the next expansion time.

[0440] In the pulling motion, the laundry may repeat the process of being pulled during the expansion time, then changing in portion to be pulled during the preparation time, and then being pulled again during the expansion time. As a result, in the pulling motion, an effect of expanding the shrunk laundry or pulling the laundry in advance so as not to be shrunk may be derived.

[0441] In one example, rotating the drum at the third speed L2 for the waiting time may be added to the pulling motion. The rotating of the drum at the third speed L2 for the waiting time may be performed in the pulling motion while the drum accelerates from the second speed L1 to the first speed H1. Accordingly, the drum 200 may rotate at the second speed L1, then decelerate to the third speed L2, and then accelerate up to the first speed H1. As a result, the acceleration force applied to the laundry in the drum 200 may be increased to further expand the laundry.

[0442] In addition, the rotating of the drum at the third speed L2 during the waiting time in the pulling motion may be performed after the drum decelerates from the first speed H1 to the second speed L1. Accordingly, the drum 200 may rotate at the first speed H1, then decelerate to the second speed L1, and then decelerate to the third speed L2. As a result, the time during which the rotation speed of the drum 200 is reduced from the first speed H1 to the third speed L2 may be increased, and thus the falling impact applied to the laundry may be reduced. In addition, a load applied to the motor 500 to brake the drum 200 may be reduced.

[0443] In one example, the waiting time may be set to be shorter than the expansion time. As a result, the time during which the laundry is pulled in the pulling motion may be secured more.

[0444] In addition, the waiting time may be set to be shorter than the preparation time. As a result, the time during which the laundry is stirred may be minimized in the pulling motion, thereby minimizing the wear of the laundry or the friction between the laundry and the drum 200.

[0445] In one example, the expansion time may be equal to or longer than a sum of the preparation time and the waiting time. Accordingly, the time during which the laundry is pulled in the pulling motion may be set to be equal to or longer than the time during which the laundry is stirred.

[0446] As a result, the high-speed period H and the low-speed period L may be periodically disposed in the pulling motion.

[0447] In addition, the low-speed period L may be further divided into two-stage speed periods. Accordingly, a total of three or more speed periods may be periodically repeated in the pulling motion.

[0448] In the pulling motion, the drum 200 may periodically repat the process of rotating at the first speed H1 for the expansion time, then decelerating to the second speed L1 and rotating for the preparation time, then decelerating again to the third speed L2 and rotating for the waiting time, and then accelerating again to the first speed H1 and rotating for the expansion time.

[0449] As a result, the pulling motion may go through the acceleration period with the acceleration force equal to or greater than 1G two times for one cycle.

[0450] FIG. 21 is a view illustrating a state of laundry when a laundry treating apparatus according to the present disclosure performs a pulling motion.

[0451] Referring to (a) in FIG. 21, the laundry inside the drum 200 may be disposed with an initial length D 1.

[0452] Referring to (b) in FIG. 21, the drum 200 may rotate at the second speed L1 for the preparation time or may rotate at the third speed L2 for the waiting time, and the laundry may be stirred in the drum 200 without ascending while being attached to the inner wall of the drum 200.

[0453] Referring to (c) in FIG. 21, the drum 200 may accelerate to the first speed H1 and rotate. Accordingly, the drum 200 may maintain the first speed H1 during the expansion time, and the expansion time may be set to be longer than a time during which the drum rotates once. Accordingly, the laundry may rotate while being attached to the inner wall of the drum 200 and may be expanded along the inner wall of the drum 200.

[0454] Referring to (d) in FIG. 21, the laundry may be expanded to have an expanded length D2 greater than the initial length D1. In addition, because the above-described process is repeated, the laundry may not shrink by continuously receiving an expansion force, and may be expanded again even when being shrunk.

[0455] FIG. 22 illustrates that the rotation step includes the flipping motion.

[0456] The rotation step S2 may include the flipping motion that rotates the drum 200 bi-directionally at the second speed L1 that is lower than the first speed H 1 that may provide the acceleration force equal to or greater than 1G.

[0457] The flipping motion may perform the tumbling motion in one direction for a predetermined time and perform the tumbling motion again in another direction for the predetermined time.

[0458] The predetermined time may correspond to a time during which the drum rotates once. In this case, the flipping motion may correspond to rotating the drum 200 once in the clockwise direction at the second speed L1 and rotating the drum 200 once in the counterclockwise direction at the second speed L1. In this case, the drum 200 may flip the laundry by stirring the laundry in one direction and then stirring the laundry in another direction.

[0459] As a result, the surface of the laundry exposed to the inside of the drum 200 may be changed, thereby preventing the specific area of the laundry from being over-dried and inducing the laundry to be uniformly dried.

[0460] The flipping motion may be intermittently performed at a specific time point when the tumbling motion is performed. Further, when the flipping motion is performed, the rotation direction of the tumbling motion may vary.

[0461] As a result, as the surface of the laundry in contact with the drum 200 in the tumbling motion varies, an area that has not been dried in the laundry may be intensively dried in a tumbling motion performed later.

[0462] In one example, the predetermined time may correspond to a time during which the drum rotates N times. For example, the predetermined time may be set to a time equal to or longer than 2 minutes. In this case, the flipping motion may correspond to the tumbling motion being performed while periodically changing in the direction.

[0463] Accordingly, when only the specific portion of the laundry is in contact with the inner wall of the drum 200 or is exposed to the inside of the drum 200 while the drum rotates in one direction, as the laundry is flipped or stirred while the drum rotates in another direction, another portion of the laundry may come into contact with the inner wall of the drum 200 or be exposed to the inside of the drum 200.

[0464] As a result, the laundry inside the drum 200 may be evenly exposed to hot air.

[0465] In one example, the flipping motion may include rotating the drum 200 for the predetermined time in one direction at the first speed H1 and rotating the drum 200 for the predetermined time in another direction at the first speed H1. In this case, the area of the laundry to which hot air is supplied may be concentrated by varying the area of the laundry attached to the inner wall of the drum 200.

[0466] In addition, the flipping motion may include rotating the drum 200 at the first speed H1 for the predetermined time in one direction and then rotating the drum 200 at the second speed L1 for the predetermined time in another direction.

[0467] FIG. 23 is a view illustrating a state of laundry when the rotation step performs the flipping motion.

[0468] Referring to (a) in FIG. 23, the drum 200 may rotate clockwise. In this regard, when the drum 200 rotates at the second speed L1, the laundry may be raised to a vertical level higher than the center O of the drum and then fall downward as in the tumbling motion.

[0469] Referring to (b) in FIG. 23, the drum 200 may temporarily stop or start to rotate counterclockwise by decelerating while rotating clockwise. The laundry accommodated in the drum 200 may be distributed under the center O area of the drum.

[0470] Referring to (c) in FIG. 23, the drum 200 may accelerate while rotating counterclockwise. In this regard, when the drum 200 rotates at the second speed L1, an effect of performing the tumbling motion in an opposite direction may be derived. The laundry may be raised to the area higher than the center O of the drum and then fall downward. In this regard, because the rotation direction is opposite to that when rotating clockwise, the laundry may rise with a different portion attached to the inner wall of the drum 200 than when rotating clockwise. Accordingly, the laundry may be stirred while at least partially flipped inside the drum 200.

[0471] As a result, when the drum 200 rotates clockwise, another area may be more exposed to hot air, so that the laundry may be evenly dried.

[0472] The flipping motion may periodically repeat the motions from (A) to (C) in FIG. 21. In addition, unlike as shown, the drum 200 may rotate at the first speed H1 in the flipping motion.

[0473] FIG. 24 illustrates that the rotation step includes a hanging motion.

[0474] The rotation step S2 may include the hanging motion in which the high-speed period H in which the laundry rotates in the state in which of being attached to the inner wall of the drum and the low-speed period L in which the laundry rotates while falling from the inner wall of the drum are periodically performed.

[0475] The hanging motion may be a motion periodically repeating the process of rotating the drum 200 at the first speed H1 for a first time period and then rotating the drum 200 at the second speed L1 lower than the first speed H1 for a second time period. That is, in the hanging motion, the drum 200 may periodically rotate in the high-speed period H and the low-speed period L.

[0476] The hanging motion corresponds to repeating the motion of rotating the drum 200 to generate the acceleration force equal to or greater than 1G for the first time period, then rotating the drum 200 to generate the acceleration force equal to or smaller than 1G for the second time period, and then rotating the drum 200 again to generate the acceleration force greater than 1G for the first time period.

[0477] The hanging motion may correspond to repeating the process of rotating the drum 200 at the first speed H1 for the first time period and then performing the tumbling motion for the second time period.

[0478] When the hanging motion is performed, the laundry may rotate while being attached to the drum 200 for the first time period, then, may be stirred or fall by being separated from the drum 200 for the second time period, and then may rotate again while being attached to the drum 200 for the first time period.

[0479] As a result, the time during which the laundry is attached to the inner wall of the drum 200 may be set to be longer also in the tumbling motion, thereby minimizing the friction on the inner wall of the drum 200. In addition, when the laundry rotates while being attached to the inner wall of the drum 200, because the laundry is fixed to the drum 200, the laundry items may be prevented from being rubbed against each other or from being worn.

[0480] To prevent the laundry from being damaged, the first time period may be set to be longer than the second time period or may be at least set to be equal to the second time period.

[0481] That is, the hanging motion may sufficiently secure the time during which the laundry rotates while being attached to the inner wall of the drum 200, thereby preventing the laundry from being unnecessarily rubbed.

[0482] As a result, a duration of the high-speed period H may be set to be equal to or longer than a duration of the low-speed period L in the hanging motion, and a total time of the high-speed period H may be set to be longer than a total time of the low-speed period L.

[0483] The hanging motion may intensively supply the area of the laundry 200 that is not in contact with the inner wall of the drum 200 to hot air while rotating the drum 200 at the first speed H1 for the first time period. In addition, the area where hot air is concentrated may be changed by stirring the laundry in the state of being separated from the drum while rotating the drum 200 at the second speed L1 for the second time period, and then not allowing another area of the laundry to be in contact with the inner wall of the drum 200 for the first time period.

[0484] As a result, the specific area of the laundry may be prevented from being over-dried in the hanging motion.

[0485] In one example, in the hanging motion, to not only sufficiently fix the laundry to the inner wall of the drum 200, but also secure the time for sufficiently stirring the laundry in the drum 200, the drum may rotate at least once in the high-speed period H and the drum may rotate at least once in the low-speed period L.

[0486] In other words, the first time period may be set to a time during which the drum 200 rotates once or longer, and the second time period may be set to a time during which the drum 200 rotates once or longer. For example, the first time period may be set to 2 minutes or longer, and the second time period may also be set to 2 minutes or longer.

[0487] The hanging motion may further include a preparation period for rotating the drum for a third time period at the third speed L2 lower than the second speed L1 between the high-speed period H and the low-speed period L. The hanging motion may further decelerate the drum 200 to the third speed L2 when decelerating the drum 200 from the first speed H1 to the second speed L1.

[0488] The laundry that has been attached to the inner wall of the drum 200 and has received the acceleration force equal to or greater than 1G may be prevented from additionally receiving a strong external force again. In addition, when the motor 500 decelerates by a force braking or the like, a deceleration time of the drum 200 is further secured by decelerating the drum 200 to the third speed L2, thereby reducing a maximum magnitude of the acceleration force or the external force applied to the laundry. Accordingly, the friction or the fluff may be prevented from occurring in the process of separating the laundry from the drum 200.

[0489] In one example, the third time period may be set to be longer than the time during which the drum rotates once, so that the time required for the laundry to be properly distributed before being stirred while ascending upward in the drum 200 may be secured. However, the third time period may be set to be shorter than the second time period, thereby preventing unnecessary drying delay.

[0490] The third speed L2 may be a speed at which the laundry is prevented from rising upward of the center O of the drum.

[0491] As a result, the hanging motion may include rotating the drum 200 at the first speed H1 for the first time period, then decelerating the drum 200 to the third speed L2 lower than the second speed L1 and rotating the drum 200 for the third time period, and then accelerating the drum 200 to the second speed L1 and rotating the drum 200 for the second time period, and repeating such process.

[0492] In the hanging motion, the rotation direction of the drum may be maintained without being changed. Accordingly, excessive load may be prevented from being generated on the motor 500, or the laundry may be prevented from being stirred and rubbed excessively.

[0493] In one example, the first time period of the hanging motion may be set to be longer than the expansion time of the pulling motion. Further, the second time period may be set to be longer than the preparation time of the pulling motion. This is because the hanging motion is the motion that induces the laundry to be sufficiently exposed to hot air while preventing the friction force from being applied to the laundry, rather than preventing the expansion of the laundry.

[0494] That is, a ratio of the high-speed period H in the hanging motion may be lower than a ratio of the high-speed period H in the pulling motion.

[0495] In addition, a time or period for reaching the next high-speed period H after the high-speed period H passes in the hanging motion may be set to be longer than a time or period for reaching the next high-speed period H after the high-speed period H passes in the pulling motion.

[0496] In one example, the pulling motion and the hanging motion may be common in that the high-speed period H and the low-speed period L are periodically performed in both motions.

[0497] However, the high-speed period H may be set to be longer than the low-speed period L in the pulling motion, and the high-speed period H in the hanging motion may be set to be longer than the high-speed period H in the pulling motion.

[0498] This is because, when the pulling motion is a motion concentrated on expanding the laundry, the hanging motion is a motion more concentrated on the drying and the stirring of the laundry.

[0499] Therefore, the low-speed period L in the hanging motion may be set to be longer than the high-speed period H in the pulling motion.

[0500] FIG. 25 is a view illustrating a state of laundry when a rotation step performs a hanging motion.

[0501] Referring to (a) in FIG. 25, the drum 200 may rotate in the clockwise direction at the second speed L1 for the second time period. In this regard, the laundry may repeat the process of ascending to the vertical level corresponding to the center O of the drum or to a location higher than the center O of the drum, descending, and then being stirred. A period in which the drum 200 rotates at the second speed L1 for the second time period may correspond to the tumbling motion.

[0502] Referring to (b) in FIG. 25, the drum 200 may rotate at the first speed H1 in the clockwise direction for the first time period. The laundry may be attached to the inner wall of the drum 200 to rotate for the first time period.

[0503] In this regard, the drum 200 may slowly accelerate from the second speed L1 to the first speed H1. For example, a time period varying from the low-speed period L to the high-speed period H in the hanging motion may be set to about 1 minute. Accordingly, excessive physical force may be prevented from being applied to the laundry, thereby preventing the damage to the laundry.

[0504] In this process, a portion of the laundry not attached to the inner wall of the drum 200 may be exposed to hot air to be intensively dried. In addition, because the laundry is attached to the inner wall of the drum 200 and continuously rotates, the effect of fixing the laundry to the drum 200 may be derived. Therefore, because the laundry and the drum 200 do not move relative to each other, the laundry and the drum 200 may be prevented from being rubbed against each other.

[0505] In addition, because all of the laundry items rotate while being attached to the inner wall of the drum 200, the laundry items are also not rubbed against each other, and a portion and the rest of the laundry may not be rubbed against each other. As a result, the friction between the laundry items may be prevented, thereby preventing fluff from being generated on the laundry.

[0506] Referring to (c) in FIG. 25, the drum 200 may decelerate to the first speed H1 again and rotate. In this regard, the drum 200 may decelerate to the third speed L2 and rotate. As a result, the laundry may not only be reliably separated from the inner wall of the drum 200, but may be continuously stirred in the process of rotating the drum 200. While the laundry is stirred, an area thereof in contact with the inner wall of the drum 200 may be exposed toward the inside of the drum 200 and dried.

[0507] In one example, a time period to decelerate from the first speed H1 to the third speed L2 may be set to about 1 minute.

[0508] The drum 200 may accelerate again to the second speed L1 and may be rotated again for the second time period. The laundry may be continuously exposed to hot air while ascending upwardly of the center O of the drum 200 and descending, and may be repeatedly stirred. Accordingly, the laundry may be dried at a higher efficiency than when the drum rotates at the first speed H1.

[0509] Referring to (d) in FIG. 25, the drum 200 may accelerate to the first speed H1 again and rotate for the first time period.

[0510] By repeating the above process, the hanging motion may intermittently perform the tumbling motion to dry the laundry. In addition, the hanging motion may attach the laundry to the inner wall of the drum 200 in the middle of the tumbling motion, thereby greatly reducing the friction of the laundry while being stirred or the time period during which the laundry is rubbed against the drum.

[0511] As a result, the hanging motion may promote both the drying of the laundry and the protection of the laundry.

[0512] The hanging motion may be performed in the constant-rate drying period A2. When the hanging motion is performed in the constant-rate drying step A2 when the dryness of the laundry is close to a target value b for entering the falling-rate drying period, the laundry may be prevented from being rubbed or worn.

[0513] In addition, the hanging motion may be performed in the falling-rate drying period A3. Because the falling-rate drying period A3 is a period in which the dryness of the laundry is beyond the target value b, the fluff or the wear may be easily generated on the laundry. Therefore, the hanging motion may be performed to protect the laundry in the falling-rate drying period.

[0514] In this regard, it is preferable that the hanging motion is performed at the end of the falling-rate drying period. This is because, because the hanging motion is a motion in which a period for fixing the laundry to the inner wall of the drum 200 is set to be long, the drying of the laundry is not able to be guaranteed when the hanging motion is performed at the beginning of the falling-rate drying period, and a necessity to protect the laundry from the wear and the damage is great at the end of the falling-rate drying period because the laundry is in the most dried state.

[0515] Therefore, the hanging motion may be performed when the dryness of the laundry reaches a specific value d in the falling-rate drying period, and be performed until the end of the falling-rate drying period.

[0516] FIG. 26 illustrates that the rotation step includes a shaking motion.

[0517] The rotation step S2 may include a shaking motion of periodically varying the rotation speed of the drum to two or more speeds.

[0518] The shaking motion may include periodically rotating the drum at the first speed H1 at which the laundry rotates while being attached to the inner wall of the drum and the second speed L1 lower than the first speed H1.

[0519] The shaking motion may provide an acceleration difference to the laundry caused by the difference in the rotation speed of the drum to induce the laundry items to be separated from each other based on the weight.

[0520] In one example, the shaking motion may include periodically varying the rotation speed of the drum 200 to at least two of the first speed H1 at which the laundry rotates while being attached to the inner wall of the drum, the second speed L1 lower than the first speed H1, and the third speed L2 lower than the second speed L1.

[0521] For example, the shaking motion may include sequentially varying the speed of the drum 200 to the second speed L1, the first speed H1, and the third speed L2.

[0522] In addition, the shaking motion may include repeatedly varying the speed of the drum 200 to the second speed L1, the first speed H1, and the third speed L2.

[0523] That is, the shaking motion may include repeating the process of rotating the drum 200 at the second speed L1, accelerating the drum 200 to the first speed H1, and then decelerating the drum 200 to the third speed L2.

[0524] When the drum 200 accelerates in the shaking motion, the drum 200 may accelerate from the third speed L2 to the second speed L1 and then accelerate from the second speed L1 to the first speed H1. Accordingly, the drum 200 may be prevented from rapidly accelerating, thereby preventing the excessive load from being generated on the motor 500 and preventing the laundry from being pressed on the inner wall of the drum 200.

[0525] In addition, when the drum 200 decelerates in the shaking motion, the inertial force difference may be maximized on the laundry that is attached to the inner wall of the drum 200 by decelerating the drum 200 from the first speed H1 to the third speed L2 at a time. Accordingly, in the shaking motion, when the drum 200 decelerates, an acceleration change greatly occurs during the deceleration of the drum 200, so that the laundry items may be separated from each other because of the inertial force difference.

[0526] In the shaking motion, the process in which the laundry items are separated from the drum 200 and the separated laundry items are evenly distributed and attached to the drum 200 to rotate is repeated.

[0527] As a result, the shaking motion may be a motion of repeating the acceleration from the low-speed period L to the high-speed period H and the deceleration from the high-speed period to the low-speed period L, and when decelerating from the high-speed period H to the low-speed period L, the drum may further decelerate compared to before the acceleration.

[0528] In one example, because the shaking motion is to change the acceleration inside the drum 200 to generate the inertial force difference on the laundry, the shorter the speed change period, the more advantageous.

[0529] However, when the speed is set to periodically vary during one rotation of the drum, a time period for which the laundry is sufficiently separated may not be secured and the excessive load may occur on the motor 500.

[0530] Therefore, the time period during which the speed of the drum changes in the shaking motion may be set to be longer than a time period for the drum to rotate once and shorter than 1 minute. For example, the period may be set to be in a range from 10 seconds to 20 seconds.

[0531] In the shaking motion, all the speed periods of the drum 200 may be completed within 1 minute.

[0532] In the shaking motion, the acceleration force applied to the laundry is changed via the change in the rotational force of the drum 200, thereby generating the difference in the inertial force applied to the laundry. Among the laundry items, heavy laundry has a great inertial force to sensitively react to the change in the rotation speed of the drum 200, and light laundry has a small inertial force to be insensitively react to the change in the rotation speed of the drum 200. Accordingly, the heavy laundry and the light laundry may be separated from each other based on the change in the rotation speed of the drum 200 because of the difference in the inertial force.

[0533] As a result, the heavy laundry will ascend and descend inside the drum based on the rotation of the drum 200 and will be frequently exposed to hot air. On the other hand, because the light laundry ascends less compared to the rotation of the drum 200, a falling impact is small and a location change amount thereof is small, so that a friction between the laundry items and a friction with the drum are small, thereby preventing the damage to the laundry.

[0534] Therefore, the shaking motion has an advantage of performing the drying cycle by separating the laundry items based on the load difference therebetween.

[0535] In one example, when the dryness of the laundry is low and the state of the laundry is close to the wet laundry state or the laundry contains the moisture, because the laundry weighs more, such laundry will react sensitively to the change in the rotation speed of the drum 200. In addition, when the dryness of the laundry is high and the state of the laundry is close to the dried laundry state or the laundry contains a small amount of moisture, because the laundry weighs less, such laundry will react insensitively to the change in the rotation speed of the drum 200.

[0536] Therefore, the shaking motion has an advantage of separating the laundry item that has been dried a lot and the laundry item that has been less dried from each other based on the difference in the dryness of the laundry items.

[0537] Because the laundry containing a relatively great amount of moisture reacts sensitively to the rotation change of the drum 200, the laundry will be frequently exposed to hot air passing through the drum 200 while continuously ascending to a high level and descending inside the drum 200. Therefore, the laundry having a low dryness or requiring further drying may be dried more in the shaking motion.

[0538] Because the laundry containing the relatively small amount of moisture insensitively reacts to the rotation change of the drum 200, the laundry ascends less inside the drum 200 and has a small area exposed to hot air. Accordingly, the laundry having high dryness or not requiring the drying may have a low drying rate in the shaking motion.

[0539] Although the shaking motion varies the rotation speed of the drum 200 in several periods, durations of the respective periods may be equal to each other.

[0540] As a result, even when the air supply step S 1 is further performed until the laundry for which the drying is more required is dried during the shaking motion, overdrying of the laundry that has been sufficiently dried may be prevented.

[0541] In one example, the hanging motion may be performed after the tumbling motion, and the shaking motion may be performed after the hanging motion. This is to classify the laundry dried via the tumbling motion and the hanging motion.

[0542] In addition, the shaking motion may be performed before the rolling motion. This is because the effect of the rolling motion is maximized when the rolling motion is performed after separating the laundry that requires further drying from the laundry that has been sufficiently dried because the rolling motion is the motion of drying the laundry while stirring the laundry at the low-speed.

[0543] In one example, because the shaking motion includes the high-speed period H, it is preferable that the shaking motion is performed in the constant-rate drying period in which the laundry still contains the moisture. In one example, the shaking motion may be performed to separate the laundry that has been completely dried from the laundry that requires further drying in the falling-rate drying period.

[0544] FIG. 27 is a view illustrating a state of laundry when the rotation step performs a shaking motion.

[0545] Referring to (a) in FIG. 27, a total of three types of laundry items may be accommodated in the drum 200.

[0546] The total of three types of laundry items may have different dryness depending on a material of the laundry or an arrangement inside the drum 200 even when being exposed to hot air for the same time period.

[0547] For example, a laundry item No. 1 may be in the wet laundry state of containing a lot of moisture because the drying has not been sufficiently performed. A laundry item No. 2 may be in the dried laundry state with little moisture as the drying has been sufficiently performed. A laundry item No. 3 may be in a state in which the drying has been partially completed.

[0548] Referring to (b) in FIG. 27, when the drum rotates at the second speed L1, all the laundry items inside the drum 200 may ascend along the drum 200 and fall at a location lower than the high point of the drum 200 and may be exposed to hot air, as in the tumbling motion.

[0549] In such process, the laundry items No. 1, 2, and 3 may be stirred in the drum 200 while forming similar trajectories. The rotation at the second speed L1 may be performed for about 10 seconds or about 20 seconds.

[0550] Referring to (c) in FIG. 27, the drum 200 may accelerate to the first speed H1 or may accelerate to an overspeed. In this case, because the laundry item No. 1 is heavy, the laundry item No. 1 may be attached to the inner wall of the drum 200 to rotate together with the drum 200. In this regard, because the laundry item No. 3 is lighter than the laundry item No. 1, the laundry item No. 3 may change less sensitively to the change in the speed of the drum 200 than the laundry item No. 1. Accordingly, although the laundry item No. 3 is disposed close to the inner wall of the drum 200, the laundry item No. 3 may have the force to be attached to the inner wall of the drum 200 weaker than that of the laundry item No. 1.

[0551] In one example, because the laundry item No. 2 is lighter than the laundry items No. 1 and 3, the laundry item No. 2 is less sensitive to the change in the speed of the drum 200. Therefore, the laundry item No. 2 may fall similar to the trajectory of rotating at the second speed L1 rather than being directly attached to the inner wall of the drum 200.

[0552] As a result, based on the change in the rotation speed of the drum, changes in trajectories of the first, second, and third laundry may occur, so that the laundry item No. 1, 2, and 3 may be separated from each other.

[0553] Thereafter, the laundry item No. 1 may repeatedly ascend and descend inside the drum 200 based on the rotation speed of the drum 200, the laundry item No. 3 may ascend to a lower vertical level than the laundry item No. 1, and the laundry item No. 2 may ascend to a lower vertical level than the laundry item No. 3. Accordingly, the laundry item No. 3 may be exposed to hot air more than the laundry item No. 2, and the laundry item No. 1 may be exposed to hot air more than the laundry item No. 3.

[0554] In addition, the laundry item No. 3 may be less rubbed against the drum 200 than the laundry item No. 1, and the laundry item No. 2 may be less rubbed against the drum 200 than the laundry item No. 3.

[0555] Therefore, as the state of the laundry is closer to the dried laundry state, like the laundry item No. 3, the fluff may occur even with a small friction, but the fluff may be prevented because of the shaking motion.

[0556] In addition, when the laundry is in the wet laundry state, like the laundry item No. 1, the fluff does not occur well even with a relatively great friction, so that it is fine for a significant falling impact to occur, and the laundry may rather be more exposed to hot air while moving with great falling.

[0557] FIG. 28 illustrates that the rotation step includes the rolling motion.

[0558] The rotation step S2 may include the rolling motion of rotating the drum such that the laundry falls or rolls at the vertical level lower than the center O of the drum.

[0559] The rolling motion is a motion of rotating the drum 200 at a speed lower than the second speed L1 at which the tumbling motion is generally performed.

[0560] Accordingly, in the rolling motion, a range or a trajectory in which the laundry moves inside the drum 200 may be minimized and a mechanical force applied to the laundry may be minimized, so that the laundry may be prevented from being damaged or worn.

[0561] In addition, in the rolling motion 200, the entire area of the laundry may be evenly exposed to the inside of the drum 200 while repeatedly rolling the laundry, thereby effectively performing the drying.

[0562] In one example, because the rolling motion 200 is to minimize the physical force applied to the laundry, the rolling motion may maintain the rotation speed of the drum 200 at the constant speed without changing the rotation direction of the drum 200.

[0563] The rolling motion may be mainly performed in the falling-rate drying period A3 because the falling impact applied to the laundry is the weakest.

[0564] FIG. 29 is a view illustrating a state of laundry when the rotation step performs a rolling motion.

[0565] In the rolling motion 200, the laundry may ascend because of the friction with the inner wall of the drum 200 as the drum 200 rotates. However, the laundry may not be able to ascend higher than a vertical level corresponding to the radius R of the drum from the low point of the drum 200 and may be separated from the inner wall of the drum 200 and roll toward the low point of the drum 200.

[0566] In the rolling motion 200, the drum may rotate at a protection speed L4 lower than the second speed L1.

[0567] The protection speed L4 may be set as a speed at which the laundry is prevented from moving upwardly of the center of the drum.

[0568] Accordingly, the laundry may repeat the process of rolling while continuously moving from the low point of the drum 200 to only one side and have the small falling impact, so that the laundry may be prevented from shrinking.

[0569] In one example, in the rolling motion 200, the laundry is stirred only in the area lower than the center O of the drum 200, so that the laundry may frequently come into contact with the dryness sensor. Therefore, a change in the dryness of the laundry may be more accurately sensed via the rolling motion 200.

[0570] A time period for which the rolling motion is performed may be set to be longer than the time period for which the shaking motion is performed. This is because the shaking motion is the motion for classifying the laundry items, and the rolling motion is the motion for drying the laundry.

[0571] In addition, it is preferable that the rolling motion is performed later than the shaking motion. This is because the laundry may be more evenly exposed to hot air in the rolling motion only when the laundry that requires the drying is separated from the laundry that has been dried via the shaking motion.

[0572] It may be suitable that the shaking motion is performed in the constant-rate drying period A2 and the rolling motion is performed in the falling-rate drying period A3.

[0573] FIG. 30 illustrates that the rotation step includes a stop motion.

[0574] Referring to (a) in FIG. 30, the rotation step S2 may include a stop motion for intermittently rotating the drum 200.

[0575] The stop motion may repeatedly perform the rotation of the drum 200 and the stop of the drum, and when the drum 200 rotates, the rotation direction of the drum 200 may be changed. In the stop motion, when the drum 200 rotates once in one direction, the drum may rotate in another direction after waiting for a stop time period.

[0576] In the stop motion, a time period for which the drum 200 stops may be set longer than a time period for which the drum 200 rotates. For example, in the stop motion, the time period for which the drum 200 stops may be set to three times or more the time period for which the drum 200 rotates.

[0577] Accordingly, energy consumption may be minimized in the stop motion. In addition, in the stop motion, the laundry may not be continuously pressurized by the self-load thereof and may be changed in location to prevent wrinkles from being formed.

[0578] Referring to (b) in FIG. 30, in the stop motion, the drum may be in a stop state.

[0579] Thereafter, the drum 200 may intermittently rotate clockwise or counterclockwise to change the location of the laundry, may stir the laundry, or may flip the laundry.

[0580] The speed at which the drum 200 rotates in the stop motion may be set to the protection speed L4.

[0581] Hereinafter, a period in which various motions of the rotation step S2 may be optimally performed will be described.

[0582] As described above, because the driver is directly fastened to the drum 200 to rotate the drum 200, the laundry treating apparatus according to the present disclosure may freely change the rotation direction, the rotation time, and the rotation speed of the drum 200.

[0583] Therefore, the rotation step S2 of the laundry treating apparatus according to the present disclosure may perform various motions for changing the rotation speed and the rotation direction of the drum 200 based on the dryness of the laundry and the internal state of the drum 200, rather than rotating the drum 200 at the constant speed in one direction.

[0584] The laundry treating apparatus according to the present disclosure may apply various motions in each period of the air supply step to protect the laundry in all drying courses and options. In addition, various motions may be applied in each period of the air supply step in the protection for protecting the fabric.

[0585] Specifically, in the laundry treating apparatus according to the present disclosure, the rotation step S2 may be composed of the high-speed period H for rotating the drum such that the laundry rotates in the state of being attached to the inner wall of the drum 200, and the low-speed period L for rotating the drum such that the laundry rotates while falling from the inner wall of the drum. While the air supply step S1 is in progress, a ratio of the high-speed period H to the low-speed period L is set to be different for each specific period, thereby performing the drying cycle while protecting the fabric and simultaneously preventing the shrinkage of the laundry.

[0586] FIG. 31 illustrates a rotation step S2 that may be applied in a preheating period in the air supply step S1.

[0587] The preheating period A1, as a state in which laundry in the wet laundry state is accommodated in the drum 200, corresponds to a period in which the drying cycle starts. Accordingly, the laundry located in the preheating period A1 may be in a state of being shrunk by water. That is, the diameter of the fiber of the laundry may be in the state of being reduced from the first diameter D1 to the second diameter D2.

[0588] When the drying cycle is performed in such process, the laundry may be dried in the shrunk state in the shape of the fiber having the second diameter D2 even when the air gap C is not removed.

[0589] To prevent the same, the rotation step S2 may perform the pulling motion in the preheating period A1. Accordingly, the laundry may expand in the preheating period A1, so that the diameter of the fiber of the laundry may return to be close to the first diameter D1.

[0590] In one example, the laundry items in the wet laundry state may be agglomerated with each other while going through a dehydration cycle. In this regard, because the laundry is stirred and pulled as the first speed H1 and the second speed L1 are repeatedly performed in the pulling motion, the agglomeration of the laundry items may be resolved.

[0591] The pulling motion may be performed during the preheating period A1. Because the preheating period A1 is in a state in which the refrigerant of the compressor is not heated to the specific temperature TC or the operating RPM of the compressor is not increased to the maximum RPM or the specific RPM, energy consumed by the laundry treating apparatus may not exceed a limit range even when the speed of the drum is periodically and rapidly changed via the pulling motion.

[0592] Because air is heated and introduced in the preheating period A1, the laundry may be dried during the pulling motion.

[0593] In one example, the pulling motion and the hanging motion may be performed together. Further, the hanging motion may be performed after the pulling motion. As a result, partial stirring and location change of the laundry together with the expansion of the laundry may be more reliably ensured during the pulling motion process.

[0594] As a result, because the pulling motion or the hanging motion is disposed in the preheating period A1, the high-speed period H and the low-speed period L may be repeatedly disposed in the rotation step S2. A sum time period of the high-speed periods H may be set to be longer than a sum time period of the low-speed periods L. In addition, a duration of the high-speed period H may be set to be longer than a duration of the low-speed period L.

[0595] When the period in which the drum rotates at the second speed L1 in the low-speed period L is defined as a constant-speed period and the period in which the drum rotates at the third speed L2 is classified as a deceleration period in the pulling period, it may be seen that the high-speed period H, the constant-speed period, and the deceleration period are periodically disposed in the preheating period A1.

[0596] Because the waiting time is set to be shorter than the preparation time in the pulling motion, it may be seen that a duration of the deceleration period is set to be shorter than a duration of the constant-speed period.

[0597] Because the high-speed period H is disposed longer than the low-speed period L, the preheating period A1 may be regarded as a period more concentrated on the expansion of the laundry rather than the stirring of the laundry.

[0598] FIG. 32 illustrates a rotation step S2 that may be applied in a constant-rate drying period A2 during the air supply step S 1.

[0599] When the temperature of the refrigerant discharged from the compressor reaches the specific temperature TC or when the operating RPM of the compressor reaches the specific RPM, the preheating period A1 ends and the constant-rate drying period A2 is performed.

[0600] The pulling motion may be terminated when the preheating period A1 ends and the constant-rate drying period A2 is entered.

[0601] The constant-rate drying period A2, as a period in which maximum hot air is introduced into the drum 200, corresponds to a period in which the drying of the laundry is performed in the full-scale. Therefore, it is preferable that the laundry inside the drum 200 is exposed to hot air as much as possible.

[0602] Therefore, the tumbling motion may be first performed in the constant-rate drying period A2. Therefore, as the tumbling motion is performed after the termination of the pulling motion, the laundry ascends upwardly of the center O of the drum in the expanded state and falls while being separated from the drum 200 at the location lower than the high point of the drum, thereby being exposed to hot air as long as possible.

[0603] In addition, the laundry may be prevented from being agglomerated while repeating the falling and the ascending, and the entire laundry may be evenly exposed to hot air as a range of being attached to the inner wall of the drum 200 also varies.

[0604] In one example, when the tumbling motion is performed for a predetermined time period, the laundry items accommodated in the drum 200 may be divided into the laundry item that has been sufficiently dried by hot air and the laundry item that requires the further drying.

[0605] When only the tumbling motion is repeatedly performed in this state, the fiber of the laundry that has been sufficiently dried may shrink to have the third diameter D3 as the air gap C is removed by the falling impact, and the surface of the laundry may be damaged by being rubbed against the inner wall of the drum 200 or another laundry item.

[0606] To prevent the same, it is preferable that the rotation step S2 performs the shaking motion. Via the shaking motion, the laundry that has been sufficiently dried and the laundry that requires further drying may be separated from each other.

[0607] As a result, the laundry that requires further drying may be intensively exposed to the hot air while being separated from the laundry that has been sufficiently dried and moving together with the motion of the drum 200.

[0608] In addition, the laundry that has been sufficiently dried may not fall together with the laundry that requires further drying, and thus may not receive the falling impact. In addition, because the load is reduced because of the evaporation of moisture, the laundry that has been sufficiently dried may not sensitively react to the motion of the drum 200, thereby preventing the over-drying and also preventing the friction or the wear.

[0609] The tumbling motion may be the motion in which the laundry is intensively dried, and the shaking motion may correspond to the motion of separating the laundry that requires further drying from the laundry items and additionally drying the same.

[0610] Accordingly, a duration of the shaking motion may be shorter than the duration of the tumbling motion. The shaking motion may be performed at the end of the constant-rate drying period A2 because it is for separating the laundry that has been sufficiently dried.

[0611] The shaking motion may be performed when the dryness of the laundry reaches the target value b. That is, the shaking motion may be performed starting from when the dryness of the laundry reaches the target value b in the constant-rate drying period A2 until the constant-rate drying period A2 ends and the falling-rate drying period A3 is entered.

[0612] In the constant-rate drying period A2, the shaking motion may be performed after the tumbling motion is performed. Further, the duration of the shaking motion may be set to be shorter than the duration of the tumbling motion.

[0613] This is because the shaking motion is the motion for classifying the dried laundry, and the tumbling motion is the motion for drying the laundry.

[0614] In one example, the hanging motion may be further performed between the tumbling motion and the shaking motion.

[0615] Therefore, when the hanging motion is performed, the high-speed period H may promote the effect of performing the tumbling motion, and the low-speed period L may prevent the laundry from being rubbed against the drum 200 or prevent the friction between the laundry items as the laundry is attached to the inner wall of the drum 200 and fixed to the drum 200.

[0616] That is, the hanging motion may be performed to prevent the damage or the friction of the laundry when the tumbling motion has been performed and the drying of the laundry has been performed to some extent. It may be seen that the hanging motion has a pause period in which the stirring of the laundry is stopped during the tumbling motion.

[0617] The hanging motion may be performed when a reference time elapses in the constant-rate drying period A2. That is, when the reference time elapses while the tumbling motion is performed, the hanging motion may be performed.

[0618] The reference time may be set to a time at which the dryness of the laundry corresponds to the reference value a, and may be set to a time when 20 minutes elapses after activating the constant-rate drying period.

[0619] The hanging motion may be performed for a predetermined time when the dryness of the laundry reaches the reference value a lower than the target value b in the constant-rate drying period A2.

[0620] The target value b of the dryness may correspond to 80% or higher, and, for example, the reference value a may correspond to 70%.

[0621] Further, the hanging motion may be performed after the tumbling motion is completed, but may be performed intermittently during the tumbling motion.

[0622] Further, the hanging motion may be performed before the shaking motion is performed after the tumbling motion is finished.

[0623] In one example, because the hanging motion is also the motion for drying the entire laundry while protecting the laundry, the hanging motion may be performed before the shaking motion. A duration of the hanging motion may be shorter than the duration of the tumbling motion, and may be set to be longer than the duration of the shaking motion.

[0624] As a result, the constant-rate drying period A2 may always be terminated with the shaking motion at the end, and the tumbling motion and the hanging motion may be performed before the shaking motion.

[0625] In one example, the shaking motion may be performed before the hanging motion. That is, this is because it may be efficient to intensively dry a specific area of the laundry while preventing the wear of the laundry via the hanging motion in the state in which all of the laundry items are classified via the shaking motion.

[0626] In one example, the duration of the shaking motion may be set to be longer than the duration of the hanging motion. This is because the laundry items may be exposed to hot air in the separated state because the shaking motion includes both the high-speed period H and the low-speed period L although it is also the period of classifying the laundry items.

[0627] Accordingly, the shaking motion may be performed longer than the duration of the hanging motion or the tumbling motion because the shaking motion may intensively dry the laundry requiring the drying while classifying the laundry items from each other.

[0628] As a result, because the tumbling motion is performed in the constant-rate drying period A2, the low-speed period L may be set to be longer than the high-speed period H even when the hanging motion and the shaking motion are performed.

[0629] That is, unlike the heating drying period A1, the constant-rate drying period A2 may be regarded as a period in which the low-speed periods L are more disposed and distributed than the heating drying periods A1 and the stirring and the hot air exposure of the laundry are centered.

[0630] In one example, because the shaking motion is disposed in the constant-rate drying period A2, the rotation step S2 may be regarded as further including a variable period in which the rotation speed of the drum varies in the constant-rate drying period A2, and the variable period may be regarded as being performed before entering the falling-rate drying period of the laundry.

[0631] When the shaking motion is performed when the dryness reaches the target value b, it may be seen that the variable period starts when the dryness reaches the reference value a after entering the constant-rate drying period.

[0632] In addition, when the shaking motion is controlled by a time rather than the dryness, it may be seen that the variable period starts when a reference time elapses after entering the constant-rate drying period.

[0633] Because the shaking motion includes a period in which the drum rotates at the overspeed that is higher than a speed in the period in which the drum rotates at a speed equal to or higher than the first speed H1, the variable period may be regarded as including both periods in which the drum rotates faster and slower than in the high-speed period H. In addition, it may be seen that the fast period, the high-speed period H, and the slow period are periodically disposed in the variable period.

[0634] In one example, when the shaking motion is performed after the tumbling motion, it may be seen that the low-speed period L is disposed before the start of the variable period. Because the tumbling motion is performed longer than the shaking motion, it may be seen that a duration of the low-speed period L in the constant-rate drying period A2 is set to be longer than the duration of the variable period.

[0635] In addition, when the hanging motion is additionally disposed between the tumbling motion and the shaking motion, it may be seen that the high-speed period H and the low-speed period L are periodically and repeatedly disposed between the low-speed period L and the variable period in the rotation step S2.

[0636] FIG. 33 illustrates a rotation step S2 that may be applied in a falling-rate drying period during the air supply step S 1.

[0637] When the constant-rate drying period A2 ends, the falling-rate drying period A3 may be performed. The falling-rate drying period A3 may be regarded as a period in which the temperature inside the drum 200 or the temperature of the air discharged to the circulation flow channel 930 starts to rise as the evaporation heat is insufficient because the moisture is significantly removed from the laundry in the constant-rate drying period A2.

[0638] That is, it may be seen that the falling-rate drying period A3 starts at a time point at which the temperature inside the drum 200 or the temperature of the air discharged to the circulation flow channel 930 reaches the reference temperature TR during the constant-rate drying period A2.

[0639] In addition, the increase in the internal temperature of the drum 200 means that the drying of the laundry has been sufficiently performed. Accordingly, when the dryness of the laundry reaches the set value c higher than the target value b, it may be seen that the falling-rate drying period A3 starts.

[0640] The set value c may correspond to 80 percent.

[0641] The falling-rate drying period A3 is a period in which most of the laundry items have been sufficiently dried, but some laundry items or some areas of the laundry item are not completely dried.

[0642] Therefore, when the rotation step S2 has many high-speed periods H like the tumbling motion in the falling-rate drying period A3, a great falling impact is generated on the dried laundry, so that the air gap C may be removed and the laundry may shrink.

[0643] To prevent the same, the rotation step S2 may perform the rolling motion when entering the falling-rate drying period A3.

[0644] In the rolling motion, because the laundry ascends and descends inside the drum 200 in a smaller vertical range than in the tumbling motion, the falling impact may be minimized on the laundry.

[0645] In addition, because the laundry moves along the rotation direction of the drum and then continuously falls from a location with a vertical level lower than the radius R of the drum from the low point of the drum and is stirred, the surface of the laundry may be evenly exposed to hot air.

[0646] Therefore, while the portion that requires the further drying of the laundry may be dried via the rolling motion, the portion that has been sufficiently dried may be prevented from shrinking as the falling impact is minimized.

[0647] The rolling motion may be performed for a set time period, and may be performed until the hanging motion to be described later is performed.

[0648] When the falling-rate drying period A3 is performed, the laundry may be further dried and thus the portion that requires the further drying may become very small. In this situation, even when the rolling motion is performed, the falling impact may be generated on the dried laundry, and the fluff may occur or the laundry may be worn because of the friction between the dried laundry and the drum 200 and the friction between the laundry items.

[0649] Therefore, the hanging motion may be further performed in the falling-rate drying period A3. The hanging motion performed in the falling-rate drying period A3 may be set such that the high-speed period H is much longer than the low-speed period L.

[0650] Accordingly, the laundry 200 may be fixed to the inner wall of the drum 200 in the hanging motion to prevent the laundry 200 from falling inside the drum 200 or the friction between the drum 200 and the laundry.

[0651] In addition, the portion of the laundry exposed to the inside of the drum 200 may be continuously dried even in the hanging motion. Therefore, the drying may be performed and the laundry may be protected at the same time in the hanging motion.

[0652] The hanging motion may be performed when the dryness of the laundry reaches the specific value d that is slightly smaller than the completion value e and greater than the set value c.

[0653] Specifically, the hanging motion may be performed after the rolling motion. That is, when the rolling motion ends, the hanging motion may be performed.

[0654] In addition, a duration of the rolling motion may be set to be longer than the duration of the hanging motion. This is because the rolling motion may have a higher drying efficiency than the hanging motion and the hanging motion may exhibit the effect of protecting the fabric when the laundry is dried to have the dryness equal to or greater than the specific value d.

[0655] In the falling-rate drying period A3, the rolling motion may be performed in an early stage and the hanging motion may be performed in a late stage. As a result, the rotation speed of the drum may be set higher in the early stage than in the late stage of the falling-rate drying period A3. That is, in the falling-rate drying period, the drum may rotate such that the laundry rotates once or more while being attached to the inner wall of the drum in the late stage by the hanging motion.

[0656] In addition, it may be seen that the falling-rate drying period is set such that the drum rotates more slowly in the early stage than in the late stage.

[0657] In addition, the drum may rotate such that the laundry may be separated from the inner wall of the drum or may roll by the rolling motion in the early stage.

[0658] In one example, because the constant-rate drying period A2 ends with the shaking motion and the falling-rate drying period A3 starts with the rolling motion, the rolling motion may be regarded as being performed after the shaking motion.

[0659] In one example, it may be seen that the duration of the low-speed period L is set to be longer than the duration of the high-speed period H because the rolling motion is performed longer than the hanging motion when viewing the falling-rate drying period A3 from a perspective of the speed of the rotation step S2.

[0660] When the rolling motion is performed in the falling-rate drying period A3, it may be seen that the low-speed period L of the rotation step S2 is set such that the laundry falls from the vertical level lower than the vertical level of the center of the drum.

[0661] When the rolling motion and the hanging motion are performed in the falling-rate drying period A3, it may be seen that, when the low-speed period L ends in the rotation step S2, the high-speed period H is disposed or the high-speed period H and the low-speed period L are periodically repeatedly disposed until completion of the falling-rate drying period A3.

[0662] It may be seen that the duration of the high-speed period H is set to be equal to or longer than the duration of the low-speed period L until the falling-rate drying period A3 is completed after the high-speed period H starts, based on the speed of the rotation step S2.

[0663] Because the hanging motion is performed when the dryness reaches the specific value d, it may be seen that a time point at which the high-speed period H starts in the rotation step S2 is set to a time point at which the dryness reaches the specific value d higher than the set value c.

[0664] FIG. 34 illustrates the rotation step S2 that may be applied in a cooling period during the air supply step S 1.

[0665] When the dryness of the laundry reaches the completion value e higher than the set value C in the falling-rate drying period, the cooling period A4 may be entered. The completion value e may be set to be a dryness equal to or higher than 90%.

[0666] It may be seen that the cooling period A4 is a period in which, although the drying of the laundry is completed, because the temperature inside the drum 200 is higher than that of outside air, the user may be exposed to hot air when the door is open.

[0667] Therefore, in the cooling period A4, the heat exchanger assembly 900 may not operate, and only the circulation blower fan 950 may operate to cool the laundry.

[0668] In the cooling period A4, because the laundry is almost completely dried, it is preferable that the drum 200 does not rotate as much as possible. This is because the laundry may be damaged even with the small friction with the drum 200 or between the laundry items in the cooling period A4.

[0669] Even then, when only air is introduced into the drum 200 in the cooling period A4, the laundry disposed at the low point of the drum 200 may be pressed by the load and the wrinkles may occur here and there on the laundry.

[0670] Accordingly, the stop motion may be performed in the cooling period A4. That is, the drum 200 may intermittently rotate via the stop motion to prevent the wrinkles from being generated on the laundry.

[0671] As a result, in the laundry treating apparatus according to the present disclosure, the rotation step S2 performed in the air supply period S1 may selectively perform one of the plurality of drum motions over time to prevent the damage and the shrinkage of the laundry and complete the drying of the laundry.

[0672] The present disclosure may be modified in various forms, and thus the scope of the present disclosure is not limited thereto. Therefore, when the modified embodiment includes the elements of the claims of the present disclosure, it should be construed as belonging to the scope of the present disclosure.

Claims

1. A method for controlling a laundry treating apparatus including a drum configured to accommodate laundry therein, a driver configured to rotate the drum, a circulation flow channel providing a space where air of the drum is circulated or moisture contained in air is condensed, and a heat exchanger assembly configured to heat air flowing through the circulation flow channel, the method comprising:

   an air supply step of supplying heated air to the drum via the heat exchanger assembly; and
   a rotation step of rotating the drum during the air supply,
   wherein the rotation step includes a hanging motion where a high-speed period where the laundry rotates in a state of being attached to an inner wall of the drum, and a low-speed period where the laundry rotates while falling from the inner wall of the drum are periodically performed.

2. The method of claim 1, wherein the drum is provided to rotate at least once in the high-speed period,
   wherein the drum is provided to rotate at least once in the low-speed period.

3. The method of claim 1, wherein a duration of the high-speed period is set to be equal to or longer than a duration of the low-speed period.

4. The method of claim 1, wherein the air supply step is divided into a preheating period, a constant-rate drying period, and a falling-rate drying period,

   wherein the constant-rate drying period is entered when a temperature of a refrigerant of the heat exchanger assembly reaches a reference value in the preheating period or when the heat exchanger assembly operates for a reference time,
   wherein the hanging motion is performed in the constant-rate drying period.

5. The method of claim 4, wherein the hanging motion is performed when dryness of the laundry is provided to reache a reference value in the constant-rate drying period.

6. The method of claim 4, wherein the rotation step further includes a tumbling motion for rotating the drum such that the laundry falls from a point lower than a high point of the drum,
   wherein the hanging motion is performed after the tumbling motion in the constant-rate drying period.

7. The method of claim 6, wherein the hanging motion is performed when the tumbling motion is performed for a reference time.

8. The method of claim 4, wherein the rotation step further includes a shaking motion of changing a rotation speed of the drum,
   wherein the hanging motion is performed before the shaking motion in the constant-rate drying period.

9. The method of claim 8, wherein the hanging motion is terminated when dryness of the laundry reaches a target value.

10. The method of claim 8, wherein the hanging motion is terminated when being performed for a specific time in the constant-rate drying period.

11. The method of claim 1, wherein the air supply step is divided into a preheating period, a constant-rate drying period, and a falling-rate drying period,

    wherein the falling-rate drying period is entered when a discharge temperature of the circulation flow channel rises to a temperature equal to or higher than a reference temperature or dryness of the laundry reaches a set value,
    wherein the hanging motion is performed in the falling-rate drying period.

12. The method of claim 11, wherein the hanging motion is performed when the dryness of the laundry reaches a specific value in the falling-rate drying period.

13. The method of claim 11, wherein when the hanging motion is performed, the hanging motion continues until the falling-rate drying period is terminated.

14. The method of claim 11, wherein the rotation includes a rolling motion of rotating the drum such that the laundry falls from a point lower than a center of the drum,
    wherein the hanging motion is performed after the

rolling motion in the falling-rate drying period.

15. The method of claim 14, wherein a duration of the hanging motion is set shorter than a duration of the rolling motion.

16. The method of claim 14, wherein the rolling motion is performed starting from a time point of entering the falling-rate drying period until the dryness of the laundry reaches a target value.

17. The method of claim 1, wherein the rotation step includes a pulling motion where a high-speed period where the laundry rotates in the state of being attached to the inner wall of the drum, and a low-speed period where the laundry rotates while falling from the inner wall of the drum are periodically performed, wherein a period of the pulling motion is shorter than a period of the hanging motion, is performed after the pulling motion is performed.

18. The method of claim 17, wherein the high-speed period is set to be longer than the low-speed period in the pulling motion,
wherein the high-speed period of the hanging motion is set to be longer than the high-speed period of the pulling motion.

19. The method of claim 18, wherein the low-speed period of the hanging motion is set to be longer than the high-speed period of the pulling motion.

20. The method of claim 18, wherein the low-speed period of the pulling motion includes:

a constant-speed period where the drum rotates such that the laundry falls from a point between a high point of the drum and a center of the drum; and
a deceleration period where a rotation speed of the drum is lower than in the constant-speed period,
wherein a duration of the deceleration period is shorter than a duration of the constant-speed period.

21. A method for controlling a laundry treating apparatus including a drum configured to accommodate laundry therein, a driver configured to rotate the drum, a circulation flow channel providing a space where air of the drum is circulated or moisture contained in air is condensed, and a heat exchanger assembly configured to heat air flowing through the circulation flow channel, the method comprising:

an air supply step of supplying heated air to the drum via the heat exchanger assembly; and
a rotation step of rotating the drum during the air supply,
wherein the rotation step includes a hanging motion where a high-speed period of rotating the drum at a first speed for a first time period, and a low-speed period of rotating the drum at a second speed lower than the first speed for a second time period are repeatedly performed.

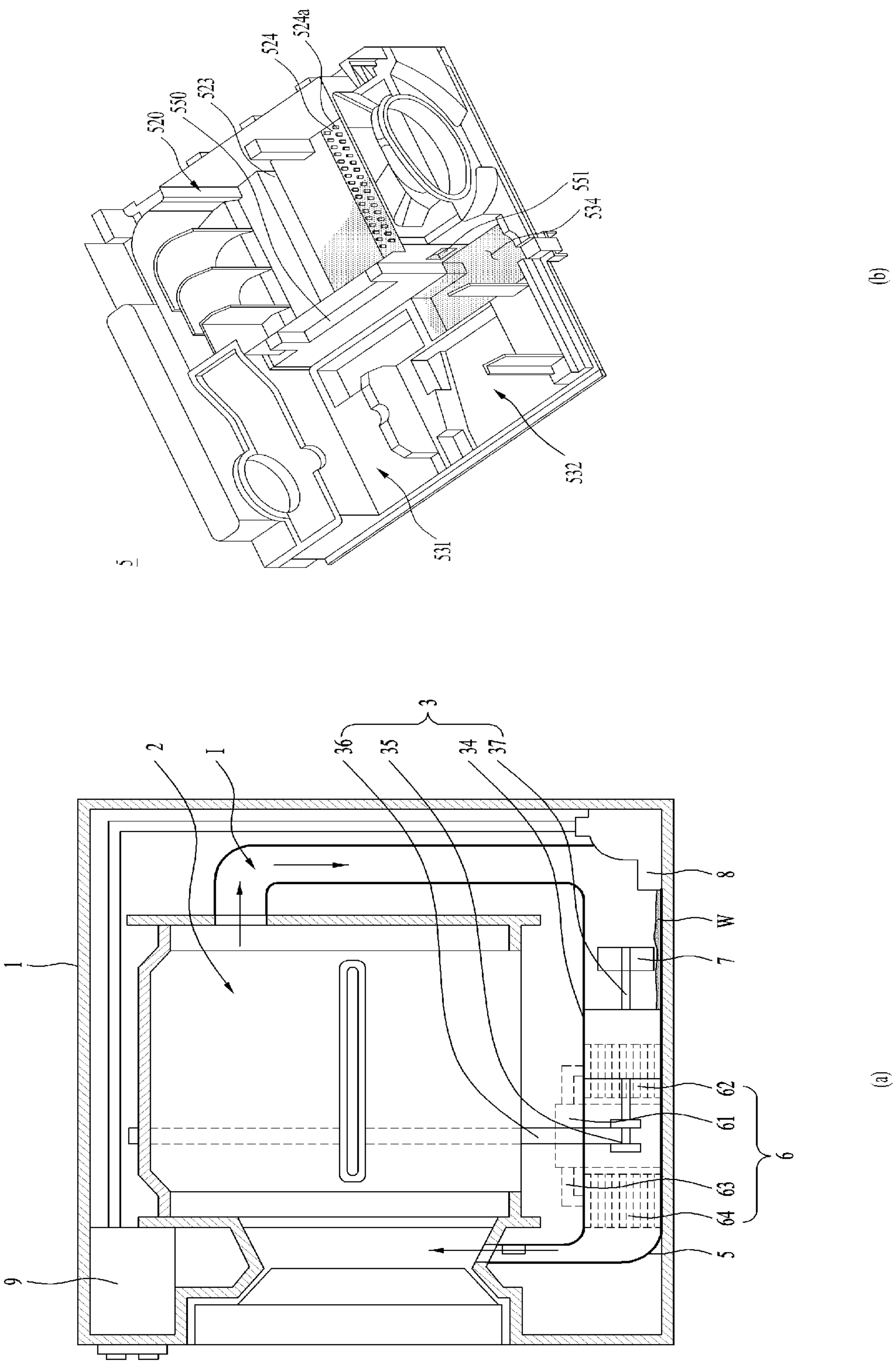
22. The method of claim 21, wherein the first time period is set to be equal to or longer than the second time period.

23. The method of claim 22, wherein the hanging motion disposes a preparation period or rotating the drum at a third speed lower than the second speed for a third time period between the high-speed period and the low-speed period.

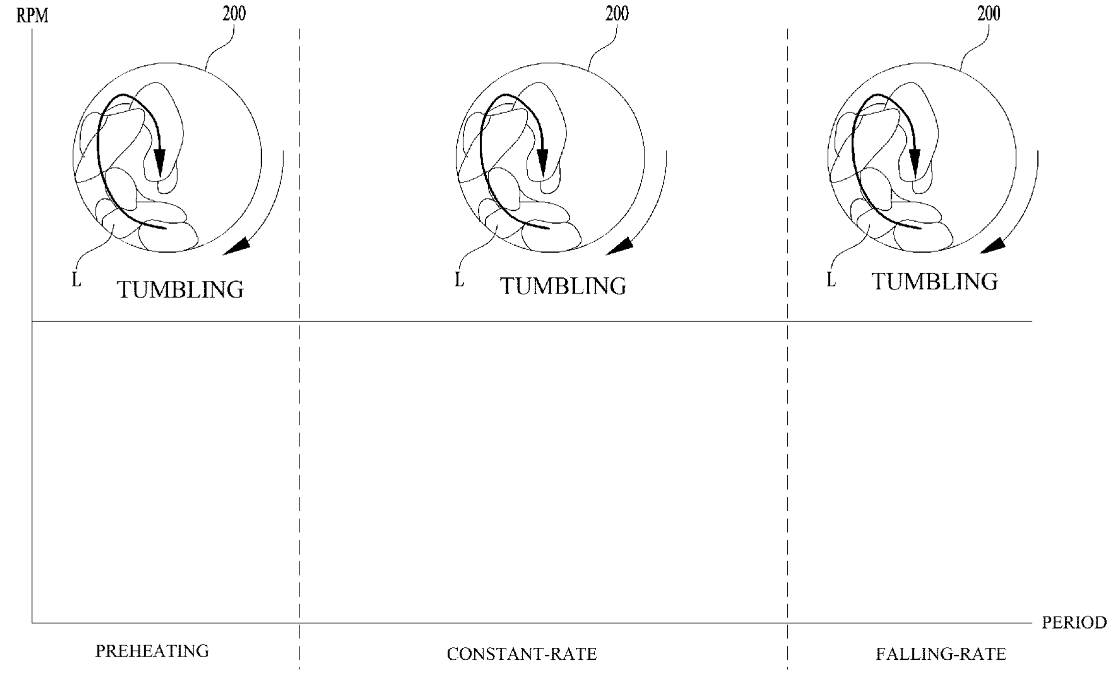
24. The method of claim 23, wherein the third time period is set shorter than the second time period.

25. The method of claim 23, wherein the third time period is set to be longer than a time period for the drum to rotate once.

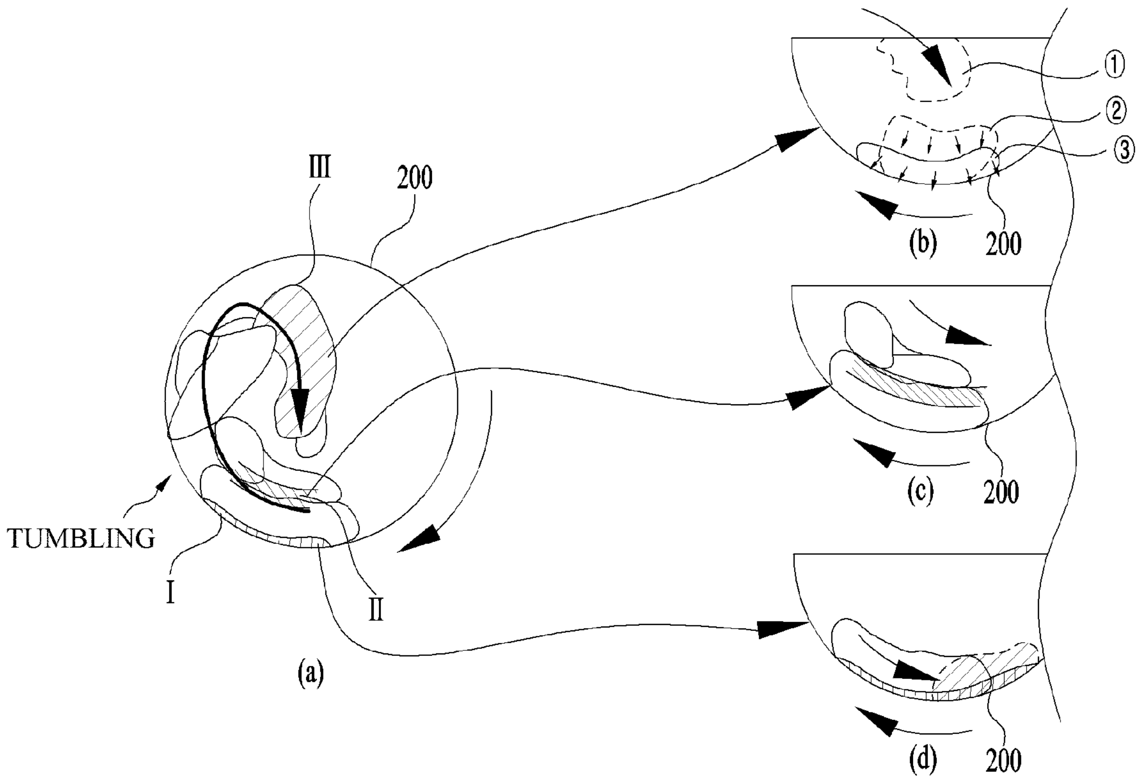
【FIG 1】Amended



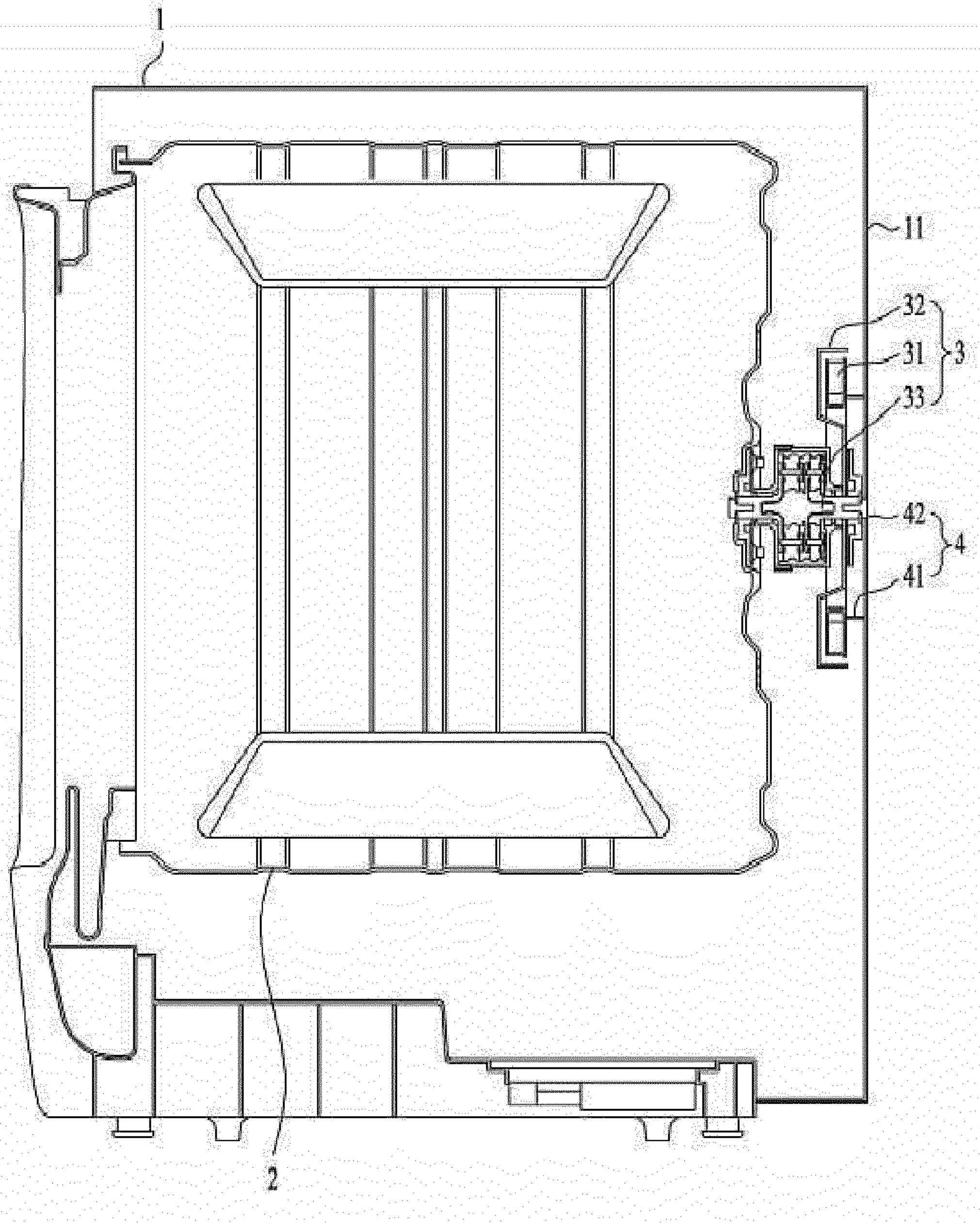
【FIG 2】


RPM
200
200
200
L
TUMBLING
L
TUMBLING
L
TUMBLING
PERIOD
PREHEATING
CONSTANT-RATE
FALLING-RATE

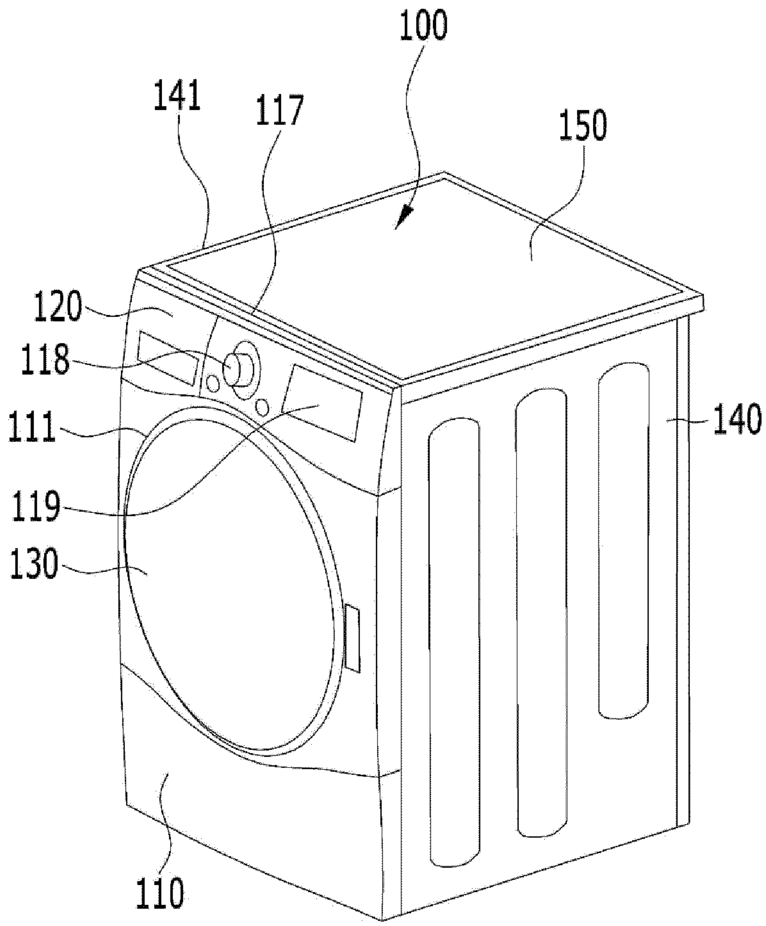
【FIG 3】



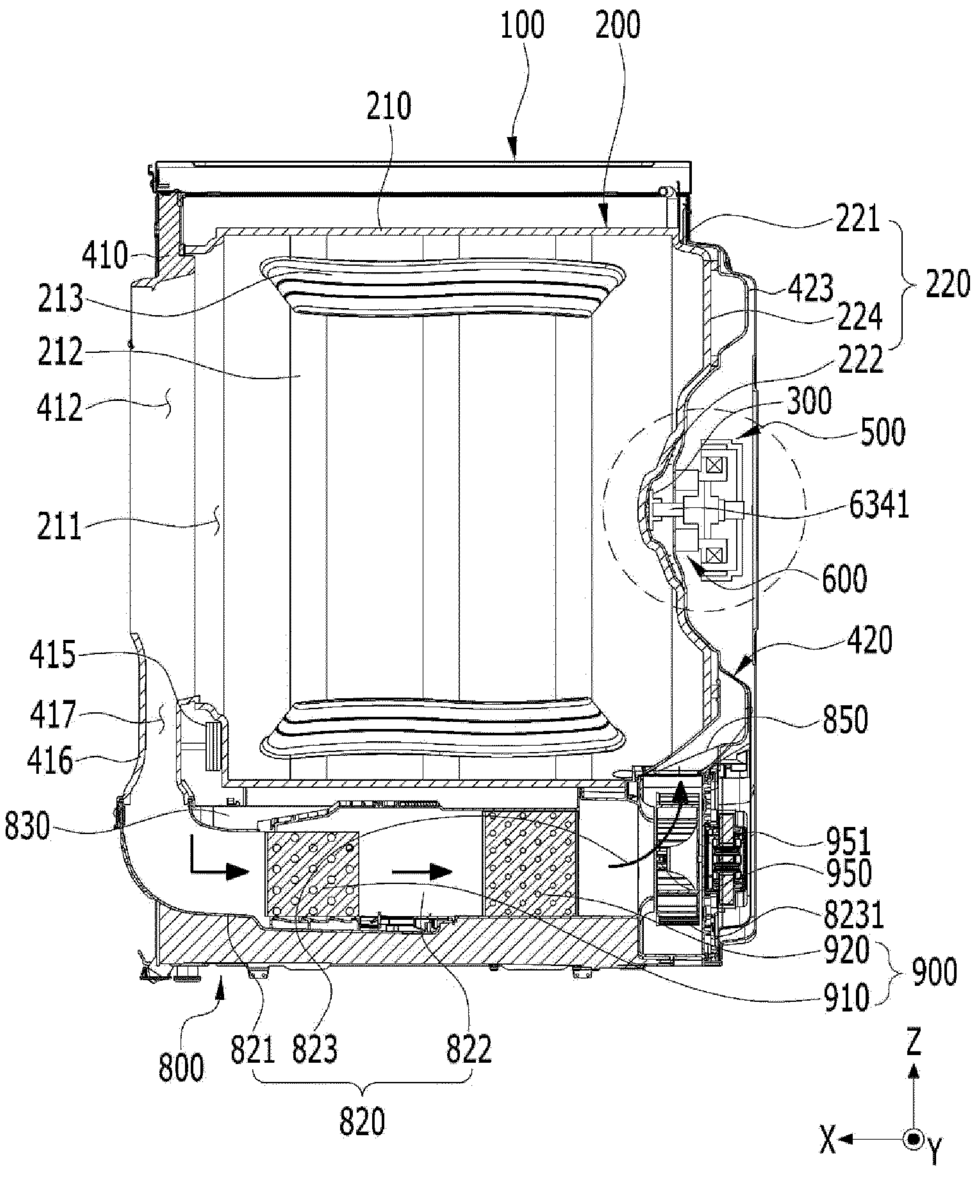
【FIG 4】



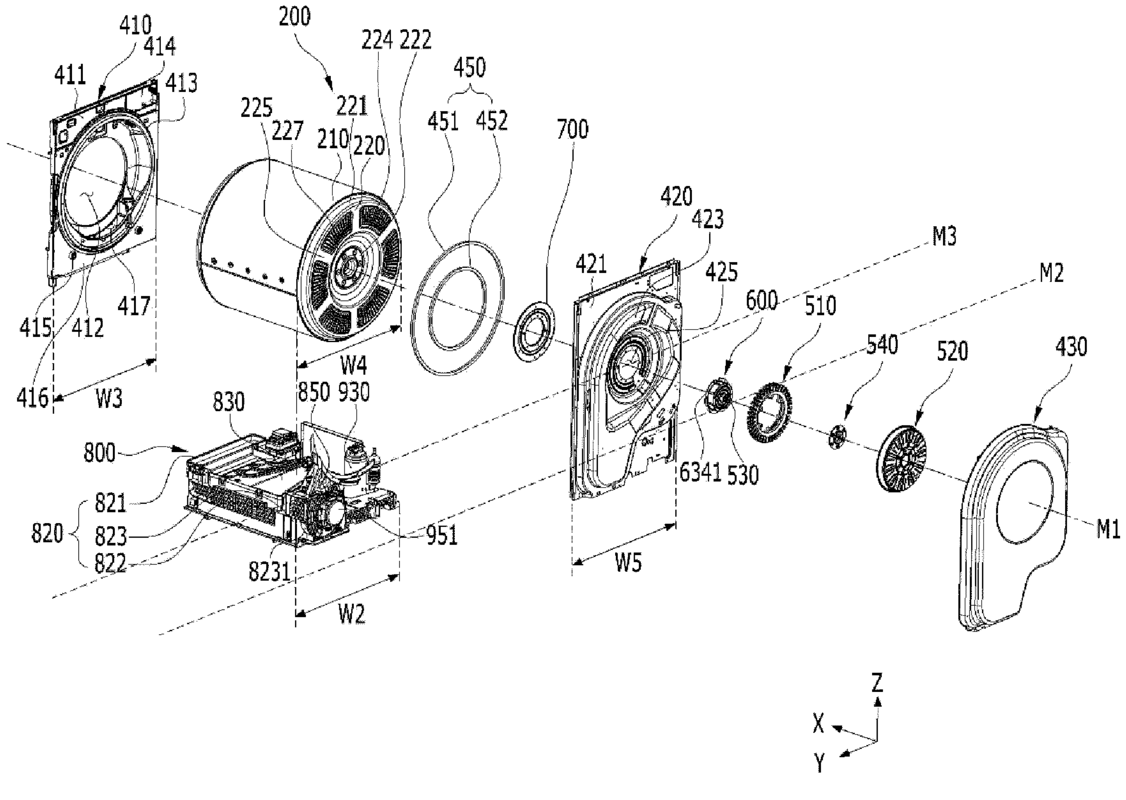
【FIG 5】



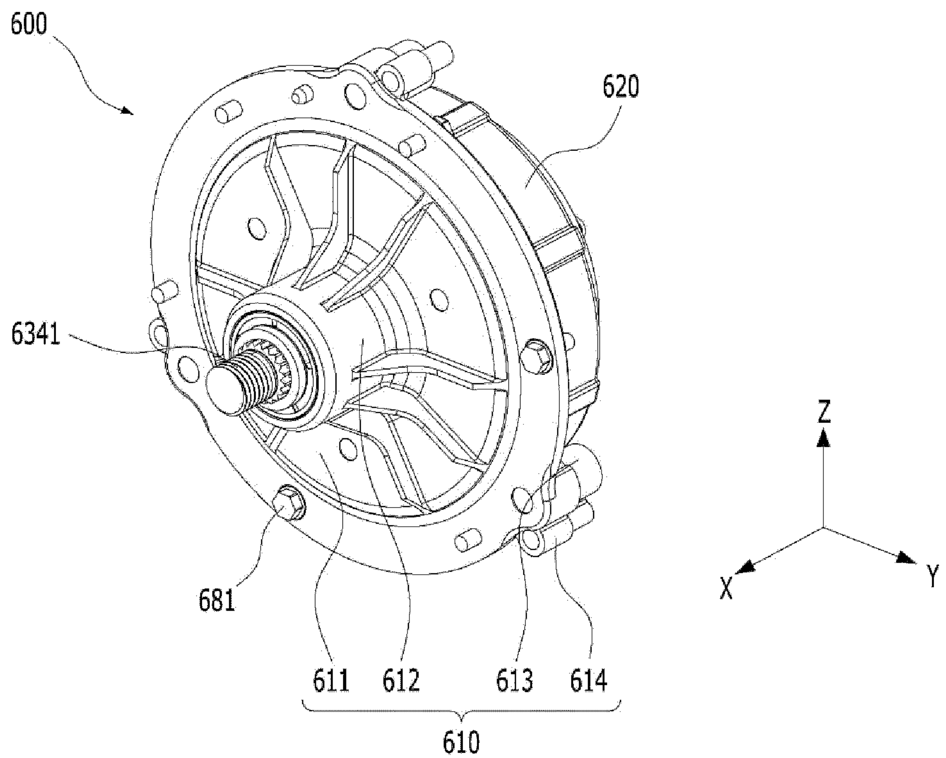
【FIG 6】


100
200
210
221
220
410
423
213
224
212
222
412
300
500
6341
211
600
420
415
850
417
416
830
951
950
8231
920
900
910
800
821
823
822
820
Z
X
Y

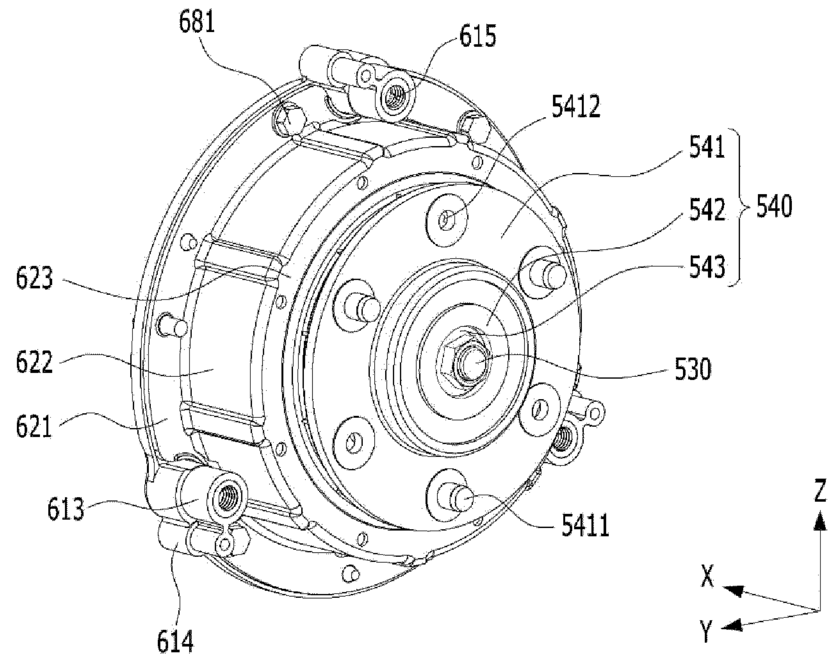
【FIG 7】


410
414
411
413
200
224 222
450
225
221
227
210
220
451
452
700
420
423
M3
421
425
M2
600
510
540
520
430
415
412
417
416
W3
W4
830
850 930
800
821
820
823
822
8231
951
W5
6341
530
M1
W2
Z
X
Y

【FIG 8】

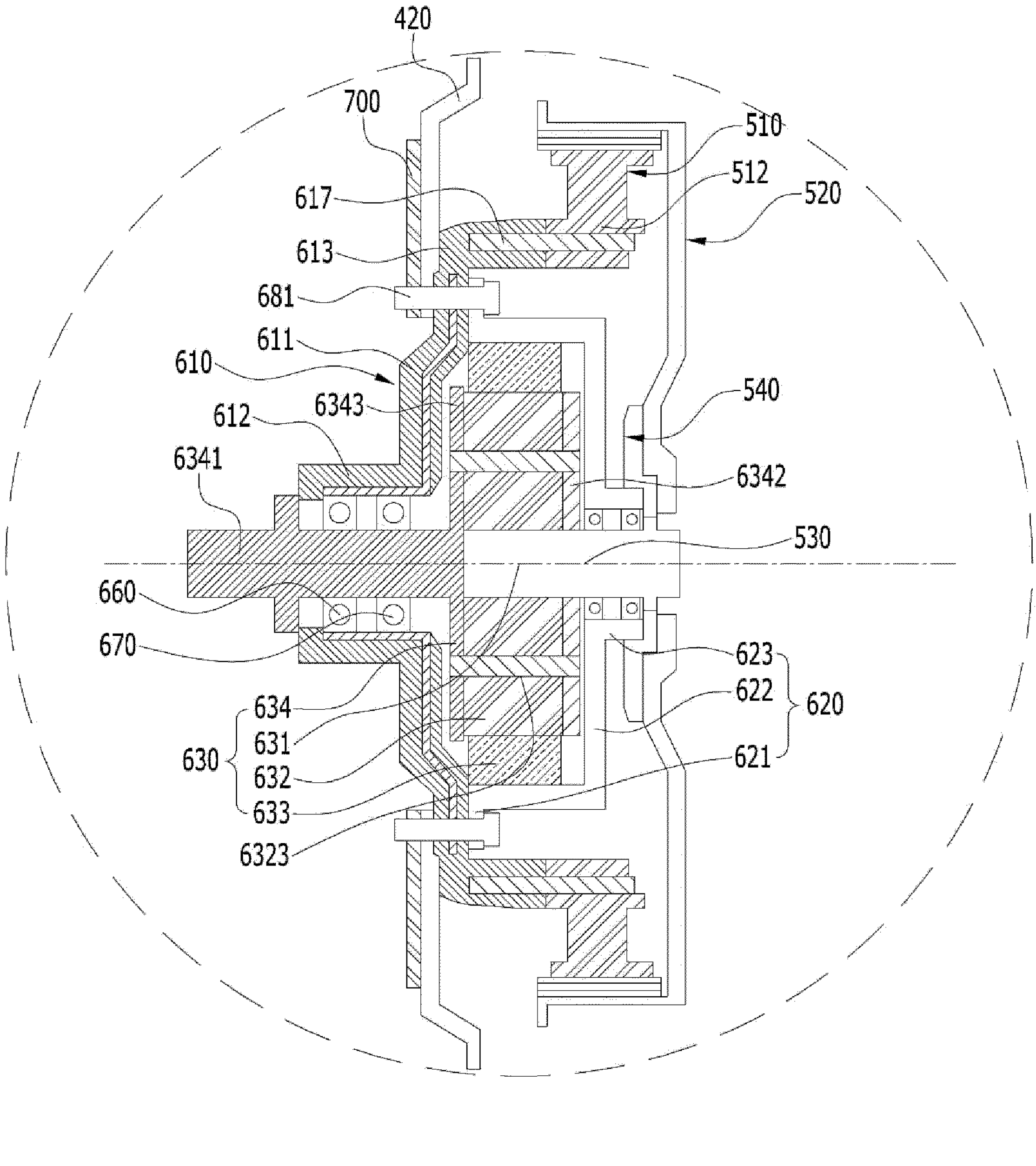

600
620
6341
681
611
612
613
614
610
Z
X
Y

(a)

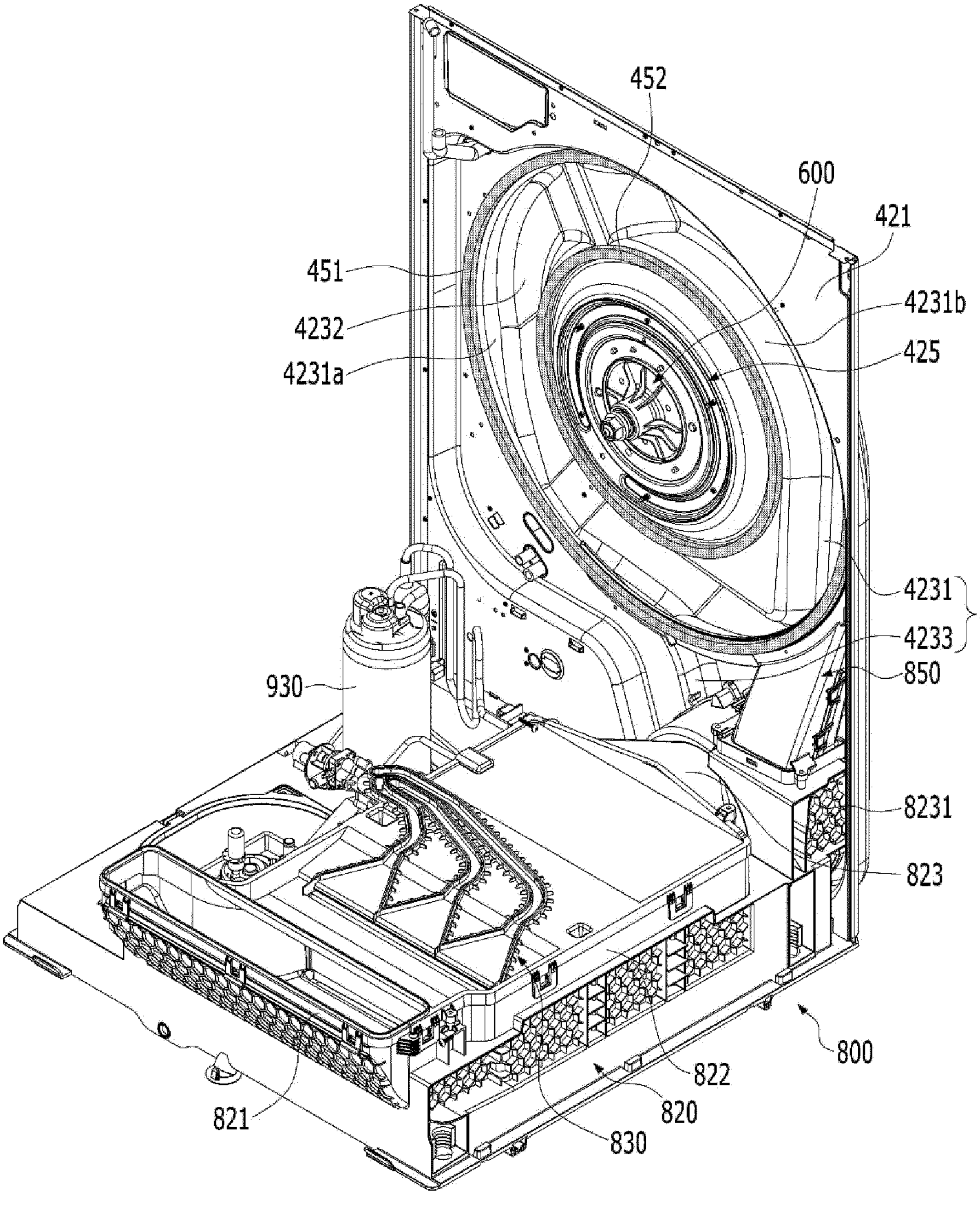

681
615
5412
541
542
540
543
623
622
621
530
613
5411
614
Z
X
Y

(b)

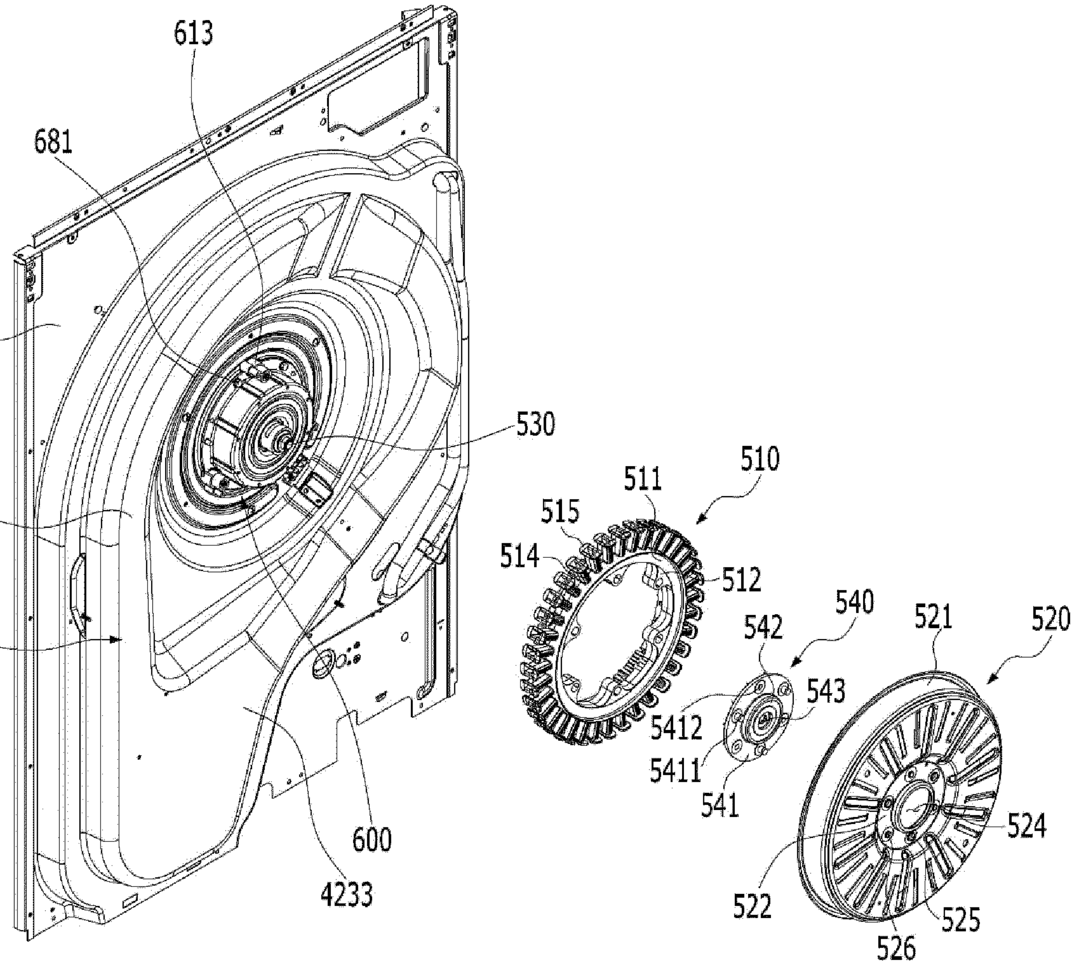
【FIG 9】


420
700
510
512
520
617
613
681
611
610
540
6343
612
6341
6342
530
660
670
623
622
620
634
631
630
632
621
633
6323

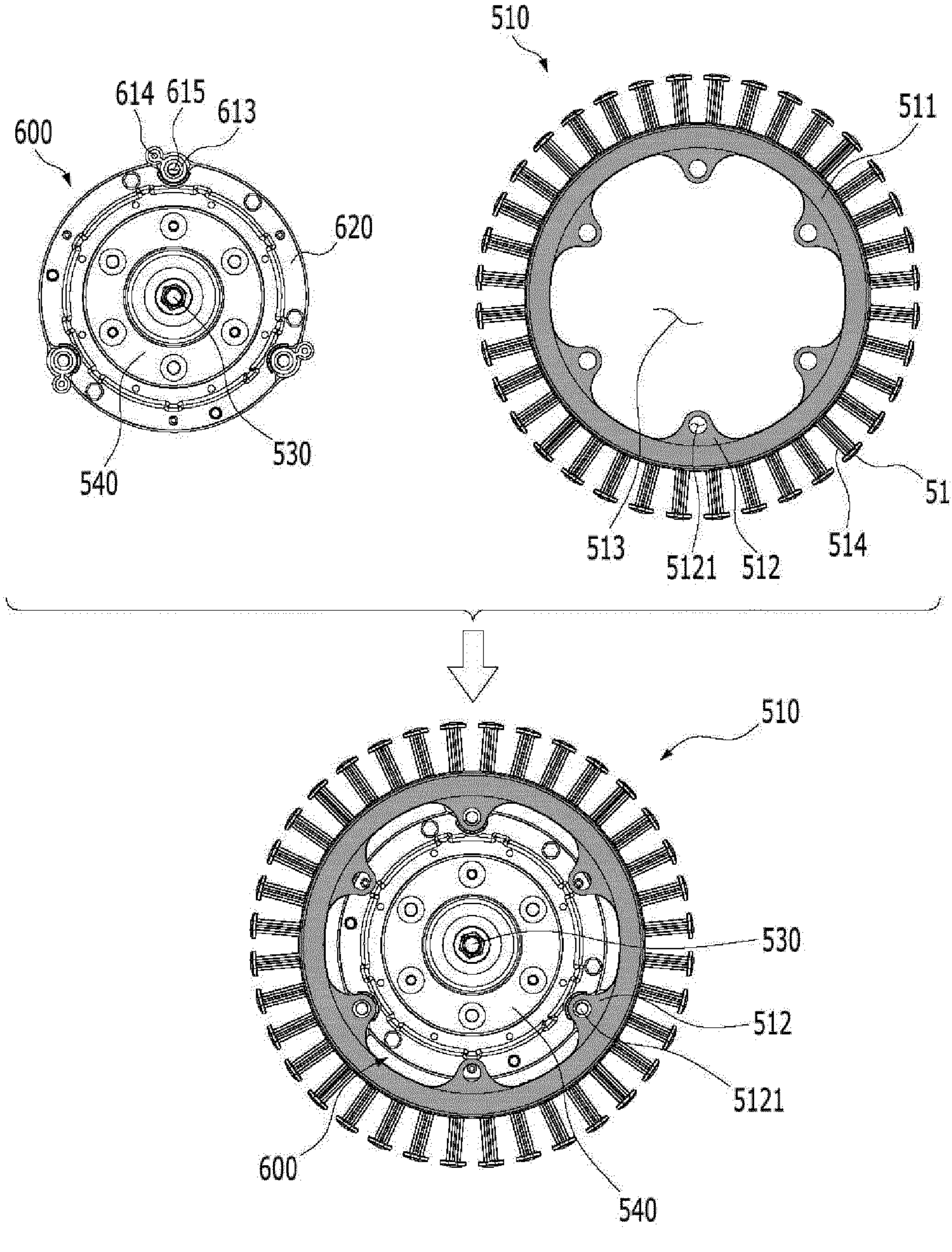
【FIG 10】


452
600
421
451
4231b
4232
425
4231a
4231
423
4233
850
930
8231
823
800
822
820
821
830

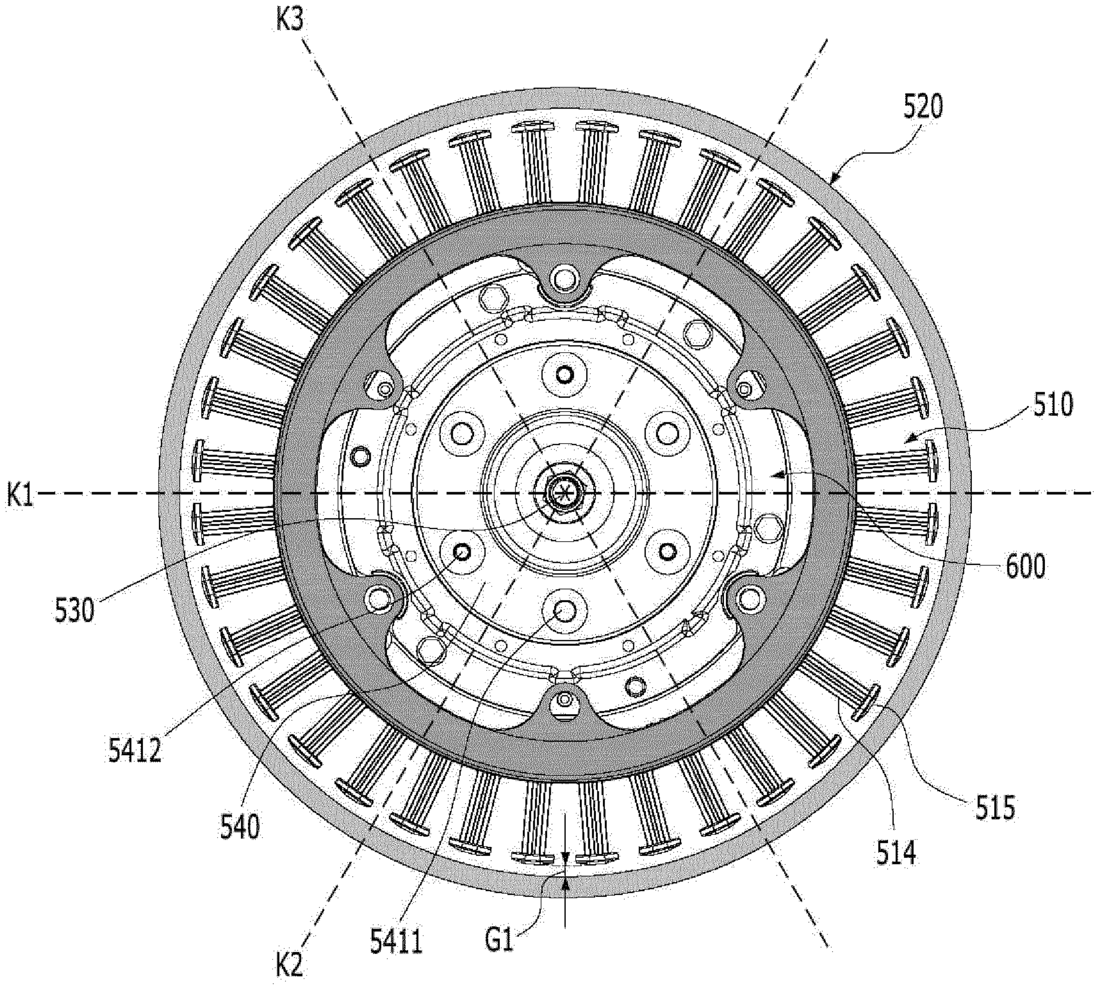
【FIG 11】


613
681
421
530
510
511
515
514
512
4231
423
540
542
521
520
543
5412
5411
541
600
4233
524
522
525
526

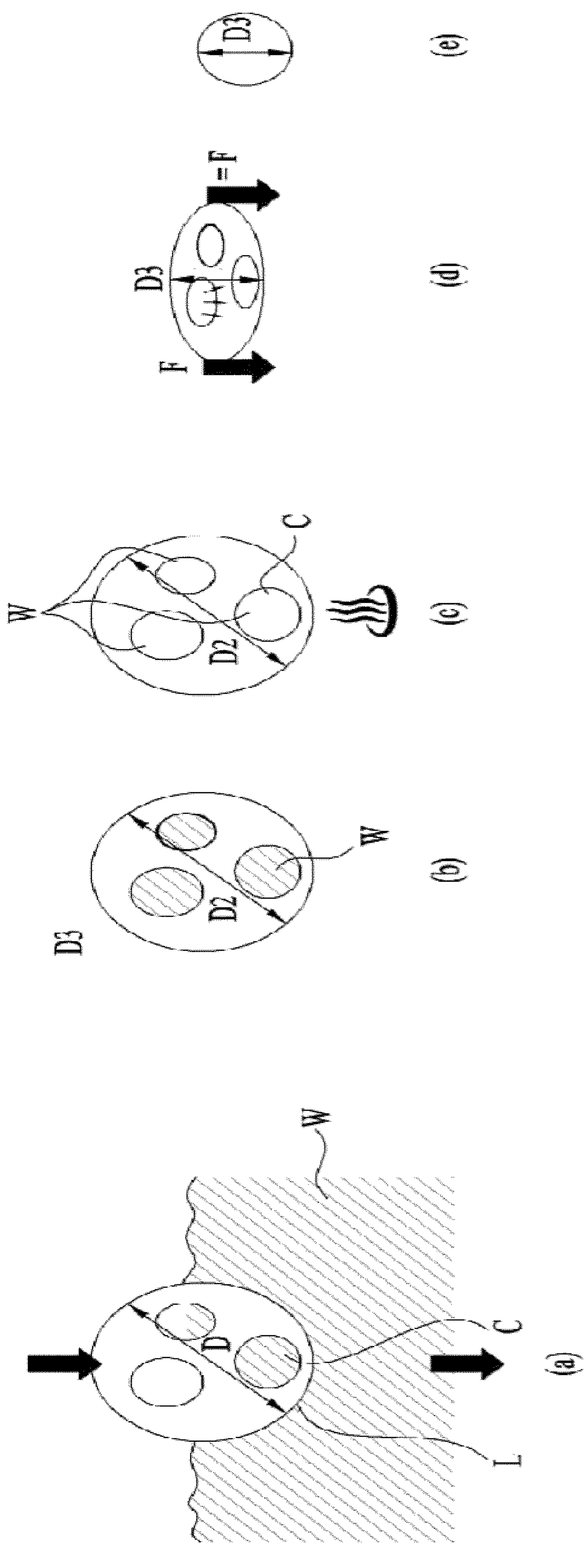
【FIG 12】


510
614 615 613
600
511
620
530
540
513
5121 512
514
515
510
530
512
5121
600
540

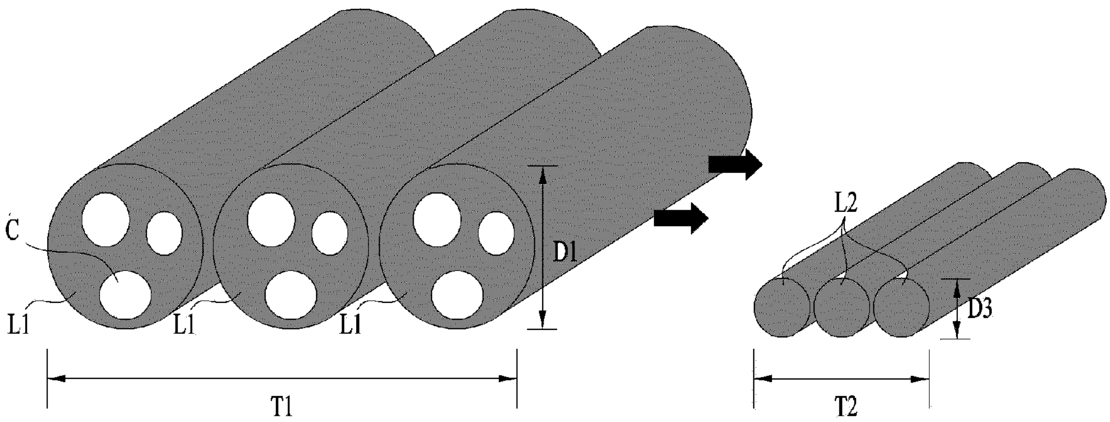
【FIG 13】



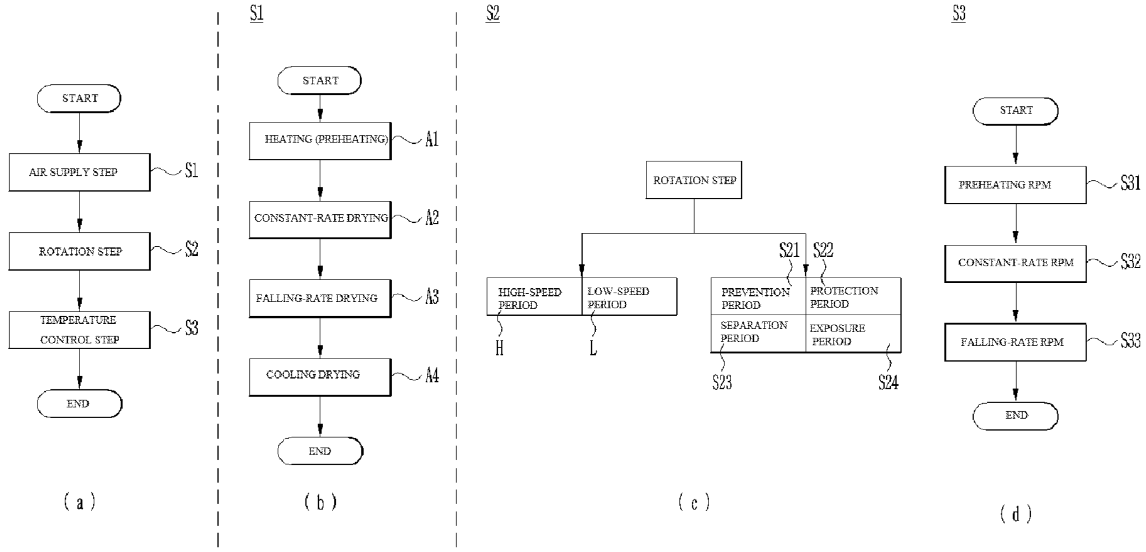
【FIG 14】amended



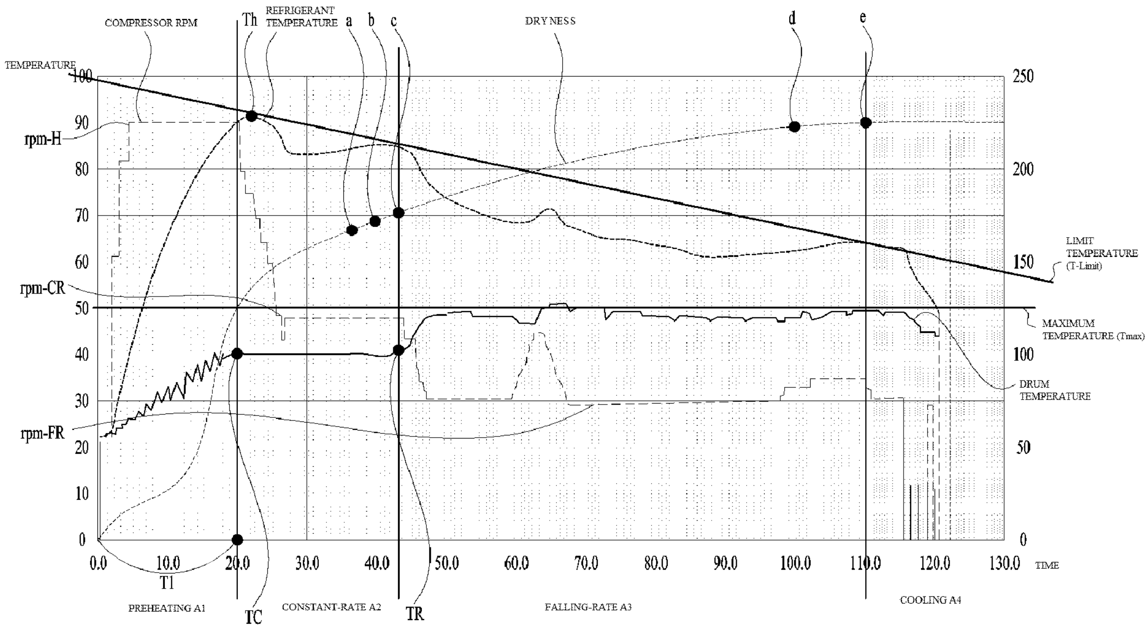
【FIG 15】


C
L1
L1
L1
D1
L2
D3
T1
T2

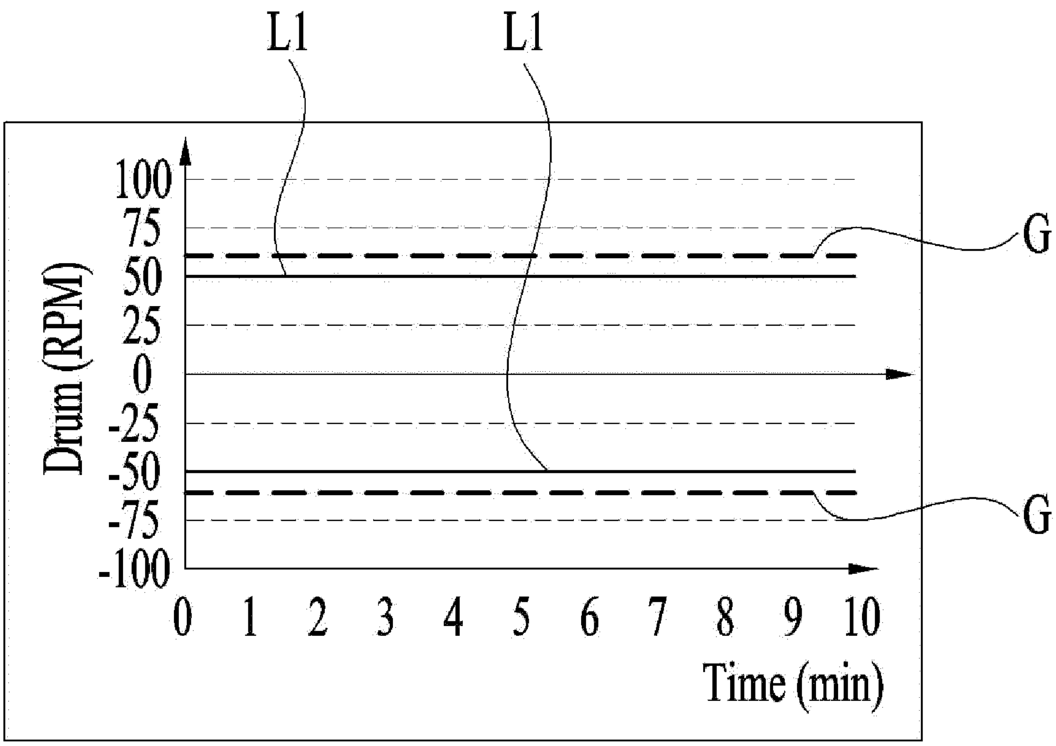
【FIG 16】


S1
S2
S3
START
AIR SUPPLY STEP
S1
ROTATION STEP
S2
TEMPERATURE CONTROL STEP
S3
END
(a)
START
HEATING (PREHEATING)
A1
CONSTANT-RATE DRYING
A2
FALLING-RATE DRYING
A3
COOLING DRYING
A4
END
(b)
ROTATION STEP
HIGH-SPEED PERIOD
LOW-SPEED PERIOD
H
L
S21
S22
PREVENTION PERIOD
PROTECTION PERIOD
SEPARATION PERIOD
EXPOSURE PERIOD
S23
S24
(c)
START
PREHEATING RPM
S31
CONSTANT-RATE RPM
S32
FALLING-RATE RPM
S33
END
(d)

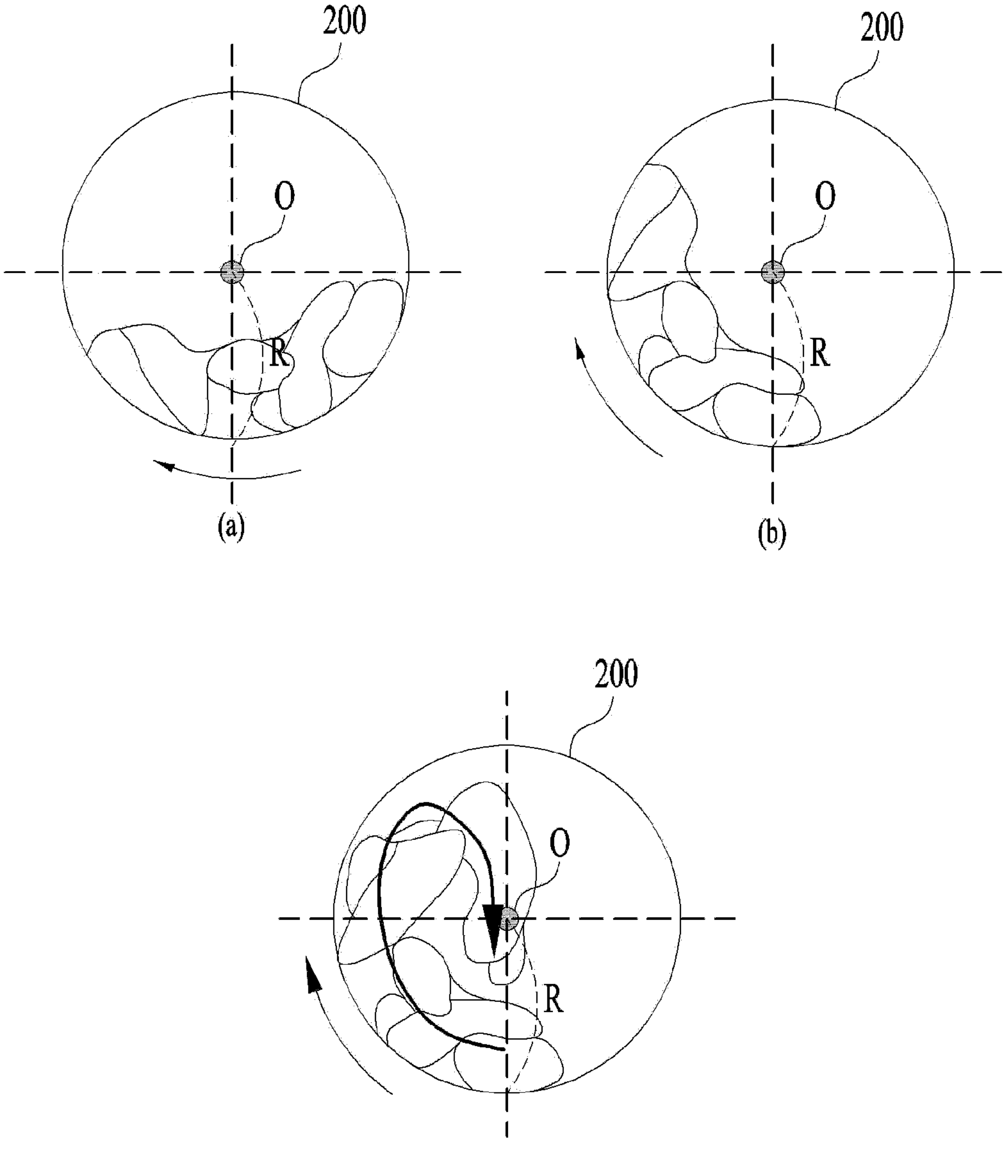
【FIG 17】


COMPRESSOR RPM
Th
REFRIGERANT TEMPERATURE
a
b
c
DRYNESS
d
e
TEMPERATURE
rpm-H
rpm-CR
rpm-FR
LIMIT TEMPERATURE (T-Limit)
MAXIMUM TEMPERATURE (Tmax)
DRUM TEMPERATURE
TIME
T1
TC
TR
PREHEATING A1
CONSTANT-RATE A2
FALLING-RATE A3
COOLING A4

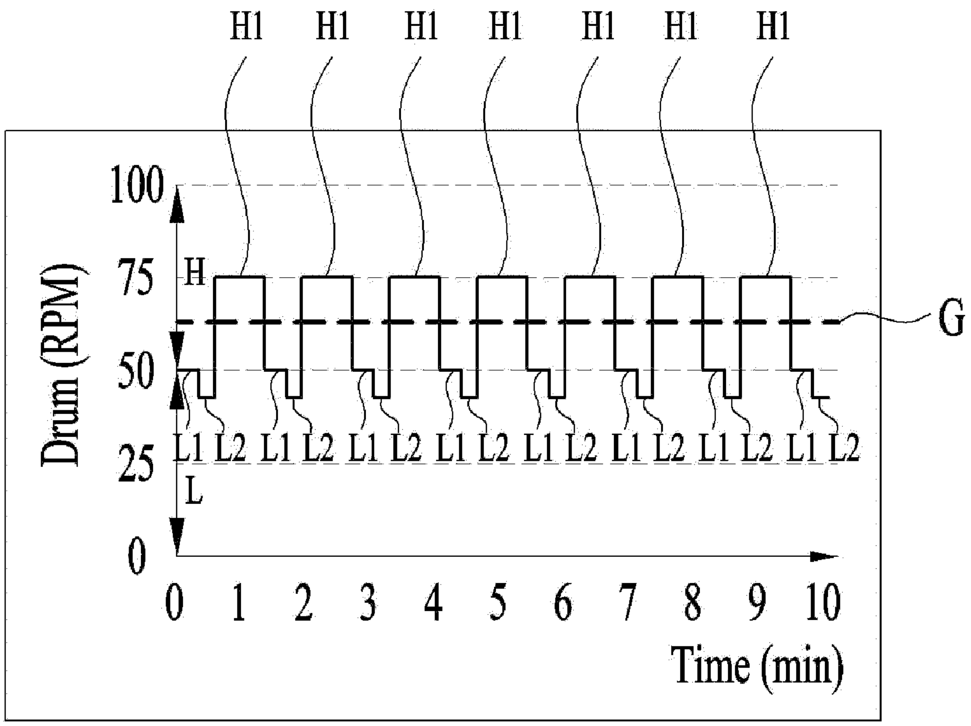
【FIG 18】


L1
L1
G
G
Drum (RPM)
Time (min)

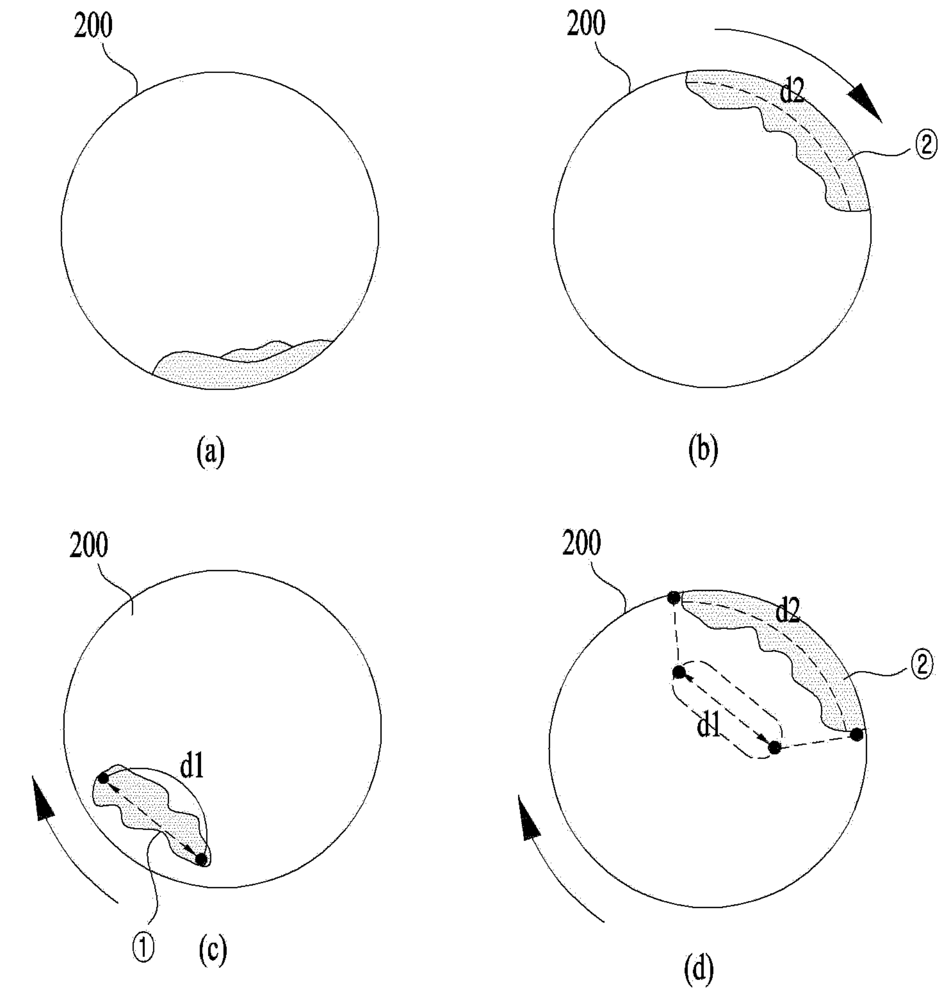
【FIG 19】



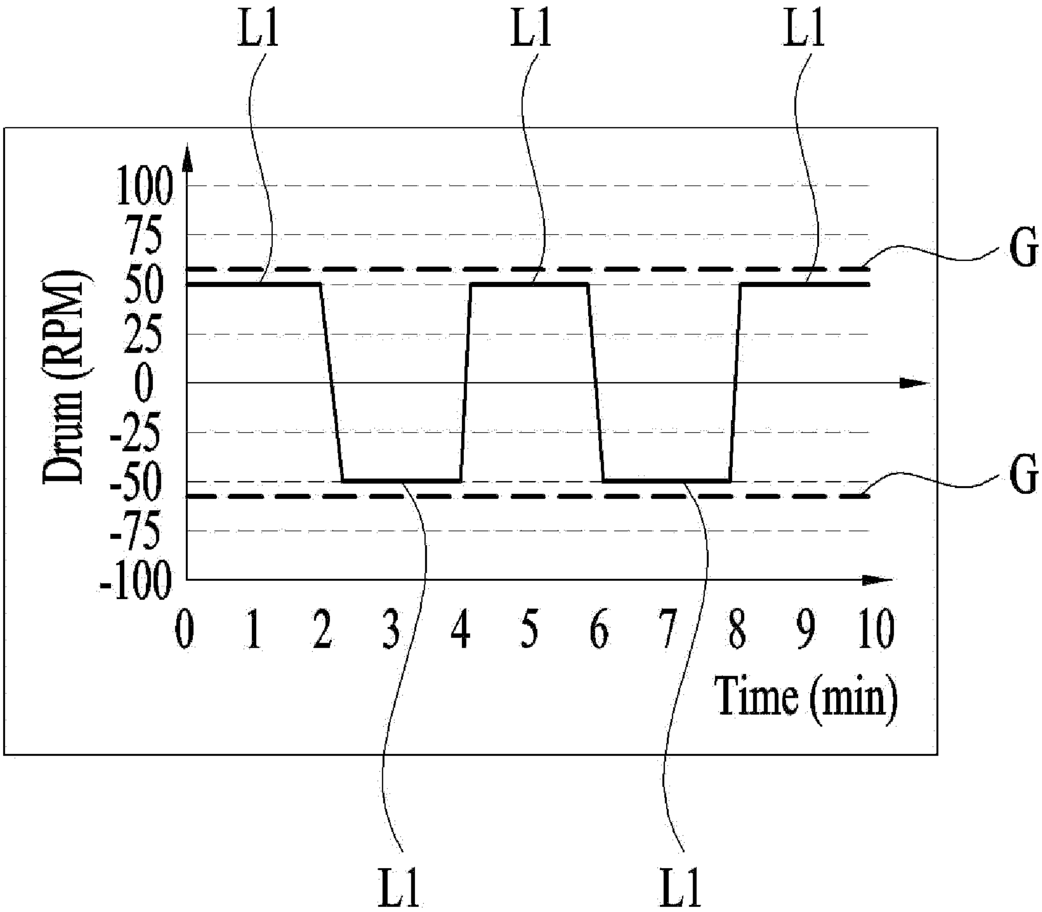
【FIG 20】


H1
H1
H1
H1
H1
H1
H1
100
75
50
25
0
H
L
G
L1
L2
Drum (RPM)
0
1
2
3
4
5
6
7
8
9
10
Time (min)

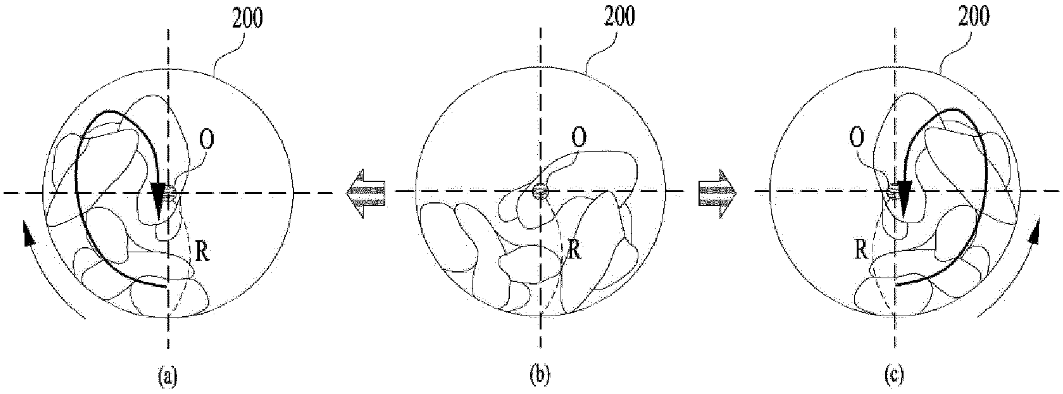
【FIG 21】



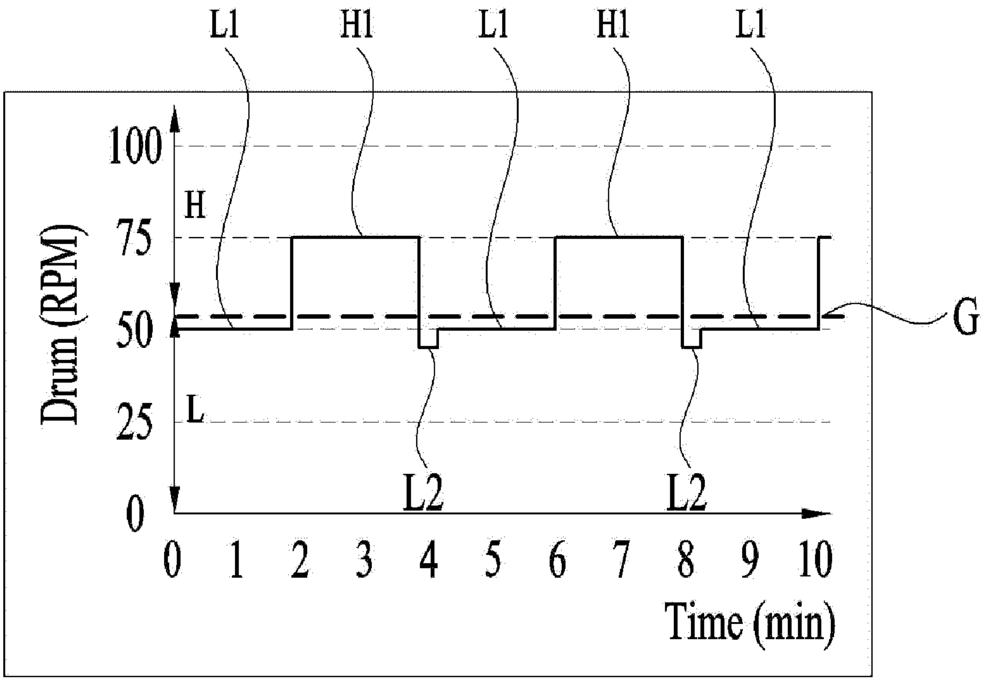
【FIG 22】


L1
L1
L1
G
G
L1
L1
100
75
50
25
0
-25
-50
-75
-100
Drum (RPM)
0 1 2 3 4 5 6 7 8 9 10
Time (min)

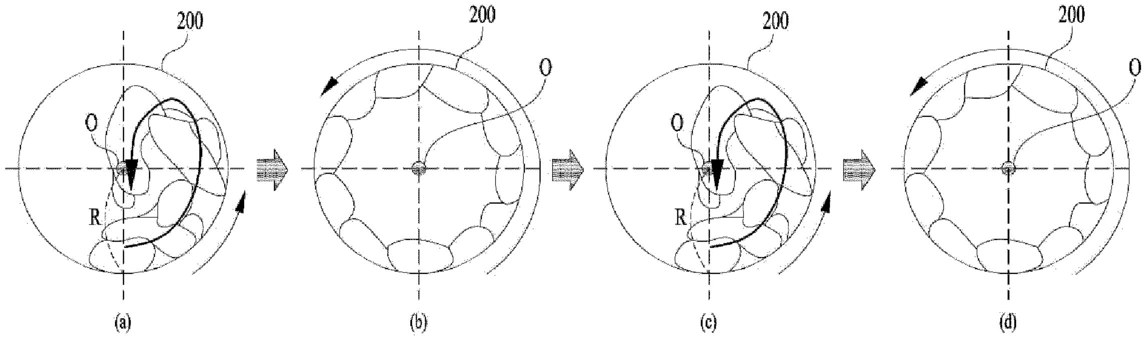
【FIG 23】


200
O
R
200
O
R
200
O
R
(a)
(b)
(c)

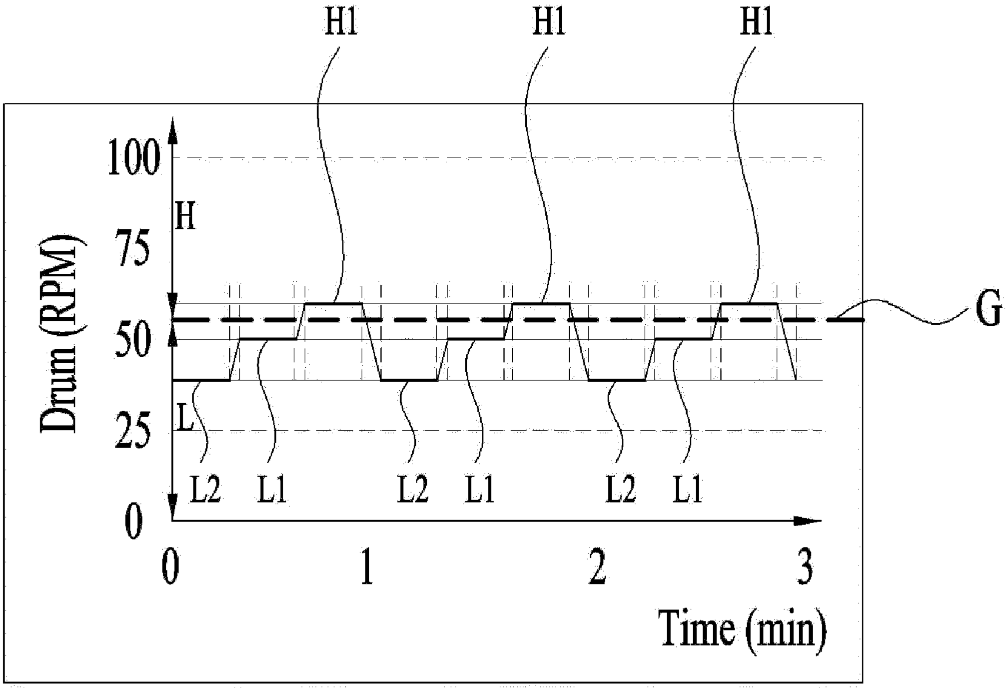
【FIG 24】


L1
H1
L1
H1
L1
100
H
75
50
L
25
0
Drum (RPM)
L2
L2
G
0 1 2 3 4 5 6 7 8 9 10
Time (min)

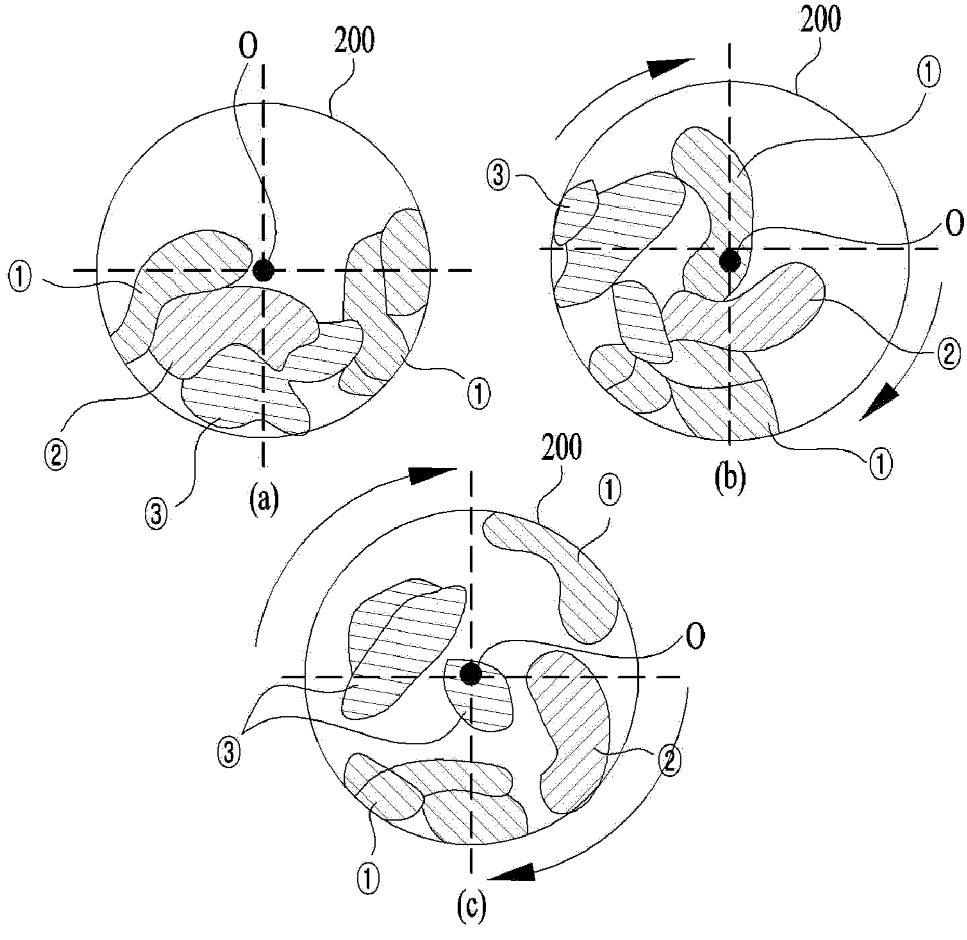
【FIG 25】


200
O
R
(a)
(b)
(c)
(d)

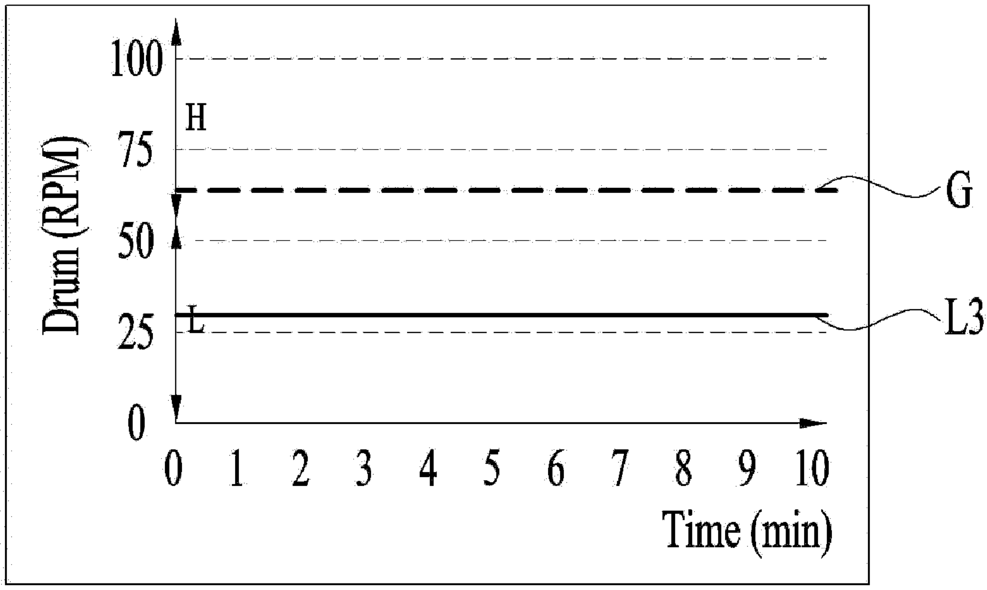
【FIG 26】


H1
H1
H1
G
100
75
50
25
0
H
L
L2
L1
Drum (RPM)
0
1
2
3
Time (min)

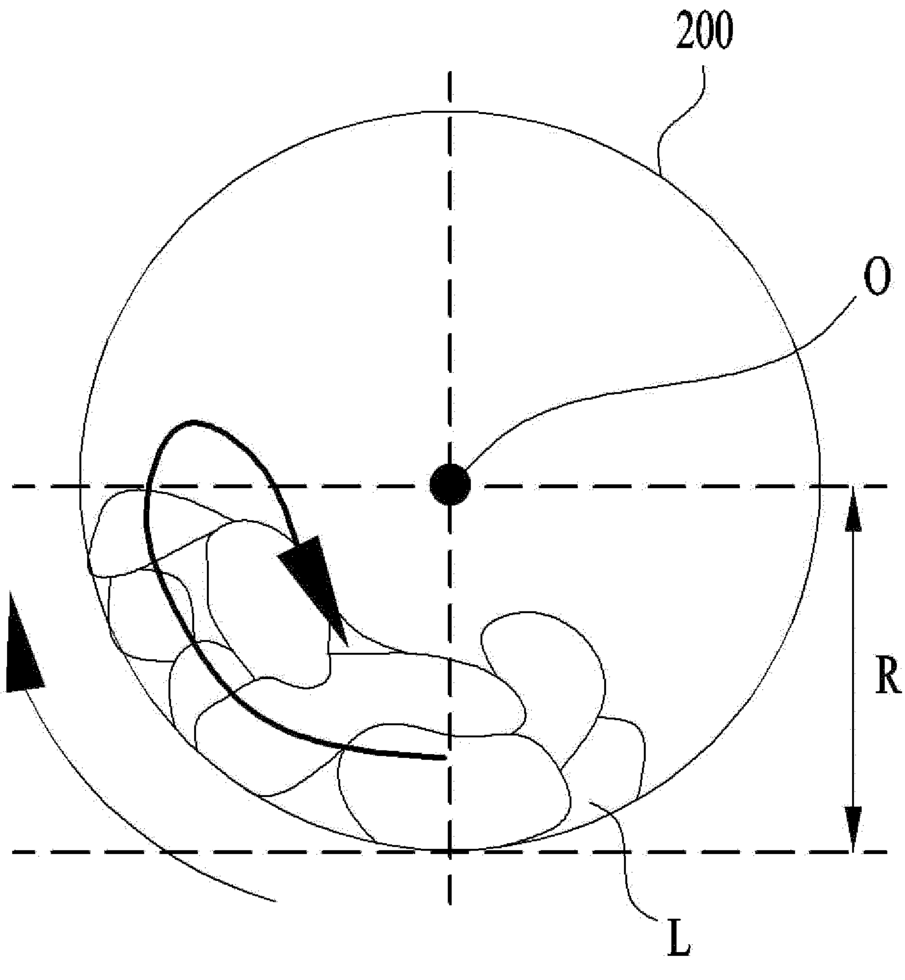
【FIG 27】



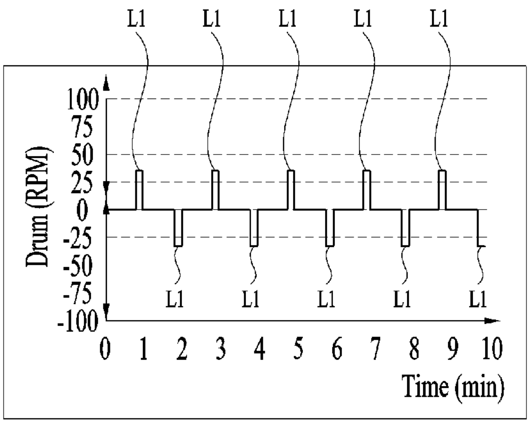
【FIG 28】



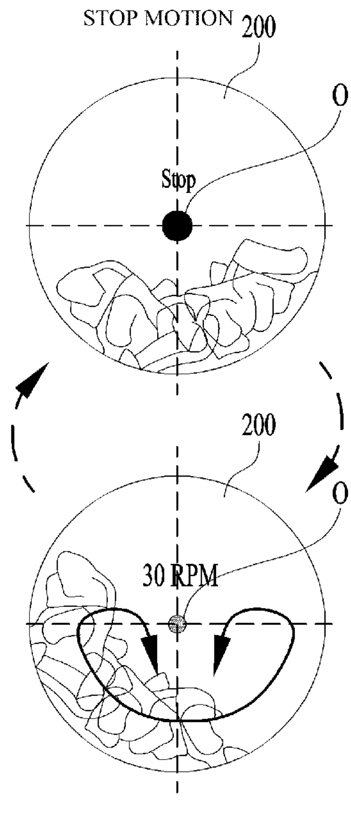
【FIG 29】



【FIG 30】

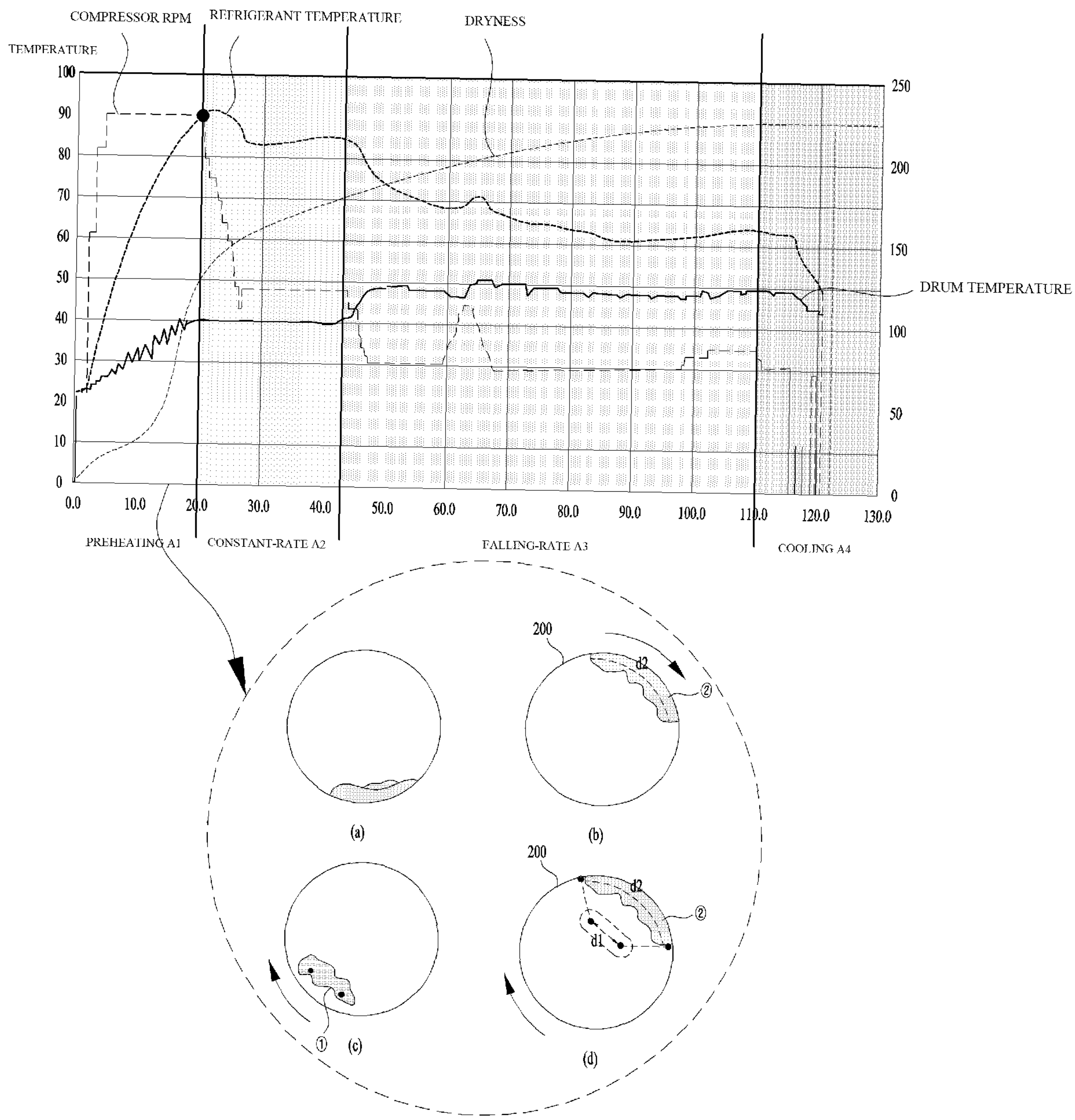

L1
Drum (RPM)
100
75
50
25
0
-25
-50
-75
-100
0 1 2 3 4 5 6 7 8 9 10
Time (min)

(a)

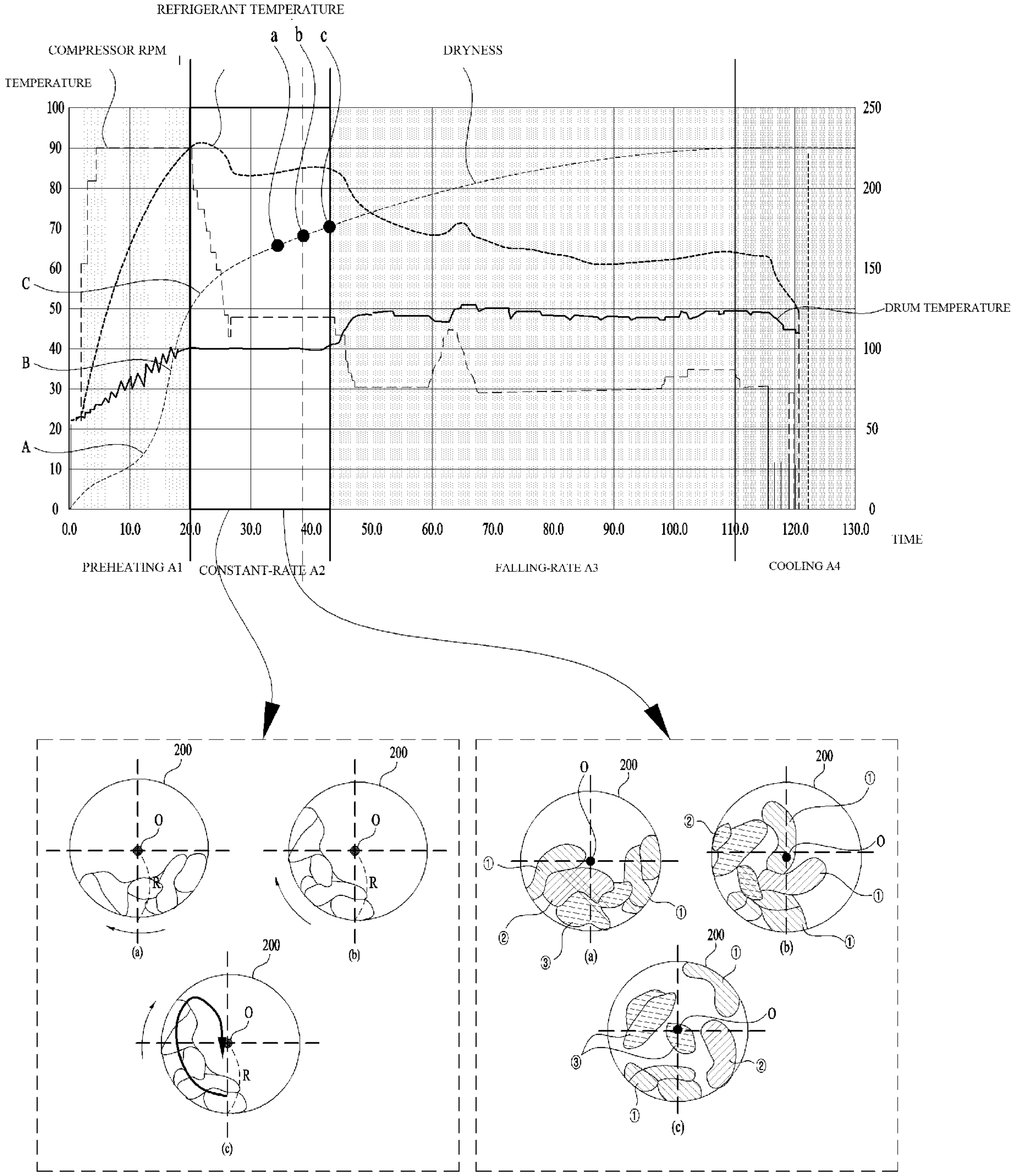

STOP MOTION
200
0
Stop
30 RPM

(b)

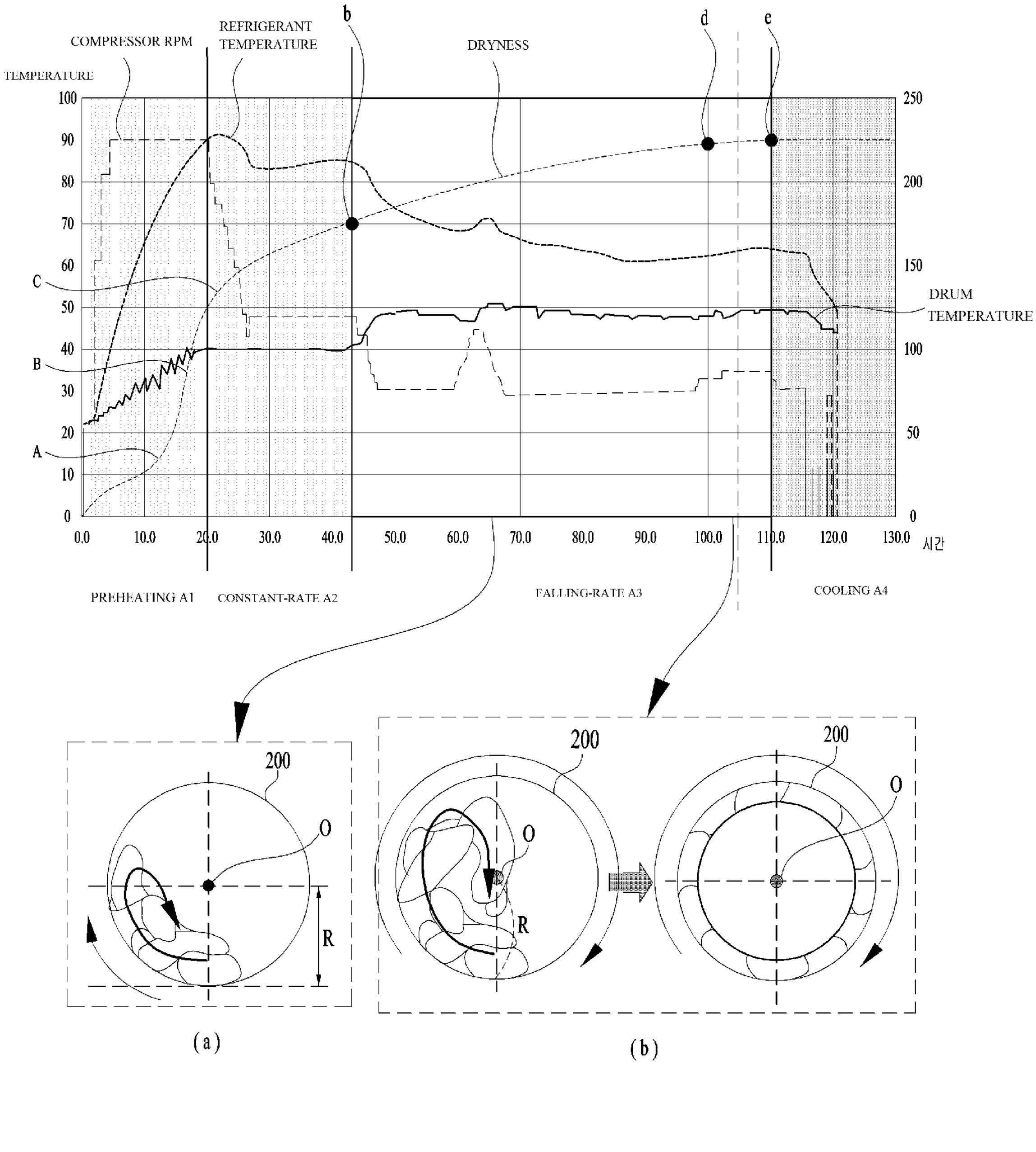
【FIG 31】


COMPRESSOR RPM
REFRIGERANT TEMPERATURE
DRYNESS
TEMPERATURE
DRUM TEMPERATURE
PREHEATING A1
CONSTANT-RATE A2
FALLING-RATE A3
COOLING A4
200
d2
②
①
d1
(a)
(b)
(c)
(d)

【FIG 32】

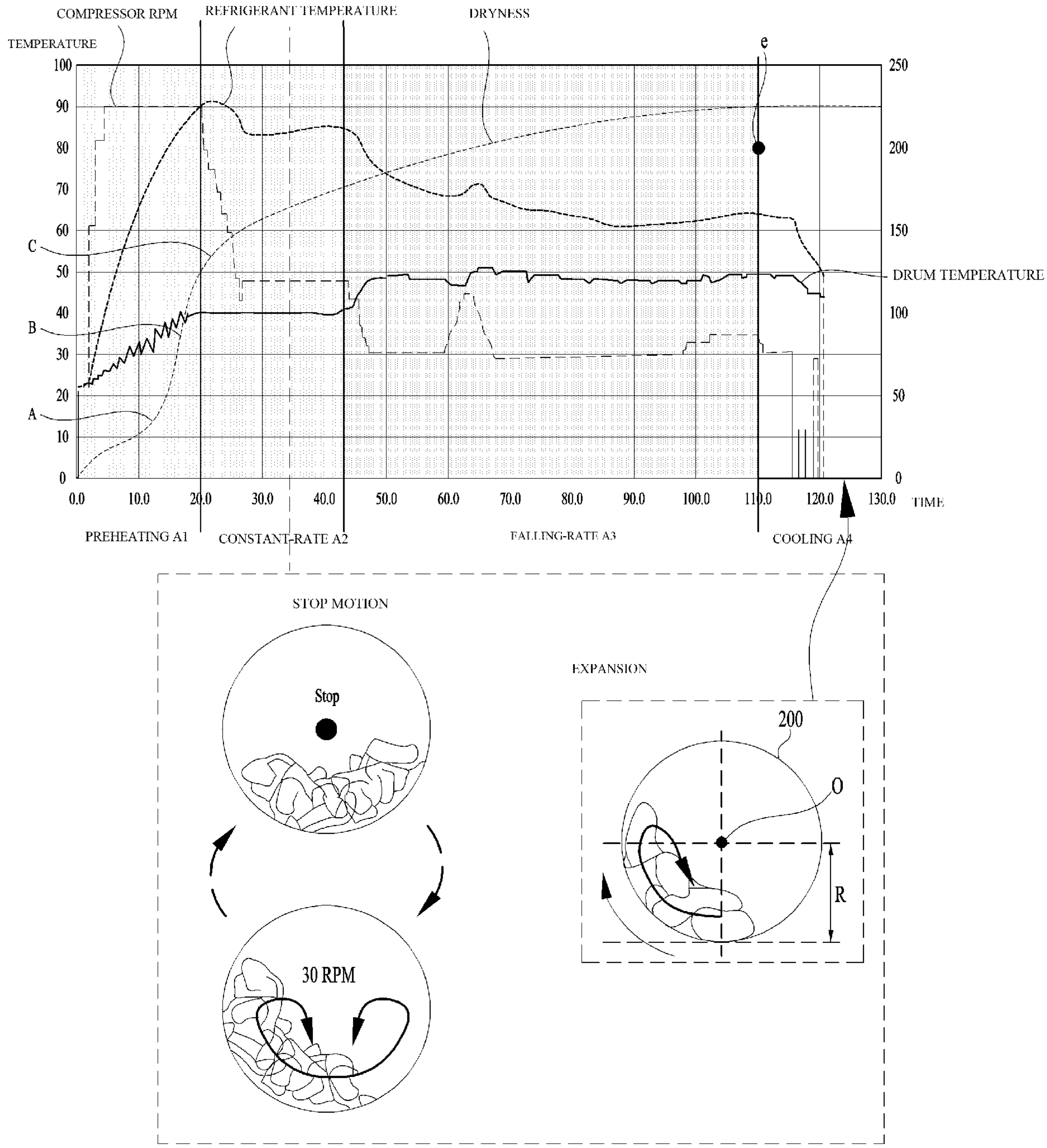

REFRIGERANT TEMPERATURE
COMPRESSOR RPM
TEMPERATURE
DRYNESS
DRUM TEMPERATURE
TIME
PREHEATING A1
CONSTANT-RATE A2
FALLING-RATE A3
COOLING A4
a
b
c
A
B
C
200
O
R
(a)
(b)
(c)
①
②
③

【FIG 33】



COMPRESSOR RPM
REFRIGERANT TEMPERATURE
TEMPERATURE
b
d
e
DRYNESS
C
B
A
DRUM TEMPERATURE
시간
PREHEATING A1
CONSTANT-RATE A2
FALLING-RATE A3
COOLING A4
200
O
R
(a)
(b)

【FIG 34】


COMPRESSOR RPM
REFRIGERANT TEMPERATURE
DRYNESS
TEMPERATURE
e
C
B
A
DRUM TEMPERATURE
TIME
PREHEATING A1
CONSTANT-RATE A2
FALLING-RATE A3
COOLING A4
STOP MOTION
Stop
30 RPM
EXPANSION
200
O
R

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2022/012522

A. CLASSIFICATION OF SUBJECT MATTER

D06F 58/38(2020.01)i; **D06F 58/08**(2006.01)i; **D06F 34/18**(2020.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

D06F 58/38(2020.01); D06F 25/00(2006.01); D06F 33/02(2006.01); D06F 37/20(2006.01); D06F 39/00(2006.01); D06F 58/20(2006.01); D06F 58/28(2006.01)

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

Korean utility models and applications for utility models: IPC as above
Japanese utility models and applications for utility models: IPC as above

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

eKOMPASS (KIPO internal) & keywords: 의류(clothes), 건조(dry), 열교환(heat change), 회전(spin), 속도(speed), 드럼(drum)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	KR 10-2013-0089026 A (LG ELECTRONICS INC.) 09 August 2013 (2013-08-09) See paragraphs [0022]-[0109], claims 1-5 and figures 1-6.	1-3,17-19,21-22 4-16,20,23-25
A	WO 2021-025194 A1 (LG ELECTRONICS INC. et al.) 11 February 2021 (2021-02-11) See paragraphs [0119]-[0137] and figures 6-7.	1-25
A	KR 10-2019-0023445 A (LG ELECTRONICS INC.) 08 March 2019 (2019-03-08) See entire document.	1-25
A	KR 10-2019-0130899 A (LG ELECTRONICS INC.) 25 November 2019 (2019-11-25) See entire document.	1-25
A	JP 2000-084287 A (MATSUSHITA ELECTRIC IND. CO., LTD.) 28 March 2000 (2000-03-28) See entire document.	1-25

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

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

Date of the actual completion of the international search	Date of mailing of the international search report
13 December 2022	**14 December 2022**
Name and mailing address of the ISA/KR **Korean Intellectual Property Office** **Government Complex-Daejeon Building 4, 189 Cheongsa-ro, Seo-gu, Daejeon 35208** Facsimile No. **+82-42-481-8578**	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 2022)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/KR2022/012522

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
KR	10-2013-0089026	A	09 August 2013	CN	103243515	A	14 August 2013
				CN	103243515	B	18 May 2016
				EP	2623659	A1	07 August 2013
				EP	2623659	B1	01 August 2018
				KR	10-2161514	B1	05 October 2020
				US	2013-0200833	A1	08 August 2013
				US	9450531	B2	20 September 2016
WO	2021-025194	A1	11 February 2021	CN	112912554	A	04 June 2021
				EP	3800288	A1	07 April 2021
				KR	10-2022-0038552	A	29 March 2022
				US	2021-0404103	A1	30 December 2021
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