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

(57) A washing machine and a method for controlling a washing machine according to an embodiment includes: a frame configured to form an exterior; a tub installed in the frame; a drum accommodated in the tub; a washing motor configured to rotate the drum; a drain motor configured to drain water from the tub; a vibration sensor provided in the frame; and a controller configured to drive the drain motor in a stopped state of the washing motor at a start of a spin-drying process, determine a resonant frequency of the frame based on a vibration value measured by the vibration sensor, and control a revolutions per minute (RPM) of the washing motor to avoid the resonant frequency during the spin-drying process.

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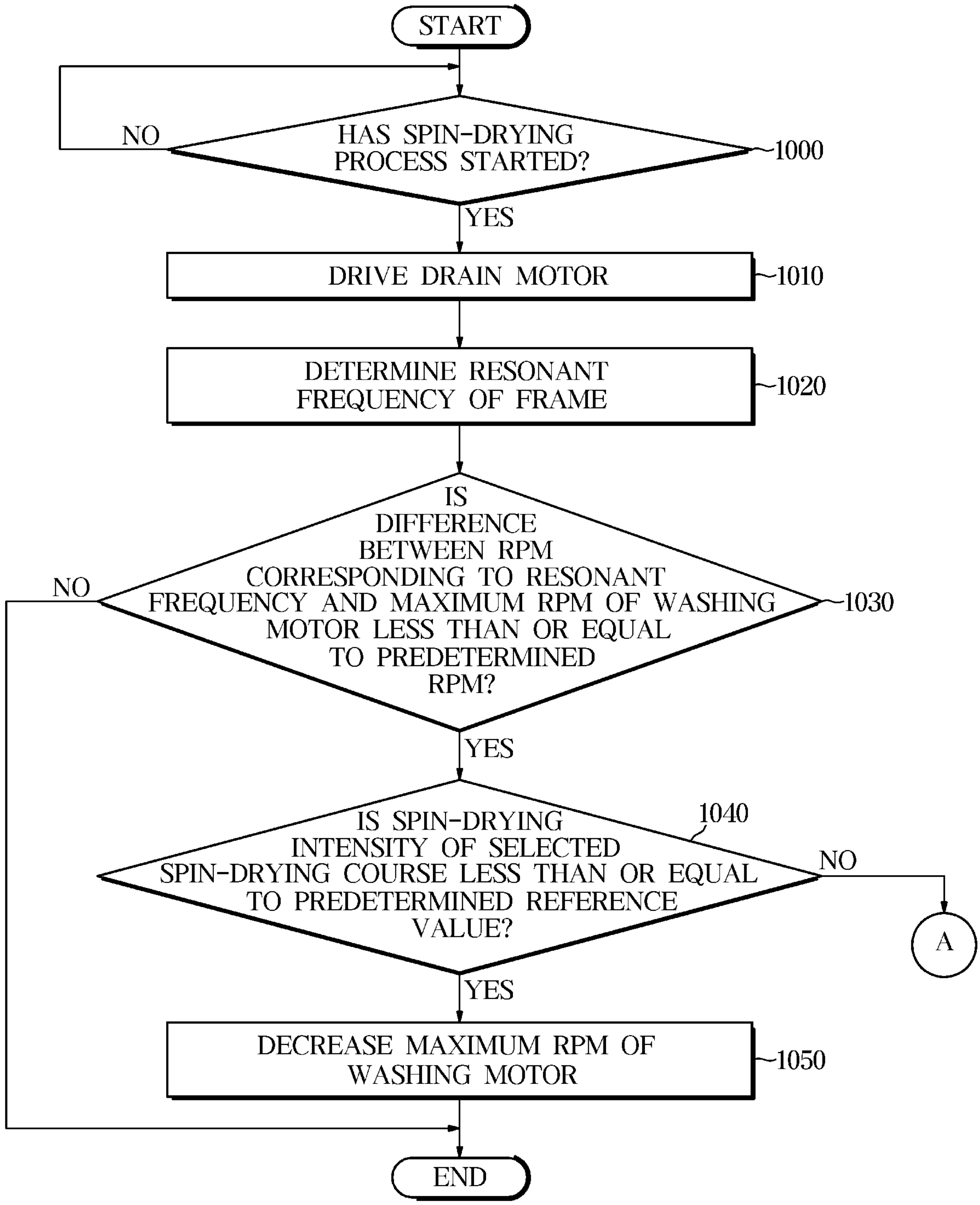
FIG. 10


START
HAS SPIN-DRYING PROCESS STARTED?
1000
NO
YES
DRIVE DRAIN MOTOR
1010
DETERMINE RESONANT FREQUENCY OF FRAME
1020
IS DIFFERENCE BETWEEN RPM CORRESPONDING TO RESONANT FREQUENCY AND MAXIMUM RPM OF WASHING MOTOR LESS THAN OR EQUAL TO PREDETERMINED RPM?
1030
NO
YES
IS SPIN-DRYING INTENSITY OF SELECTED SPIN-DRYING COURSE LESS THAN OR EQUAL TO PREDETERMINED REFERENCE VALUE?
1040
NO
A
YES
DECREASE MAXIMUM RPM OF WASHING MOTOR
1050
END

Description

[Technical Field]

[0001] The disclosure relates to a washing machine and a method for controlling the washing machine, and more specifically, to a washing machine that may reduce vibration noise generated during a spin-drying process and a method for controlling spin-drying of the washing machine.

[Background Art]

[0002] In general, a washing machine may include a tub and a drum rotatably installed in the tub, and may wash laundry by rotating the drum containing laundry in the tub. The washing machine may perform a washing process of laundry, a rinsing process of the washed laundry, and a spin-drying process of the rinsed laundry.

[0003] In the spin-drying process, water absorbed in the laundry may be separated from the laundry by accelerating and decelerating the drum containing the laundry at high speed.

[0004] In the spin-drying process, because the drum rotates at high speed, large vibrations may occur according to the eccentricity of the laundry, which may damage parts of the washing machine.

[Disclosure]

[Technical Problem]

[0005] An aspect of the disclosure provides a washing machine that may measure a resonant frequency of the washing machine frame and perform a spin-drying process by avoiding the resonant frequency.

[Technical Solution]

[0006] According to an aspect of the disclosure, a washing machine may include: a frame configured to form an exterior; a tub installed in the frame; a drum accommodated in the tub; a washing motor configured to rotate the drum; a drain motor configured to drain water from the tub; a vibration sensor provided in the frame; and a controller configured to drive the drain motor in a stopped state of the washing motor at a start of a spin-drying process, determine a resonant frequency of the frame based on a vibration value measured by the vibration sensor, and control a revolutions per minute (RPM) of the washing motor to avoid the resonant frequency during the spin-drying process.

[0007] The controller may be configured to change the RPM of the washing motor, based on a difference between a maximum RPM of the washing motor and a resonant band RPM in the spin-drying process being less than or equal to a predetermined RPM.

[0008] The controller may be configured to change the RPM of the washing motor, based on a predetermined spin-drying intensity in the spin-drying process.

[0009] The controller may be configured to reduce a maximum RPM of the washing motor, based on a spin-drying intensity of the spin-drying process being less than or equal to a predetermined reference value.

[0010] The controller may be configured to increase a maximum RPM of the washing motor, based on a spin-drying intensity of the spin-drying process being greater than a predetermined reference value.

[0011] The controller may be configured to increase acceleration of the washing motor, based on the RPM of the washing motor being increased and a difference from a resonant band RPM reaching a predetermined RPM or less in the spin-drying process.

[0012] The washing machine according to an embodiment may further include an output interface, wherein the controller may be configured to control the output interface to output a message notifying that a time required for the spin-drying process is changed by controlling the RPM of the washing motor.

[0013] The washing machine according to an embodiment may further include an output interface, wherein the controller may be configured to control the output interface to output a message notifying that a time required for the spin-drying process is changed by controlling the RPM of the washing motor.

[0014] The washing machine according to an embodiment may further include an input interface, wherein the controller may be configured to control the washing motor at an existing RPM, based on a command to stop changing the RPM of the washing motor being input to the input interface.

[0015] According to an embodiment of the disclosure, a method for controlling a washing machine may include: driving a drain motor configured to drain water from a tub installed in a frame in a stopped state of a washing motor; measuring a vibration value by a vibration sensor provided in the frame based on the drain motor being driven; determining a resonant frequency of the frame based on the vibration value; and controlling an RPM of the washing motor to avoid the resonant frequency.

[0016] The RPM of the washing motor may be changed based on a difference between a maximum RPM of the washing motor and a resonant band RPM in the spin-drying process being less than or equal to a predetermined RPM.

[0017] The RPM of the washing motor may be changed based on a predetermined spin-drying intensity in the spin-drying process.

[0018] According to an embodiment of the disclosure, the method may further include reducing a maximum RPM of the washing motor based on a spin-drying intensity of the spin-drying process being less than or equal to a predetermined reference value.

[0019] According to an embodiment of the disclosure, the method may further include increasing a maximum RPM of the washing motor based on a spin-drying intensity of the spin-drying process being greater than a predetermined reference value.

[0020] According to an embodiment of the disclosure, the method may further include increasing acceleration of the washing motor, based on the RPM of the washing motor being increased and a difference from a resonant band RPM reaching a predetermined RPM or less in the spin-drying process.

[0021] According to an embodiment of the disclosure, the method may further include controlling an output interface to output a message notifying that a time required for the spin-drying process is changed by controlling the RPM of the washing motor.

[0022] According to an embodiment of the disclosure, the method may further include controlling communication circuitry to transmit information notifying that a time required for the spin-drying process is changed by controlling the RPM of the washing motor to an external device.

[0023] According to an embodiment of the disclosure, the method may further include controlling the washing motor at an existing RPM, based on a command to stop changing the RPM of the washing motor being input to an input interface.

[Advantageous Effects]

[0024] According to an embodiment, a washing machine may minimize the time required for a spin-drying process and prevent vibration noise generated during the spin-drying process.

[0025] According to an embodiment, a washing machine may avoid a resonant frequency of a frame measured by driving a drain motor, thereby preventing vibration in advance before vibration occurs in a spin-drying process.

[Description of Drawings]

[0026]

FIG. 1 is a view illustrating an exterior of a washing machine according to an embodiment.

FIG. 2 is a side cross-sectional view of a washing machine according to an embodiment.

FIG. 3 is a control block diagram of a washing machine according to an embodiment.

FIG. 4 is a graph of vibration values according to an operation of a drain motor of a washing machine according to an embodiment.

FIG. 5 is a three-dimensional diagram illustrating vibration values according to an operation of a drain motor of a washing machine according to an embodiment.

FIG. 6 is a diagram illustrating frame vibration due to resonant frequency in a washing machine according to an embodiment.

FIG. 7 is a diagram illustrating vibration displacement at a resonance point of a washing machine according to an embodiment.

FIG. 8 is a diagram illustrating vibration displacement in a case where vibration is avoided in a washing machine according to an embodiment.

FIG. 9 is a view illustrating a washing machine communicating with external devices according to an embodiment.

FIG. 10 is a flowchart for changing a maximum revolutions per minute (RPM) of a washing motor in a washing machine according to an embodiment.

FIG. 11 is a flowchart for controlling acceleration to reduce vibration in a washing machine according to an embodiment.

[Modes of the Invention]

[0027] Embodiments described in the disclosure and configurations shown in the drawings are merely examples of the embodiments of the disclosure, and may be modified in various different ways at the time of filing of the application to replace the embodiments and drawings of the disclosure.

[0028] The terms used in the specification are merely used to describe embodiments, and are not intended to limit and/or restrict the disclosure.

[0029] For example, it is to be understood that the singular forms are intended to include the plural unless the context clearly dictates otherwise.

[0030] In addition, it is to be understood that when the terms "includes," "comprises," "including," and/or "comprising," when used in this specification, specify the presence of stated features, figures, steps, operations, components, members, or combinations thereof, but do not preclude the presence or addition of one or more other features, figures, steps, operations, components, members, or combinations thereof.

[0031] In addition, it is to be understood that the terms "first", "second", or the like, may be used only to distinguish one component from another, not intended to limit the corresponding component in other aspects.

[0032] In addition, the terms such as "~portion", "~device", "~block", "~member", "~module" and the like may refer to a unit for processing at least one function or act. For example, the terms may refer to at least one process processed by at least one hardware, such as a field-programmable gate array (FPGA)/application specific integrated circuit (ASIC), software stored in memory, or processors.

[0033] Hereinafter, embodiments of the disclosure are described in detail with reference to accompanying drawings. In describing of the drawings, similar reference numerals may be used for similar or related elements.

[0034] An operation principle and embodiments of the disclosure are described below with reference to accompanying drawings.

[0035] FIG. 1 is a view illustrating an exterior of a washing machine according to an embodiment. FIG. 2 is a side cross-sectional view of a washing machine according to an embodiment.

[0036] A washing machine 10 according to an embodiment may be a drum-type washing machine that washes laundry by repeatedly lifting and lowering the laundry by rotating a drum 130, or may be an electric washing machine that washes laundry by using the water current generated by a pulsator when the drum 130 rotates. However, in the embodiments described below, for detailed description, an example in which the washing machine 10 according to an embodiment is a drum-type washing machine is described.

[0037] Referring to FIG. 1 and FIG. 2, the washing machine 10 may include a frame 100 and a door 102 disposed at a front of the frame 100. An inlet 101a for inserting or taking out laundry may be disposed at the center of the front of the frame 100. The door 102 may open and close the inlet 101a. One side of the door 102 may be rotatably mounted by a hinge. Closing of the inlet 101a by the door 102 may be detected by a door switch 103. When the inlet 101a is closed and the washing machine 10 operates, the door 102 may be locked by a door lock 104.

[0038] In addition, the washing machine 10 may include a control panel 110, a tub 120, the drum 130, a driver 140, a water supply 150, a drainage 160, a detergent supply portion 170, and a vibration sensor 180.

[0039] The control panel 110 may be disposed on an upper front side of the frame 100. The control panel 110 may include an input interface 112 for obtaining a user input, and a display 111 for displaying operation information of the washing machine 10. The control panel 110 may provide a user interface for interaction between a user and the washing machine 10.

[0040] The tub 120 may be disposed in the frame 100, and may accommodate water for washing and/or rinsing. The tub 120 may include tub front parts 121 in which an opening 121a is formed at the front, and tub rear parts 122 having a cylindrical shape with a closed rear. The opening 121a may be provided at the front of the tub front parts 121 for inserting laundry into the drum 130 disposed inside the tub 120 or for taking laundry out of the drum 130. A bearing 122a for rotatably fixing a washing motor 141 may be provided at a rear wall of the tub rear parts 122.

[0041] The drum 130 may be rotatable in the tub 120 and may accommodate laundry. The drum 130 may include a cylindrical drum body 131, drum front parts 132 in front of the drum body 131, and drum rear parts 133 in the rear of the drum body 131. The tub 120 and the drum 130 may be positioned at an angle relative to the ground. However, the tub 120 and the drum 130 may also be positioned horizontally relative to the ground.

[0042] Through holes 131a connecting the inside of the drum 130 and the inside of the tub 120, and a lifter 131b for lifting the laundry to an upper part of the drum 130 while the drum 130 rotates may be provided on an inner surface of the drum body 131. The drum front parts 132 may be provided with an opening 132a for inserting the laundry into the drum 130 or taking the laundry out of the drum 130. The drum rear parts 133 may be connected to a shaft 141a of the washing motor 141 that rotates the drum 130.

[0043] The washing motor 141 may rotate the drum 130. The washing motor 141 may be included in the driver 140. The washing motor 141 may be positioned outside the tub rear parts 122 and may be connected to the drum rear parts 133 through the shaft 141a. The shaft 141a may penetrate the tub rear parts 122 and may be rotatably supported by the bearing 122a disposed in the tub rear parts 122.

[0044] The washing motor 141 may include a stator 142 fixed to the outside of the tub rear parts 122, and a rotor 143 that is rotatable and connected to the shaft 141a. The rotor 143 may rotate by magnetic interaction with the stator 142, and the rotation of the rotor 143 may be transmitted to the drum 130 through the shaft 141a. The washing motor 141 may include, for example, a brushless direct current (BLDC) motor or a permanent synchronous motor (PMSM) whose rotation speed is easy to control.

[0045] According to various embodiments, the washing machine 10 may further include a pulsator (not shown) that rotates independently of the drum 130.

[0046] The pulsator may rotate independently of the drum 130 to form a water flow inside the drum 130.

[0047] In an embodiment, the pulsator may be powered by the washing motor 141, or may be powered by a pulsator motor that is provided separately from the washing motor 141.

[0048] In a case where the pulsator is powered by the washing motor 141, the washing motor 141 may be implemented as a dual rotor motor including one stator and two rotors (e.g., an inner rotor and an outer rotor), and one of the two rotors may be connected to the drum 130, and the other may be connected to the pulsator.

[0049] The water supply 150 may supply water to the tub 120 and the drum 130. The water supply 150 may include a water supply pipe 151 connected to an external water supply source to supply water to the tub 120, and a water supply valve 152 arranged on the water supply pipe 151. The water supply pipe 151 may be arranged above the tub 120 and may extend from the external water supply source to a detergent container 171. Water may flow to the tub 120 through the detergent container 171.

[0050] The water supply valve 152 may open or close the water supply pipe 151 in response to an electrical signal of the controller 190. The water supply valve 152 may allow or block the supply of water from the external water supply source to the tub 120. The water supply valve 152 may include, for example, a solenoid valve that opens and closes in response to an electrical signal.

[0051] The drainage 160 may discharge water contained in the tub 120 and/or the drum 10 to the outside. The drainage 160 may include a drain pipe 161 extending from a lower side of the tub 120 to the outside of the frame 100, and a drain motor 162 operating a drain pump arranged on the drain pipe 161. The drain motor 162 may be connected to the drain pump to pump water in the drain pipe 161 to the outside of the frame 100.

[0052] The detergent supply portion 170 may supply detergent to the tub 120 and/or the drum 130. The detergent supply portion 170 may include the detergent container 171 disposed above the tub 120 to store detergent, and a mixing pipe 172 connecting the detergent container 171 to the tub 120. The detergent container 171 may be connected to the water supply pipe 151, and water supplied through the water supply pipe 151 may be mixed with detergent in the detergent container 171. The mixture of detergent and water may be supplied to the tub 120 through the mixing pipe 172.

[0053] FIG. 3 is a control block diagram of a washing machine according to an embodiment.

[0054] The washing machine 10 may further include the electrical/electronic configurations described below, in addition to the mechanical configurations described with reference to FIG. 1 and FIG. 2.

[0055] Referring to FIG. 3, the washing machine 10 may include the control panel 110, the driver 140, the water supply valve 152, the drain motor 162, the vibration sensor 180, and the controller 190.

[0056] The washing machine 10 may include the control panel 110, the driver 140, the water supply valve 152, the drain motor 162, the vibration sensor 180, the controller 190, and/or communication circuitry 195. The controller 190 may be electrically connected to the components of the washing machine 10 and control an operation of each of the components.

[0057] The control panel 110 may include a display 111 for displaying wash settings and/or washing operation information in response to a user input, and the input interface 112 for receiving a user input. The control panel 110 may provide a user interface for interaction between a user and the washing machine 10. For example, the input interface 112 may include a power button, an operation button, a course selection dial, and a detail setting button. The input interface 112 may include, for example, a tact switch, a push switch, a slide switch, a toggle switch, a micro switch, or a touch switch.

[0058] The display 111 may include a screen displaying various information and an indicator displaying detail settings selected by the setting button. The display 111 may include, for example, a liquid crystal display (LCD) panel, a light emitting diode (LED) panel, or the like.

[0059] Washing courses of the washing machine 10 may include predetermined washing settings (e.g., washing temperature, number of rinses, spin speed) according to the type of laundry (e.g. shirts, pants, underwear, blankets) and the material of laundry (e.g., cotton, polyester, wool). For example, a standard washing may include generalized settings for most laundry, and a bedclothes washing may include optimized settings for washing bedclothes. The washing courses may include a standard washing, intensive washing, wool washing, bedclothes washing, baby clothes washing, towel washing, small load washing, boil washing, energy saving washing, outdoor clothes washing, rinsing + spin-drying, spin-drying, and the like.

[0060] The driver 140 may include the washing motor 141 and drive circuitry 200. The drive circuitry 200 may supply a drive current for driving the washing motor 141 to the washing motor 141 in response to a drive signal (motor control signal) from the controller 190. The drive circuitry 200 may rectify alternating current (AC) power of an external power source, convert the power into direct current (DC) power, and convert the DC power into driving power in a sine wave form. The drive circuitry 200 may include an inverter that outputs the converted driving power to the washing motor 141. The inverter may include a plurality of switching elements, and may open (off) or close (on) a plurality of switches based on a drive signal from the controller 190. A drive current may be supplied to the washing motor 141 according to the opening or closing of the switching elements. In addition, the drive circuitry 200 may include a current sensor (not shown) that may measure the drive current output from the inverter.

[0061] The controller 190 may calculate a rotation speed of the washing motor 141 based on a rotor electrical angle of the washing motor 141. The rotor electrical angle may be obtained from a position sensor 94 disposed in the washing motor 141. For example, the controller 190 may calculate the rotation speed of the washing motor 141 based on a change in the rotor electrical angle with respect to a sampling time interval. The position sensor (not shown) may be implemented as a Hall sensor, an encoder, or a resolver. In addition, the controller 190 may calculate the rotation speed of the washing motor 141 based on a drive current value measured by the current sensor 91.

[0062] The washing motor 141 may rotate the drum 130 under control of the controller 190. The controller 190 may drive the washing motor 141 to follow a target rotation speed.

[0063] The drive circuitry 200 may supply a drive current to the washing motor 141 according to a motor control signal (e.g., a rotation speed command, a rotation deceleration command) of the controller 190.

[0064] The washing motor 141 may rotate the drum 130 depending on the drive current from the drive circuitry 200. For example, the washing motor 141 may rotate the drum 130 to allow the rotation speed of the drum 130 to follow the rotation speed command output from the controller 190 according to the drive current.

[0065] In addition, the washing motor 141 may decelerate the drum 130 to allow the rotation speed of the drum 130 to follow the rotation deceleration command output from the controller 190 according to the drive current.

[0066] The water supply valve 152 may be opened in response to a water supply signal from the controller 190. Water may be supplied to the tub 120 through the water supply pipe 151 by opening the water supply valve 152.

[0067] The drain motor 162 may discharge water to the outside of the frame 100 through the drain pipe 161 in response to a drain signal from the controller 190. According to the operation of the drain motor 162, water contained in the tub 120 may be discharged to the outside of the frame 100 through the drain pipe 161.

[0068] The vibration sensor 180 may detect vibration of the frame 100. Specifically, the vibration sensor 180 may detect the vibration of the frame 100 generated by rotation of the drum 130 during a washing cycle (e.g., a spin-drying process).

[0069] The vibration sensor 180 may be installed at any location of the frame 100, and because the vibration sensor 180 measures the vibration of the frame 100 caused by the operation of the drain motor 162, an accuracy of the measured vibration value may be increased as the vibration sensor 180 is located closer to the drain motor 162.

[0070] Due to an imbalance of the laundry in the drum 130, the eccentricity of the drum 130 occurs, and the vibration of the tub 120 may occur due to the eccentricity of the drum 130. In a state where the laundry is placed unbalanced, an increase in the rotation speed of the washing motor 141 may increase in the vibration of the tub 120, and a noise caused by the vibration of the tub 120 may also increase.

[0071] The vibration sensor 180 may output a vibration signal about the vibration of the frame 100. An amplitude of the vibration signal may be defined as a vibration value when the frame 100 vibrates. That is, unlike existing technologies, the vibration sensor may measure the vibration value of the frame 100.

[0072] The vibration sensor 180 may include a micro electromechanical systems (MEMS) sensor that outputs a three-axis acceleration of an object whose vibration is to be measured.

[0073] The controller 190 may continuously receive the vibration signal output from the vibration sensor 180 until the operation of the drain motor 162 is completed, and may measure a resonant frequency of the frame 100 based on the vibration value.

[0074] According to various embodiments, the vibration sensor 180 may be implemented as the driver 140.

[0075] Specifically, a drive controller 250 may indirectly detect the vibration of the frame 100 generated from the drain motor 162 based on the drive current value measured by the current sensor 91 and/or the drive voltage for driving the washing motor 141 and/or a speed of the rotor 143 measured by the position sensor 94.

[0076] The drive controller 250 may determine the vibration value of the frame 100 based on the drive current value measured by the current sensor 91 and/or the drive voltage for driving the washing motor 141 and/or the drive voltage for driving the washing motor 141 and/or the speed of the rotor 143 measured by the position sensor 94, and may transmit information about the determined vibration value to the controller 190.

[0077] That is, the vibration sensor 180 may be implemented as a separate sensor for directly measuring the vibration of the frame 100, and may also be implemented as the drive controller 250 for controlling the washing motor 141.

[0078] In various embodiments, in a case where the controller 190 is provided integrally with the drive controller 250, the vibration sensor 180 may include the current sensor 91 and/or a voltage sensor for measuring the drive voltage for driving the washing motor 141 and/or the position sensor 94.

[0079] The controller 190 may include a processor 191 generating a control signal related to an operation of the washing machine 10, and memory 192 storing programs, applications, instructions, and/or data for the operation of the washing machine 10. The processor 191 and the memory 192 may be implemented as separate semiconductor devices or as a single semiconductor device.

[0080] In addition, the controller 190 may include a plurality of processors or a plurality of memories. The controller 190 may be provided at various locations in the washing machine 10. For example, the controller 190 may be included in a printed circuit board provided in the control panel 110.

[0081] The processor 191 may include operation circuitry, memory circuitry, and control circuitry. The processor 191 may include a single chip or a plurality of chips. In addition, the processor 191 may include a single core or a plurality of cores.

[0082] The memory 192 may store a program for performing a washing cycle according to a washing course and data including wash settings according to a washing course. In addition, the memory 192 may store a currently selected washing course and wash settings (e.g., spin-drying mode) based on a user input.

[0083] In an embodiment, the memory 192 may store a program including an algorithm for performing a washing cycle according to a washing course and wash settings, an algorithm for calculating a resonant frequency of the frame from a vibration value of the frame, an algorithm for changing a maximum spin-drying speed or a spin-drying acceleration to avoid the resonant frequency, and the like.

[0084] The memory 192 may include a volatile memory, such as static random access memory (SRAM) or dynamic random access memory (DRAM), and a non-volatile memory, such as read only memory (ROM) or erasable programmable read only memory (EPROM). The memory 192 may include a single memory device or may include a plurality of memory devices.

[0085] The processor 191 may process data and/or signals using the programs provided from the memory 192, and may transmit control signals to each component of the washing machine 10 based on the processing results. For example, the processor 191 may process a user input received through the control panel 110. In response to the user input, the processor 191 may output a control signal for controlling the display, the washing motor 141, the water supply valve 152 and the drain motor 162.

[0086] The processor 191 may control the driver 140, the water supply valve 152, and the drain motor 162 to perform a washing cycle including a washing process, a rinsing process, and a spin-drying process. In addition, the processor 191 may control the control panel 110 to display wash settings and washing operation information.

[0087] In addition, the processor 191 may control the communication circuitry 195 to transmit predetermined information to an external device.

[0088] The communication circuitry 195 may transmit data to an external device or receive data from an external device based on the control of the controller 190. For example, the communication circuitry 195 may communicate with a server and/or a user terminal device and/or a home appliance to transmit and receive various data.

[0089] For the communication, the communication circuitry 195 may establish a direct (e.g., wired) communication channel or a wireless communication channel between external electronic devices (e.g., server, user terminal device, and/or home appliance), and support the performance of the communication through the established communication channel. According to an embodiment, the communication circuitry 195 may include a wireless communication module (e.g., a cellular communication module, a short-range wireless communication module, or a global navigation satellite system (GNSS) communication module) or a wired communication module (e.g., a local area network (LAN) communication module, or a power line communication module). Among these communication modules, the corresponding communication module may communicate with an external device through a first network (e.g., a short-range wireless communication network, such as Bluetooth, wireless fidelity (Wi-Fi) direct, or infrared data association (IrDA)) or a second network (e.g., a long-range wireless communication network, such as a legacy cellular network, a 5G network, a next-generation communication network, the Internet, or a computer network (e.g., LAN or wide area network (WAN)). These various types of communication modules may be integrated as one component (e.g., a single chip) or implemented as a plurality of separate components (e.g., multiple chips).

[0090] According to various embodiments, the communication circuitry 195 may establish communication with a user terminal device through a server.

[0091] In various embodiments, the communication circuitry 195 may include a Wi-Fi module, and may perform communication with an external server and/or a user terminal device based on establishing communication with an access point (AP) in the home.

[0092] Although the configuration of the washing machine 10 has been described above, the washing machine 10 may further include various configurations within the scope of general technology.

[0093] FIG. 4 is a graph of vibration values according to an operation of a drain motor of a washing machine according to an embodiment. FIG. 5 is a three-dimensional diagram illustrating vibration values according to an operation of a drain motor of a washing machine according to an embodiment.

[0094] Referring to FIG. 4, the controller 190 may measure a resonant frequency of the frame 100, and change a spin-drying process accordingly to minimize vibration of the washing machine 10.

[0095] In this instance, the controller 190 may determine the resonant frequency of the frame 100 that varies depending on a floor condition on which the washing machine 10 is installed.

[0096] Specifically, the vibration of the washing machine 10 increases as the eccentricity due to the laundry increases, and the vibration of the frame 100 also increases in proportion to the eccentricity. However, in a case where the resonant frequency of the frame 100 changes depending on the floor condition on which the washing machine 10 is installed and the frame 100 vibrates significantly at a specific speed, the vibration of the washing machine frame 100 may increase even in a case where the eccentricity is small.

[0097] In conditions of high hardness such as concrete or tiles, a resonant frequency of the frame 100 is approximately 30 Hz (1800 rpm), and thus in a case where the spin-drying speed is 1100 rpm or less, no significant vibration occurs. However, in conditions of low hardness such as wood or a pedestal, a resonant frequency of the frame 100 is approximately 13 Hz (780 rpm), and thus in a case where the speed is maintained near 780 rpm, the frame 100 may significantly vibrate even in a case where the eccentricity is small.

[0098] Accordingly, the controller 190 may determine a resonant frequency of the frame 100 on a floor where the washing machine 10 is installed based on the operation of the drain motor 162, and control the washing motor 141 based on the determined resonant frequency.

[0099] FIG. 4 shows acceleration data measured by the vibration sensor 180 in each section of the spin-drying process. The controller 190 operates only the drain motor 162 to drain water from the tub 120 at a beginning of the spin-drying process, and the vibration of the frame 100 may occur differently depending on an operating state of the drain motor 162. Once the controller 190 operates the drain motor 162, vibration occurs, the vibration is transmitted to the frame 100 of the washing machine 10, and thus the vibration of the frame 100 also increases. In this instance, the vibration value generated may be detected by the vibration sensor 180, and the controller 190 may determine the resonant frequency of the frame 100 based on the vibration value of the frame 100.

[0100] Specifically, (a) of FIG. 4 indicates a section in which the controller 190 operates the drain motor 162 and vibration occurs due to the drain motor 162, and (b) of FIG. 4 indicates a section in which the controller 190 stops the operation of the drain motor 162 and vibration does not occur.

[0101] In addition, a right side of (b) of FIG. 4 may indicate a vibration value of the frame according to a spin-drying profile.

[0102] As such, when the controller 190 operates or stops the drain motor 162, a difference in the vibration value occurs, and the controller 190 may determine the resonant frequency of the frame 100 based on the difference in the vibration value.

[0103] In FIG. 5, vibration data of the frame 100 in a case where the controller 190 operates only the drain motor 162 at the beginning of the spin-drying process may be confirmed.

[0104] Specifically, in FIG. 5, the solid line represents the vibration data in an x-axis direction measured by the vibration sensor 180, the dashed line represents the vibration data in a y-axis direction measured by the vibration sensor 180, and the dotted line represents the vibration data in a z-axis direction measured by the vibration sensor 180.

[0105] In a case where the controller 190 operates only the drain motor 162, it may be confirmed that the frame 100 vibrates at a specific frequency, and this frequency is the resonant frequency of the frame 100. The resonant frequency of the frame 100 varies depending on a floor condition, and in a case where the spin-drying process is controlled by avoiding the resonant frequency of the frame 100, the vibration of the frame 100 may be minimized.

[0106] As a method of measuring a resonant frequency of the frame 100 by the controller 190 using the vibration sensor 180, a cycle may be measured by detecting zero-crossings, i.e., a zero-cross point of a signal, or the resonant frequency of the frame 100 may be measured through frequency analysis using a fast Fourier transform (FFT). The method of measuring the resonant frequency by the controller 190 is not limited thereto, and may be implemented in various ways.

[0107] FIG. 6 is a diagram illustrating frame vibration due to resonant frequency in a washing machine according to an embodiment.

[0108] Referring to FIG. 6, the dotted line is a resonant frequency range (a) of the frame 100, and a revolutions per minute (RPM) in the resonant frequency range may be defined as a resonant band RPM. In addition, the solid line is a vibration displacement (mm) of the frame 100, and the dashed line is an RPM of the washing motor according to a spin-drying profile.

[0109] That is, spin-drying proceeds to the right side of an x-axis according to the spin-drying profile, and the solid line rises sharply in a section of 100 seconds, which indicates a first resonance of the frame 100. Thereafter, the solid line shows a sharp rise in a section from 200 to 250 seconds, which indicates a second resonance of the frame 100, and may cause strong vibrations together with a high RPM of the washing motor 141.

[0110] Accordingly, the washing machine according to an embodiment may control the washing motor 141 to control the vibration in the second resonance.

[0111] The resonant frequency range (a) of the frame 100 may vary depending on an environment in which the washing machine 10 is installed and the specifications of the washing machine 10 itself. Accordingly, the controller 190 requires to measure the resonant frequency of the frame 100 when the drain motor 162 operates, and based on the measured resonant frequency value, the controller 190 may control the RPM of the washing motor 141 to be lower or higher than the resonant band RPM corresponding to the resonant frequency value during the spin-drying process.

[0112] In addition, in a case where the controller 190 controls the RPM of the washing motor 141 to be higher than the resonant band RPM, the controller 190 may increase a rotation acceleration of the washing motor 141 to quickly pass through the resonant band RPM.

[0113] That is, upon start of the spin-drying process, the washing machine 10 according to an embodiment may drive the drain motor 162, determine the resonant frequency of the frame 100 based on the vibration value measured by the vibration sensor 180, and control the RPM of the washing motor 141 to avoid the resonant frequency during the spin-drying process, which will be described in detail in FIG. 10.

[0114] FIG. 7 is a diagram illustrating vibration displacement at a resonance point of a washing machine according to an embodiment. FIG. 8 is a diagram illustrating vibration displacement in a case where vibration is avoided in a washing machine according to an embodiment.

[0115] In a case where vibration control is not performed in the washing machine 10 according to an embodiment and an unbalanced load occurs due to an imbalance, a maximum vibration displacement of the tub 120 occurs when passing through a resonance point at a beginning of a spin-drying process, as shown in FIG. 7.

[0116] In a case where a gap between the tub 120 and the frame 100 of the washing machine 10 is not sufficient, the tub 120 may hit the frame 100 and apply an impact to a main body of the washing machine 10, which may cause a spin-drying failure in which the spin-drying process may not be performed. In addition, the washing machine 10 may be damaged, resulting in property damage.

[0117] On the other hand, in a case where the controller 190 determines the resonant frequency of the frame 100 based on the operation of the drain motor 162 at the beginning of the spin-drying process and controls the spin-drying process by avoiding the resonant frequency, the RPM of the washing motor 141 may be maintained by avoiding the resonant band RPM, and thus the vibration displacement of the tub 120 is not large, as shown in FIG. 8.

[0118] Accordingly, the washing machine 10 according to an embodiment may measure the resonant frequency of the frame 100 before passing through the resonance point in the spin-drying process where unbalance is highly likely to occur, thereby reducing the vibration of the tub 120.

[0119] FIG. 9 is a view illustrating a washing machine communicating with external devices according to an embodiment.

[0120] Referring to FIG. 9, the washing machine 10 may communicate with an external server 300 and/or a user terminal device 400 via the communication circuitry 195.

[0121] For example, the washing machine 10 may communicate with the user terminal device 400 via the external server 300 as a medium.

[0122] The controller 190 may control the communication circuitry 195 to transmit a message notifying that a time required for a spin-drying process of the washing motor 141 is changed to an external device (e.g., the external server 300 and/or the user terminal device 400).

[0123] In various embodiments, the user terminal device 400 may output a visual indication corresponding to the message notifying that the time required for the spin-drying process is changed based on receiving the message notifying that the time required for the spin-drying process is changed from the washing machine 10.

[0124] For example, in a case where the time required for the spin-drying process increases, the user terminal device 400 may output a phrase "the spin-drying time is increased to reduce vibration." In addition, in a case where the time required for the spin-drying process decreases, the user terminal device 400 may output a phrase "the spin-drying time is decreased to reduce vibration."

[0125] In addition, the washing machine 10 according to an embodiment may further include an input interface. The controller 190 may control the washing motor 141 at an existing RPM based on an input of a command to stop changing the RPM of the washing motor 141 to the input interface.

[0126] That is, the controller 190 may perform washing according to an existing washing time in a case where a user does not desire to change a washing time even if he or she feels vibration.

[0127] In addition, the controller 190 may receive a command to stop changing the RPM of the washing motor 141 from the user terminal device, and may perform washing according to an existing washing time based on the received command.

[0128] According to the disclosure, by notifying the user of state information of the spin-drying process through the user terminal device 400, the user may take appropriate action according to the state of the spin-drying process.

[0129] FIG. 10 is a flowchart for changing a maximum RPM of a washing motor in a washing machine according to an embodiment. FIG. 11 is a flowchart for controlling acceleration to reduce vibration in a washing machine according to an embodiment.

[0130] Referring to FIG. 10, upon start of a spin-drying process, the controller 190 may drive the drain motor 162, determine a resonant frequency of the frame 100 based on a vibration value measured by the vibration sensor 180, and control an RPM of the washing motor 141 to avoid the resonant frequency during the spin-drying process.

[0131] Specifically, the controller 190 may determine whether the spin-drying process has started (1000). In this instance, the spin-drying process may be operations of washing, rinsing, and spin-drying according to a user input for a washing course, or an operation of only spin-drying according to a user input for spin-drying.

[0132] Based on determining that the spin-drying process has started (Yes in operation 1000), the controller 190 may drive the drain motor 162 (1010) in a state where the washing motor 141 is stopped to discharge water in the tub 120 to the outside of the washing machine 10. In this instance, the drain motor 162 may operate the drain pump and may discharge the remaining water in the tub 120 through the drain pipe extended to the outside of the frame 100.

[0133] Thereafter, the controller 190 may determine the resonant frequency of the frame 100 while only the drain motor 162 operates (1020). As described above, when the drain motor 162 operates, vibration occurs, the vibration is transmitted to the frame 100, and thus the vibration sensor 180 provided in the frame 100 may detect the vibration value of the frame 100.

[0134] Thereafter, the controller 190 may determine the resonant frequency of the frame 100 based on a zero-crossing point or fast Fourier transform (FFT).

[0135] The controller 190 may determine a resonant band RPM corresponding to the resonant frequency, and may determine a difference between the resonant band RPM and a maximum RPM of the washing motor 141 (1030).

[0136] Based on determining that the difference between the resonant band RPM and the maximum RPM of the washing motor 141 is less than or equal to a predetermined RPM (Yes in operation 1030), the controller 190 may determine whether a spin-drying intensity of a spin-drying course selected by a user is less than or equal to a predetermined reference value (1040).

[0137] That is, based on determining that the difference between the resonant band RPM and the maximum RPM of the washing motor 141 is less than or equal to the predetermined RPM, the controller 190 may determine that the maximum RPM at which the washing motor 141 maintains the longest time during the spin-drying process is close to the resonant band RPM, and may change the RPM of the washing motor 141 to avoid the resonant band RPM.

[0138] Thereafter, the controller 190 may determine whether the spin-drying intensity of the spin-drying course selected by the user is less than or equal to the predetermined reference value (1040). Based on determining that the spin-drying intensity of the spin-drying course selected by the user is less than or equal to the predetermined reference value (Yes in operation 1040), the controller 190 may determine that the spin-drying course is a 'wool course' or a 'hand washing course' with a low spin-drying intensity, and decrease the maximum RPM of the washing motor 141 (1050).

[0139] As such, the controller 190 may decrease the maximum RPM of the washing motor 141 for a spin-drying course with a low spin-drying intensity to avoid the resonant band RPM.

[0140] Accordingly, in the case of easily damaged laundry, the washing machine 10 according to an embodiment may reduce vibration while protecting the laundry by reducing the maximum RPM of the washing motor 141.

[0141] Referring to FIG. 11 together, based on determining that the spin-drying intensity of the spin-drying course selected by the user exceeds the predetermined reference value (No in operation 1040), the controller 190 may increase the maximum RPM of the washing motor 141 (1100).

[0142] That is, based on determining that the spin-drying intensity of the spin-drying course selected by the user exceeds the predetermined reference value, the controller 190 may determine that the spin-drying course is an 'intensive washing course' or an 'intensive spin-drying course' with a strong spin-drying intensity, and increase the maximum RPM of the washing motor 141 to avoid the resonant band RPM.

[0143] Accordingly, in the case of laundry that is not easily damaged, the washing machine 10 according to an embodiment may reduce vibration while performing intensive spin-drying by increasing the maximum RPM of the washing motor 141.

[0144] In addition, the controller 190 may start drum acceleration according to the increased maximum RPM of the washing motor 141 (1110). Thereafter, the controller 190 may determine whether a difference between the RPM corresponding to the resonant frequency and a current RPM of the washing motor 141 has reached a predetermined RPM or less (1120).

[0145] That is, in a case where the difference between the resonant band RPM and the current RPM of the washing motor 141 decreases and the RPM of the washing motor 141 is close to the resonant band RPM, vibration will occur significantly, and thus the controller 190 may increase the rotation acceleration of the washing motor 141 to quickly avoid the corresponding RPM (1130).

[0146] As such, the controller 190 may increase the RPM of the washing motor 141 for spin-drying, and when the RPM of the washing motor 141 is close to the resonant band RPM, the controller 190 may increase the rotation acceleration of the washing motor 141 to allow the washing motor to quickly pass through the resonant band RPM.

[0147] Accordingly, the controller 190 may reduce a time for which the drum rotates at the resonant band RPM, thereby reducing the time for which maximum vibration occurs. As a result, the washing machine 10 according to an embodiment may reduce a magnitude and time of the vibration occurring in the washing machine 10, and thus durability of the washing machine 10 may be improved, and user inconvenience may be reduced.

[0148] Meanwhile, the disclosed embodiments may be implemented in the form of a recording medium that stores instructions executable by a computer. The instructions may be stored in the form of program codes, and when executed by a processor, the instructions may create a program module to perform operations of the disclosed embodiments. The recording medium may be implemented as a computer-readable recording medium.

[0149] The computer-readable recording medium may include all kinds of recording media storing instructions that may be interpreted by a computer. For example, the computer-readable recording medium may be a Read Only Memory (ROM), a Random Access Memory (RAM), a magnetic tape, a magnetic disk, a flash memory, an optical data storage device, etc.

[0150] In addition, the computer-readable storage medium may be provided in the form of a non-transitory storage medium. Here, when a storage medium is referred to as "non-transitory", it may be understood that the storage medium is tangible and does not include a signal (e.g., an electromagnetic wave), but rather that data is semi-permanently or temporarily stored in the storage medium. For example, a "non-transitory storage medium" may include a buffer in which data is temporarily stored.

[0151] According to an embodiment, the method according to the various embodiments disclosed herein may be provided in a computer program product. The computer program product may be traded between a seller and a buyer as a product. The computer program product may be distributed in the form of a machine-readable storage medium (e.g., compact disc read only memory (CD-ROM)), or may be distributed (e.g., download or upload) through an application store (e.g., Play Store™) online or directly between two user devices (e.g., smartphones). In the case of online distribution, at least a portion of the computer program product (e.g., downloadable app) may be stored at least semi-permanently or may be temporarily generated in a storage medium, such as a memory of a server of a manufacturer, a server of an application store, or a relay server.

[0152] Although disclosure has been shown and described in relation to specific embodiments, it would be appreciated by those skilled in the art that changes and modifications may be made in these embodiments without departing from the principles and scope of the disclosure, the scope of which is defined in the claims and their equivalents.

Claims

1. A washing machine, comprising:

a frame configured to form an exterior;
a tub installed in the frame;
a drum accommodated in the tub;
a washing motor configured to rotate the drum;
a drain motor configured to drain water from the tub;
a vibration sensor provided in the frame; and
a controller configured to drive the drain motor in a stopped state of the washing motor at a start of a spin-drying process, determine a resonant frequency of the frame based on a vibration value measured by the vibration sensor, and control a revolutions per minute (RPM) of the washing motor to avoid the resonant frequency during the spin-drying process.

2. The washing machine of claim 1, wherein the controller is configured to change the RPM of the washing motor, based on a difference between a maximum RPM of the washing motor and a resonant band RPM in the spin-drying process being less than or equal to a predetermined RPM.

3. The washing machine of claim 1, wherein the controller is configured to change the RPM of the washing motor, based on a predetermined spin-drying intensity in the spin-drying process.

4. The washing machine of claim 3, wherein the controller is configured to reduce a maximum RPM of the washing motor, based on a spin-drying intensity of the spin-drying process being less than or equal to a predetermined reference value.

5. The washing machine of claim 3, wherein the controller is configured to increase a maximum RPM of the washing motor, based on a spin-drying intensity of the spin-drying process being greater than a predetermined reference value.

6. The washing machine of claim 1, wherein the controller is configured to increase acceleration of the washing motor, based on the RPM of the washing motor being increased and a difference from a resonant band RPM reaching a predetermined RPM or less in the spin-drying process.

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

an output interface,
wherein the controller is configured to control the output interface to output a message notifying that a time required for the spin-drying process is changed by controlling the RPM of the washing motor.

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

communication circuitry;
wherein the controller is configured to control the communication circuitry to transmit information notifying that a time required for the spin-drying process is changed by controlling the RPM of the washing motor to an external device.

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

an input interface,
wherein the controller is configured to control the washing motor at an existing RPM, based on a command to stop changing the RPM of the washing motor being input to the input interface.

10. A method for controlling a washing machine, the method comprising:

driving a drain motor configured to drain water from a tub installed in a frame in a stopped state of a washing motor;
measuring a vibration value by a vibration sensor provided in the frame based on the drain motor being driven;
determining a resonant frequency of the frame based on the vibration value; and
controlling a revolutions per minute (RPM) of the washing motor to avoid the resonant frequency.

11. The method of claim 10, wherein the RPM of the washing motor is changed based on a difference between a maximum RPM of the washing motor and a resonant band RPM in the spin-drying process being less than or equal to a predetermined RPM.

12. The method of claim 10, wherein the RPM of the washing motor is changed based on a predetermined spin-drying intensity in the spin-drying process.

13. The method of claim 12, further comprising:
reducing a maximum RPM of the washing motor based on a spin-drying intensity of the spin-drying process being less than or equal to a predetermined reference value.

14. The method of claim 12, further comprising:
increasing a maximum RPM of the washing motor based on a spin-drying intensity of the spin-drying

process being greater than a predetermined reference value.

15. The method of claim 10, further comprising: increasing acceleration of the washing motor, based on the RPM of the washing motor being increased and a difference from a resonant band RPM reaching a predetermined RPM or less in the spin-drying process.

FIG. 1

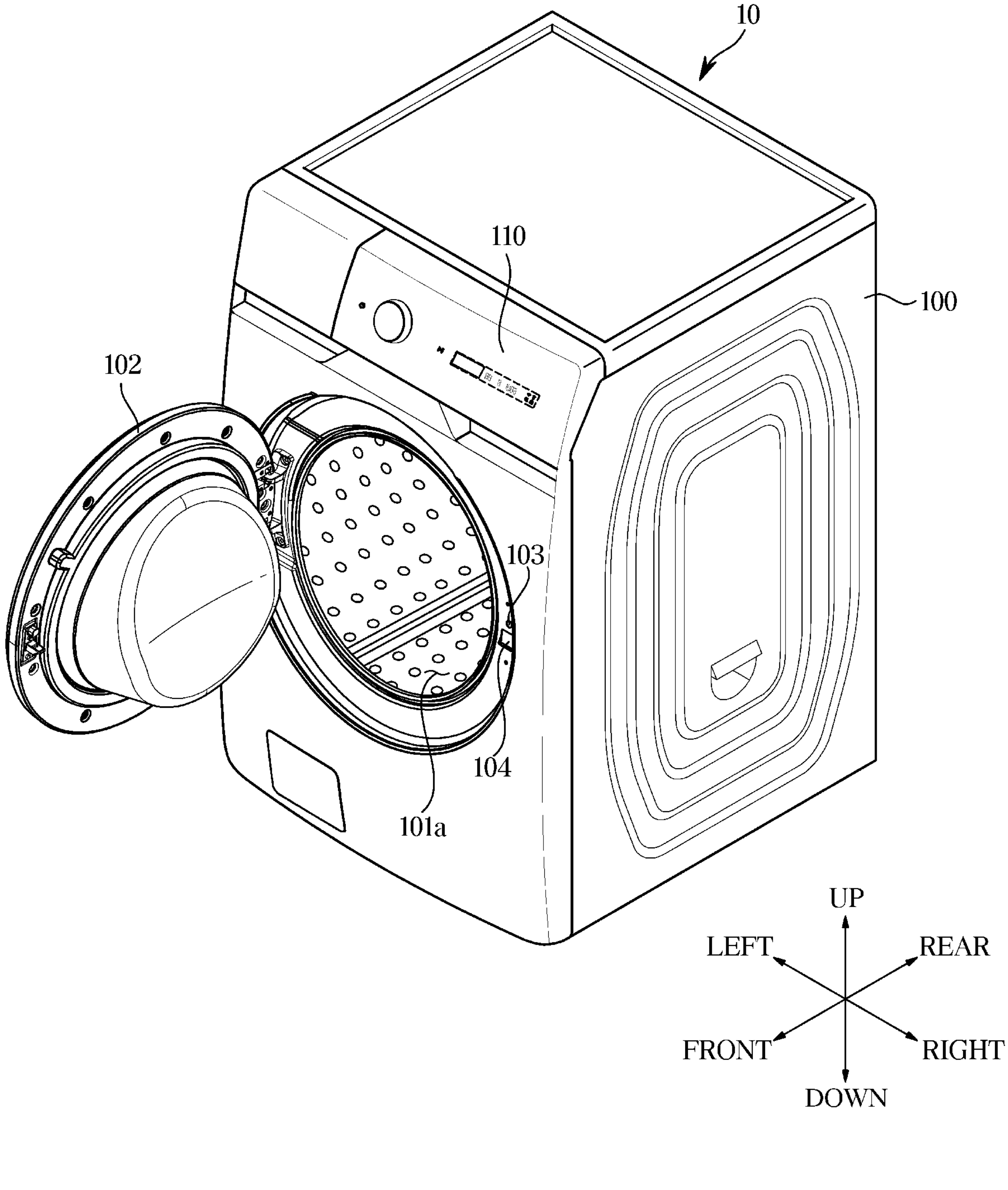


FIG. 2

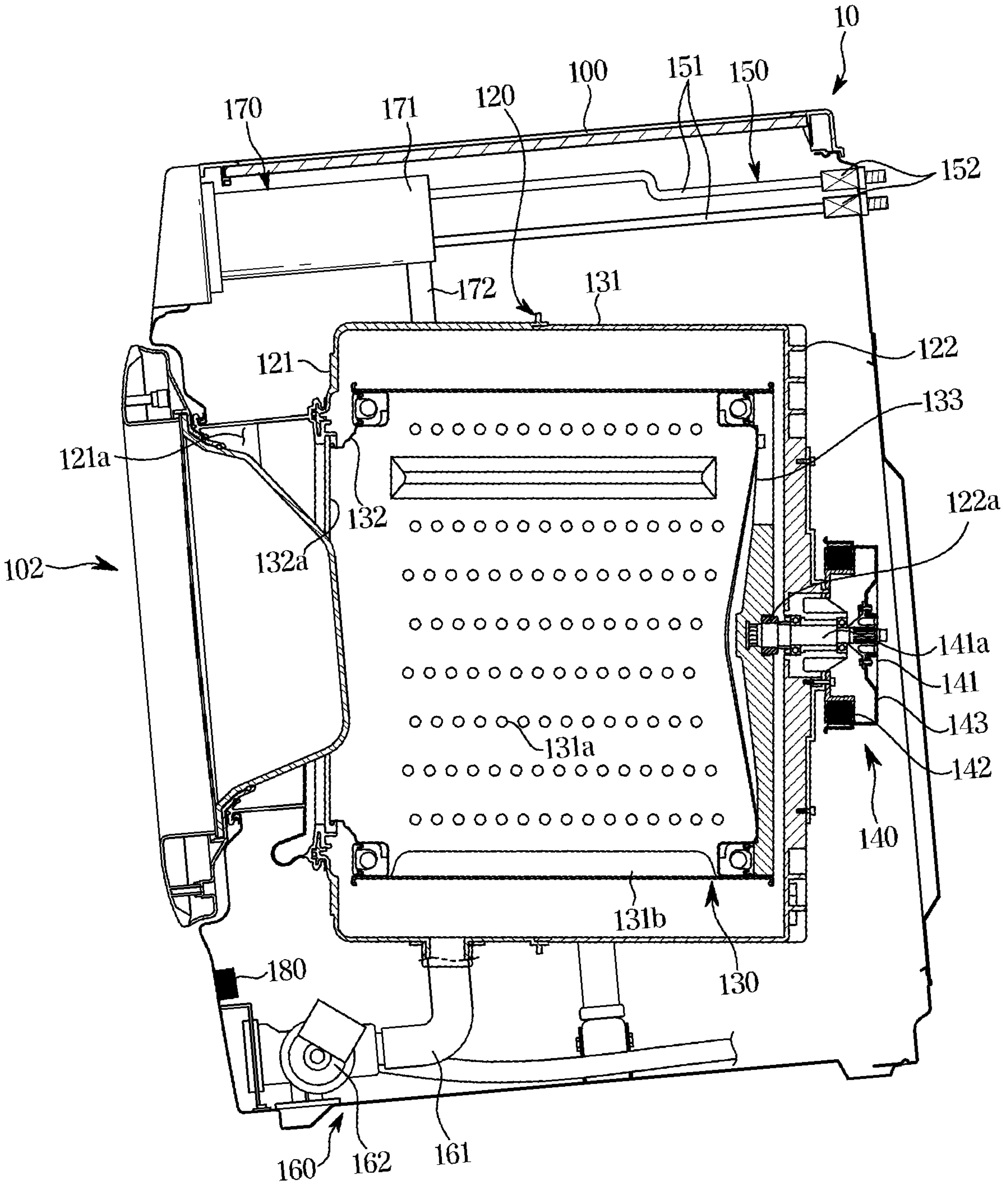
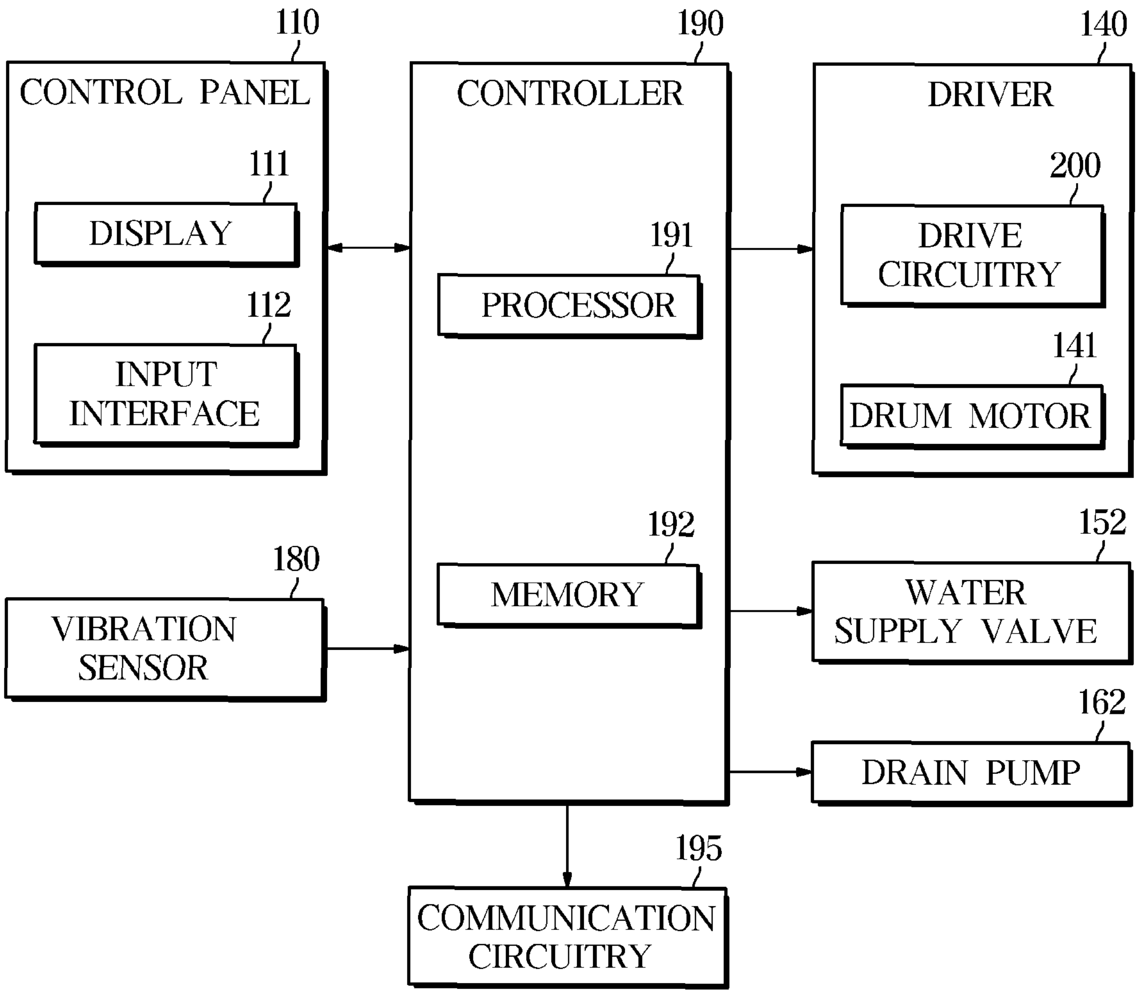

10
100
151
150
170
171
120
152
131
172
122
121
133
121a
132
122a
102
132a
141a
141
143
131a
142
140
131b
180
130
160
162
161

FIG. 3



110
CONTROL PANEL
111
DISPLAY
112
INPUT INTERFACE
190
CONTROLLER
191
PROCESSOR
192
MEMORY
140
DRIVER
200
DRIVE CIRCUITRY
141
DRUM MOTOR
180
VIBRATION SENSOR
152
WATER SUPPLY VALVE
162
DRAIN PUMP
195
COMMUNICATION CIRCUITRY

FIG. 4

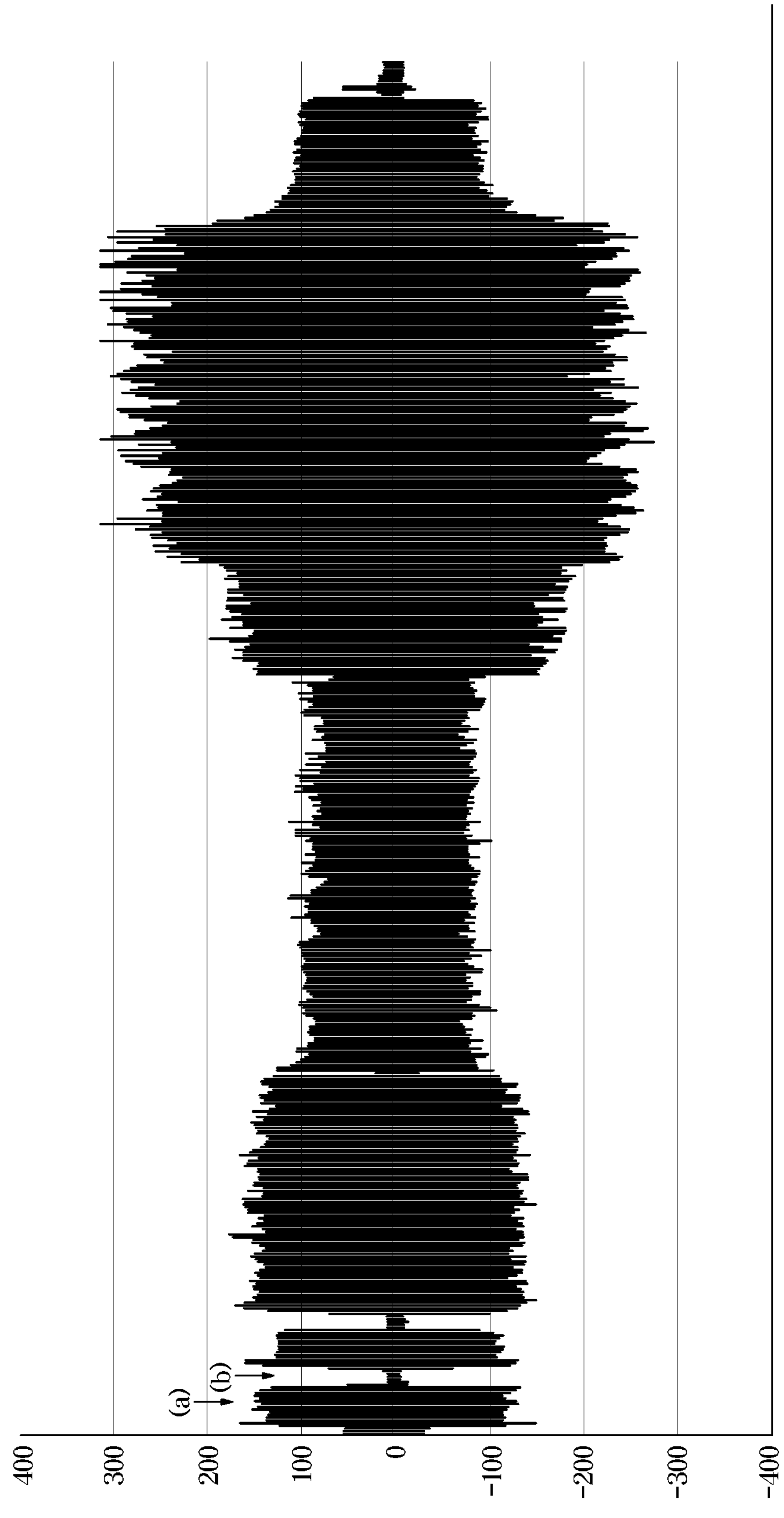


FIG. 5

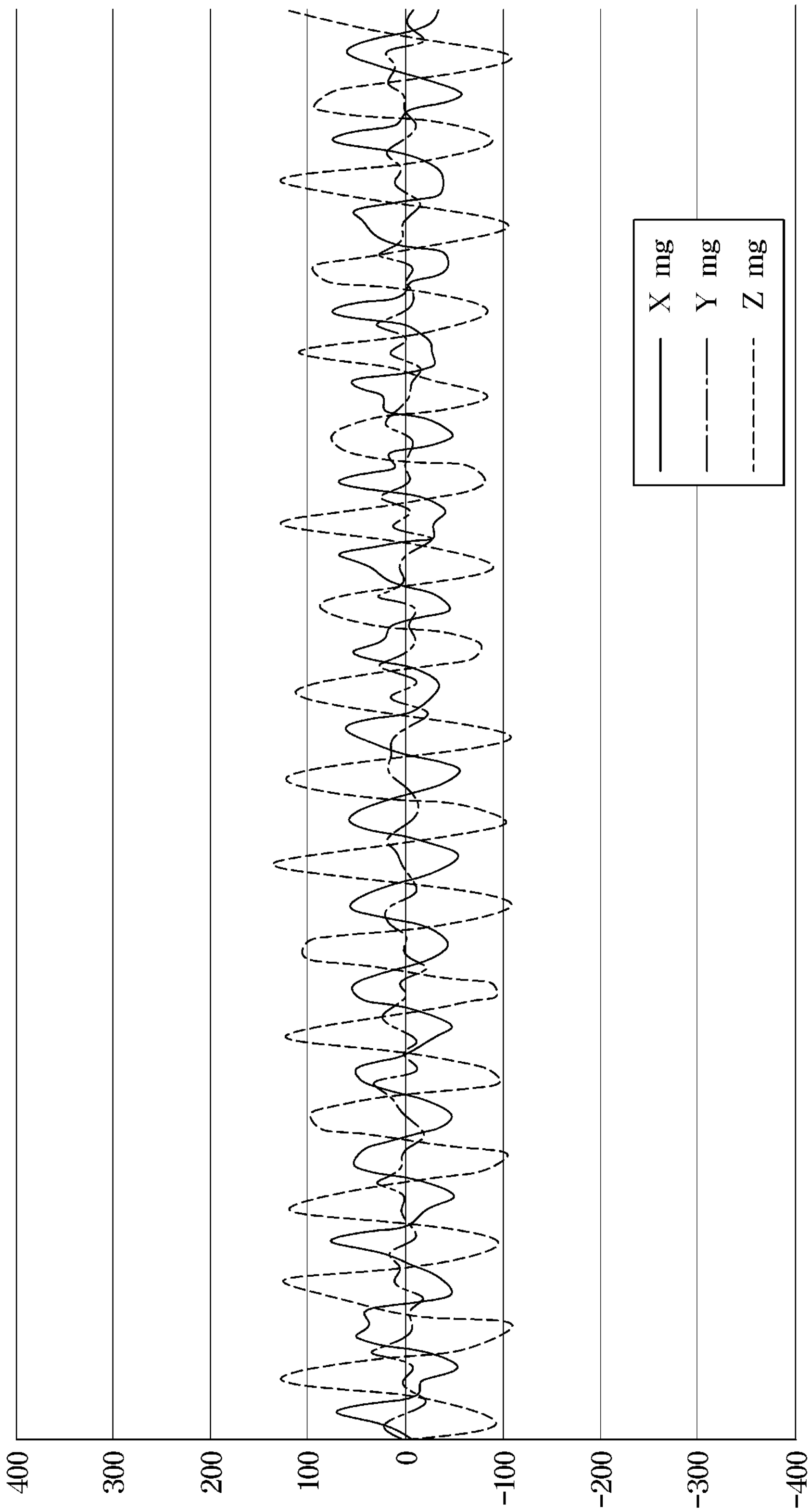


FIG. 6

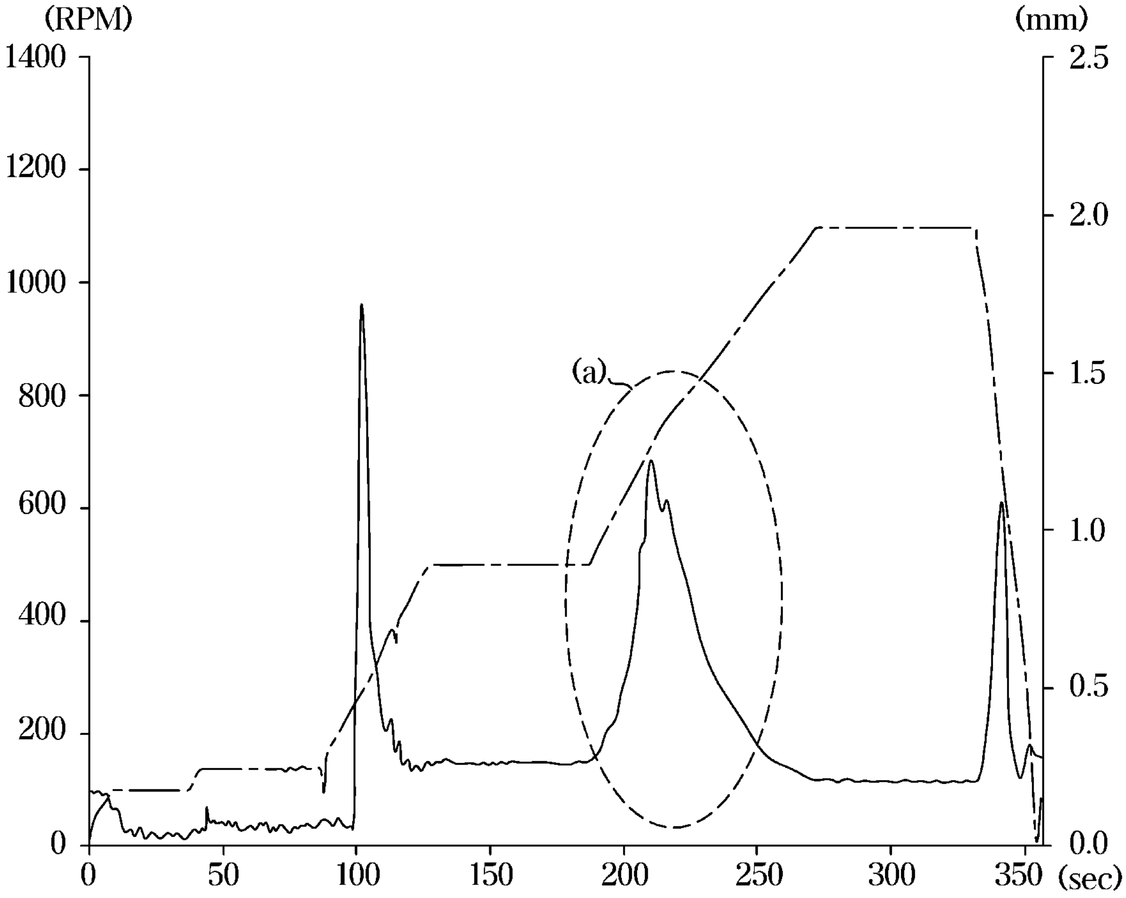

(RPM)
(mm)
1400
1200
1000
800
600
400
200
0
2.5
2.0
1.5
1.0
0.5
0.0
(a)
0
50
100
150
200
250
300
350
(sec)

FIG. 7

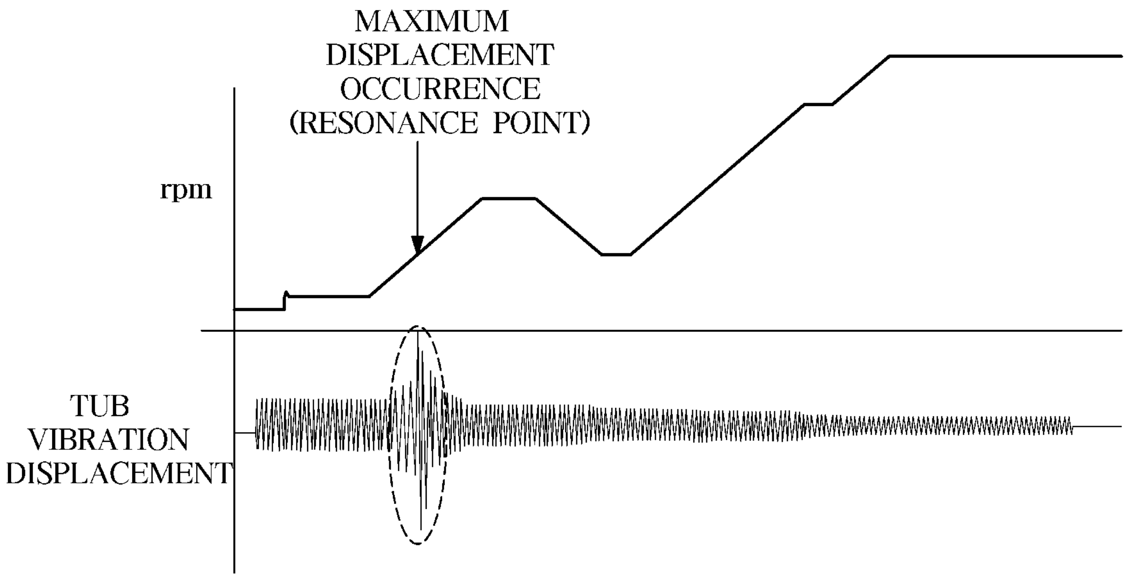

MAXIMUM
DISPLACEMENT
OCCURRENCE
(RESONANCE POINT)
rpm
TUB
VIBRATION
DISPLACEMENT

FIG. 8

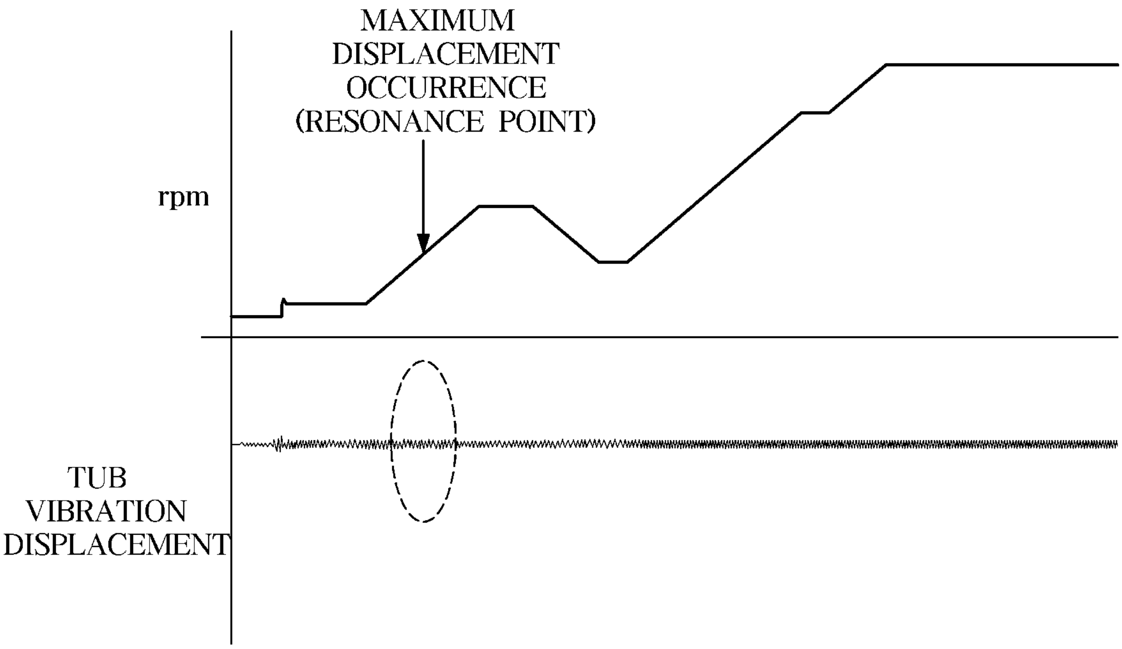

MAXIMUM
DISPLACEMENT
OCCURRENCE
(RESONANCE POINT)
rpm
TUB
VIBRATION
DISPLACEMENT

FIG. 9

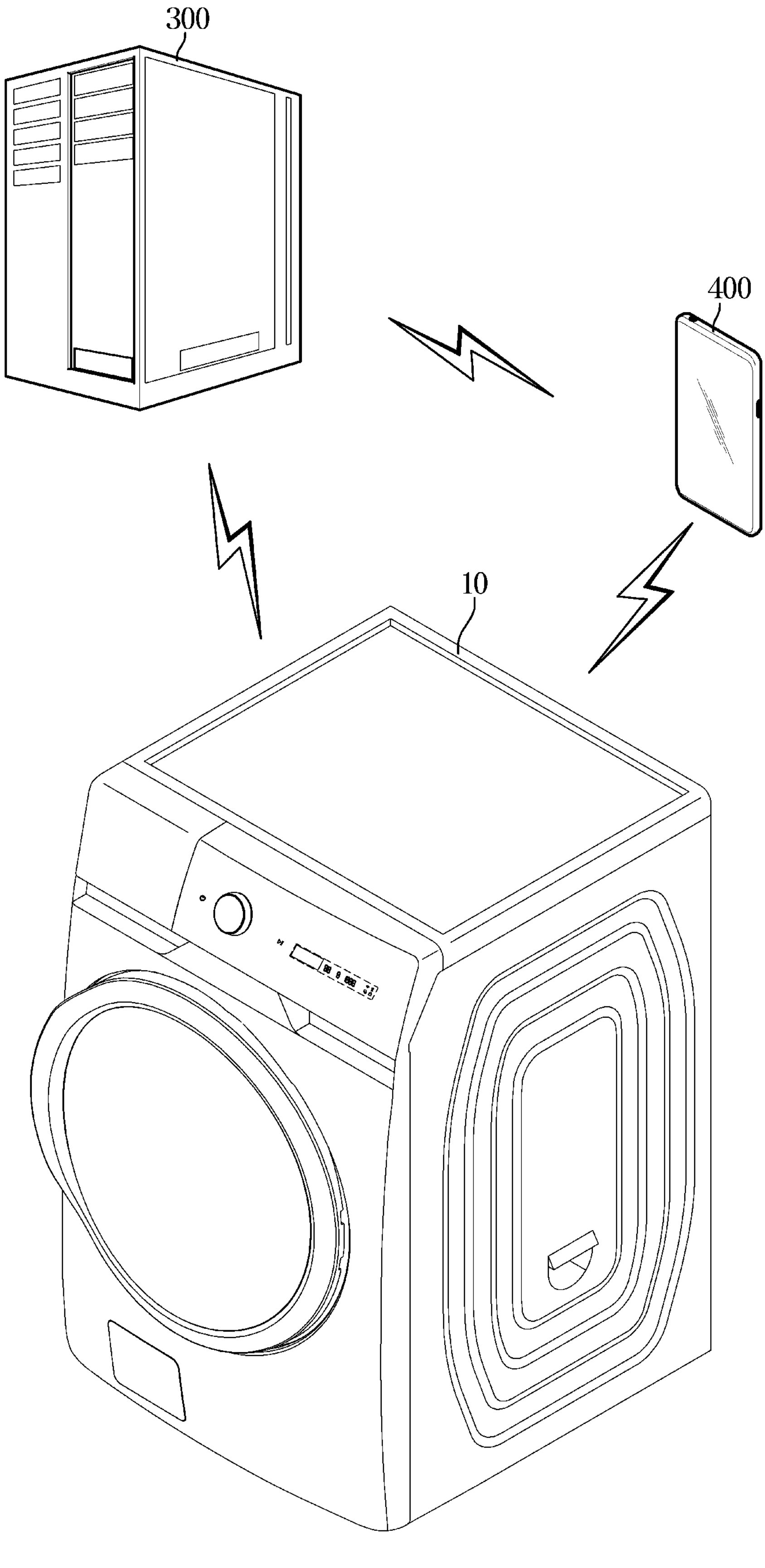


FIG. 10

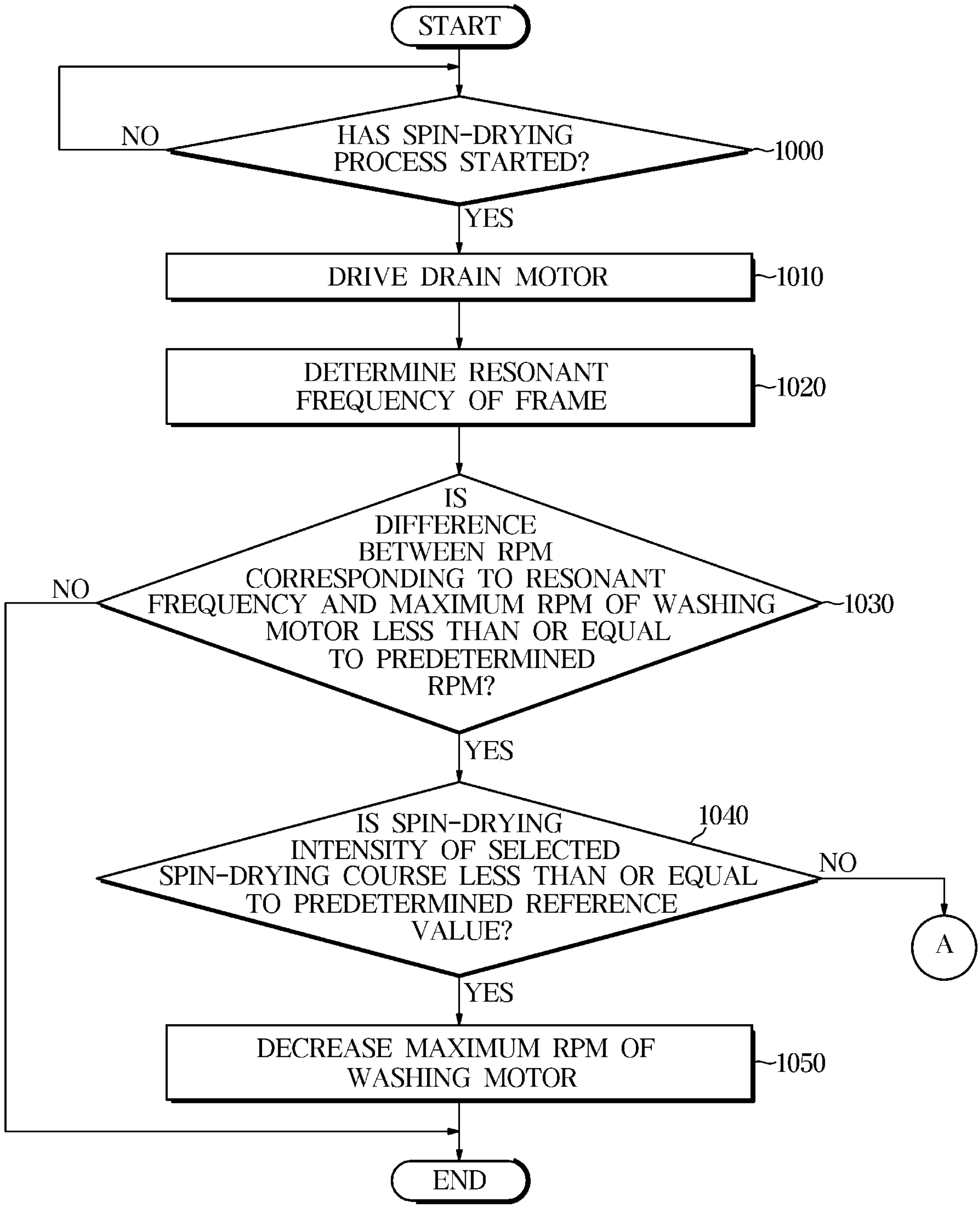
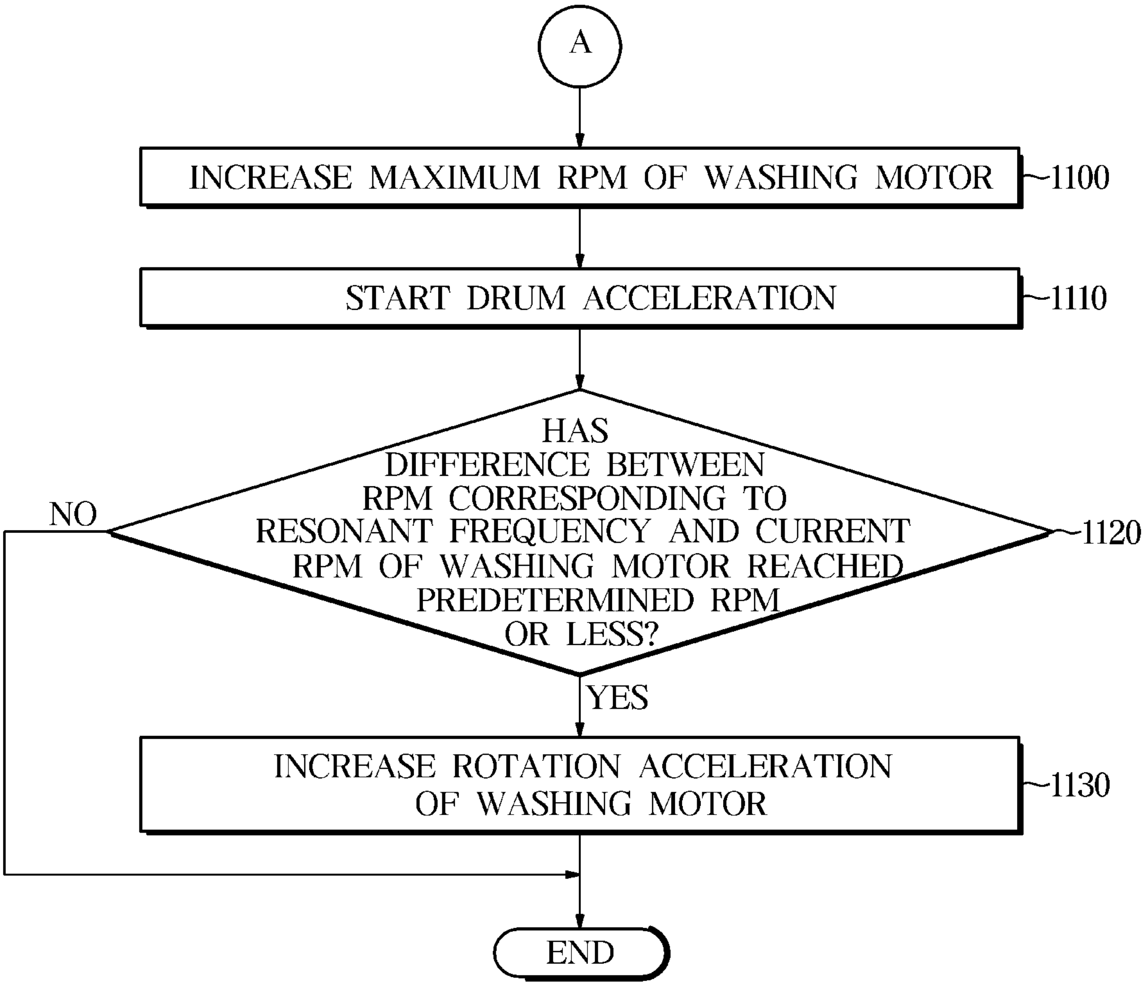

START
HAS SPIN-DRYING PROCESS STARTED?
NO
YES
1000
DRIVE DRAIN MOTOR
1010
DETERMINE RESONANT FREQUENCY OF FRAME
1020
IS DIFFERENCE BETWEEN RPM CORRESPONDING TO RESONANT FREQUENCY AND MAXIMUM RPM OF WASHING MOTOR LESS THAN OR EQUAL TO PREDETERMINED RPM?
NO
YES
1030
IS SPIN-DRYING INTENSITY OF SELECTED SPIN-DRYING COURSE LESS THAN OR EQUAL TO PREDETERMINED REFERENCE VALUE?
1040
NO
A
YES
DECREASE MAXIMUM RPM OF WASHING MOTOR
1050
END

FIG. 11


A
INCREASE MAXIMUM RPM OF WASHING MOTOR
1100
START DRUM ACCELERATION
1110
HAS DIFFERENCE BETWEEN RPM CORRESPONDING TO RESONANT FREQUENCY AND CURRENT RPM OF WASHING MOTOR REACHED PREDETERMINED RPM OR LESS?
1120
NO
YES
INCREASE ROTATION ACCELERATION OF WASHING MOTOR
1130
END

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2023/007135

A. CLASSIFICATION OF SUBJECT MATTER

D06F 37/20(2006.01)i; **D06F 37/22**(2006.01)i; **D06F 39/08**(2006.01)i; **D06F 37/30**(2006.01)i; **D06F 34/16**(2020.01)i; **D06F 33/48**(2020.01)i; **D06F 33/44**(2020.01)i; **D06F 34/30**(2020.01)i; **D06F 34/32**(2020.01)i; **D06F 34/34**(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 37/20(2006.01); D06F 33/02(2006.01); D06F 33/30(2020.01); D06F 34/05(2020.01); D06F 34/18(2020.01); D06F 37/04(2006.01); D06F 58/02(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: 세탁기(washing machine), 프레임(frame), 터브(tub), 드럼(drum), 세탁 모터(washing motor), 배수 모터(drain motor), 진동 센서(vibration sensor), 제어부(control part), 탈수 행정(dehydration course), 공진 주파수(resonance frequency)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2007-236585 A (MATSUSHITA ELECTRIC IND. CO., LTD.) 20 September 2007 (2007-09-20) See abstract, paragraphs [0008]-[0101], claims 5 and 14 and figures 1-21.	1-15
Y	KR 10-2015-0052696 A (SAMSUNG ELECTRONICS CO., LTD.) 14 May 2015 (2015-05-14) See paragraphs [0040]-[0106] and figures 1-7.	1-15
Y	KR 10-2021-0132627 A (SAMSUNG ELECTRONICS CO., LTD.) 04 November 2021 (2021-11-04) See abstract, paragraphs [0041] and [0141] and figure 1.	8
A	KR 10-2020-0030251 A (LG ELECTRONICS INC.) 20 March 2020 (2020-03-20) See claims 1-11 and figures 13-16.	1-15
A	JP 2010-057848 A (PANASONIC CORP.) 18 March 2010 (2010-03-18) See claims 1-2 and figures 1-5.	1-15

☐ 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
19 September 2023	**19 September 2023**

Name and mailing address of the ISA/KR	Authorized officer
Korean Intellectual Property Office **Government Complex-Daejeon Building 4, 189 Cheongsa-ro, Seo-gu, Daejeon 35208**	
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