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(54) **CLOTHES DRYER AND ANTI-ICING DRIVING METHOD**

(57) Various embodiments of the present disclosure relate to a condensing type clothes dryer that predicts the risk of freezing in advance, notifies a user of the risk in advance, and provides driving in a previously prepared, anti-freeze mode according to selection by the user. The clothes dryer for this purpose may comprise: a temperature acquisition unit for acquiring a temperature value; a drum configured to accommodate an object to be dried; a passage configured to guide air discharged from the inside of the drum to the outside of the drum, and then to be introduced back into the drum; a heat pump system configured to heat the air that is to be introduced back into the inside of the drum, and including a compressor, a condenser, an expansion valve, and an evaporator, through which a refrigerant circulates; and a controller. The controller may control, in response to receiving, from the user, a command for an anti-freeze mode operation, the clothes dryer such that a heating operation in which after the compressor is driven for a first period of time, the compressor is stopped for a second period of time is repeatedly performed for a plurality of times.

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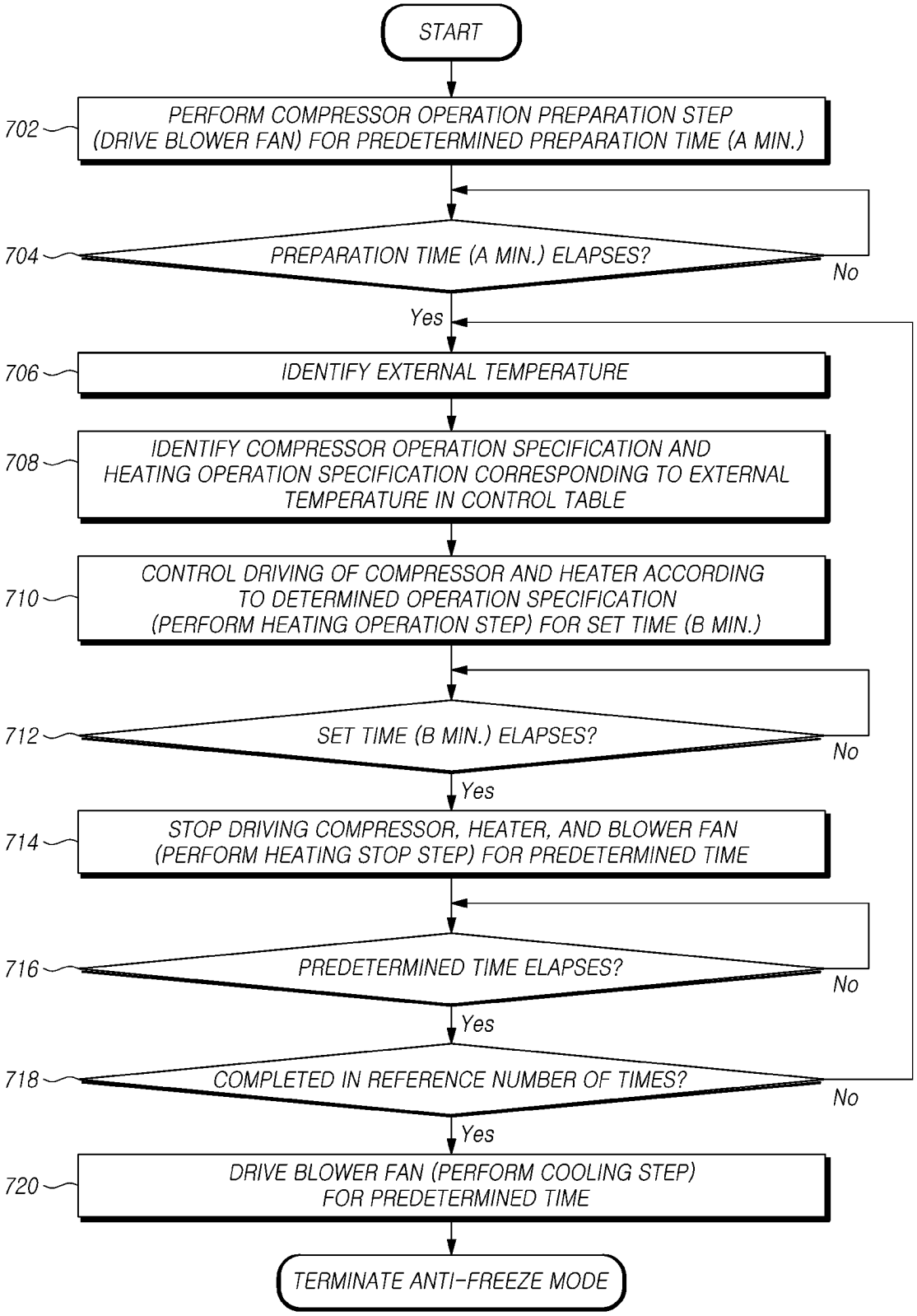
FIG. 7


START
702
PERFORM COMPRESSOR OPERATION PREPARATION STEP (DRIVE BLOWER FAN) FOR PREDETERMINED PREPARATION TIME (A MIN.)
704
PREPARATION TIME (A MIN.) ELAPSES?
No
Yes
706
IDENTIFY EXTERNAL TEMPERATURE
708
IDENTIFY COMPRESSOR OPERATION SPECIFICATION AND HEATING OPERATION SPECIFICATION CORRESPONDING TO EXTERNAL TEMPERATURE IN CONTROL TABLE
710
CONTROL DRIVING OF COMPRESSOR AND HEATER ACCORDING TO DETERMINED OPERATION SPECIFICATION (PERFORM HEATING OPERATION STEP) FOR SET TIME (B MIN.)
712
SET TIME (B MIN.) ELAPSES?
No
Yes
714
STOP DRIVING COMPRESSOR, HEATER, AND BLOWER FAN (PERFORM HEATING STOP STEP) FOR PREDETERMINED TIME
716
PREDETERMINED TIME ELAPSES?
No
Yes
718
COMPLETED IN REFERENCE NUMBER OF TIMES?
No
Yes
720
DRIVE BLOWER FAN (PERFORM COOLING STEP) FOR PREDETERMINED TIME
TERMINATE ANTI-FREEZE MODE

Description

[Technical Field]

[0001] The disclosure relates to a clothes dryer and, more specifically, to a clothes dryer that predicts a risk of freezing and informs the user of the risk, and provides driving in a prepared anti-freeze driving mode according to the user's selection and a method for controlling the same.

[Background Art]

[0002] A clothes dryer is a device for drying objects by supplying hot air into a drum containing the objects made of various materials, which may include clothes, towels, and blankets, while rotating the drum at low speed. Typically, clothes dryers may be categorized into exhausting type dryers that directly discharge the humid air from the drum to the outside after heat exchange with the drying objects in the drum and circulating (or condensing) dryers that dehumidify and heat the humid air from the drum to circulate back into the drum, rather than directly discharging the humid air to the outside. The condensing dryers have a heat pump system composed of a compressor, a condenser, an expansion valve, and an evaporator, and is configured to circulate refrigerant among them. In the condensing dryer, the humid air discharged from the drum is heat exchanged (and dehumidified) through contact to the evaporator of the heat pump system and is heated through the condenser, and the resultant hot, dry air is introduced back into the drum. Condensate from the air builds up on the surface of the evaporator during the heat exchange process. The condensate on the surface of the evaporator accumulates on the bottom of the base and then moves to the pump chamber, and the pump operates to discharge the condensate accumulated in the pump chamber to the outside at regular periods or based on a predetermined water level.

[Detailed Description of the Invention]

[Technical Problem]

[0003] In a condensing dryer, if the external temperature of the space where the dryer is installed is decreased, the condensate remaining inside the dryer may freeze, and the frozen condensate may disturb the operation of the dryer. For example, the freezing of the condensate remaining on the surface of the evaporator deteriorates the rate of heat exchange with the air discharged from the drum. For example, freezing of the condensate remaining in the hose inside the clothes dryer deteriorates smooth drainage. For example, freezing of the condensate remaining in the pump chamber constrains the impeller of the pump, impeding the operation of the pump and turning the clothes dryer into a drain failure detection state without the condensate being discharged from the pump chamber. There are a variety of methods that have been tried to de-ice clothes dryers, all of which are reactive and require significant time and effort to remove the ice, causing user inconvenience. In addition, many of the methods that are commonly tried to remove ice, such as pouring hot water into the pump chamber, are likely to cause accidents or even failure of the clothes dryer.

[0004] An aspect of the disclosure is to provide a clothes dryer that may be driven in an anti-freeze mode for preventing freezing when there is a risk of freezing and may effectively prevent freezing while minimizing noise or power consumption occurring as the dryer runs, and an anti-freeze mode driving method.

[0005] Another aspect of the disclosure is to provide a clothes dryer that may predict a risk of freezing, inform the user of the risk, and operate in a prepared anti-freeze mode according to the user's selection.

[Technical Solution]

[0006] According to an aspect of the disclosure, a clothes dryer may comprise a temperature acquisition unit configured to obtain a temperature value, a drum configured to accommodate an object to be dried, a flow passage configured to guide air discharged from an inside of the drum to an outside of the drum, and then to be introduced back into the inside of the drum, a heat pump system configured to heat the air that is to be introduced back into the inside of the drum, and the heat pump system including a compressor, a condenser, an expansion valve, and an evaporator through which a refrigerant circulates, and a controller. The controller is configured to. , in response to receiving a command from a user for an anti-freeze mode operation, control the clothes dryer to repeatedly perform a heating operation for a plurality of times. In the heating operation, after the compressor is driven for a first period of time, the compressor is stopped for a second period of time.

[0007] According to another aspect of the disclosure, a method for performing an anti-freeze operation in a clothes dryer, the clothes dryer including a temperature sensor, a drum, a blower fan configured to cause air to move inside and outside the drum, a motor configured to rotate the blower fan, a heat pump including a compressor, and a heater configured to heat the air that is introduced into the drum, may comprise repeating a heating operation for a plurality of times. The heating operation may include driving the motor, the compressor, and the heater for a first period of time based on an operation specification determined according to a temperature measured by the temperature sensor, and stopping the motor, the compressor, and the heater for a second period of time., The method may include performing a cooling operation in which the motor is driven for a third period of time with the compressor and the heater stopped.

[0008] The clothes dryer according to various embodiments of the disclosure may maintain its internal tem-

perature not to decrease to the freezing temperature by driving in the anti-freeze mode although the external temperature is decreased, thereby allowing the user to conveniently use the clothes dryer anytime when he/she desires to dry clothes without inconveniences due to freezing. The clothes dryer and anti-freeze driving method according to various embodiments of the disclosure may minimize the driving of the motor, compressor, and heater within a range of bringing about an anti-freeze effect, thereby preventing excessive waste of power for anti-freeze purposes and excessive noise. The clothes dryer according to various embodiments of the disclosure may predict a risk of freezing when the external temperature decreases and inform the user of the risk, thereby allowing the user to be aware of the risk of freezing and take appropriate proactive measures.

[0009] Effects of the present invention are not limited to the foregoing, and other unmentioned effects would be apparent to one of ordinary skill in the art from the following description. In other words, unintended effects in practicing embodiments of the disclosure may also be derived by one of ordinary skill in the art from the embodiments of the disclosure.

[Brief Description of the Drawings]

[0010]

FIG. 1 is a perspective view illustrating an outer appearance of a condensing clothes dryer 100 according to an embodiment of the disclosure;

FIG. 2 is a side cross-sectional view illustrating the condensing clothes dryer of FIG. 1;

FIG. 3 is a view conceptually illustrating an air circulation path of air circulating inside and outside the drum of the condensing clothes dryer of FIG. 1 and a refrigerant circulation path of the heat pump system;

FIG. 4 is a functional block diagram schematically illustrating operation functions of the condensing clothes dryer of FIG. 1 according to an embodiment of the disclosure;

FIG. 5 is a flowchart schematically illustrating an overall process in which a condensing clothes dryer predicts a risk of freezing and performs an operation corresponding thereto under the control of the controller of FIG. 4 according to an embodiment of the disclosure;

FIG. 6 illustrates an example of a notification displayed on a user equipment (UE) when a freezing risk prediction message generated by the controller of FIG. 4 is provided to the UE according to an embodiment of the disclosure;

FIG. 7 is a flowchart illustrating a process of performing an operation in an anti-freeze mode according to an embodiment of the disclosure;

FIG. 8 illustrates a time table showing each step of a process of performing an operation in an anti-freeze mode according to FIG. 7;

FIG. 9 is a view illustrating changes in power consumption over time when an operation in an anti-freeze mode is performed on a condensing clothes dryer according to an embodiment of the disclosure;

FIG. 10 is a view schematically illustrating changes, over time, in temperature of each component of a condensing clothes dryer in an initial time when an operation in an anti-freeze mode is performed on a condensing clothes dryer according to an embodiment of the disclosure; and

FIG. 11 is a view schematically illustrating changes, over time, in temperature of each component of a clothes dryer in an initial time of operation when an operation in an anti-freeze mode according to an embodiment of the disclosure is performed through driving of a heater and a compressor of a heat pump system and when the operation in the anti-freeze mode is performed by driving only the compressor of the heat pump system.

[Mode for Carrying out the Invention]

[0011] Embodiments of the present invention are now described with reference to the accompanying drawings in such a detailed manner as to be easily practiced by one of ordinary skill in the art. However, the disclosure may be implemented in other various forms and is not limited to the embodiments set forth herein. The same or similar reference denotations may be used to refer to the same or similar elements throughout the specification and the drawings. Further, for clarity and brevity, no description is made of well-known functions and configurations in the drawings and relevant descriptions.

[0012] FIG. 1 is a perspective view illustrating an outer appearance of a condensing clothes dryer according to an embodiment of the disclosure. FIG. 2 is a side cross-sectional view illustrating the condensing clothes dryer of FIG. 1.

[0013] Referring to FIGS. 1 and 2, a condensing clothes dryer 100 according to an embodiment of the disclosure may include a housing 110 forming an outer appearance, a drum 120 rotatably disposed in the housing 110 and configured to accommodate an object to be dried, a drum driver 130 driving the drum 120 to rotate, an air circulation flow passage 140 guiding air discharged from an inside of the drum 120 back to be introduced back into the inside of the drum 120, and a heat pump system 150 removing moisture from the air passing through the air circulation flow passage 140 and applying heat.

[0014] According to an embodiment of the disclosure, the housing 110 may have a substantially hexahedral shape, but the disclosure is not limited thereto. According to various embodiments of the disclosure, the housing 110 may include a base plate 111, a front cover 112, a top cover 113, and a side/rear cover 114. According to various embodiments of the disclosure, the front cover

112 may include an opening (not shown) formed in the center. A door 115 may be rotatably installed on the front cover 112 in a position corresponding to the opening. According to various embodiments of the disclosure, the opening on the front cover 112 may be opened or closed by opening and closing the door 115.

[0015] According to various embodiments of the disclosure, an input unit 117 for receiving control inputs from the user and a display 118 for displaying a screen for guiding the user's input or various pieces of information regarding the operation of the dryer 100 may be disposed at the upper end of the front cover 112 of the housing 110. According to an embodiment of the disclosure, as shown in FIG. 1, the input unit 117 may include at least one input unit among a j og shuttle or dial-type input unit 117a, which may be gripped and rotated by the user, and a touch pad or key/button-type input unit 117b, but the disclosure is not limited thereto. According to an embodiment of the disclosure, a selection of anti-freeze mode and an operation start/stop command may be received from the user through the input unit 117. According to an embodiment of the disclosure, the display 118 may include various types of display panels, such as an LCD, LED, OLED, QLED or micro LED, and have a touch pad on the front surface thereof to be implemented as a touchscreen, but the disclosure is not limited to a specific type of display. According to various embodiments of the disclosure, operation states and user manipulation states of the clothes dryer 100 may be displayed through the display 118. According to various embodiments, a risk of freezing may be made known through the display 118, and a message inquiring about the operation in anti-freeze mode may be displayed through the display 118.

[0016] According to an embodiment of the disclosure, a temperature sensor 119 may be disposed near the display 118 at an upper end of the front cover 112 of the housing 110. According to an embodiment of the disclosure, the temperature sensor 119 may detect the temperature of the surrounding external air of the condensing clothes dryer 110 and transfer the detected temperature to a controller (see FIG. 4) described below. In the drawings and the related descriptions, the temperature sensor 119 for measuring the external temperature is illustrated and described as being disposed next to the display 118 at an upper end of the front cover 112 of the housing 110, but the disclosure is not limited thereto. According to another embodiment of the disclosure, the temperature sensor 119 may be disposed at any other positions appropriate for measuring the external temperature, e.g., at any position on the front cover 112, top cover 113, or side/rear cover 114 of the housing 110.

[0017] According to various embodiments of the disclosure, the drum 120 may have a cylindrical shape with open front and rear surfaces and horizontally disposed. According to various embodiments of the disclosure, the front surface and rear surface of the drum 120 may be rotatably supported by a front panel 121 and a rear panel 122, respectively, fixed to the housing 110. According to various embodiments of the disclosure, an open part 123 may be formed in positions corresponding to the above-described door 115 and opening (not shown) in the front cover 112, in the center of the front panel 121. According to various embodiments of the disclosure, the opening of the front cover 112 and the open part 123 on the front panel 121 may be opened and closed together by opening and closing the above-described door 115. According to various embodiments of the disclosure, when the opening in the front cover 112 and the open part 123 are opened, the item to be dried may be put into the inside of the drum 120 or the drying item may be removed from the inside of the drum 120.

[0018] According to various embodiments of the disclosure, an exhaust port 124 may be formed on a lower side of the front panel 121. According to various embodiments of the disclosure, air from the inside of the drum 120 may be discharged to the outside through the exhaust port 124. According to various embodiments of the disclosure, a drum discharge temperature sensor 127 may be disposed near the exhaust port 124 to measure the temperature of the air discharged from inside the drum 120, but the disclosure is not limited thereto. In the drawings, the drum discharge temperature sensor 127 is illustrates as being disposed near the exhaust port 124 on the front duct 144 described below, but the disclosure is not limited thereto. According to another embodiment of the disclosure, the drum discharge temperature sensor 127 may be disposed at any position near the exhaust port 124 inside or outside the drum 120 to be able to measure the temperature of the air discharged from the drum 120.

[0019] According to various embodiments of the disclosure, on the rear panel 122 supporting the rear surface of the drum 120, a hot air inlet 125 for allowing hot dry air to flow into the drum 120 may be formed. According to various embodiments of the disclosure, high-temperature dry air may be introduced into the drum 120 from the air circulation flow passage 140, which is described below, through the hot air inlet 125.

[0020] According to various embodiments of the disclosure, the drum 120 may include a plurality of lifters 126 protruding on the inner circumferential surface as shown in FIG. 2. According to various embodiments of the disclosure, the lifters 126 on the inner circumferential surface of the drum 120 may lift the drying item to elevate and drop the drying item while the drying process proceeds while the drum 120 rotates, thereby allowing the drying item to be evenly dried on several surfaces thereof. According to various embodiments of the disclosure, a roller 128 may be provided on the outer circumferential surface of the drum 120 to support the drum 120 to smoothly rotate, but the disclosure is not limited thereto.

[0021] According to various embodiments of the disclosure, the drum driver 130 may include a driving motor 131 disposed under the drum 120 inside the housing 110 and a driving pulley 132 connected to the driving motor 131 and receiving power from the driving motor 131 to

rotate. According to various embodiments of the disclosure, the drum driver 130 may include a belt 133 to rotate the drum 120 while being rotated by the rotation of the driving pulley 132. According to various embodiments of the disclosure, the belt 133 may be installed to surround the outer circumferential surface of the driving pulley 132 and the outer circumferential surface of the drum 120 and, as the driving pulley 132 is rotated as the driving motor 131 is driven, the drum 120 may be rotated. According to various embodiments of the disclosure, the drum 120 may be rotated clockwise and/or counterclockwise as the driving motor 131 is driven.

[0022] According to various embodiments of the disclosure, the air circulation flow passage 140 may include a blower fan 141 disposed on the air circulation flow passage 140 to circulate air through the air circulation flow passage 140 and a blower fan case 142 to receive the blower fan 141. According to various embodiments of the disclosure, the air circulation flow passage 140 may include the front duct 144 connecting the exhaust port 124 on the side of the front panel 121 of the drum 120 and the blower fan 141, and a rear duct 145 connecting the downstream portion of the blower fan 141 to the hot air inlet 125 on the rear panel 122 of the drum 120.

[0023] According to an embodiment of the disclosure, as shown in FIG. 2, the blower fan 141 may be connected to the driving motor 131 for driving the drum 120 to be rotated by the rotation of the driving motor 131, but the disclosure is not limited thereto. According to another embodiment of the disclosure, a separate motor (not shown) may further be provided in the housing 110 to drive the blower fan 141. According to various embodiments of the disclosure, by the air flow generated by the rotation of the blower fan 141, the air from the inside of the drum 120 may be discharged to the outside through the exhaust port 124, pass through the air circulation flow passage 140, and be introduced back into the inside of the drum 120 through the hot air inlet 125.

[0024] According to various embodiments of the disclosure, a filter 146 may be disposed on the front duct 144 of the air circulation flow passage 140. According to an embodiment of the disclosure, the filter 146 may filter foreign bodies in the air discharged through the exhaust port 124 from the inside of the drum 120, e.g., dust or lint from the drying item inside the drum 120. According to various embodiments of the disclosure, at least a portion of the heat pump system 150 described below and a heater 146 may be disposed on the rear duct 145 of the air circulation flow passage 140.

[0025] According to an embodiment of the disclosure, the heat pump system 150 may dehumidify and heat the air circulating through the air circulation flow passage 140, particularly the rear duct 145, into a hot dry state. According to various embodiments of the disclosure, the heat pump system 150 may include a compressor (156 of FIG. 3), a condenser 152, an expansion valve (158 of FIG. 3), and an evaporator 154, and the refrigerant may sequentially circulate between the components. According to various embodiments of the disclosure, some of the components of the heat pump system 150, e.g., the evaporator 154 and the condenser 152, may be received on the air circulation flow passage 140. According to various embodiments of the disclosure, the humid air discharged from the inside of the drum 120 and introduced into the front duct 144 may be cooled through contact with the evaporator 154 on the air circulation flow passage 140 and, during the cooling process, moisture may be removed from the air, forming condensate around the evaporator 154. According to various embodiments of the disclosure, the air cooled through contact with the evaporator 154 may be heated through contact with the condenser 152 on the air circulation flow passage 140 into a high-temperature and dry state.

[0026] According to various embodiments of the disclosure, as shown in FIG. 2, the heater 146 may be disposed downstream of the above-described heat pump system 150, particularly the evaporator 154 and the condenser 152, on the rear duct 145. According to various embodiments of the disclosure, the heater 146 may further heat the air heated by the condenser 152. According to various embodiments of the disclosure, it is possible to more quickly increase the temperature of the air supplied to the drum 120 by assisting the condenser 152 in further heating the air by the heater 146.

[0027] FIG. 3 is a view conceptually illustrating an air circulation path of air circulating inside and outside the drum 120 of the condensing clothes dryer 100 of FIG. 1 and a refrigerant circulation path of the heat pump system 150. Referring to FIG. 3, the air circulation path (shown in a solid line) shows the flow of air between the drum 120 and the air circulation flow passage 140 described above in connection with FIG. 2. The refrigerant circulation path (indicated by a dashed line) shown in FIG. 3 shows a refrigerant flow between the components of the heat pump system 150 described above in connection with FIG. 2.

[0028] According to various embodiments of the disclosure, the compressor 156 may compress a gaseous refrigerant into a high-temperature and high-pressure state and discharge the compressed high-temperature and high-pressure refrigerant. For example, according to an embodiment of the disclosure, the compressor 156 may compress the refrigerant through reciprocation of the piston or rotation of the rotator, but the disclosure is not limited thereto. According to various embodiments of the disclosure, the refrigerant discharged from the compressor 156 may pass through the refrigerant temperature sensor 159 and the temperature may be measured by the refrigerant temperature sensor 159. According to various embodiments of the disclosure, the refrigerant discharged from the compressor 156 may be transferred to the condenser 152. According to various embodiments of the disclosure, the condenser 152 may condense the compressed gaseous refrigerant into liquid, while discharging heat to the outside. According to various embodiments of the disclosure, the liquid refrigerant con-

densed by the condenser 152 may be transferred to the expansion valve 158. According to various embodiments of the disclosure, the expansion valve 158 may expand the high-temperature and high-pressure liquid refrigerant condensed in the condenser 152 into a low-pressure liquid refrigerant. According to various embodiments of the disclosure, the evaporator 154 may evaporate the liquid refrigerant expanded through the expansion valve 158, and the resultant low-temperature and low-pressure gas refrigerant may be returned to the compressor 156. According to various embodiments of the disclosure, the evaporator 154 may absorb heat from the surroundings through an evaporation process of changing the low-pressure liquid refrigerant into a gaseous refrigerant. In short, as shown in FIG. 3, in the heat pump system 150, the refrigerant may circulate in the order of the compressor 156, the condenser 152, the expansion valve 158, and the evaporator 154.

[0029] According to various embodiments of the disclosure, as described above, humid air may be discharged from the drum 120 (e.g., through the exhaust port 124 shown in FIG. 2). According to various embodiments of the disclosure, the humid air discharged from the drum 120 may pass through the blower fan 141 and then contact the evaporator 154 of the heat pump system 150 as shown in FIG. 3. According to various embodiments of the disclosure, the evaporator 154 may absorb the heat from the surroundings through the evaporation process of the refrigerant and cool the ambient air as described above. Accordingly, if the air around the evaporator 154 is cooled down to the dew point or less, the moisture in the air may condense on the surface of the evaporator 154, ridding the air of moisture. According to various embodiments of the disclosure, water (condensate) condensed on the surface of the evaporator 154 may be collected in a water tray container (not shown) provided under the evaporator 154. The water collected in the water tray container may be moved to a separate reservoir, e.g., the pump chamber, to be drained outside of the clothes dryer 100.

[0030] According to various embodiments of the disclosure, the air dehumidified and cooled through contact to the evaporator 154 may be heated through contact to the condenser 152 as described above. According to various embodiments of the disclosure, as described above, the condenser 152 may discharge heat in the process of condensing the compressed gaseous refrigerant into liquid, and the ambient air may be heated by the discharged heat. According to various embodiments of the disclosure, the air heated through the condenser 152 may be moved to the drum 120 and be further heated by the heater 146 as shown in FIG. 3. According to various embodiments of the disclosure, as described above, the air which is dehumidified and heated into a high-temperature dry state through the evaporator 154 and the condenser 152 and the heater 146 of the heat pump system 150 may be introduced back into the drum 120 (through the hot air inlet 125 in FIG. 2), drying the drying item inside the drum 120.

[0031] FIG. 4 is a functional block diagram schematically illustrating operation functions of the clothes dryer 100 of FIG. 1 according to an embodiment of the disclosure. For convenience of description, the description taken in conjunction with the drawings may focus primarily on components necessary to understand operational functions according to an embodiment of the disclosure, with the other functions omitted. According to an embodiment of the disclosure, as shown in FIG. 4, a condensing clothes dryer 100 may include a temperature sensor 119 measuring the temperature of external air surrounding the dryer 100, an input unit 117 receiving a control command from the user, a communication unit 410 supporting communication with an external user equipment (UE) and/or an external data server through an external communication network according to a wired/wireless scheme, the driving motor 131 driving rotation of the drum 120 and the blower fan 141, the compressor 156 of the heat pump system 150, the refrigerant temperature sensor 159 measuring the temperature of the refrigerant discharged from the compressor 156, the heater 146 disposed on the rear duct 145 of the air circulation path 140 to heat the air to be supplied to the inside of the drum 120, a controller 420 controlling the overall operation of each component of the condensing clothes dryer 100, a control table 430 storing various information necessary to control the condensing clothes dryer 100, and the display 118 displaying information regarding various statuses of the clothes dryer 100.

[0032] According to an embodiment of the disclosure, the temperature sensor 119 may measure the temperature of the external air surrounding the clothes dryer 100. According to an embodiment of the disclosure, as described above in connection with FIG. 1, the temperature sensor 119 may be disposed on one side of an upper end of the front cover 112 of the condensing clothes dryer 100, but the disclosure is not limited thereto. According to another embodiment of the disclosure, the temperature sensor 119 may be disposed at any position appropriate for measuring the external temperature. According to an embodiment of the disclosure, the temperature measured by the temperature sensor 119 may be continuously transferred to the controller 420 described below.

[0033] According to an embodiment of the disclosure, the input unit 117 may receive various inputs/commands from the user. According to an embodiment of the disclosure, the input unit 117 may receive a selection for the operation mode of the dryer 100, e.g., an anti-freeze mode or a dry mode, from the user According to an embodiment of the disclosure, the input unit 117 may receive an operation start and/or stop command according to the selected mode, from the user.

[0034] According to various embodiments of the disclosure, the communication unit 410 may support communication with various types of external devices, e.g., a predesignated UE or external data server through an

external communication network according to various types of wired/wireless communication protocols. According to an embodiment of the disclosure, the communication unit 410 may support any short-range wireless communication protocol such as Bluetooth, wireless LAN (WLAN), Zigbee, or Z-wave. According to an embodiment of the disclosure, the communication unit 410 may support any communication protocol such as TCP/IP, UDP, HTTP, HTTPS, FTP, SFTP, or MQTT. According to an embodiment of the disclosure, the communication unit 410 may also support any wireless communication protocol such as GSM, CDMA, WCDMA, WiMAX, LTE, LTE-A, 5G, or 6G. According to an embodiment of the disclosure, the communication unit 410 may receive information about the temperature change related to the location of the condensing clothes dryer 100 from an external data server according to any wired or wireless communication protocol. According to an embodiment of the disclosure, the communication unit 410 may transmit a message indicating that a freezing risk has occurred to an external UE according to any wired or wireless communication protocol. According to an embodiment of the disclosure, the communication unit 410 may receive an operation command according to the anti-freeze mode from the external UE according to any wired or wireless communication protocol.

[0035] According to various embodiments of the disclosure, the driving motor 131 may rotate clockwise and/or counterclockwise according to the control signal from the controller 420 to be described below. According to an embodiment of the disclosure, as described above in connection with FIG. 1, the rotation of the driving motor 131 may rotate the drum 120 through the driving pulley 132 and the belt 133 of the drum driver 130. According to an embodiment of the disclosure, the driving motor 131 may also be connected to the blower fan 141 to rotate the blower fan 141, but the disclosure is not limited thereto.

[0036] According to various embodiments of the disclosure, the compressor 156 may operate according to a predetermined operating frequency under the control of the controller 420 to be described below. According to various embodiments of the disclosure, the compressor 156 may compress the gaseous refrigerant into a high-temperature and high-pressure state and then discharge it. According to various embodiments of the disclosure, as the operating frequency of the compressor 156 increases, the temperature of the refrigerant discharged from the compressor 156 may increase. According to various embodiments of the disclosure, the temperature of the refrigerant discharged from the compressor 156 may be measured by the refrigerant temperature sensor 159. According to an embodiment of the disclosure, as is described below, when the clothes dryer 100 operates in the anti-freeze mode, the controller 420 may adjust the operation frequency of the compressor 156 considering the measured value of the refrigerant temperature sensor 159.

[0037] According to an embodiment of the disclosure, as described above with reference to FIG. 1, the heater 146 may be disposed on the rear duct 145 of the air circulation flow passage 140 to heat air to be supplied into the drum 120. According to an embodiment of the disclosure, as described above with reference to FIG. 1, the heater 146 may be disposed on a downstream side of the heat pump system 150 (e.g., downstream of the evaporator 154 and the condenser 152 on the rear duct 145) on the rear duct 145, but the disclosure is not limited thereto. According to an embodiment of the disclosure, the heater 146 may include one or more coil heaters, and may control the temperature of air supplied into the drum 120 by on/off control of the heater. According to an embodiment of the disclosure, as described above, when the clothes dryer 100 operates in the anti-freeze mode, the on/off control of the heater 146 may be performed according to the measured value of the refrigerant temperature sensor 159.

[0038] According to various embodiments of the disclosure, the controller 420 may monitor a temperature value (ambient temperature) related to the condensing clothes dryer 100 and continuously determine whether there is a risk of freezing. According to an embodiment of the disclosure, the controller 420 may continuously obtain the temperature measured by, e.g., the temperature sensor 119 and/or the related temperature from an external data server (e.g., the weather server) through the communication unit 410, and may determine whether the obtained temperature meets a freezing risk requirement. According to an embodiment of the disclosure, the controller 420 may continuously monitor and determine whether the obtained temperature remains less than or equal to a threshold for a predetermined time or more. According to an embodiment of the disclosure, when it is determined that the freezing risk requirement is met, the controller 420 may generate a message indicating the determination. According to an embodiment of the disclosure, the controller 420 may transmit a message indicating the freezing risk to the display 118. According to an embodiment of the disclosure, the controller 420 may transmit a message indicating the freezing risk to a predetermined external UE through the communication unit 410.

[0039] According to various embodiments of the disclosure, the controller 420 may receive, from the above-described input unit 117, various inputs or commands from the user, received on the input unit 117. According to an embodiment of the disclosure, the controller 420 may also receive various inputs or commands transmitted from the external UE through the communication unit 410 described above. According to an embodiment of the disclosure, the controller 420 may receive selection of the anti-freeze mode by the user from the input unit 117 or the communication unit 410. According to an embodiment of the disclosure, the controller 420 may receive an operation start and/or stop command from the user through the input unit 117 or the communication unit

410.

[0040] According to an embodiment of the disclosure, upon receiving the selection of the anti-freeze mode and the operation start command through the input unit 117 or the communication unit 410, the controller 420 may start the operation according to the anti-freeze mode. According to an embodiment of the disclosure, the controller 420 may obtain, e.g., various control information to be used when operating in the anti-freeze mode from the control table 430, e.g., operation specifications for each condition of the compressor 156 and/or the heater 146. According to an embodiment of the disclosure, the controller 420 may continuously receive and monitor the temperature measurement value of the refrigerant discharged by the compressor 156 from the refrigerant temperature sensor 159 after the operation in the anti-freeze mode is started. According to an embodiment of the disclosure, the controller 420 may control the operation of the driving motor 131, the compressor 156, and/or the heater 146 based on the control information obtained from the control table 430 and the refrigerant temperature obtained from the refrigerant temperature sensor 159, thereby performing the operation in the anti-freeze mode.

[0041] FIG. 5 is a flowchart schematically illustrating an overall process in which a condensing clothes dryer 100 predicts a risk of freezing and performs an operation corresponding thereto under the control of the controller 420 of FIG. 4 according to an embodiment of the disclosure.

[0042] First, in step 502, the control unit 420 may determine whether the freezing risk requirement is met. According to an embodiment of the disclosure, the controller 420 may obtain the temperature value continuously measured from the temperature sensor 119, and determine whether the freezing risk requirement is met by comparing the received temperature value with a reference value. According to an embodiment of the disclosure, the controller 420 may determine whether the freezing risk requirement is met by continuously obtaining the temperature value from the outside (e.g., an external data server) through the communication unit 410 and comparing the received temperature value with the reference value. According to an embodiment of the disclosure, when the temperature obtained over a predetermined time (e.g., 10 seconds or more) remains less than or equal to the reference value (e.g., 2 degrees Celsius), it may be determined that the freezing risk requirement is met, but the disclosure is not limited thereto.

[0043] When it is determined in step 502 that the freezing risk requirement is met, the procedure may proceed to step 504. In step 504, the controller 420 may generate a message indicating that a freezing risk has occurred and inquiring about whether to perform an operation in the anti-freeze mode. According to an embodiment of the disclosure, the controller 420 may control to display the generated message through the display 118. According to another embodiment of the disclosure, the controller 420 may transmit the generated message to a pre-registered UE through the communication unit 430.

[0044] In this regard, FIG. 6 illustrates an example of a message displayed on the display 118 or the UE when a freezing risk prediction message generated by the controller 420 of FIG. 4 is provided to the display 118 or the UE (not shown). Referring to FIG. 6, on the left side is shown a graph 602 indicating temperature changes over time around the condensing clothes dryer 100, and at the top of the graph 602 is shown a message 604 indicating that there is a freezing risk. Further, on the right side of FIG. 6, a guide 606 for a method of operating the condensing clothes dryer 100 in the anti-freeze mode is shown at an upper end. As illustrated, for example, a guide is displayed to power on and enter the function menu to select anti-freeze. FIG. 6 illustrates a method in which the clothes dryer 100 itself starts an operation in the anti-freeze mode through the input unit 117, but the disclosure is not limited thereto. According to another embodiment of the disclosure, the guide provided through the display 118 of the condensing clothes dryer 100 may include a method for entering the anti-freeze mode operation through manipulation of the input unit 117 of the condensing clothes dryer 100 as in the guide 606 of FIG. 6 or, alternatively, the guide provided through the UE may include a method for remote control command input to allow the dryer 100 to enter the anti-freeze mode operation by inputting a remote control command on the UE, but the disclosure is not limited to a specific case. Meanwhile, a brief guide 608 for the operation performed when the operation according to the anti-freezing mode is started is displayed at the lower right of FIG. 6. As illustrated, there is provided a guide indicating that the operation for a predetermined time (B minutes) and the stop for a predetermined time (C minutes) are repeated 16 hours and are then released, but this is merely an example, and the disclosure is not limited thereto. According to an embodiment of the disclosure, the operation time of B minutes may be shorter than the stop time of C minutes, but the disclosure is not limited thereto. The examples shown in FIG. 6 are merely examples, and the disclosure is not limited thereto.

[0045] Meanwhile, although not illustrated in FIG. 6, according to an embodiment of the disclosure, in providing the guide on the method for operating in the anti-freeze mode, a phrase guiding to empty the drum 120 before start may be provided together. According to an embodiment of the disclosure, in the condensing clothes dryer 100, when the operation in the anti-freeze mode is performed with the drying item present in the drum 120, and the water sensor is detected (unlike in the typical case of entering the drain check mode when the dry mode is performed), a message indicating to remove the drying item from the drum 120 may be provided to the UE through the display 118 or the communication unit 410, but the disclosure is not limited thereto.

[0046] Referring back to FIG. 5, in step 506, the controller 420 may determine whether a command for starting the operation in the anti-freeze mode (e.g., selection

of the anti-freeze mode and operation start command) is received from the user. According to an embodiment of the disclosure, the selection of the anti-freeze mode and the operation start command may be received from the user through the input unit 117 of the housing 110. According to another embodiment of the disclosure, the selection of the anti-freeze mode and the operation start command from the user may be received from the UE through the communication unit 410. Typically, it may be required in many cases that remote control is set to be enabled on the dryer to control the operation of the clothes dryer according to remote control. According to an embodiment of the disclosure, in the case of the selection of the anti-freeze mode and the operation start command, remote control from the UE may be allowed regardless of whether remote control is set to be enabled on the clothes dryer 100, but the disclosure is not limited thereto. When it is determined that the operation start command in the anti-freeze mode is received from the user in step 506, the procedure proceeds to operation 508, and the controller 420 may operate each component of the dryer 100, e.g., the driving motor 131, the heat pump system 150, and/or the heater 146 to perform the operation in the anti-freeze mode.

[0047] FIG. 7 is a flowchart illustrating in more detail a process of performing an operation in an anti-freeze mode under the control of the controller 420 in step 508 of FIG. 5.

[0048] If the operation in the anti-freeze mode starts, in step 702, the controller 420 may enter the compressor operation preparation step to start driving the driving motor 131 and may wait a predetermined time period (e.g., A minutes). During the time, the blower fan 141 may be driven by the driving of the driving motor 131, and the subsequent operations may be prepared with the compressor 156 (and heater 146) of the heat pump system 150 stopped. In step 704, it is determined whether a predetermined time period (e.g., A minutes) elapses and, when the predetermined time elapses, the procedure proceeds to step 706, starting the heating operation step.

[0049] In step 706, the controller 420 may first identify the external temperature. According to an embodiment of the disclosure, the controller 420 may identify the external temperature at the time from, e.g., the above-described temperature sensor 119. According to another embodiment of the disclosure, the controller 420 may identify the external temperature at the time by the temperature measured by another temperature sensor (e.g., the drum discharge temperature sensor 127) installed on the clothes dryer 100.

[0050] Then, in step 708, the controller 420 may obtain the compressor operation specifications and the heater operation specifications from the control table 430 based on the temperature identified in step 706. Although not shown, according to an embodiment of the disclosure, in the control table 430, a plurality of sections for the external temperature may be divided and, for each section, an initial operation frequency and/or discharge refrigerant target temperature for the compressor 156 may be defined. According to an embodiment of the disclosure, the lower the temperature, the higher the initial operation frequency of the compressor 156 and the discharge refrigerant target temperature may be defined, but the disclosure is not limited thereto. Although not shown, according to an embodiment of the disclosure, in the control table 430, a plurality of sections for the external temperature may be divided and, for each section, turn-on and turn-off conditions for the heater 146 (e.g., a refrigerant discharge temperature condition for turning on the heater 146 and a refrigerant discharge temperature condition for turning off the heater 146) may be defined. According to an embodiment of the disclosure, the turn-off condition of the heater 146 may be set to be constant regardless of the section to which the external temperature belongs, and the turn-on condition may be defined as a higher temperature as the temperature decreases, but the disclosure is not limited thereto. According to an embodiment of the disclosure, the controller 420 may obtain, from the control table 430, the initial operation frequency of the compressor 156 and/or the discharged refrigerant target temperature defined corresponding to the section to which the external temperature identified in step 706 belongs, as the compressor operation specification. According to an embodiment of the disclosure, the controller 420 may obtain, from the control table 430, a condition for turning on and off the heater 456 defined corresponding to the section to which the external temperature identified in step 706 belongs, as the heater operation specification.

[0051] Then, in step 710, the controller 420 may control each of the compressor 156 and the heater 146 to be driven for a predetermined time period (e.g., B minutes), based on the compressor operation specification and the heater operation specification obtained in step 708. According to an embodiment of the disclosure, the controller 420 may control the compressor 156 to start operation according to the compressor operation specification obtained in step 708, e.g., at the obtained initial operation frequency and, after the temperature of the refrigerant discharged from the compressor 156 reaches the discharged refrigerant target temperature, control the compressor 156 to operate while adjusting the operation frequency of the compressor 156 to maintain the temperature. Accordingly, according to an embodiment of the disclosure, each heating operation step may have a first section where the compressor 156 is driven at the initial operation frequency of the compressor operation specification and a second section where, after the refrigerant discharge temperature increases to the target as a result of the driving in the first section, the compressor 156 is driven at a frequency adjusted to maintain the increased temperature. According to an embodiment of the disclosure, the controller 420 may turn on, e.g., the heater 146 according to the heater operation specification obtained in step 708 and may then control the operation of the heater 146 in such a manner as to, if the temperature of

the refrigerant discharged from the compressor 156 reaches the obtained turn-off condition, turn off the heater 146 and, if reaching the turn-on condition, turn on the heater 146. According to an embodiment of the disclosure, the heater 146 may be continuously controlled to turn on/off according to temperature changes while the heating operation step lasts.

[0052] In step 712, it is determined whether the set time period (e.g., B minutes) elapses and, if so, the procedure may proceed to step 714, entering the heating stop step. In step 714, the controller 420 may wait for a predetermined time period (e.g., C minutes) with all of the driving motor 131, the compressor 156, and the heater 146 stopped. In step 716, it is determined whether the predetermined time period (e.g., C minutes) elapses and, if so, the procedure may proceed to step 718. According to an embodiment of the disclosure, as is described below, the heating operation step of step 706 to step 712 and the heating stop step of step 714 to step 716 may be repeated multiple times (e.g., D times), and only in the final round, the duration of the heating stop step may be set to be slightly shorter (e.g., C-3 minutes) than that in the other heating stop steps, but the disclosure is not limited thereto.

[0053] In step 718, it may be determined whether the heating operation step of step 706 to step 712 and the heating stop step of step 714 to step 716 are repeated a predetermined number of times (e.g., D times). In step 718, if it is determined that the steps are not repeated the predetermined number of times, the procedure may return to step 706. In step 718, if it is determined that the steps are repeated the predetermined number of times, the procedure may proceed to step 720, entering the cooling step for a predetermined time period (e.g., E minutes). In the cooling step 720, the controller 420 may cool the internal components of the dryer 100 by driving only the driving motor 131 (and resultant driving of the blower fan) for a predetermined time with the compressor 156 and the heater 146 stopped.

[0054] In the disclosure, in connection with FIG. 7, it is illustrated that the heating operation step is performed over step 706 to step 712. In other words, in the disclosure, it is described that after the compressor operation preparation step of step 702 to step 704 is terminated, in each round of entering the heating operation step, the controller 420 identifies (step 706) the external temperature, obtains (step 708) the corresponding operation specifications, and controls the driving (steps 710 to 712) of the compressor 156 and the heater 146 for a predetermined time according to the obtained specifications. However, the disclosure is not limited thereto. According to another embodiment of the disclosure, the identifying of the external temperature and the obtaining of the operation specifications corresponding thereto may be performed only once in an initial time (e.g., before or after the compressor operation preparation step (steps 702 to 704)) of the overall process of performing the operation in the anti-freeze mode. For example, according to another embodiment of the disclosure, the heating operation step may be defined as including only the above-described steps 710 and 712 and, after step 718 (when the operation is not completed a predetermined number of times), the procedure may return to step 710 rather than going to step 706, but the disclosure is not limited to a specific form.

[0055] FIG. 8 illustrates a time table showing each step of a process of performing an operation in an anti-freeze mode according to FIG. 7.

[0056] As illustrated in FIG. 8, after the operation is started at time T0, the compressor operation preparation step (e.g., driving only the driving motor 131) may be performed for A minutes (e.g., 2 minutes). Then, at time T1(T0+A minutes), a first heating step may be performed. As illustrated, the first heating step may include a heating operation step for B minutes (e.g., driving the driving motor 131, the compressor 156, and the heater 146) and a following heating stop step for C minutes (e.g., stopping all of the driving motor 131, the compressor 156, and the heater 146). Then, immediately thereafter, a second heating step may be performed. As illustrated, the second heating step, like the first heating step, may include a heating operation step for B minutes and a following heating stop step for C minutes. Referring to FIG. 8, the heating step may be repeated D times, and as described above with reference to FIG. 7, only the heating stop step of the final, D-th heating step may be performed for a shorter time of C-3 minutes. Then, the heating step is finished, and a cooling step for E minutes (e.g., 1 minute) may be performed at time T2 (T0 + A minutes + ((B minutes + C minutes) * D times -3 minutes).

[0057] FIG. 9 is a view illustrating changes in power consumption over time when an operation in an anti-freeze mode is performed on a condensing clothes dryer 100 according to an embodiment of the disclosure. FIG. 9 shows a change in power consumption when, e.g., the heating step of the anti-freeze mode is repeated eight times, but the disclosure is not limited thereto. As illustrated in FIG. 9, it may be identified that the power consumption changes in a similar pattern for each heating step. As illustrated, e.g., in an initial time of each heating step (specifically, in an initial time of the heating operation step), the driving motor 131, the compressor 156, and the heater 146 are all driven, and thus it may be identified that the power consumption is relatively high. It may be identified that after the refrigerant discharge temperature reaches a predetermined temperature so that the operation frequency of the compressor 156 is adjusted and/or the heater 146 is turned off, in the remaining heating operation step, the power consumption is relatively reduced, and in the following heating stop step, the driving motor 131, the compressor 156, and the heater 146 all are stopped so that the power consumption drops to zero. As illustrated in FIG. 9, after all eight heating steps are performed, it may be identified that the procedure is terminated after slight power consumption occurs due to driving of the driving motor 131 during the last cooling

step. As shown in FIG. 9, for example, since no power consumption occurs during the heating stop step, the total power consumption according to the operation in the anti-freeze mode for preventing the condensing clothes dryer 100 from freezing may not be excessively increased.

[0058] FIG. 10 is a view schematically illustrating changes, over time, in temperature of each component of a condensing clothes dryer 100 in an initial time when an operation in an anti-freeze mode is performed on a condensing clothes dryer 100 according to an embodiment of the disclosure. Specifically, FIG. 10 shows example temperature changes over time in each component of the clothes dryer 100, specifically inside the dryer, at the bottom of the pump chamber, and in the pump chamber, in relation to performing the operation in the anti-freeze mode.

[0059] As illustrated in FIG. 10, if the heating operation step in the anti-freeze mode is started at time T1, it may be identified that the temperature inside of the dryer, at the bottom of the pump chamber, and in the pump chamber all rises rapidly. Then, it may be identified that after reaching a predetermined temperature, the temperature gently decreases, and if the next heating operation step is started, the temperature inside of the dryer, at the bottom of the pump chamber, and in the pump chamber all rises rapidly. As illustrated in FIG. 10, while the operation in the anti-freeze mode is performed, the temperature of each component of the clothes dryer 100 may be maintained to be higher than the temperature at which freezing may occur continuously while repeatedly rising and falling.

[0060] FIG. 11 is a view schematically illustrating changes, over time, in temperature of each component of a clothes dryer in an initial time of operation when an operation in an anti-freeze mode according to an embodiment of the disclosure is performed through driving of a heater and a compressor of a heat pump system (hybrid type) and when the operation in the anti-freeze mode is performed by driving only the compressor of the heat pump system (heat pump type). FIG. 11(a) illustrates example temperature changes in each component of the clothes dryer 100, specifically, inside the dryer, at the bottom of the pump chamber, and in the pump chamber, in the hybrid type, i.e., when the heater and the compressor of the heat pump system are used together. FIG. 11(b) illustrates example temperature changes in each component of the clothes dryer 100, specifically, inside the dryer, at the bottom of the pump chamber, and in the pump chamber, in the heat pump type, i.e., when only the compressor of the heat pump system is used without the heater. Comparison between (a) and (b) of FIG. 11 reveals that in the hybrid type, the temperature of each component of the dryer rises faster. Accordingly, use of both the heat pump system and the heater as shown in FIG. 11(a) when performing the operation in the anti-freeze mode may reduce the duration of the heating operation step and accordingly minimize noise and create a pleasant living environment as compared with FIG. 11(b).

[0061] The terms as used herein are provided merely to describe some embodiments thereof, but are not intended to limit the disclosure. As used herein, the singular forms "a," "an," and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. As used herein, each of such phrases as "A or B," "at least one of A and B," "at least one of A or B," "A, B, or C," "at least one of A, B, and C," and "at least one of A, B, or C," may include all possible combinations of the items enumerated together in a corresponding one of the phrases. As used herein, the term 'and/or' should be understood as encompassing any and all possible combinations by one or more of the enumerated items. As used herein, the terms "include," "have," and "comprise" are used merely to designate the presence of the feature, component, part, or a combination thereof described herein, but use of the term does not exclude the likelihood of presence or adding one or more other features, components, parts, or combinations thereof. As used herein, the terms "first" and "second" may modify various components regardless of importance and/or order and are used to distinguish a component from another without limiting the components.

[0062] As used herein, the terms "configured to" may be interchangeably used with the terms "suitable for," "having the capacity to," "designed to," "adapted to," "made to," or "capable of" depending on circumstances. The term "configured to" does not essentially mean "specifically designed in hardware to." Rather, the term "configured to" may mean that a device can perform an operation together with another device or parts. For example, a 'device configured (or set) to perform A, B, and C' may be a dedicated device to perform the corresponding operation or may mean a general-purpose device capable of various operations including the corresponding operation.

[0063] As used herein, the term "part" or "module" may include a unit implemented in hardware, software, or firmware, and may interchangeably be used with other terms, for example, "logic," "logic block," "part," or "circuitry". A part or module may be a single integral component, or a minimum unit or part thereof, adapted to perform one or more functions. For example, according to an embodiment, 'part' or 'module' may be implemented in a form of an application-specific integrated circuit (ASIC).

[0064] According to various embodiments, each component (e.g., a module or a program) of the above-described components may include a single entity or multiple entities. Some of the plurality of entities may be separately disposed in different components. According to various embodiments, one or more of the above-described components may be omitted, or one or more other components may be added. Alternatively or additionally, a plurality of components (e.g., modules or programs) may be integrated into a single component. In

such a case, according to various embodiments, the integrated component may still perform one or more functions of each of the plurality of components in the same or similar manner as they are performed by a corresponding one of the plurality of components before the integration. According to various embodiments, operations performed by the module, the program, or another component may be carried out sequentially, in parallel, repeatedly, or heuristically, or one or more of the operations may be executed in a different order or omitted, or one or more other operations may be added.

[0065] In the disclosure, the above-described description has been made mainly of specific embodiments, but the disclosure is not limited to such specific embodiments, but should rather be appreciated as covering all various modifications, equivalents, and/or substitutes of various embodiments.

Claims

1. A clothes dryer, comprising:

a temperature acquisition unit configured to obtain a temperature value;
a drum configured to accommodate an object to be dried;
a flow passage configured to guide air discharged from an inside of the drum to an outside of the drum, and then to be introduced back into the inside of the drum;
a heat pump system configured to heat the air that is to be introduced back into the inside of the drum, the heat pump system including a compressor, a condenser, an expansion valve, and an evaporator through which a refrigerant circulates; and
a controller configured to, in response to receiving a command from a user for an anti-freeze mode operation, control the clothes dryer to repeatedly perform a heating operation for a plurality of times, wherein in the heating operation, after the compressor is driven for a first period of time, the compressor is stopped for a second period of time.

2. The clothes dryer of claim 1, further comprising:

a control table including operation frequencies for the compressor, the operation frequencies being defined for respective temperatures, in relation to the anti-freeze mode operation,
wherein the controller is configured to, in response to receiving the command for the anti-freeze mode operation, obtain a corresponding operation frequency among the operation frequencies from the control table based on the obtained temperature value, and
the driving of the compressor for the first period of time includes driving the compressor according to the obtained corresponding operation frequency.

3. The clothes dryer of claim 2, further comprising:

a refrigerant temperature sensor configured to obtain a temperature of refrigerant discharged from the compressor,
wherein the control table includes target temperatures for the refrigerant, the target temperatures being defined for the respective temperatures, and
the driving of the compressor for the first period of time includes:

driving the compressor according to the obtained operation frequency until the obtained temperature of the refrigerant reaches a corresponding target temperature among the target temperatures, and
after the obtained temperature of the refrigerant reaches the corresponding target temperature, driving the compressor according to an adjusted operation frequency so that the obtained temperature of the refrigerant remains at the corresponding target temperature.

4. The clothes dryer of claim 1, further comprising:

a heater installed on the flow passage; and
a control table including turn-on/off conditions for the heater, the turn-on/off conditions being defined for respective temperatures, in relation to the anti-freeze mode operation,
wherein the controller is configured to:

in response to receiving the command for the anti-freeze mode operation, obtain a corresponding turn-on/off condition among the turn-on/off conditions for the heater from the control table based on the obtained temperature value, and
repeatedly turn on/off the heater according to the obtained corresponding turn-on/off condition while the compressor is driven for the first period of time.

5. The clothes dryer of claim 4, further comprising:

a refrigerant temperature sensor configured to obtain a temperature of refrigerant discharged from the compressor,
wherein the corresponding turn-on/off condition for the heater is determined based on the obtained temperature of the refrigerant.

6. The clothes dryer of claim 1, wherein the first period of time is shorter than the second period of time.

7. The clothes dryer of claim 1, wherein the controller is configured to, in response to receiving the command for the anti-freeze mode operation, control the clothes dryer to perform a preparatory operation of waiting for a predetermined time with the compressor turned off before starting the heating operation.

8. The clothes dryer of claim 7, further comprising:

a blower fan configured to cause air to move in the flow passage,
wherein the controller is configured to control the blower fan to be driven while the preparatory operation is performed.

9. The clothes dryer of claim 1, further comprising a blower fan configured to cause air to move in the flow passage,
wherein the controller is configured to control the blower fan to be driven with the compressor and a heater turned off for a predetermined time after the heating operation is performed the plurality of times.

10. The clothes dryer of claim 1, wherein the controller is configured to:

monitor the obtained temperature value and,
upon determining that there is a risk of freezing as a result of the monitoring, generate a message indicating the risk of freezing.

11. The clothes dryer of claim 10, wherein the temperature acquisition unit includes at least one of a temperature sensor installed on the clothes dryer and a communication unit configured to obtain the temperature value from an external server through a communication network.

12. The clothes dryer of claim 10, wherein the message includes an inquiry as to whether to perform the anti-freeze mode operation.

13. The clothes dryer of claim 10, further comprising:

a display configured to output information for the user; and
an input unit configured to receive an input from the user,
wherein the controller is configured to

control the message to be displayed through the display, and
receive the command from the user for the anti-freeze mode operation through the input unit in response to the display of the message.

14. The clothes dryer of claim 10, further comprising:

a communication unit configured to communicate with a pre-registered user equipment (UE) through a communication network,
wherein the controller is configured to:

control the message to be transmitted to the UE through the communication unit, and
receive the command for the anti-freeze mode operation from the UE through the communication unit.

15. A method for performing an anti-freeze operation in a clothes dryer, the clothes dryer including a temperature sensor, a drum, a blower fan configured to cause air to move inside and outside the drum, a motor configured to rotate the blower fan, a heat pump including a compressor, and a heater configured to heat the air that is introduced into the drum, the method comprising:

repeating a heating operation for a plurality of times, the heating operation including: driving the motor, the compressor, and the heater for a first period time based on an operation specification determined according to a temperature measured by the temperature sensor, stopping the motor, the compressor, and the heater for a second period of time; and
performing a cooling operation in which the motor is driven for a third period of time with the compressor and the heater stopped.

FIG. 1

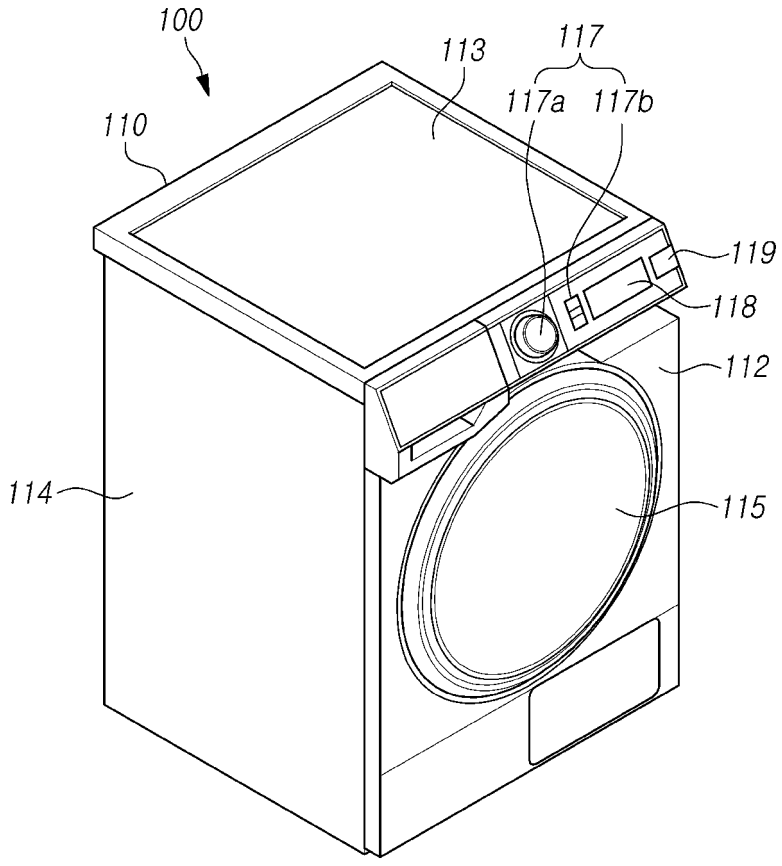
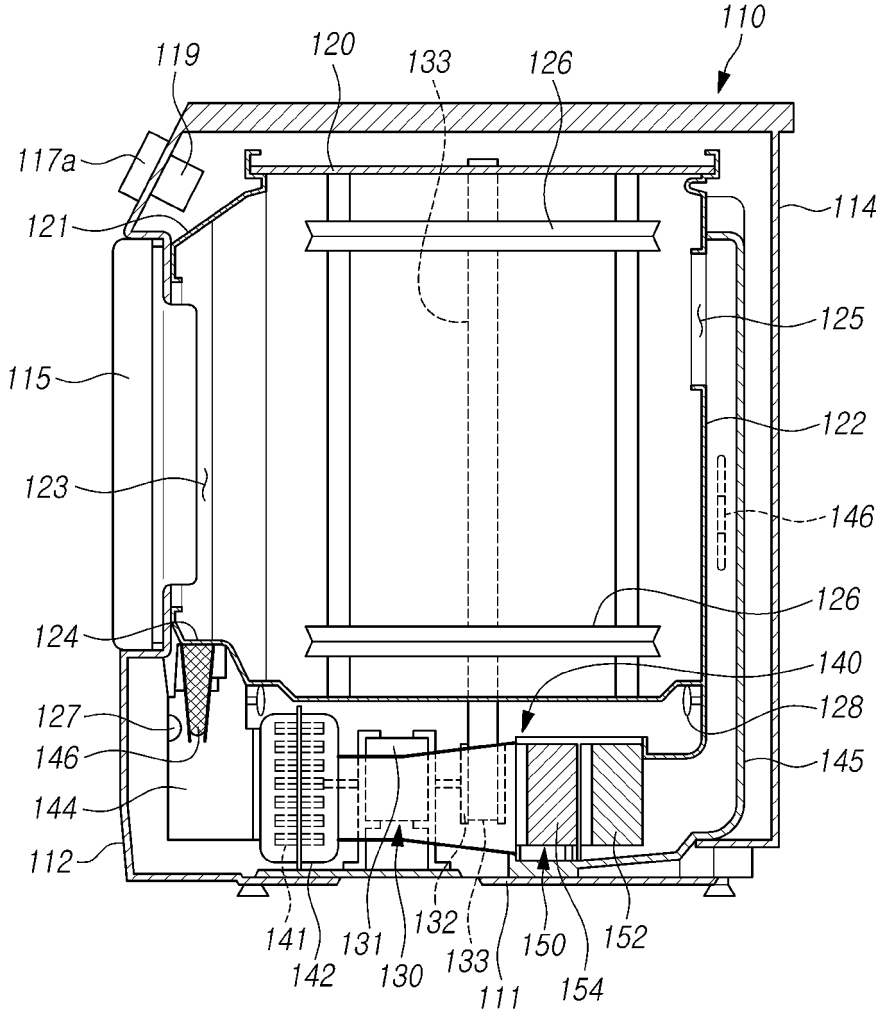


FIG.2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119
120
133
126
117a
121
114
125
115
122
123
146
126
124
140
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131
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133
150
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142
130
111
154

FIG.3

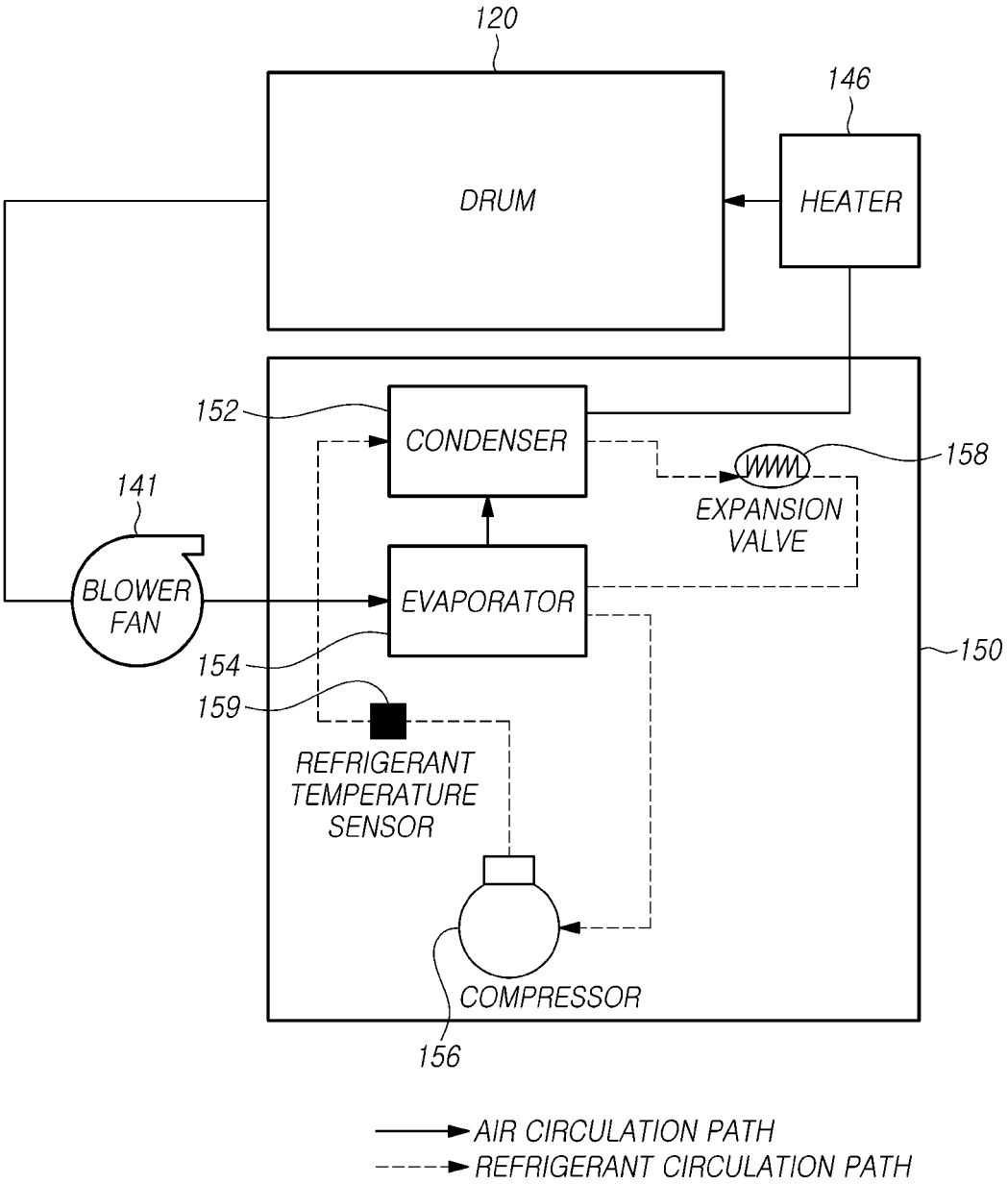

120
DRUM
146
HEATER
152
CONDENSER
158
EXPANSION VALVE
141
BLOWER FAN
EVAPORATOR
150
154
159
REFRIGERANT TEMPERATURE SENSOR
COMPRESSOR
156
AIR CIRCULATION PATH
REFRIGERANT CIRCULATION PATH

FIG.4

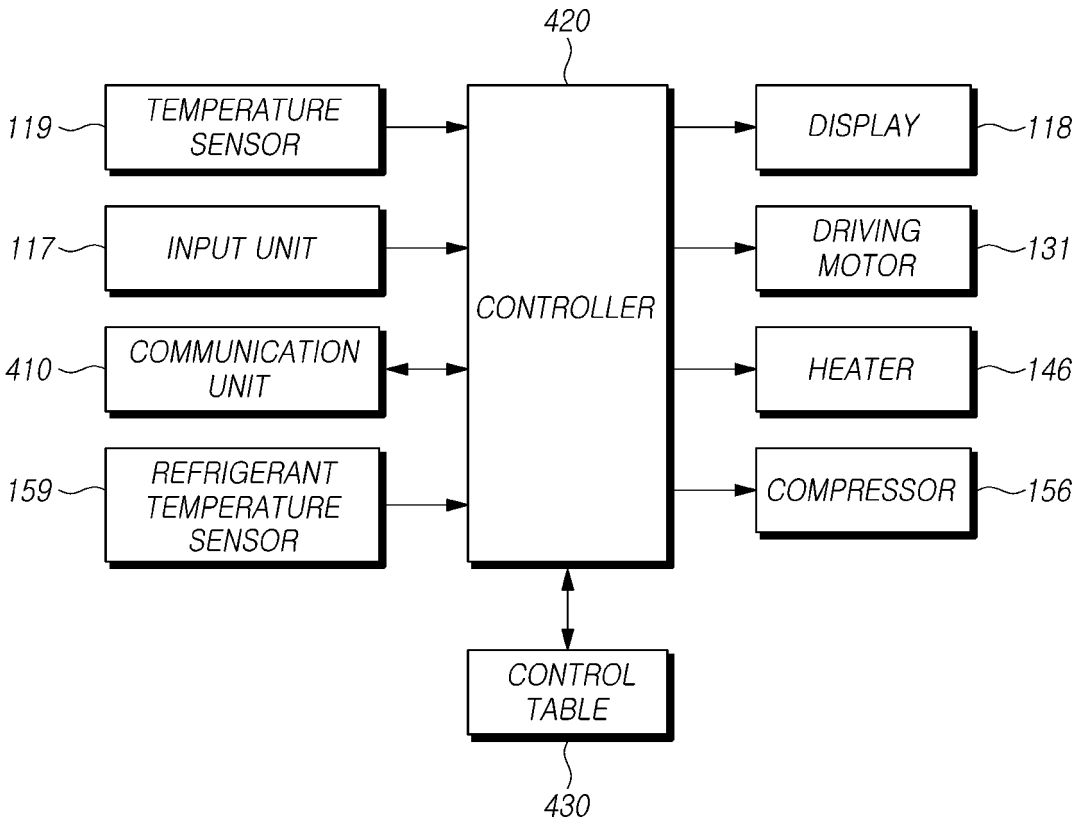

420
119
TEMPERATURE SENSOR
117
INPUT UNIT
410
COMMUNICATION UNIT
159
REFRIGERANT TEMPERATURE SENSOR
CONTROLLER
DISPLAY
118
DRIVING MOTOR
131
HEATER
146
COMPRESSOR
156
CONTROL TABLE
430

FIG.5

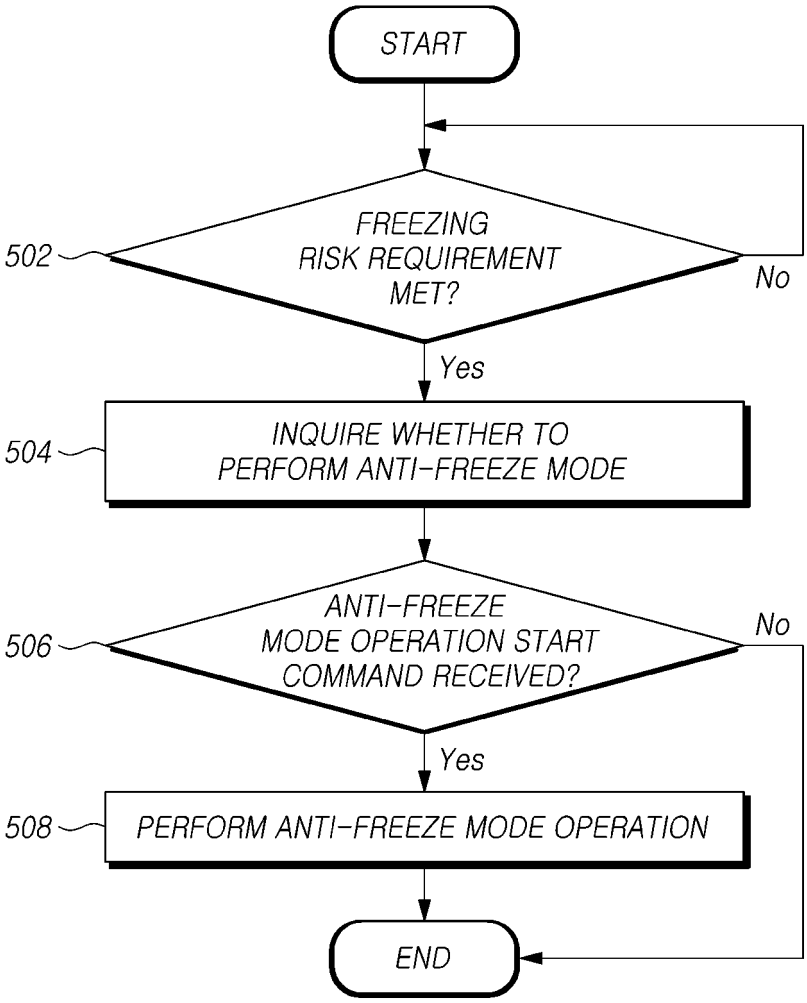

START
502
FREEZING RISK REQUIREMENT MET?
No
Yes
504
INQUIRE WHETHER TO PERFORM ANTI-FREEZE MODE
506
ANTI-FREEZE MODE OPERATION START COMMAND RECEIVED?
No
Yes
508
PERFORM ANTI-FREEZE MODE OPERATION
END

FIG.6

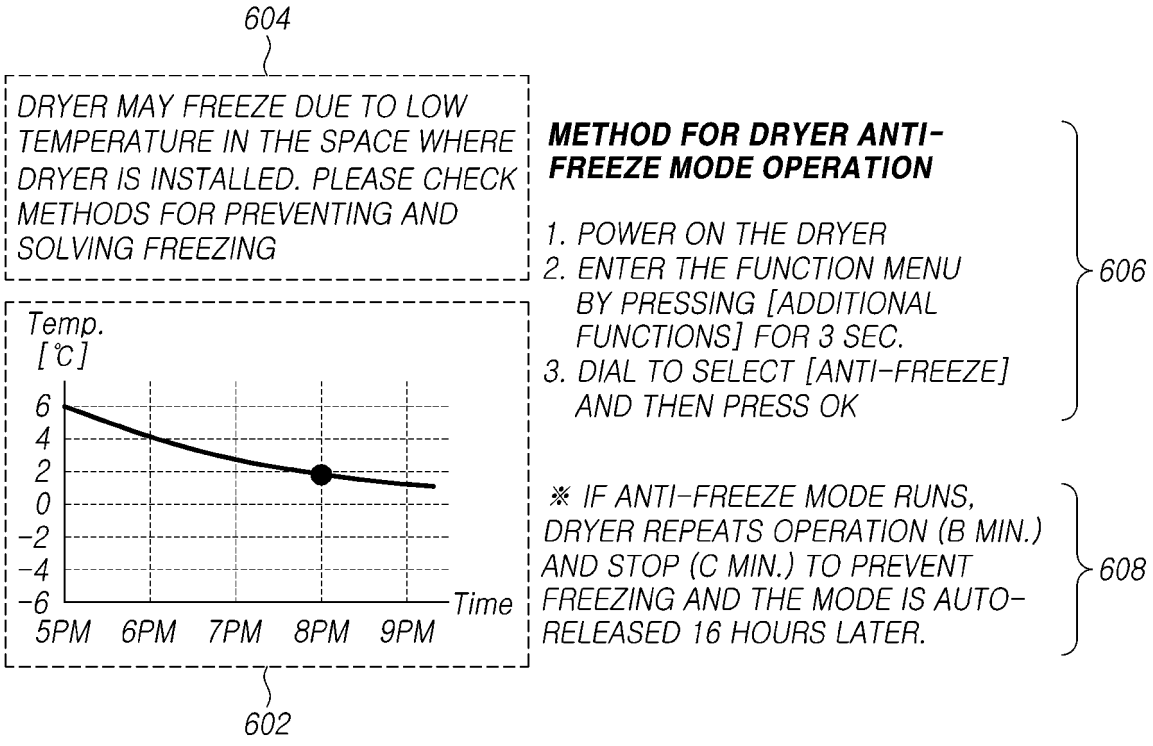

604
DRYER MAY FREEZE DUE TO LOW TEMPERATURE IN THE SPACE WHERE DRYER IS INSTALLED. PLEASE CHECK METHODS FOR PREVENTING AND SOLVING FREEZING
Temp. [℃]
6
4
2
0
-2
-4
-6
Time
5PM
6PM
7PM
8PM
9PM
602
METHOD FOR DRYER ANTI-FREEZE MODE OPERATION
1. POWER ON THE DRYER
2. ENTER THE FUNCTION MENU BY PRESSING [ADDITIONAL FUNCTIONS] FOR 3 SEC.
3. DIAL TO SELECT [ANTI-FREEZE] AND THEN PRESS OK
606
※ IF ANTI-FREEZE MODE RUNS, DRYER REPEATS OPERATION (B MIN.) AND STOP (C MIN.) TO PREVENT FREEZING AND THE MODE IS AUTO-RELEASED 16 HOURS LATER.
608

FIG. 7

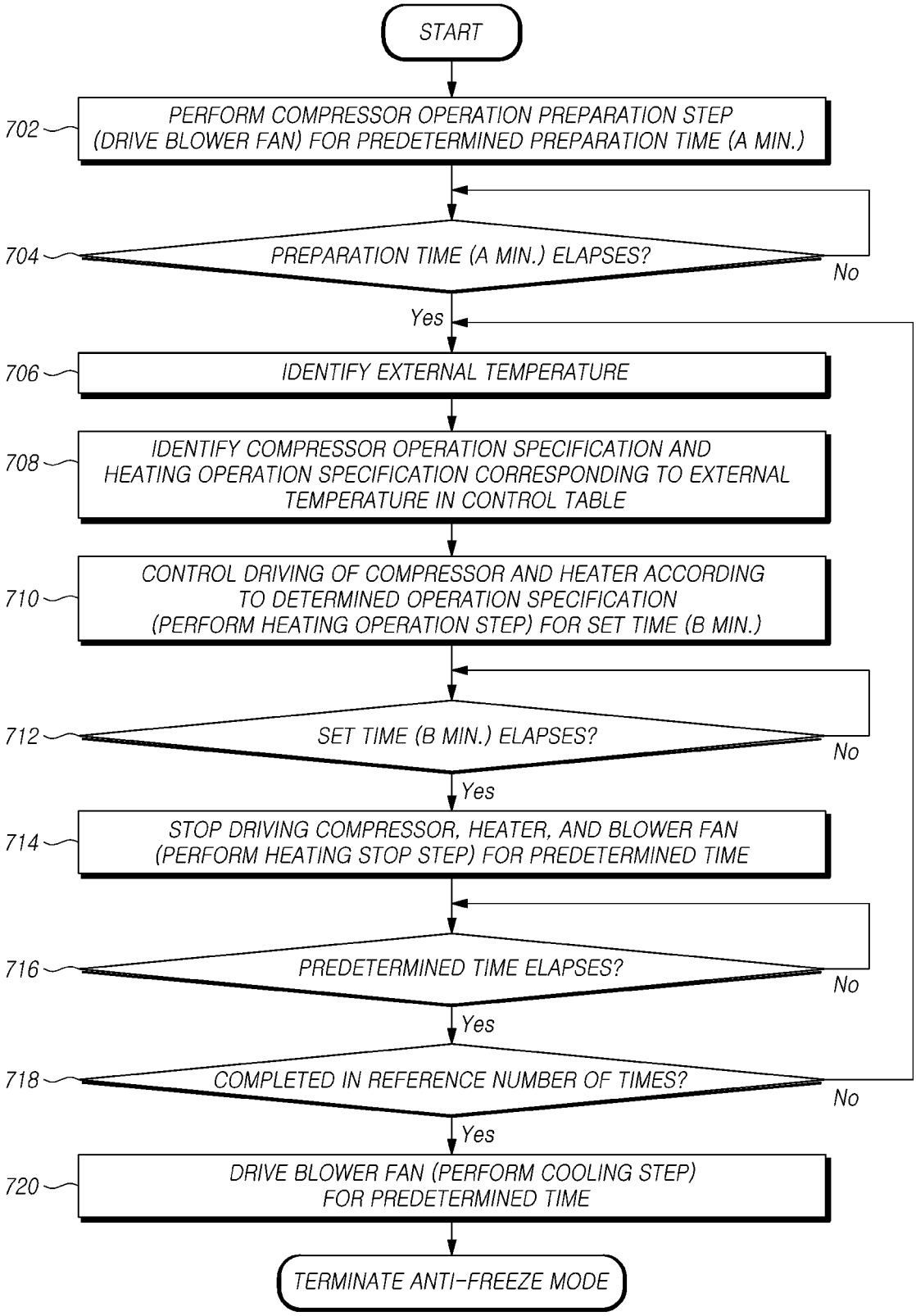

START
702
PERFORM COMPRESSOR OPERATION PREPARATION STEP (DRIVE BLOWER FAN) FOR PREDETERMINED PREPARATION TIME (A MIN.)
704
PREPARATION TIME (A MIN.) ELAPSES?
No
Yes
706
IDENTIFY EXTERNAL TEMPERATURE
708
IDENTIFY COMPRESSOR OPERATION SPECIFICATION AND HEATING OPERATION SPECIFICATION CORRESPONDING TO EXTERNAL TEMPERATURE IN CONTROL TABLE
710
CONTROL DRIVING OF COMPRESSOR AND HEATER ACCORDING TO DETERMINED OPERATION SPECIFICATION (PERFORM HEATING OPERATION STEP) FOR SET TIME (B MIN.)
712
SET TIME (B MIN.) ELAPSES?
No
Yes
714
STOP DRIVING COMPRESSOR, HEATER, AND BLOWER FAN (PERFORM HEATING STOP STEP) FOR PREDETERMINED TIME
716
PREDETERMINED TIME ELAPSES?
No
Yes
718
COMPLETED IN REFERENCE NUMBER OF TIMES?
No
Yes
720
DRIVE BLOWER FAN (PERFORM COOLING STEP) FOR PREDETERMINED TIME
TERMINATE ANTI-FREEZE MODE

FIG.8

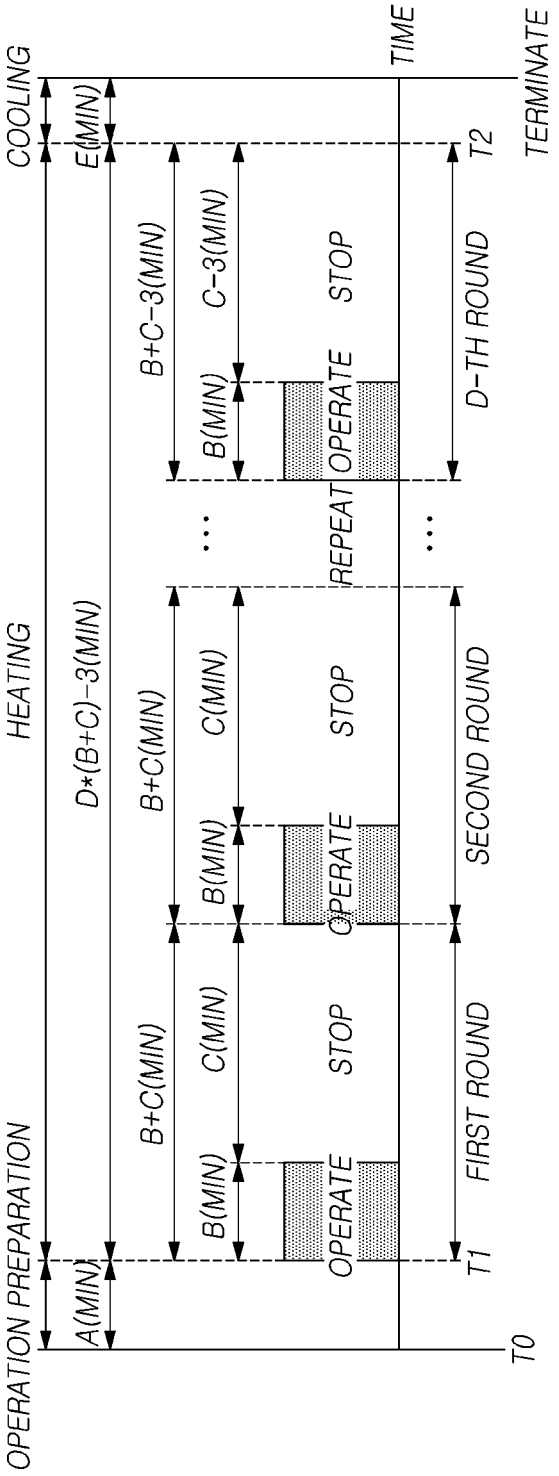

OPERATION PREPARATION
HEATING
COOLING
TIME
TERMINATE
A(MIN)
D*(B+C)-3(MIN)
E(MIN)
T0
T1
T2
B(MIN)
B+C(MIN)
C(MIN)
OPERATE
STOP
FIRST ROUND
SECOND ROUND
REPEAT
B+C-3(MIN)
C-3(MIN)
D-TH ROUND

FIG.9

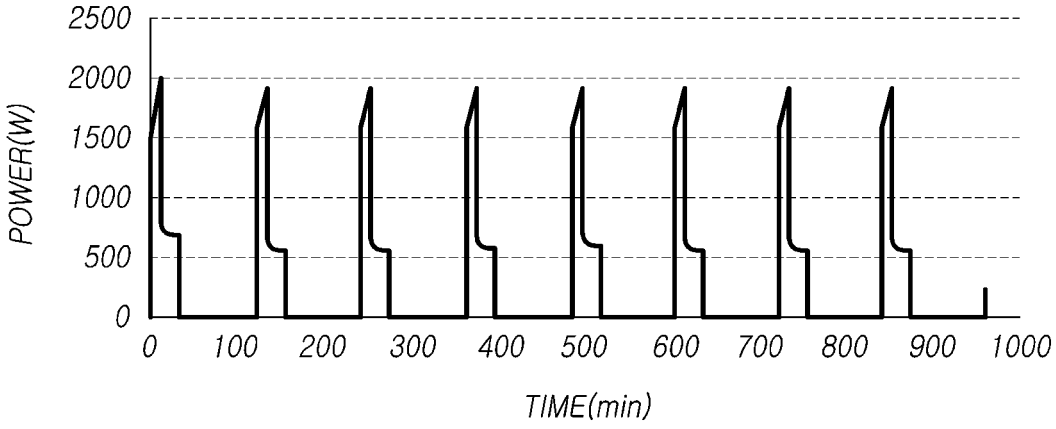

2500
2000
1500
1000
500
0
POWER(W)
0
100
200
300
400
500
600
700
800
900
1000
TIME(min)

FIG. 10

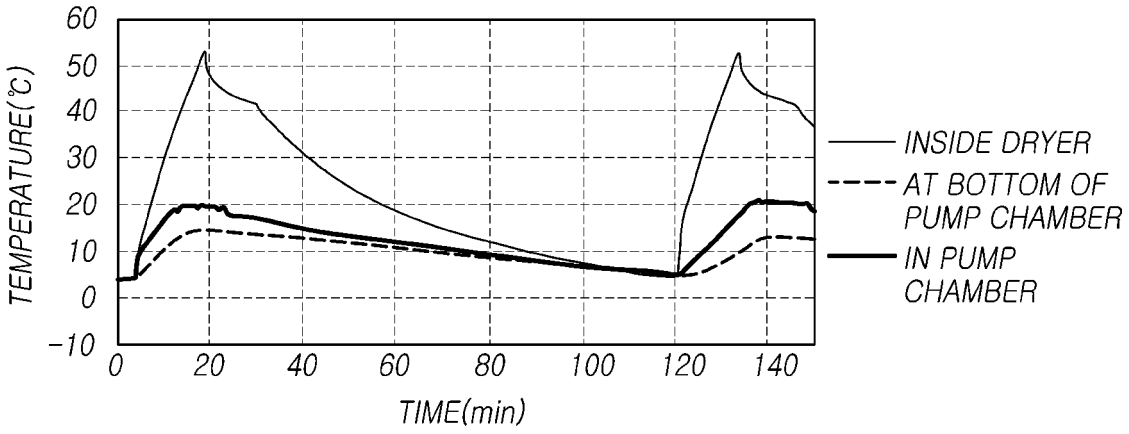
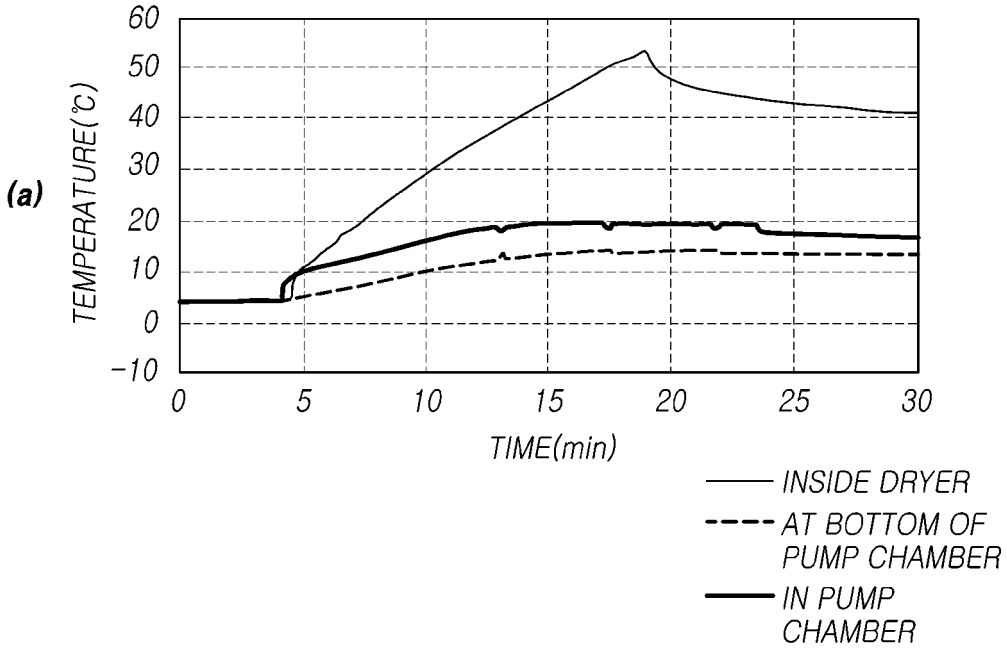
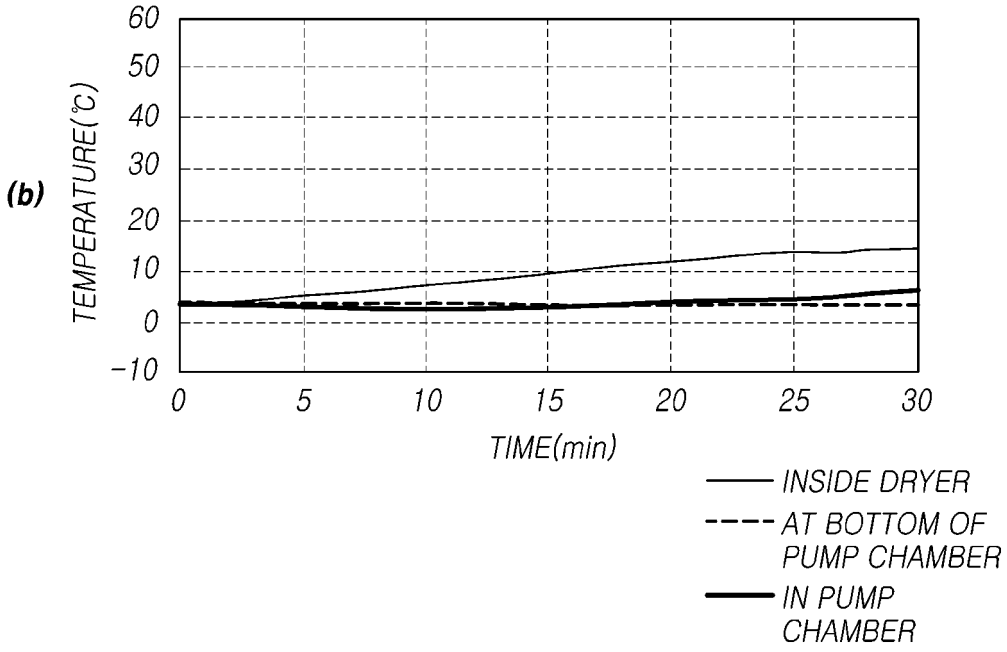

60
50
40
30
20
10
0
-10
TEMPERATURE(℃)
0
20
40
60
80
100
120
140
TIME(min)
INSIDE DRYER
AT BOTTOM OF PUMP CHAMBER
IN PUMP CHAMBER

FIG. 11


(a)
TEMPERATURE(℃)
60
50
40
30
20
10
0
-10
0
5
10
15
20
25
30
TIME(min)
INSIDE DRYER
AT BOTTOM OF PUMP CHAMBER
IN PUMP CHAMBER


(b)
TEMPERATURE(℃)
60
50
40
30
20
10
0
-10
0
5
10
15
20
25
30
TIME(min)
INSIDE DRYER
AT BOTTOM OF PUMP CHAMBER
IN PUMP CHAMBER

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2022/016178

A. CLASSIFICATION OF SUBJECT MATTER

D06F 58/50(2020.01)i; **D06F 58/40**(2020.01)i; **D06F 58/26**(2006.01)i; **D06F 58/20**(2006.01)i; **D06F 58/24**(2006.01)i; **D06F 58/46**(2020.01)i; **D06F 34/14**(2020.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

D06F 58/50(2020.01); D06F 58/02(2006.01); D06F 58/20(2006.01); D06F 58/28(2006.01); D06F 58/30(2020.01); D06F 58/32(2020.01)

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: 드럼(drum), 건조(dry), 온도(temperature), 센서(sensor), 결빙(freezing)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	KR 10-2019-0057682 A (LG ELECTRONICS INC.) 29 May 2019 (2019-05-29) See paragraphs [0039]-[0119] and figures 1-4.	1-15
A	KR 10-2019-0121656 A (LG ELECTRONICS INC.) 28 October 2019 (2019-10-28) See paragraphs [0030]-[0138] and figures 1-6.	1-15
A	JP 2021-045330 A (TOSHIBA LIFESTYLE PRODUCTS & SERVICES CORP.) 25 March 2021 (2021-03-25) See entire document.	1-15
A	JP 2009-195364 A (PANASONIC CORP.) 03 September 2009 (2009-09-03) See entire document.	1-15
A	JP 10-328496 A (HITACHI LTD.) 15 December 1998 (1998-12-15) See entire document.	1-15

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

* Special categories of cited documents:
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"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
01 February 2023	**01 February 2023**
Name and mailing address of the ISA/KR **Korean Intellectual Property Office** **Government Complex-Daejeon Building 4, 189 Cheongsa-ro, Seo-gu, Daejeon 35208** Facsimile No. **+82-42-481-8578**	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/KR2022/016178

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		EP 3754095 B1	16 March 2022
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JP 2009-195364 A	03 September 2009	None	
JP 10-328496 A	15 December 1998	None	

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