



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
01.07.2015 Bulletin 2015/27

(51) Int Cl.:
D06F 37/40 (2006.01) D06F 37/42 (2006.01)

(21) Application number: **14177051.1**

(22) Date of filing: **15.07.2014**

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**
Designated Extension States:
BA ME

(71) Applicant: **Dongbu Daewoo Electronics
Corporation
Seoul 100-769 (KR)**

(72) Inventor: **Lee, Jae Woo
Seoul 100-769 (KR)**

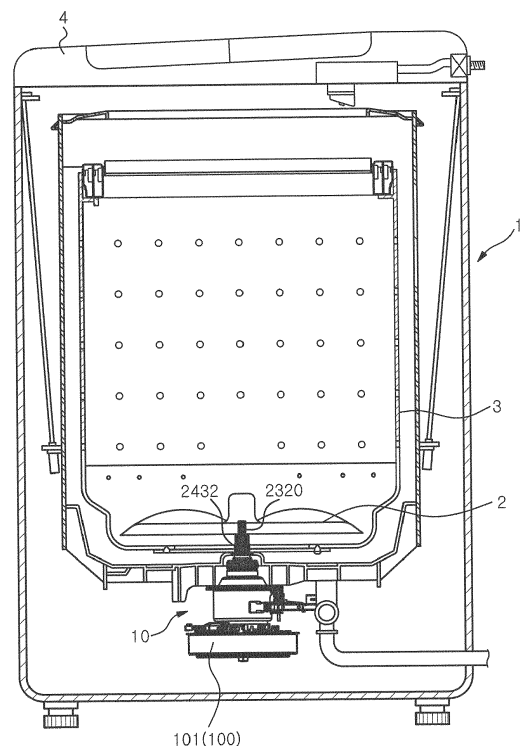
(30) Priority: **26.12.2013 KR 20130164180**

(74) Representative: **Rau, Schneck & Hübner
Patentanwälte Rechtsanwälte PartGmbB
Königstraße 2
90402 Nürnberg (DE)**

(54) **Power transmission apparatus and power control apparatus for a washing machine**

(57) A washing machine includes a power transmission apparatus and a power control apparatus. The power transmission apparatus includes a driving unit (100), a gear mechanism (2000) including an input shaft (2100) connected to the driving unit (100), a reduction assembly (2200) coupled to the input shaft (2100) to reduce its rotational speed to a preset gear ratio, a washing shaft (2300) coupled to the reduction assembly (2200) that rotates at the gear ratio, and a water removal assembly (2400) selectively connected to the driving unit (100) in a water removal mode for independently rotating from the washing shaft (2300), a coupling unit (300) selectively transmitting a power of the driving unit (100) to the water removal assembly (2400) in the water removal mode, and a brake unit (400) selectively forcing the water removal assembly (2400) to stop in the water removal mode.

FIG. 1



Description

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application is based on and claims priority to Korean Patent Application No. 10-2013-0164180, filed on December 26, 2013, the disclosure of which is incorporated herein in its entirety by reference.

TECHNICAL FIELD

[0002] Embodiments according to the present disclosure relate to a power transmission apparatus and a power control apparatus for a washing machine.

BACKGROUND

[0003] In general, a washing machine removes contaminants from clothes, bedding, etc., (hereinafter, referred to as laundry) using friction and the impact of water driven by the back-and-forth rotation of a pulsator. The amount and type of laundry may be sensed by sensors, and a washing mode may be automatically selected and an appropriate amount of water supplied according to the amount and type of laundry, under control of a microcomputer.

[0004] A water tub may be installed in the washing machine's cabinet to hold water. The water tub may include a washing tub that is used during washing and drying (e.g., spin-drying). The pulsator is in the washing tub and, during washing, can rotate bi-directionally (the pulsator rotates in one direction, then the other, back-and-forth).

[0005] During drying (e.g., in the spin-drying mode), a shaft that is connected to the washing tub rotates the washing tub at a high speed in one direction.

[0006] The washing machine may include a driving motor as a power source. A power transmission apparatus is provided in the washing machine to selectively transfer power from the driving motor to the pulsator or to the shaft connected to the washing tub.

[0007] As mentioned above, during spin-drying, the washing tub rotates at high speed. If a user were to open the door of the washing machine during spin-drying, the user might be harmed. To prevent this, the washing machine includes a security device that prevents a user from opening the door of the washing machine during spin-drying.

[0008] The security device may include a magnet installed on the door of the washing machine, a sensor on a body of the washing machine to sense whether the door is open, a controller that transmits a control signal from the sensor, and a door locking unit that can prevent the door from being opened in response to the control signal.

[0009] In atypical washing machine, the number of components needed to prevent the door of the washing machine from being opened during spin-drying, and the complexity of the structure used to lock the door, can

increase manufacturing costs and hence can increase the price of the washing machine.

[0010] Also, in atypical washing machine, a user trying to open the door of the washing machine during spin-drying cannot do so because the door is locked. Accordingly, to open the door, the user needs to either stop the spin-drying operation or wait for it to end.

[0011] Additional information regarding conventional washing machines can be found in Korean Patent Publication No. 10-1995-14460.

SUMMARY

[0012] Embodiments according to the present disclosure provide a power transmission apparatus and a power control apparatus for a washing machine. Embodiments according to the present disclosure can reduce manufacturing costs and simplify the structure of the washing machine by reducing the number of components. Embodiments according to the present disclosure allow a door of the washing machine to be easily, conveniently, and safely opened when the washing machine is in a spin-drying or dehydration mode. (As used herein, the term "dehydration" refers to the removal of water from laundry, e.g., spin-drying and/or drying, and/or to the removal [e.g., drainage] of water from the water tub/washing tub, and terms such as "dehydration assembly," "dehydration mode," and the like refer to the components and processes associated with water removal.)

[0013] In one or more embodiments according to the present disclosure, a power transmission apparatus for a washing machine includes: a driving unit; a gear mechanism that includes an input shaft coupled to the driving unit, a reduction assembly coupled to the input shaft that can reduce rotational speed to a preset gear ratio, a washing shaft coupled to the reduction assembly that can rotate at the gear ratio, and a water removal assembly selectively connected to the driving unit in the water removal mode and that can rotate independently from the washing shaft; a coupling unit that selectively transfers power from the driving unit to the water removal assembly in the water removal mode; and a brake unit that can selectively force the water removal assembly to stop in the water removal mode.

[0014] The driving unit may be a direct drive motor that can transmit power to the input shaft and can be rotated in different directions (forward and reverse) according to a control signal.

[0015] In one or more embodiments, the driving unit includes a first rotor that can transfer power to the input shaft, and a second rotor installed on the same axis as the first rotor and that can transfer power to the water removal assembly.

[0016] In one or more embodiments, the reduction assembly includes a sun gear formed on one end of the input shaft, a planetary pinion that meshes with the sun gear, and a ring gear that meshes with the planetary pinion. The sun gear and the planetary pinion can be located

within the circumference of the ring gear.

[0017] One end of the washing shaft may be connected to a carrier coupled with the planetary pinion, while another end of the washing shaft may be connected to a pulsator.

[0018] In one or more embodiments, the water removal assembly includes: a water removal rotational body that receives power from the driving unit through the coupling unit; a drum coupled to the water removal rotational body and that rotates around the same center as the reduction assembly; and a water removal shaft having one end coupled to the bottom of the drum and another end coupled to a washing tub.

[0019] The water removal rotational body may include a first gear coupled with the coupling unit and a flange below the first gear and coupled to the drum.

[0020] In one or more embodiments, the coupling unit includes: a sliding coupler on an outer circumferential surface of the water removal rotational body that can move up and down while being coupled with the first gear and selectively coupled with the driving unit; an elastic member that provides an elastic force toward the driving unit to couple the sliding coupler with the driving unit; and a push lever that provides an external force opposing the elastic force of the elastic member to separate the sliding coupler from the driving unit.

[0021] The sliding coupler may include a first spline portion coupled to the second rotor of the driving unit, and a second spline portion below the first spline portion and coupled to the first gear of the water removal rotational body.

[0022] The coupling unit may further include a stopper unit that can limit the rotation of the sliding coupler when the sliding coupler is separated from the second rotor, to prevent the sliding coupler from rotating freely in a washing mode.

[0023] The gear mechanism may include a case containing the water removal rotational body and the drum, but fixed in place so it does not rotate.

[0024] The stopper unit may include a first stopper below the sliding coupler and having protrusions along a circumference that are separated from one another, and a second stopper on a stop flange coupled to the case that can engage with the first stopper to limit the rotation of the first stopper.

[0025] The push lever may be coupled to the case or to the stop flange.

[0026] In one or more embodiments according to the present invention, a power control apparatus for a washing machine includes: a driving unit including a first rotor on a central axis and a second rotor on the same axis as the first rotor; a gear mechanism including an input shaft connected to the driving unit, a reduction assembly coupled to the input shaft that can reduce rotational speed to a preset gear ratio, a washing shaft coupled to the reduction assembly and that can rotate at the gear ratio, and a water removal assembly selectively connected to the driving unit in a water removal mode that can rotate

independently from the washing shaft; a coupling unit that selectively transfers power from the driving unit to the water removal assembly in the water removal mode; a brake unit that can selectively force the water removal assembly to stop in the water removal mode; a sensing unit that can sense an open door of the washing machine; and a control unit that can determine whether the washing machine is in a washing mode or in the water removal mode, can cut off power between the coupling unit and the second rotor in the washing mode, can connect power between the coupling unit and the second rotor in the water removal mode, and can forcibly stop the water removal assembly by controlling the brake unit in response to a signal from the door opening sensing unit indicating the door is open.

[0027] The reduction assembly may include a sun gear formed on one end of the input shaft, a planetary pinion meshed with the sun gear, and a ring gear meshed with the planetary pinion.

[0028] In one or more embodiments, the water removal assembly includes: a water removal rotational body that receives power from the driving unit through the coupling unit; a drum coupled to the water removal rotational body and rotating around the same rotational center as the reduction assembly; and a water removal shaft having one end coupled to the bottom of the drum and another end coupled to a washing tub.

[0029] The water removal rotational body may include a first gear coupled to the coupling unit, and a flange below the first gear and coupled to the drum.

[0030] In one or more embodiments, the coupling unit includes: a sliding coupler on an outer circumferential surface of the water removal rotational body and capable of moving up and down while being coupled to the first gear and selectively coupled to the second rotor; an elastic member that provides an elastic force toward the second rotor to couple the sliding coupler with the second rotor; and a push lever that provides an external force opposing the elastic force of the elastic member to separate the sliding coupler from the second rotor.

[0031] The sliding coupler may include a first spline portion coupled to the second rotor of the driving unit, and a second spline portion below the first spline portion and coupled to the first gear of the water removal rotational body.

[0032] The coupling unit may further include a stopper unit that can limit the rotation of the sliding coupler when it is separated from the second rotor, to prevent the sliding coupler from rotating freely in the washing mode.

BRIEF DESCRIPTION OF THE DRAWINGS

[0033]

FIG. 1 is a cross-sectional view of a washing machine including a power transmission apparatus in one or more embodiments according to the present invention;

FIG. 2 is a perspective view of a power transmission apparatus in one or more embodiments of the washing machine;

FIG. 3 is an exploded perspective view of a power transmission apparatus in an embodiment according to the present invention;

FIG. 4 is an exploded perspective view of a driving unit and a power transmission apparatus in an embodiment according to the present invention;

FIG. 5 is a perspective view of a first rotor and second rotor of a driving unit in an embodiment according to the present invention;

FIG. 6 is a perspective view of a gear mechanism, a coupling unit, and a brake unit in an embodiment according to the present invention;

FIG. 7 is an exploded perspective view illustrating a structure of a gear mechanism in an embodiment according to the present invention;

FIG. 8 is a cross-sectional view illustrating a power transmission apparatus for a washing machine in a washing mode, in one or more embodiments according to the present invention;

FIG. 9 is a cross-sectional view illustrating a power transmission apparatus for a washing machine in a water removal (e.g., spin-drying) mode, in one or more embodiments according to the present invention; and

FIG. 10 is a block diagram illustrating control logic in a power control apparatus of a washing machine in embodiments according to the present invention.

DETAILED DESCRIPTION

[0034] Hereinafter, configurations and functions of embodiments according to the present invention will be described in detail with reference to the attached drawings. The following description corresponds to one or more of different aspects of the present invention, which may be claimed, and which form a part of a detailed description of the embodiments.

[0035] While describing the embodiments, a detailed description of well-known elements or functions may be omitted for clarity and brevity.

[0036] Since the present invention may have various modifications and several embodiments, exemplary embodiments will be shown in the drawings and will be described in detail. However, the present invention is not limited to the exemplary embodiments, and instead should be understood as including all modifications, equivalents, and substitutes included in the spirit and the technical scope of the present invention.

[0037] It will be understood that although the terms "first", "second", etc., may be used herein to describe various components, these components should not be limited by these terms. These terms may only be used to distinguish one component from another.

[0038] It will be understood that when a component is referred to as being "connected to" another component,

it can be directly or indirectly connected to the other component. That is, for example, intervening components may be present. On the other hand, when a component is referred to as being "directly connected to" another component, it will be understood that there are no intervening components.

[0039] Terms are used herein only to describe the exemplary embodiments but not to limit the present invention. Singular expressions, unless defined otherwise, include plural expressions.

[0040] Hereinafter, embodiments according to the present invention will be described in detail with reference to the attached drawings.

[0041] FIG. 1 is a cross-sectional view illustrating a power transmission apparatus 10 in a washing machine 1 in one or more embodiments according to the present invention. FIG. 2 is a perspective view illustrating the power transmission apparatus 10 in embodiments according to the present invention. FIG. 3 is an exploded perspective view of the power transmission apparatus 10 in an embodiment according to the present invention.

[0042] In the embodiments of FIGS. 1 to 3, the power transmission apparatus 10 may comprise a driving unit 100, a gear mechanism 2000, a coupling unit 300, and a brake unit 400.

[0043] The meaning of "an embodiment according to the present invention" is that an embodiment according to the present disclosure does not consist of only the described configurations but also may include other configurations (e.g., known in the washing machine arts) as well as the above-mentioned configurations. However, in order to not obscure the subject matter of the present disclosure, their detailed descriptions may be omitted.

[0044] When the power transmission apparatus 10 shown in FIG. 2 is actually installed in the washing machine 1, its top and bottom are reversed relative to the orientation shown in the figure, so that the driving unit 100 is disposed toward the bottom of the washing machine.

[0045] However, the following description and drawings will be described based on the orientation shown in FIG. 2 instead of the direction of the power transmission apparatus 10 shown in FIG. 1.

[0046] The driving unit 100 may rotate bi-directionally, in a forward direction or in a reverse direction, according to an external control signal. The control signal may also control the rotational speed of the driving unit 100.

[0047] In the embodiment of FIG. 3, the driving unit 100 includes an external housing 101 and a stator 102 inside the housing 101. The stator 102 can convert electrical energy into kinetic energy. The housing 101 can be rotated by the stator 102.

[0048] In the embodiments of FIGS. 3 and 5, the driving unit 100 includes a first rotor 110 and second rotor 120. The first rotor 110 is installed on a central axis of the housing 101. A first rotor gear 111 is formed on an inner circumference of the first rotor 110.

[0049] The second rotor 120 is mounted in the housing

101 and may be installed on the same axis as the first rotor 110. Accordingly, the housing 101, first rotor 110, and second rotor 120 may rotate about the same axis. The second rotor 120 may be coupled to an outer circumference of the first rotor 110 and thus may rotate together with the first rotor 110.

[0050] When the first rotor 110 and second rotor 120 are coupled to the housing 101 and can rotate together, the first rotor 110 can transmit power to an input shaft 2100 of the gear mechanism 2000, and the second rotor 120 can selectively transmit power to a water removal or "dehydration" (e.g., drying, particularly spin-drying) assembly 2400 of the gear mechanism 2000. To allow the second rotor 120 to selectively transmit the power to the water removal assembly 2400, a second rotor gear 121 may be formed on the second rotor 120, protruding downward as shown in FIG. 5. The teeth of the second rotor gear 121 are formed in a circumferential direction at regular intervals.

[0051] A configuration and structure of the gear mechanism 2000 including the input shaft 2100 and water removal assembly 2400 will be described below in detail.

[0052] In the embodiments of FIGS. 3 and 4, the gear mechanism 2000 includes the input shaft 2100, a reduction assembly 2200, a washing shaft 2300, and the water removal assembly 2400.

[0053] The input shaft 2100 can be connected to the first rotor 110 of the driving unit 100 and can transfer power from the driving unit 100 to the reduction assembly 2200.

[0054] An input gear 2110 on one end of the input shaft 2100 can mesh with the first rotor gear 111 of the first rotor 110. The input gear 2110 can be connected to the first rotor gear 111 and receive power from the first rotor 110.

[0055] A sun gear 2210 on another end of the input shaft 2100 (e.g., an opposite end) can transfer power to the reduction assembly 2200.

[0056] Also, in the embodiments of FIGS. 3 and 7, the reduction assembly 2200 is gear-coupled to the input shaft 2100 and reduces rotational speed according to a preset gear ratio. The reduction assembly 2200 can reduce rotational speed and increase rotational force by receiving power from the input shaft 2100, thereby providing the driving unit 100 with enough power to perform washing and "dehydrating" (e.g., spin-drying) operations.

[0057] In one embodiment, the reduction assembly 2200 includes the sun gear 2210, a number of planetary pinions 2220, and a ring gear 2230. In addition, a carrier 2240 (refer to FIG. 8) may be included in the reduction assembly 2200.

[0058] The sun gear 2210 is formed on one end of the input shaft 2100 and can transmit the power of the input shaft 2100 to the reduction assembly 2200.

[0059] A planetary pinion 2220 can be installed so that at least two of its pinions are in contact with an outer circumferential surface of the sun gear 2210. Each planetary pinion 2220 may be disposed so that it is not in

contact with another planetary pinion 2220.

[0060] An inner circumferential surface of the ring gear 2230 is gear-coupled to outer circumferential surfaces of the planetary pinions 2220. The sun gear 2210 and planetary pinions 2220 may be contained within the circumference of the ring gear 2230.

[0061] Also, in the embodiments of FIGS. 8 and 9, the carrier 2240 is coupled to rotational axes 2221 of the planetary pinions 2220.

[0062] The reduction assembly 2200 can properly control the sun gear 2210, planetary pinions 2220, and ring gear 2230, thereby establishing the desired gear ratio. Accordingly, the reduction assembly 2200 can reduce the power and speed transferred from the driving unit 100 to the input shaft 2100.

[0063] The washing shaft 2300 is connected to the reduction assembly 2200 and rotates at a speed that depends on the gear ratio. One end of the washing shaft 2300 is connected to the carrier 2240 and may rotate at the same rate as the carrier. The other end of the washing shaft 2300 may be connected to the pulsator 2 as shown in FIG. 1, to rotate the pulsator 2 and generate water flow. As a result, the pulsator 2 rotates at the preset gear ratio, back-and-forth between a forward direction and a reverse direction according to the rotational direction of the driving unit 100.

[0064] The water removal assembly 2400 operates in the "dehydration mode" (e.g., during spin-drying). The water removal assembly 2400 is selectively connected to the driving unit 100 to receive power, and may rotate independently from the washing shaft 2300. The water removal assembly 2400 is powered via the second rotor 120.

[0065] In the embodiments of FIGS. 3 and 7, the water removal assembly 2400 includes a water removal rotational body 2410, a drum 2420, and a water removal shaft 2430.

[0066] The water removal rotational body 2410 rotates by selectively receiving power from the driving unit 100 through the coupling unit 300. In one embodiment, the water removal rotational body 2410 includes a first gear 2411 and a flange 2412.

[0067] The first gear 2411 is formed on top of the water removal rotational body 2410 and is powered by the driving unit 100 through the coupling unit 300. The first gear 2411 may be cylindrical in shape.

[0068] The flange 2412 is formed below the first gear 2411 in the water removal rotational body 2410. In one embodiment, the size of the flange 2412 corresponds to the size of the drum 2420, so that the flange can be assembled to the drum 2420.

[0069] The drum 2420 is disposed below and coupled to the water removal rotational body 2410, and may rotate on the same axis as the water removal rotational body 2410. A space may be formed in the drum 2420 to allow it to be coupled to the reduction assembly 2200.

[0070] In one embodiment, an inner portion of the drum 2420 may be directly coupled to an outer portion of the

ring gear 2230 of the reduction assembly 2200. Accordingly, when the drum 2420 rotates, the ring gear 2230 also rotates. When the drum 2420 stops, the ring gear 2230 also stops.

[0071] The water removal shaft 2430 is located below the drum 2420 on an outer circumferential surface of the washing shaft 2300. The washing shaft 2300 is partially within the water removal shaft 2430 as shown in FIGS. 8 and 9. A bearing installed between the washing shaft 2300 and water removal shaft 2430 allows the washing shaft 2300 to rotate independently from the water removal shaft 2430.

[0072] In one or more of the FIG. 8 embodiments, one end 2310 of the washing shaft 2300 is connected to the carrier 2240 of the reduction assembly 2200 in the drum 2420, and another end 2320 of the washing shaft 2300 (e.g., an opposite end) may be coupled to the pulsator 2 and can rotate the pulsator 2 in the washing mode. One end 2431 of the water removal shaft 2430 is coupled to the drum 2420 and may rotate together with the drum 2420 as a single unit, and the other end 2432 of the water removal shaft 2430 is coupled to the washing tub 3 shown in FIG. 1 and can rotate the washing tub 3 in the water removal (e.g., spin-drying) mode. In the water removal mode, the driving unit 100 may be controlled to rotate in one direction, and accordingly, the washing tub 3 may rotate in that direction.

[0073] The coupling unit 300 selectively transmits power from the driving unit 100 to the water removal assembly 2400, to allow the washing tub 3 to be rotated by the water removal shaft 2430 in the water removal mode.

[0074] When power from the driving unit 100 is transferred to the water removal assembly 2400 through the coupling unit 300, the washing tub 3 is rotated and water in the washing tub 3 is removed from the laundry (e.g., by spin-drying). The effectiveness of spin-drying may be increased by rotating the washing tub 3 at a high speed in one direction.

[0075] In the washing mode, the coupling unit 300 does not transfer power from the driving unit 100 to the water removal assembly 2400, and so the washing tub 3 is not rotated.

[0076] In the embodiments of FIGS. 6 to 9, the coupling unit 300 includes a sliding coupler 310, an elastic member 320, and a push lever 330.

[0077] The sliding coupler 310 is on an outer circumferential surface of the water removal rotational body 2410 (specifically, on the first gear 2411) and can move up and down while being gear-coupled to the first gear 2411, and can thereby be selectively gear-coupled to the driving unit 100.

[0078] In one embodiment, the sliding coupler 310 includes a first spline portion 311 and a second spline portion 312. The first spline portion 311 is on an upper inner circumferential surface of the sliding coupler 310 and can be coupled to the second rotor 120 of the driving unit 100.

[0079] The first spline portion 311 includes grooves and protrusions that correspond to the second rotor gear

121 of the second rotor 120. Accordingly, when the sliding coupler 310 moves toward the second rotor 120, the protrusions of the first spline portion 311 are inserted into grooves of the second rotor gear 121 so that it can be powered by the second rotor 120.

[0080] The second spline portion 312 is below the first spline portion 311 on the inner circumferential surface of the sliding coupler 310. The second spline portion 312 is always gear-coupled to the first gear 2411 of the water removal rotational body 2410, and transfers power from the second rotor 120 to the water removal rotational body 2410.

[0081] More specifically, as shown in FIG. 9, although the sliding coupler 310 moves toward the second rotor 120, because the second spline portion 312 is always gear-coupled to the first rotor 2411, the second spline portion 312 can transfer power from the second rotor 120 to the water removal rotational body 2410.

[0082] Also, as shown in FIG. 8, the coupling unit 300 may further include a stopper unit 340 to prevent the sliding coupler 310 from rotating freely if not coupled to the second rotor 120.

[0083] The stopper unit 340 can prevent the sliding coupler 310 from rotating freely in the washing mode. Accordingly, when power is not transferred from the second rotor 120, the sliding coupler 310 will not freely rotate and may be fixed in place by the stopper unit 340. As a result, in the washing mode, when the pulsator 2 is rotating and induces water flow inside the washing tub 3, the washing tub 3 may be fixed in place instead of being moved by the force of the flowing water.

[0084] In the embodiments of FIGS. 4 and 6, the gear mechanism 2000 includes a case 2500. The case 2500 contains the water removal rotational body 2410 and drum 2420, but is fixed in place instead of rotating with the water removal rotational body 2410 and drum 2420. The case 2500 can cover and protect the water removal rotational body 2410 and drum 2420.

[0085] Also, the stopper unit 340, as shown in FIGS. 6 and 8, may include a first stopper 341 and a second stopper 342.

[0086] In the embodiments of FIGS. 6 and 8, the first stopper 341 is below the sliding coupler 310 and may include protrusions that are formed along a circumference of the sliding coupler 310 and separated from one another at regular intervals.

[0087] The second stopper 342 is on the case 2500 facing the first stopper 341. Because the case 2500 is fixed in place and does not move, rotation of the first stopper 341 is restricted when the first stopper 341 is engaged with the second stopper 342.

[0088] The second stopper 342 has a structure that corresponds to the first stopper 341 and may include protrusions that are formed along a circumference and are separated from one another at regular intervals.

[0089] The second stopper 342 may be directly on the case 2500, or it may be on a stop flange 2510 coupled to the case 2500.

[0090] Also, the elastic member 320 provides the sliding coupler 310 with an elastic force that allows the sliding coupler 310 to be gear-coupled to the driving unit 100. Because of the elastic force of the elastic member 320, the sliding coupler 310 can move toward the driving unit 100 and be gear-coupled with the second rotor 120 of the driving unit 100. The elastic member 320 may be a coil spring.

[0091] The push lever 330 provides the sliding coupler 310 with an external force that can overcome the elastic force of the elastic member 320 and allows the sliding coupler 310 to be released from the driving unit 100.

[0092] The push lever 330 may be installed on the case 2500 or on the stop flange 2510, so that the push lever 330 can pivot.

[0093] In the washing mode, shown in FIG. 8, when the push lever 330 is pivoted toward and pushes the sliding coupler 310, the sliding coupler 310 overcomes the elastic force of the elastic member 320, moves downward, and is released from the second rotor 120. Consequently, power is not transferred to the water removal assembly 2400 and the stopper unit 310 prevents the sliding coupler 310 from rotating, thereby preventing the water removal assembly 2400 from rotating in the washing mode.

[0094] In the water removal mode, shown in FIG. 9, when the push lever 330 is not pushing against the sliding coupler 310, the sliding coupler 310 is gear-coupled with the second rotor 120 due to the elastic force of the elastic member 320 and power is transferred to the water removal assembly 2400.

[0095] The push lever 330 may be operated according to an external control signal. A coupling actuator 331 that operates according to the control signal may be installed on an end of the push lever 330. The coupling actuator 331 can pull the end of the push lever 330 to allow the push lever 330 to push the sliding coupler 310.

[0096] The brake unit 400 (FIGS. 3 and 4) can forcibly stop the water removal assembly 2400 from rotating in the water removal mode if, for example, a user opens the door 4 of the washing machine 1, so that the washing tub 3 will stop and thus cannot harm the user. The brake unit 400 forcibly stops rotation of the water removal assembly 2400 according to an external control signal generated when the door 4 is open, thereby rapidly stopping rotation of the washing tub 3.

[0097] In the embodiments of FIGS. 3 and 4, the brake unit 400 includes a brake band portion 410 and a brake rod portion 420.

[0098] The brake band portion 410 is disposed along an outer circumferential surface of the drum 2420. While the drum 2420 is rotating in the water removal mode, the brake band portion 410 will not prevent rotation of the drum 2420. However, if the door 4 is open, for example, then the brake band portion 410 may be pulled tightly around and stops rotation of the drum 2420.

[0099] The brake rod portion 420 is connected to the brake band portion 410 and provides an external force

that causes the brake band portion 410 to tighten around the drum 2420, thereby stopping the rotation of the drum 2420.

[0100] The brake rod portion 420 may be operated by a brake actuator (not shown in FIGS. 3 and 4) that in turn is actuated in response to an external control signal.

[0101] Hereinafter, a power control apparatus of the washing machine 1 in an embodiment according to the present invention will be described with reference to FIG. 10.

[0102] The power control apparatus includes a door opening sensing unit 500 and a control unit 600 in addition to the driving unit 100, the gear mechanism 2000, the coupling unit 300, and the brake unit 400 described above.

[0103] The door opening sensing unit 500 senses opening of the door 4 and may be installed adjacent to the door 4. The door opening sensing unit 500 can be implemented using any of the different kinds of sensing units known in the art, and so a detailed description is not provided herein.

[0104] In the FIG. 10 embodiment(s), the control unit 600 receives a washing signal 20 when the washing machine 1 is in washing mode, and receives a water removal signal 30 when the washing machine is in water removal mode. The washing signal 20 and water removal signal 30 may be generated when a user actuates either a washing switch or a water removal switch or through another means.

[0105] In the washing mode, the control unit 600 can disconnect the sliding coupler 310 and the second rotor 120, by operating the coupling actuator 331 installed on the end of the push lever 330.

[0106] Specifically, when the push lever 330 pushes the sliding coupler 310 via the coupling actuator 331, the sliding coupler 310 overcomes the elastic force of the elastic member 320 and, as shown in FIG. 8, moves downward, thereby releasing the sliding coupler 310 from the second rotor 120 and cutting off power to the second rotor 120.

[0107] In the water removal mode, the control unit 600 can connect the coupling unit 300 and the second rotor 120 by operating the coupling actuator 331, which separates the push lever 330 from the sliding coupler 310 as shown in FIG. 9.

[0108] Specifically, when an external force is not applied by the push lever 330 to the sliding coupler 310, the sliding coupler 310 moves toward the second rotor 120 due to the elastic force supplied by the elastic member 320. As a result, the sliding coupler 310 is gear-coupled to the second rotor 120 and can be powered by the second rotor 120, thereby allowing the water removal assembly 2400 to rotate.

[0109] As described above, if the door 4 is open while in water removal mode, the control unit 600 determines the door 4 is open in response to a signal from the door opening sensing unit 500, and controls the brake unit 400 using the brake actuator, thereby forcibly stopping the

water removal assembly 2400. Accordingly, if a user opens the door 4 of the washing machine 1, the water removal assembly 2400 and the washing tub 3 both stop rapidly at the same time, thereby preventing an accident.

[0110] Embodiments according to the present invention provide a power transmission apparatus and power control apparatus for a washing machine that reduce manufacturing costs and simplify the structure of the washing machine by reducing the number of components. Embodiments according to the invention allow a user to safely open a door of the washing machine in water removal mode, by rapidly stopping the water removal assembly and tub if the door is open. Embodiments according to the present invention are applicable to, but are not limited to, washing machine tubs and drums that are powered using a direct drive motor, and are particularly beneficial in top-loading washing machines and/or washing machines driven by smaller motors.

[0111] While one or more embodiments according to the present invention have been described with reference to the figures, it will be understood by those of ordinary skill in the art that various changes in form and details may be made therein without departing from the spirit and scope of the present invention as defined by the following claims.

Claims

1. An apparatus for a washing machine, the apparatus comprising:

a driving unit;

a gear mechanism comprising:

an input shaft coupled to the driving unit;
a reduction assembly coupled to the input shaft and configured to reduce a rotational speed to a preset gear ratio;

a washing shaft coupled to the reduction assembly and configured to rotate at the gear ratio; and

a water removal assembly selectively connected to the driving unit in a water removal mode and configured to rotating independently from the washing shaft;

a coupling unit configured to selectively transfer power from the driving unit to the water removal assembly in the water removal mode; and
a brake unit configured to selectively force the water removal assembly to stop in the water removal mode.

2. The apparatus of claim 1, wherein the driving unit comprises:

a first rotor configured to transfer power to the

input shaft; and

a second rotor installed on the same axis as the first rotor and configured to transfer power to the water removal assembly.

3. The apparatus of claim 1, wherein the reduction assembly comprises:

a sun gear formed on one end of the input shaft;
a planetary pinion capable of meshing with the sun gear; and

a ring gear capable of meshing with the planetary pinion.

4. The apparatus of claim 3, wherein the water removal assembly comprises:

a water removal rotational body configured to receive power from the driving unit through the coupling unit;

a drum coupled to the water removal rotational body; and

a water removal shaft having one end coupled to the drum and another end coupled to a washing tub and configured to rotate the washing tub.

5. The apparatus of claim 4, wherein the water removal rotational body comprises:

a first gear coupled with the coupling unit; and
a flange coupled to the first gear and to the drum.

6. The apparatus of claim 5, wherein the coupling unit comprises:

a sliding coupler on an outer circumferential surface of the water removal rotational body and capable of moving up and down while being coupled with the first gear and selectively coupled with the driving unit;

an elastic member coupled to the sliding coupler and configured to provide an elastic force toward the driving unit to couple the sliding coupler with the driving unit; and

a push lever coupled to the sliding coupler and configured to provide a force opposing the elastic force to separate the sliding coupler from the driving unit.

7. The apparatus of claim 6, wherein the sliding coupler comprises:

a first spline portion coupled to the second rotor of the driving unit; and

a second spline portion coupled to the first gear of the water removal rotational body.

8. The apparatus of claim 7, wherein the coupling unit

further comprises a stopper unit configured to restrain rotation of the sliding coupler when the sliding coupler is separated from the driving unit.

9. The apparatus of claim 8, wherein the gear mechanism comprises a case containing the water removal rotational body and the drum, wherein the case is fixed in place relative to the water removal rotational body and the drum. 5
10. The apparatus of claim 9, wherein the stopper unit comprises: 10
- a first stopper coupled to the sliding coupler and having a plurality of protrusions formed along its circumference and separated from one another; and
 - a second stopper coupled to a stop flange coupled with the case and configured to engage with the first stopper to limit rotation of the first stopper. 15
11. An apparatus for a washing machine, the apparatus comprising: 20
- a driving unit comprising: 25
 - a first rotor provided on a central axis; and
 - a second rotor installed on the central axis; 30
 - a gear mechanism comprising: 35
 - an input shaft coupled to the driving unit;
 - a reduction assembly coupled to the input shaft and configured to reducing a rotational speed according to a preset gear ratio;
 - a washing shaft coupled to the reduction assembly and configured to rotate at the gear ratio, and
 - a water removal assembly selectively coupled to the driving unit in a water removal mode and configured to rotating independently from the washing shaft; 40
 - a coupling unit configured to selectively transferring power from the driving unit to the water removal assembly in a water removal mode;
 - a brake unit;
 - a sensing unit for sensing opening of a door of the washing machine; and 50
 - a control unit configured to determining when the washing machine is operating in a washing mode and when the washing machine is operating in the water removal mode, for cutting off power between the coupling unit and the second rotor in the washing mode, for connecting power between the coupling unit and the second rotor in the water removal mode, and for forcibly stop-

ping the water removal assembly by controlling the brake unit in response to a signal from the door opening sensing unit indicating the door is open.

12. The apparatus of claim 11, wherein the water removal assembly comprises: 5
- a water removal rotational body configured to receiving power from the driving unit through the coupling unit;
 - a drum coupled to the water removal rotational body; and
 - a water removal shaft having one end coupled to the drum and another end coupled to a washing tub. 10
13. The apparatus of claim 12, wherein the water removal rotational body comprises: 15
- a first gear coupled to the coupling unit; and
 - a flange coupled to the drum. 20
14. The apparatus of claim 13, wherein the coupling unit comprises: 25
- a sliding coupler on an outer circumferential surface of the water removal rotational body and capable of moving up and down while coupled with the first gear and coupled with the second rotor;
 - an elastic member coupled to the sliding coupler and providing an elastic force toward the second rotor to couple the sliding coupler with the second rotor; and
 - a push lever coupled to the sliding coupler and providing an external force opposing the elastic force of the elastic member to release the sliding coupler from the second rotor. 35
15. The apparatus of claim 14, wherein the sliding coupler comprises: 40
- a first spline portion coupled to the second rotor; and
 - a second spline portion capable of coupling with the first gear of the water removal rotational body. 45

FIG. 1

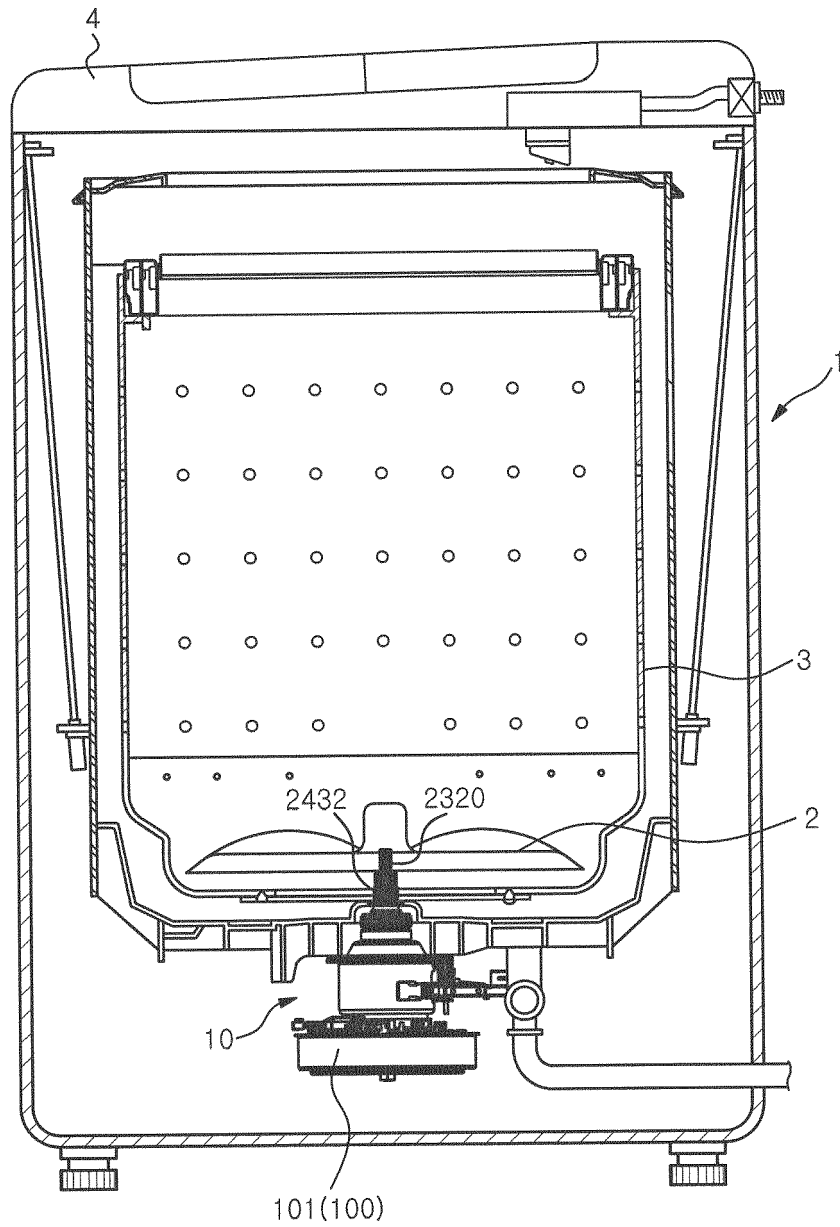


FIG. 2

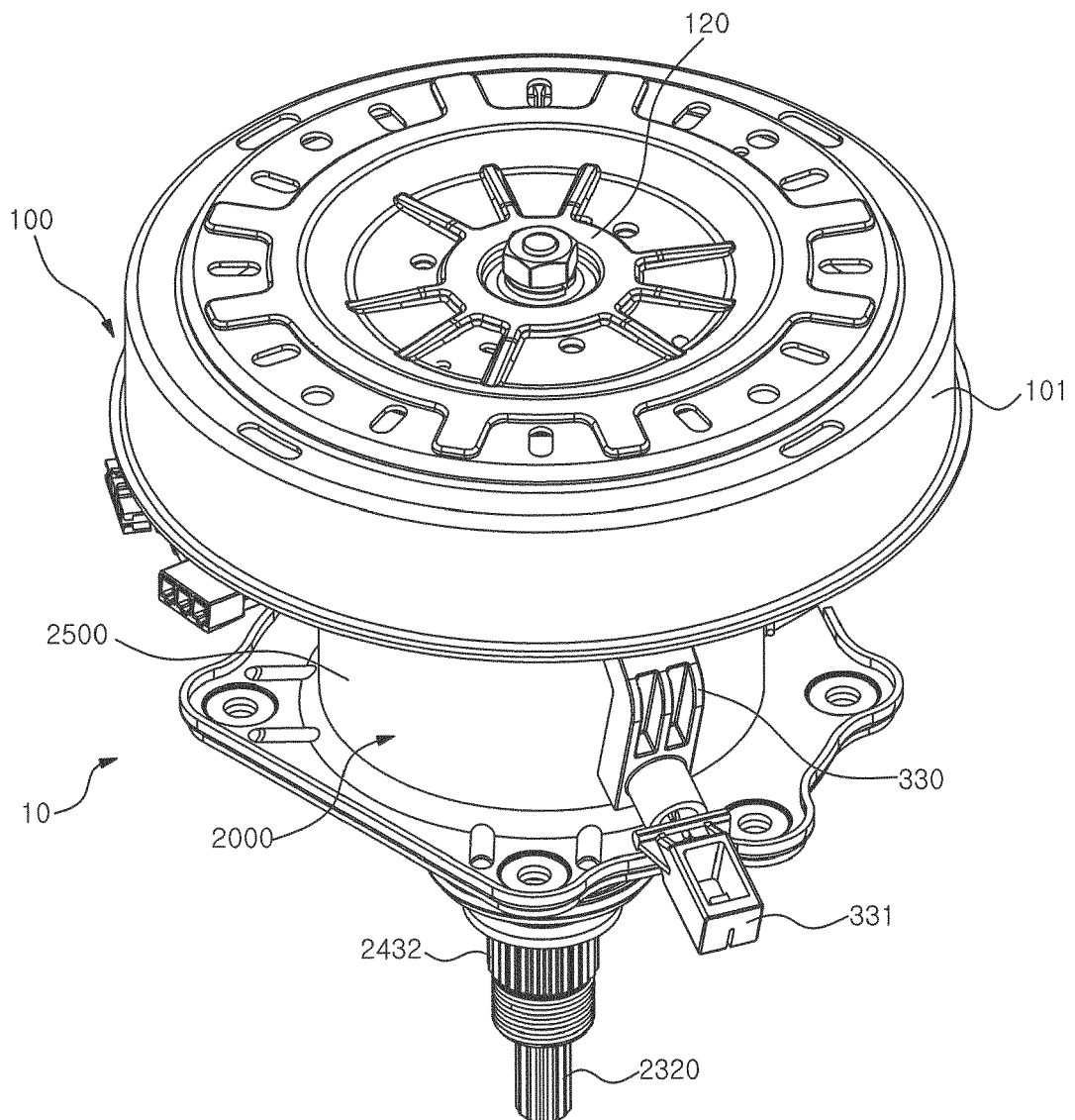


FIG. 3

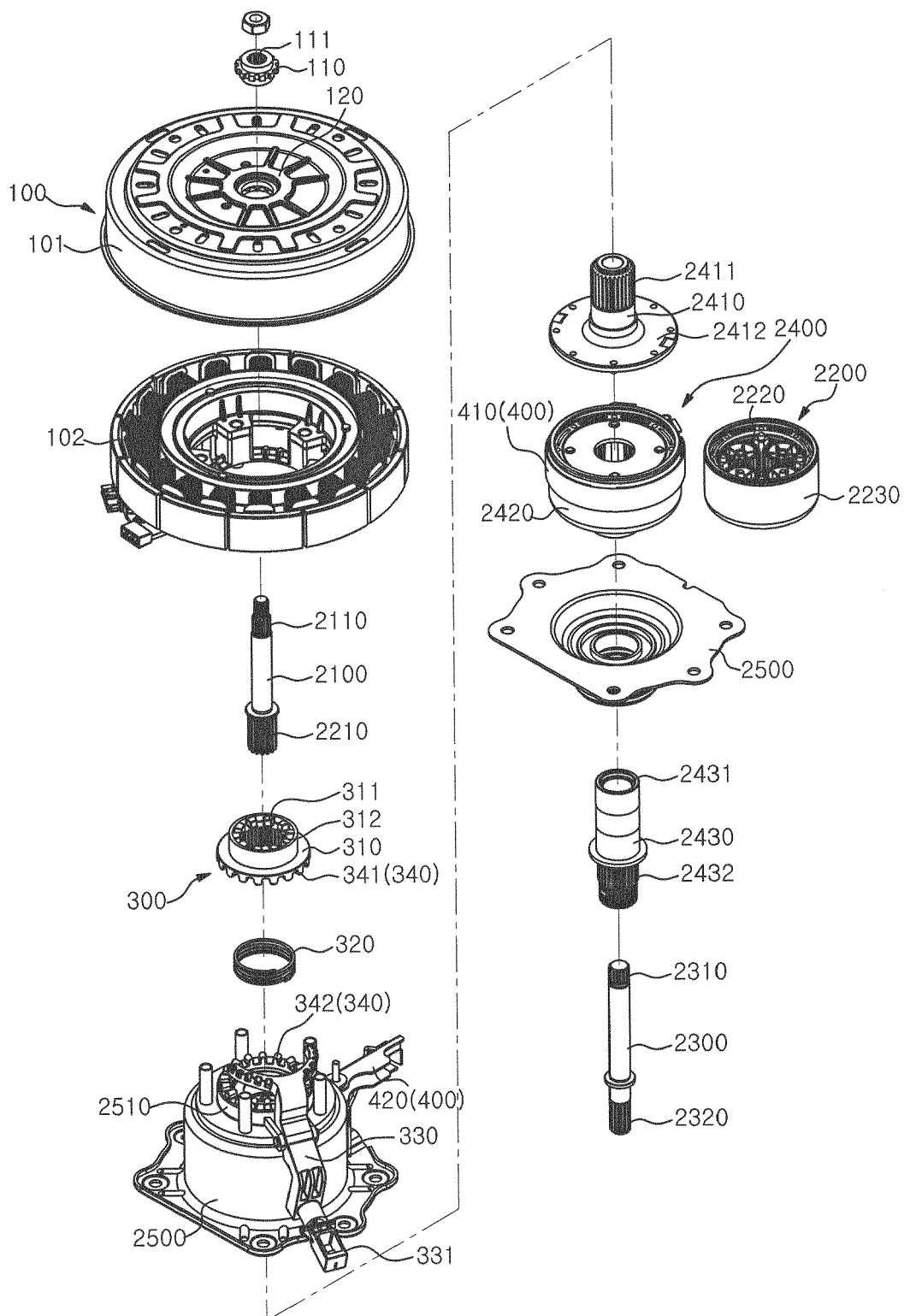


FIG. 4

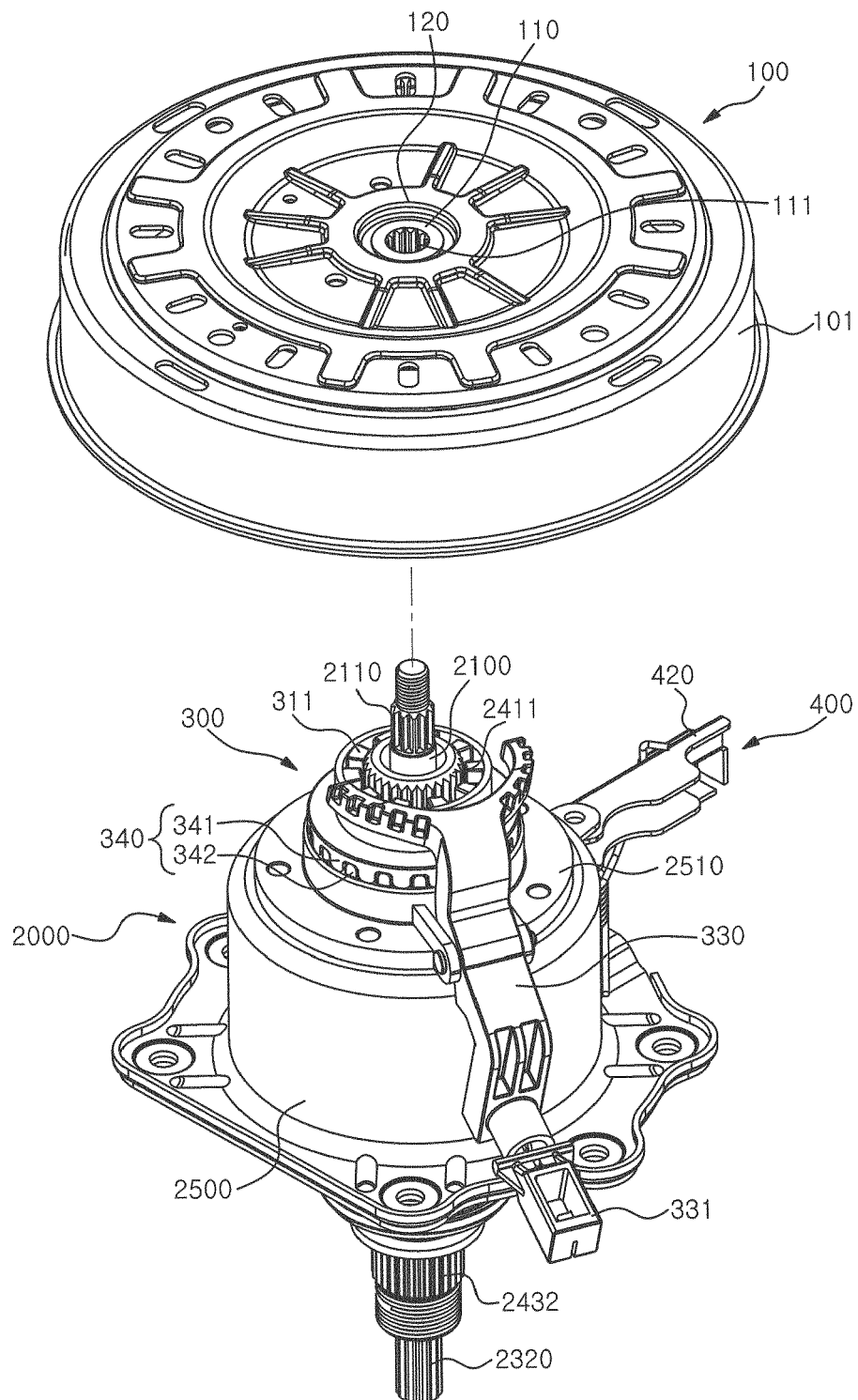


FIG. 5

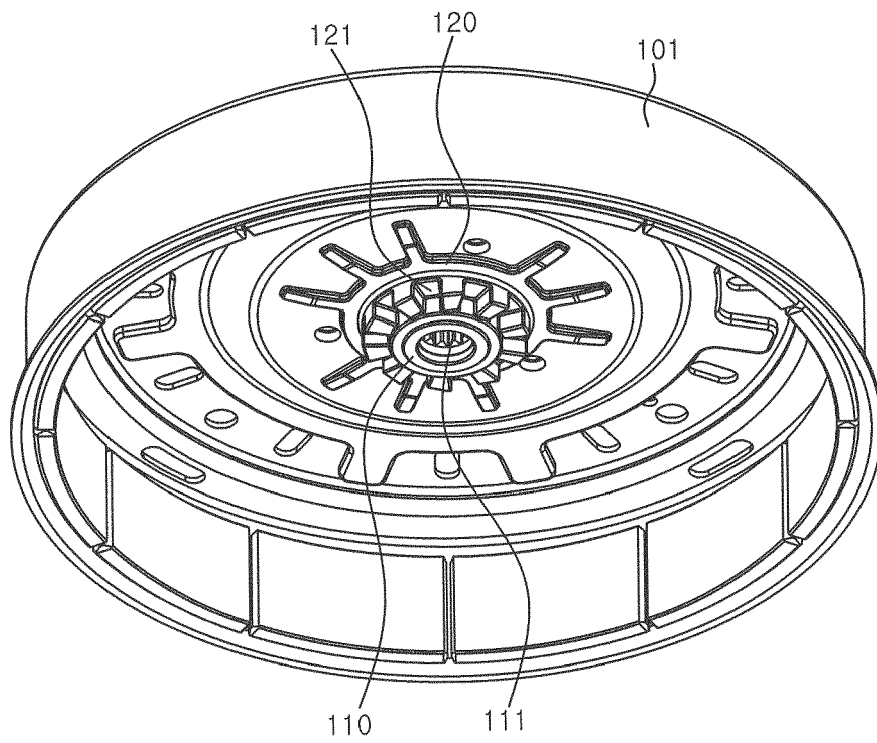


FIG. 6

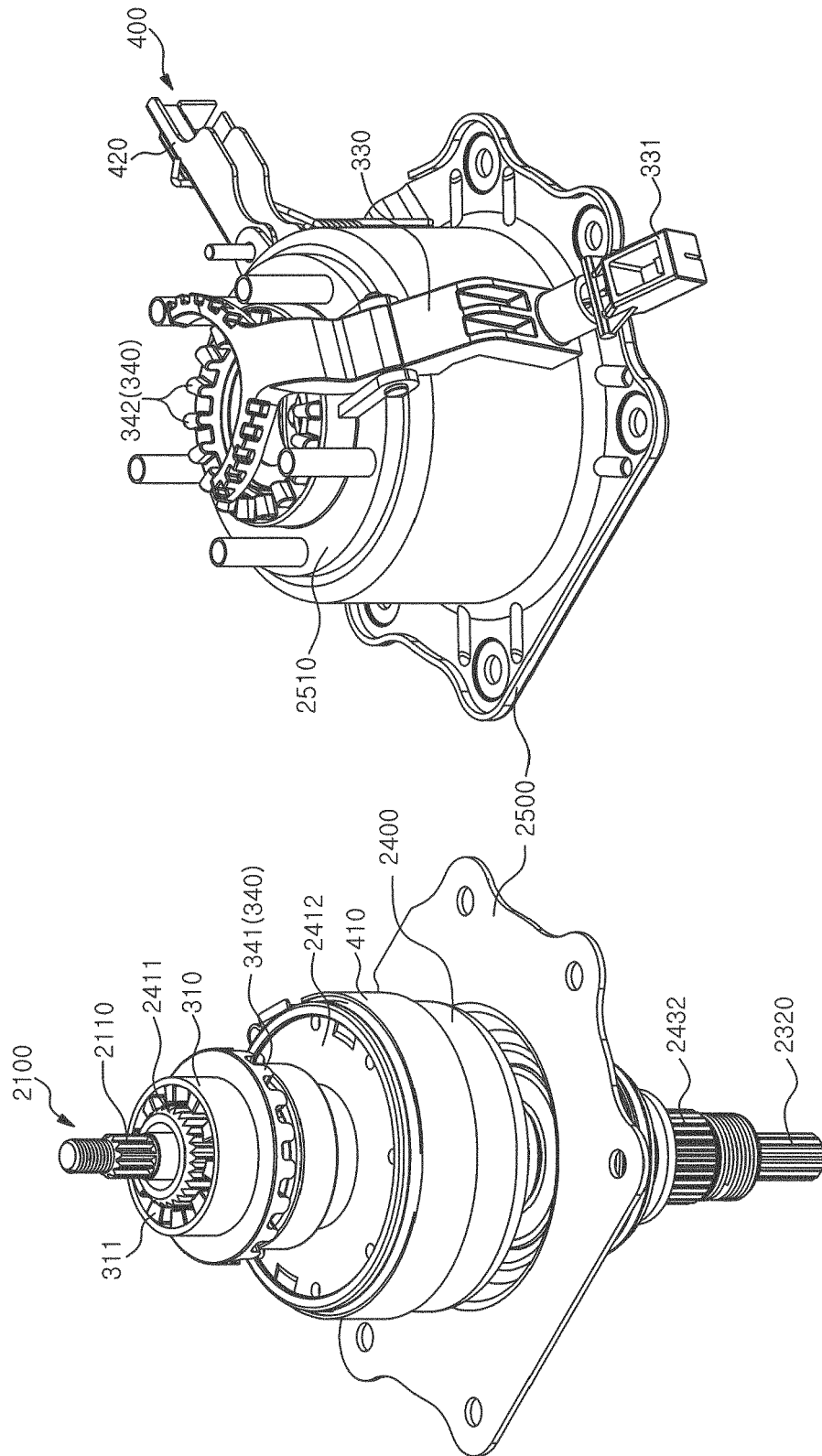


FIG. 7

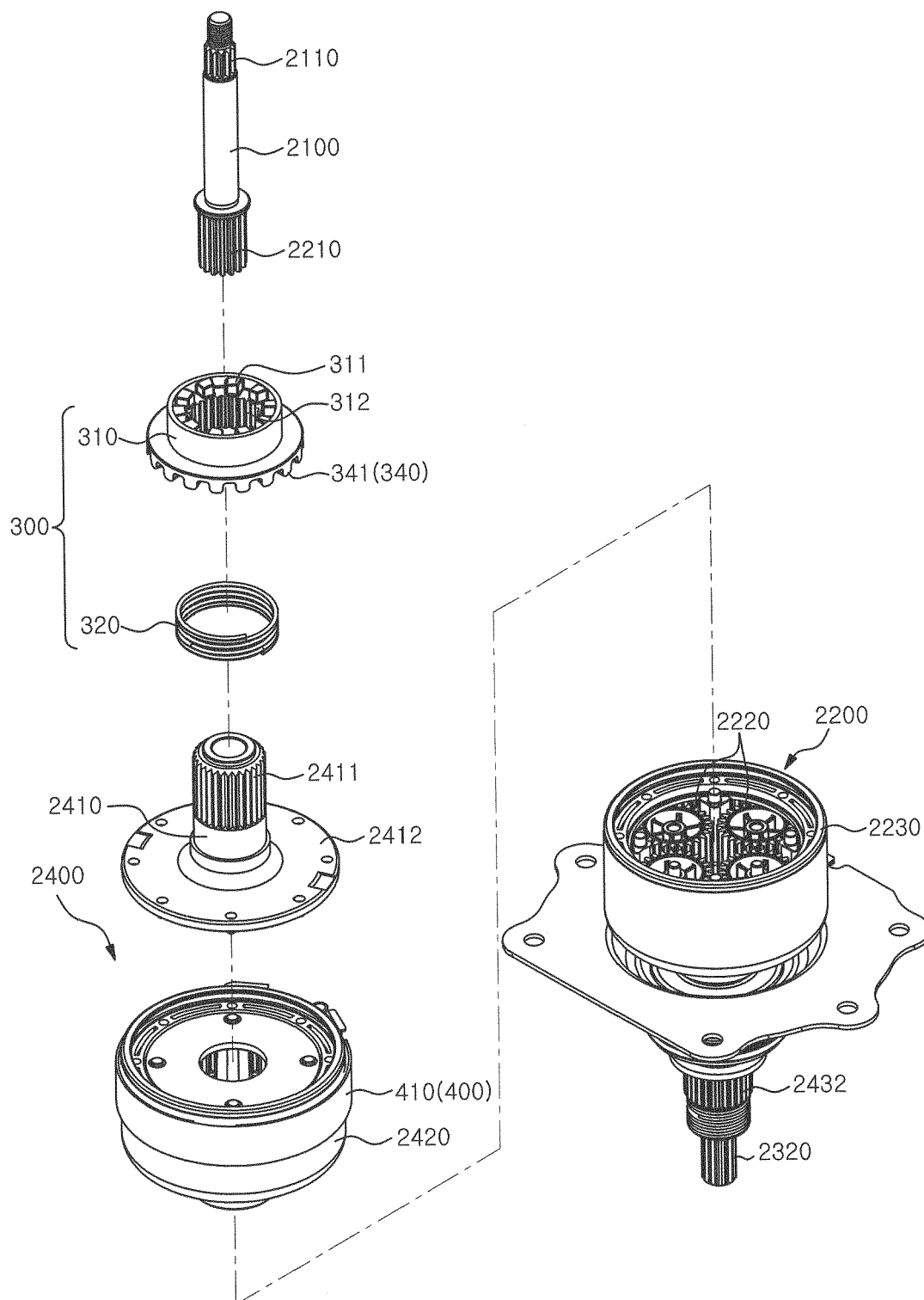


FIG. 8

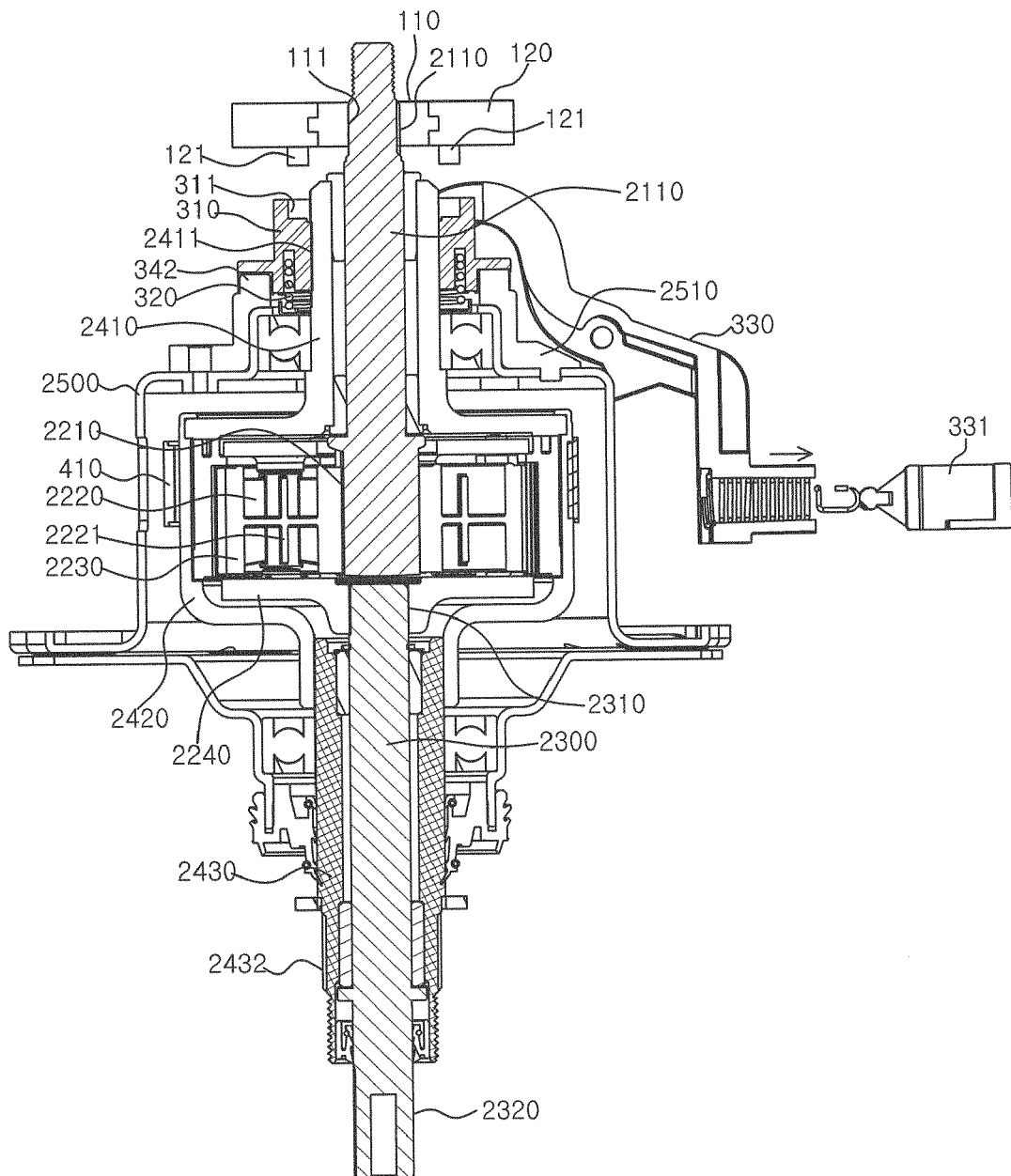


FIG. 9

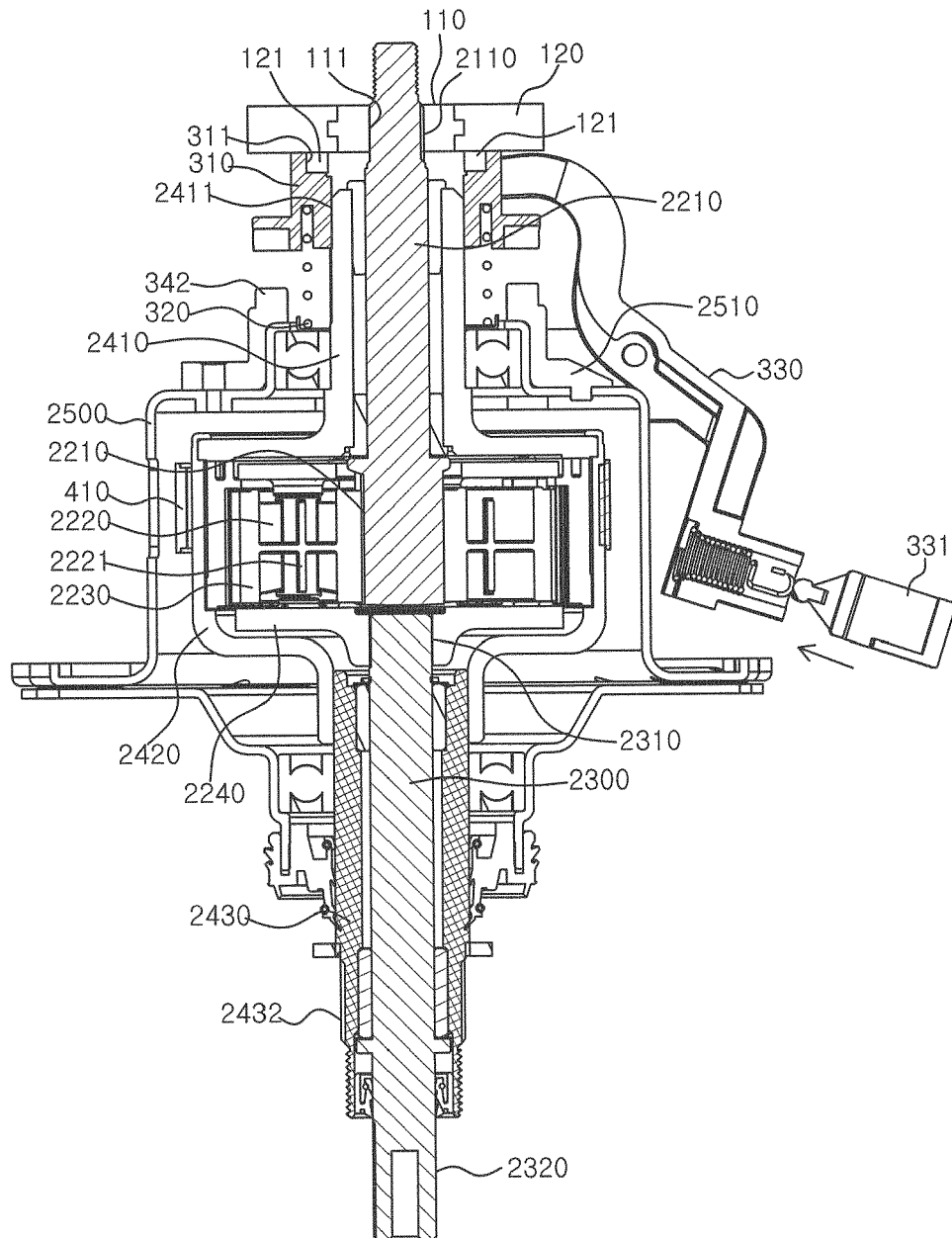
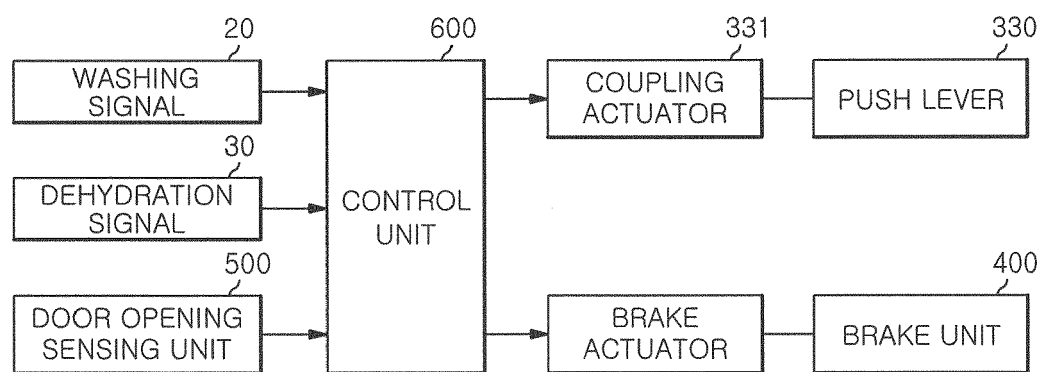


FIG. 10





EUROPEAN SEARCH REPORT

Application Number
EP 14 17 7051

5

10

15

20

25

30

35

40

45

50

55

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 2004/069020 A2 (LG ELECTRONICS INC [KR]; CHO KI CHUL [KR]; CHOI SOUNG BONG [KR]; KIM M) 19 August 2004 (2004-08-19) * page 10, line 5 - page 42, line 2; figures 1-10B *	1-15	INV. D06F37/40 D06F37/42
X	----- US 6 176 108 B1 (BAE SANG-CHUL [KR] ET AL) 23 January 2001 (2001-01-23) * column 4, line 56 - column 7, line 22; figures 1-6 *	1-15	
A	----- US 6 041 625 A (NAGAI KAZUNOBU [JP] ET AL) 28 March 2000 (2000-03-28) * column 5, line 66 - column 21, line 14; figures 1-7, 15B *	1-15	
			TECHNICAL FIELDS SEARCHED (IPC)
			D06F
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 17 April 2015	Examiner Engelhardt, Helmut
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 14 17 7051

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

17-04-2015

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2004069020 A2	19-08-2004	AT 498346 T	15-03-2011
		AU 2004210281 A1	19-08-2004
		EP 1589864 A2	02-11-2005
		JP 5079667 B2	21-11-2012
		JP 2006517126 A	20-07-2006
		JP 2009034552 A	19-02-2009
		US 2005166643 A1	04-08-2005
		US 2009120137 A1	14-05-2009
		WO 2004069020 A2	19-08-2004

US 6176108 B1	23-01-2001	CN 1224784 A	04-08-1999
		JP 3024108 B2	21-03-2000
		JP H11244578 A	14-09-1999
		US 6176108 B1	23-01-2001

US 6041625 A	28-03-2000	AU 701365 B2	28-01-1999
		AU 2839797 A	29-01-1998
		CN 1170791 A	21-01-1998
		CN 1419332 A	21-05-2003
		CN 1503447 A	09-06-2004
		CN 1893237 A	10-01-2007
		CN 1893238 A	10-01-2007
		JP 3290354 B2	10-06-2002
		JP H1015278 A	20-01-1998
		NZ 328233 A	26-01-1998
		US 6041625 A	28-03-2000

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- KR 1020130164180 [0001]
- KR 10199514460 [0011]