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(54) **METHOD AND APPARATUS MAINTAINING LIQUID BEVERAGES IN A SUPERCOOLED STATE**

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(57) **ABSTRACT**

Disclosed herein is a refrigerator including a device to restrain the freezing of liquid-phase beverages, thereby stably maintaining the supercooled state of the liquid-phase beverages. The refrigerator includes a main body, a supercooling chamber disposed in the main body such that cool air is supplied to the supercooling chamber, a microwave generator to oscillate microwaves to the supercooling chamber, and a control unit to control the magnitude of the microwaves oscillated from the microwave generator. The present invention has the effect of restraining the freezing of the liquid-phase beverages, thereby stably maintaining the supercooled state of the liquid-phase beverages, and therefore, increasing the supercooled degree of the liquid-phase beverages.

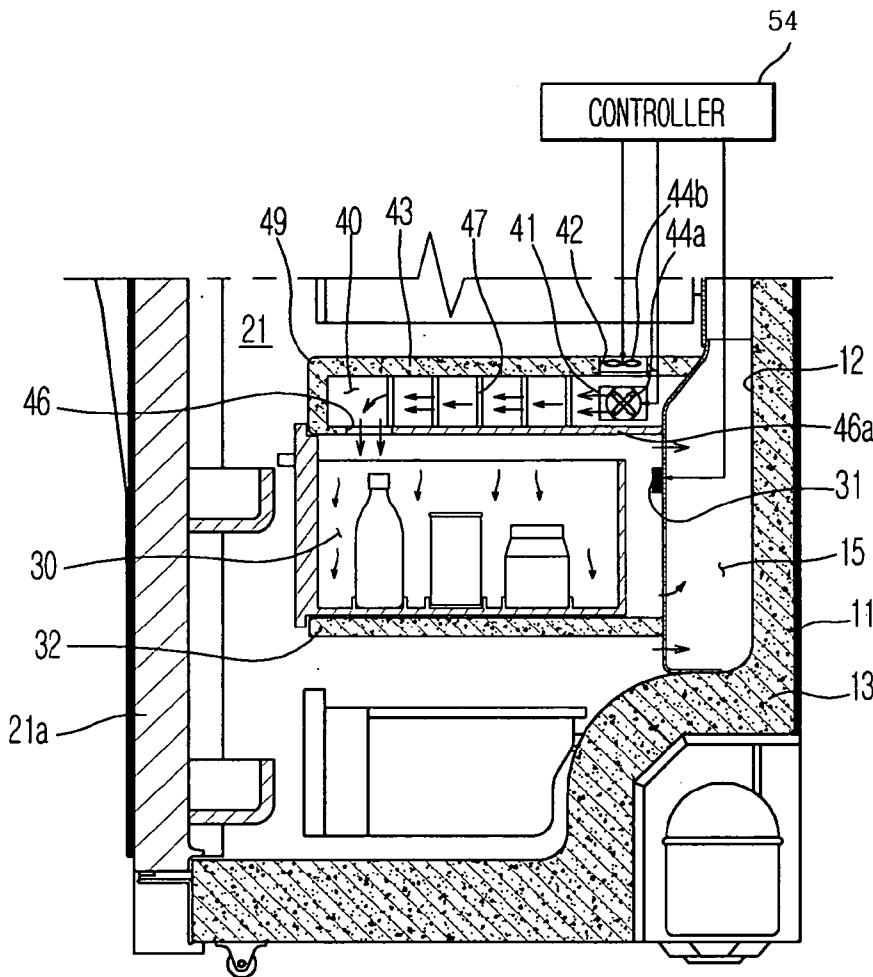


Fig. 1

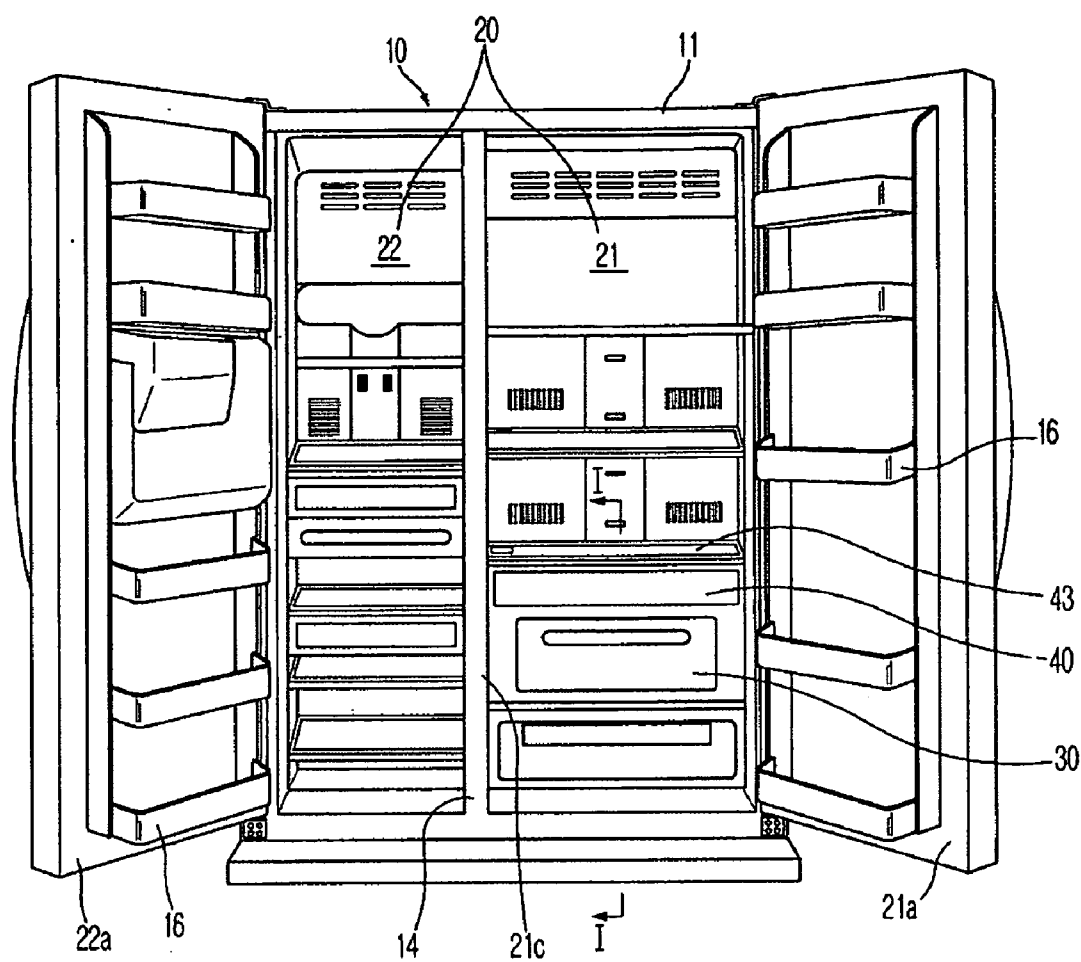


Fig. 2

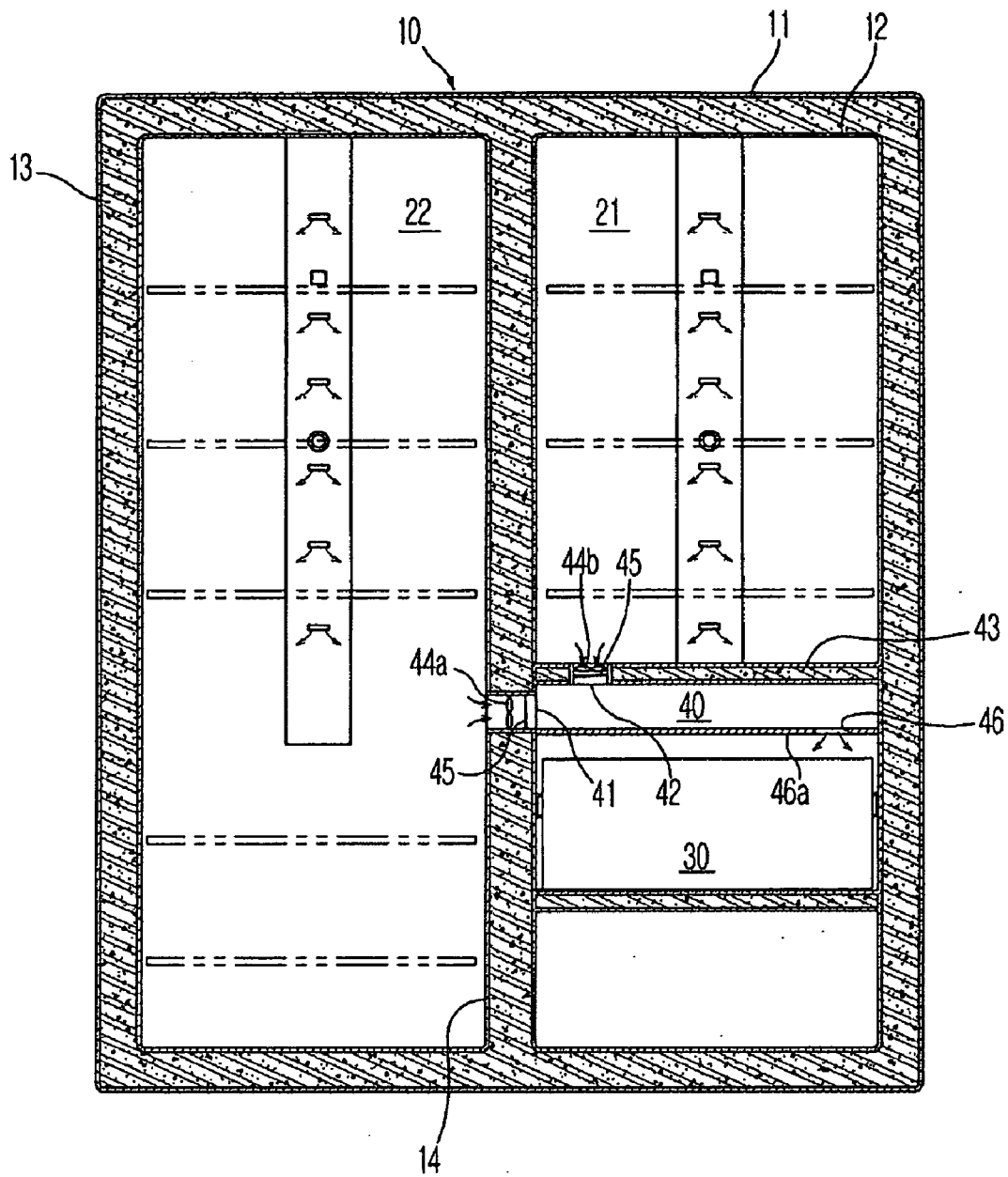


Fig. 3

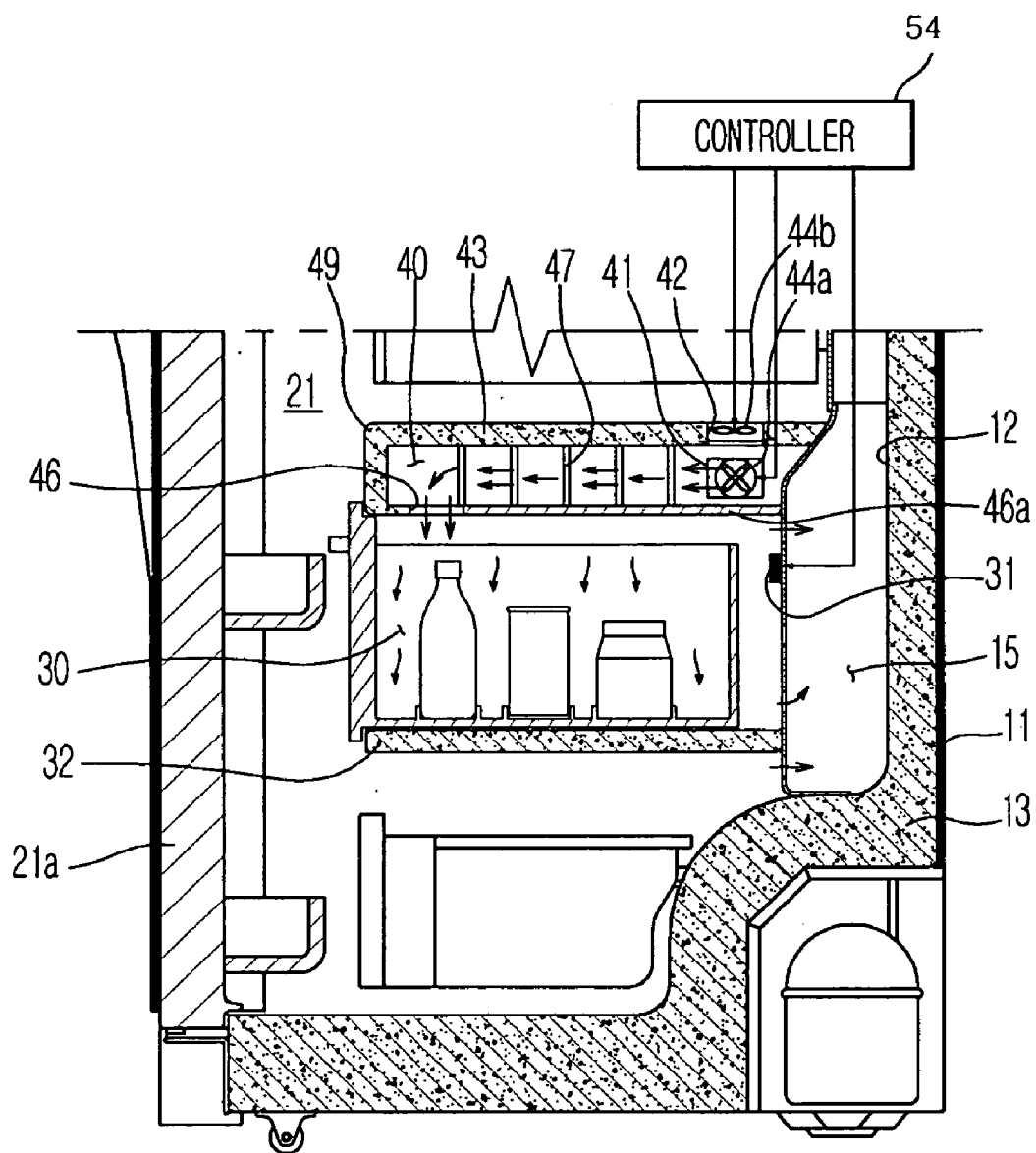


Fig. 4a

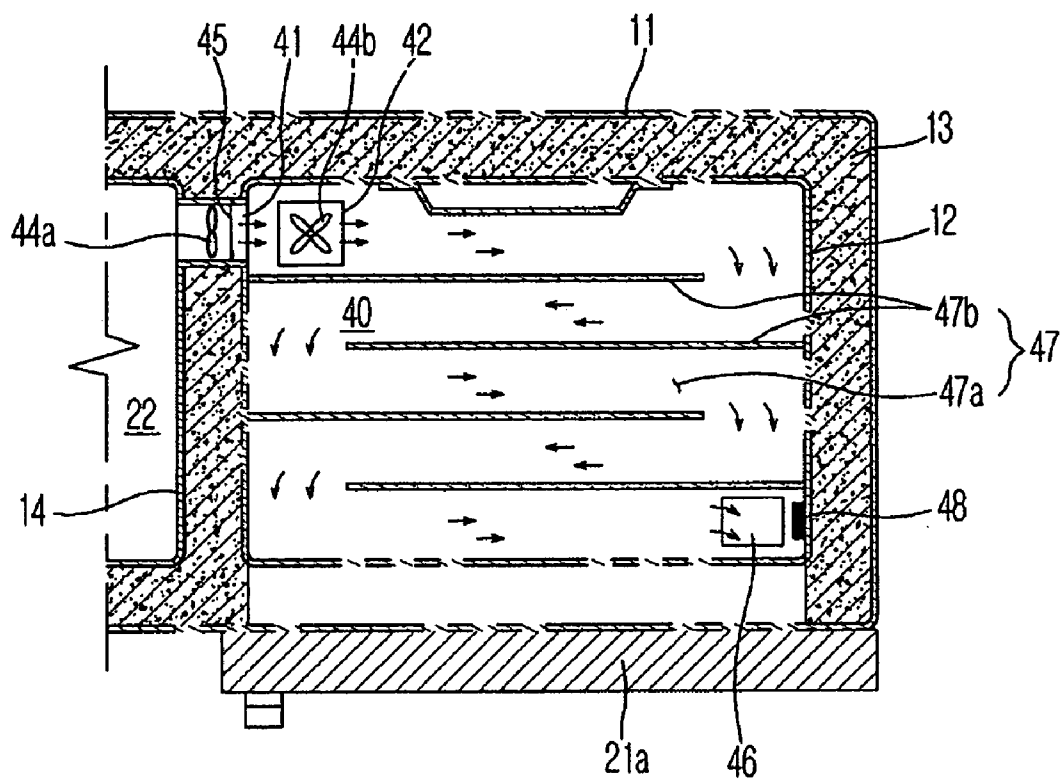


Fig. 4b

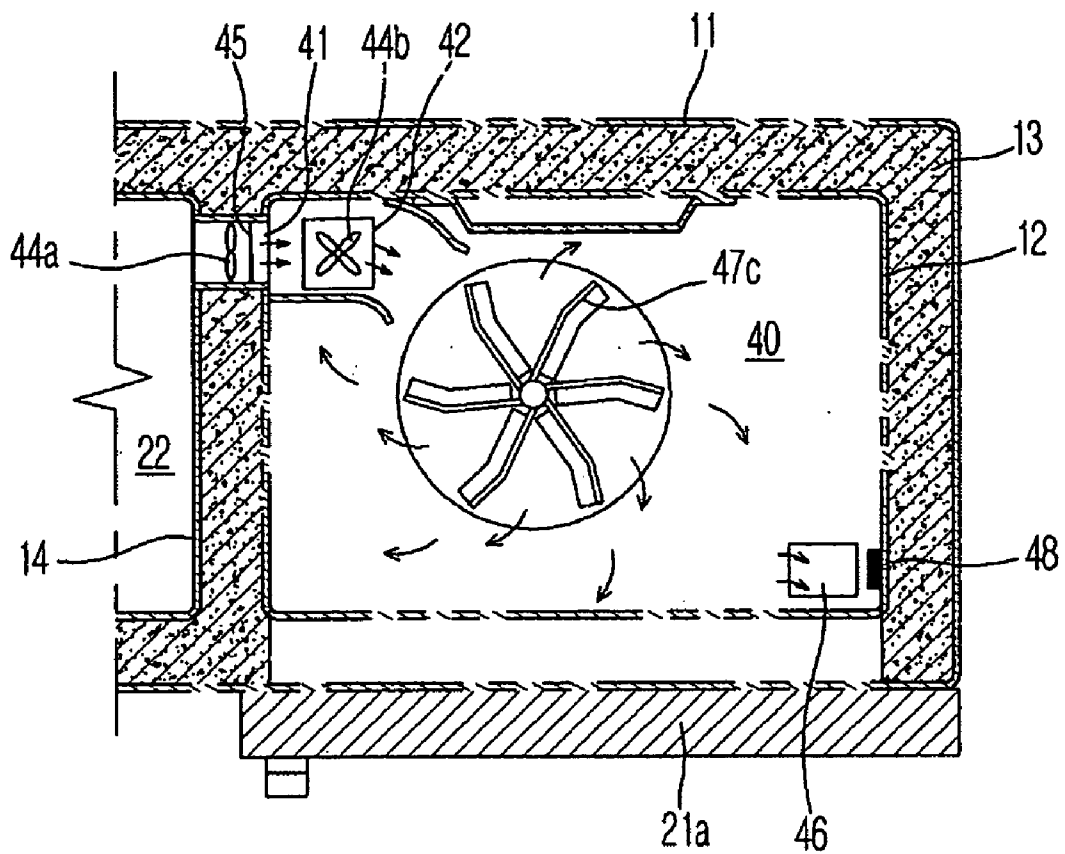


Fig. 5

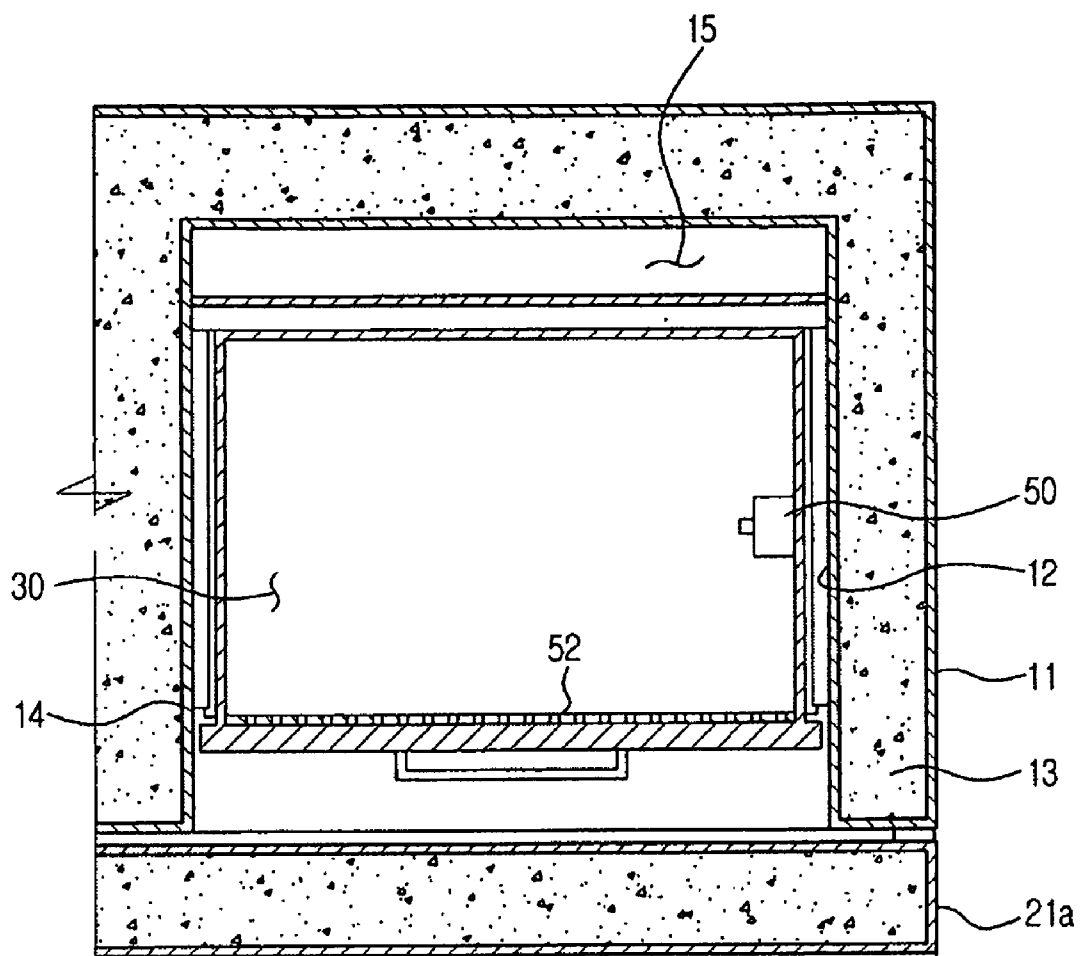


Fig. 6

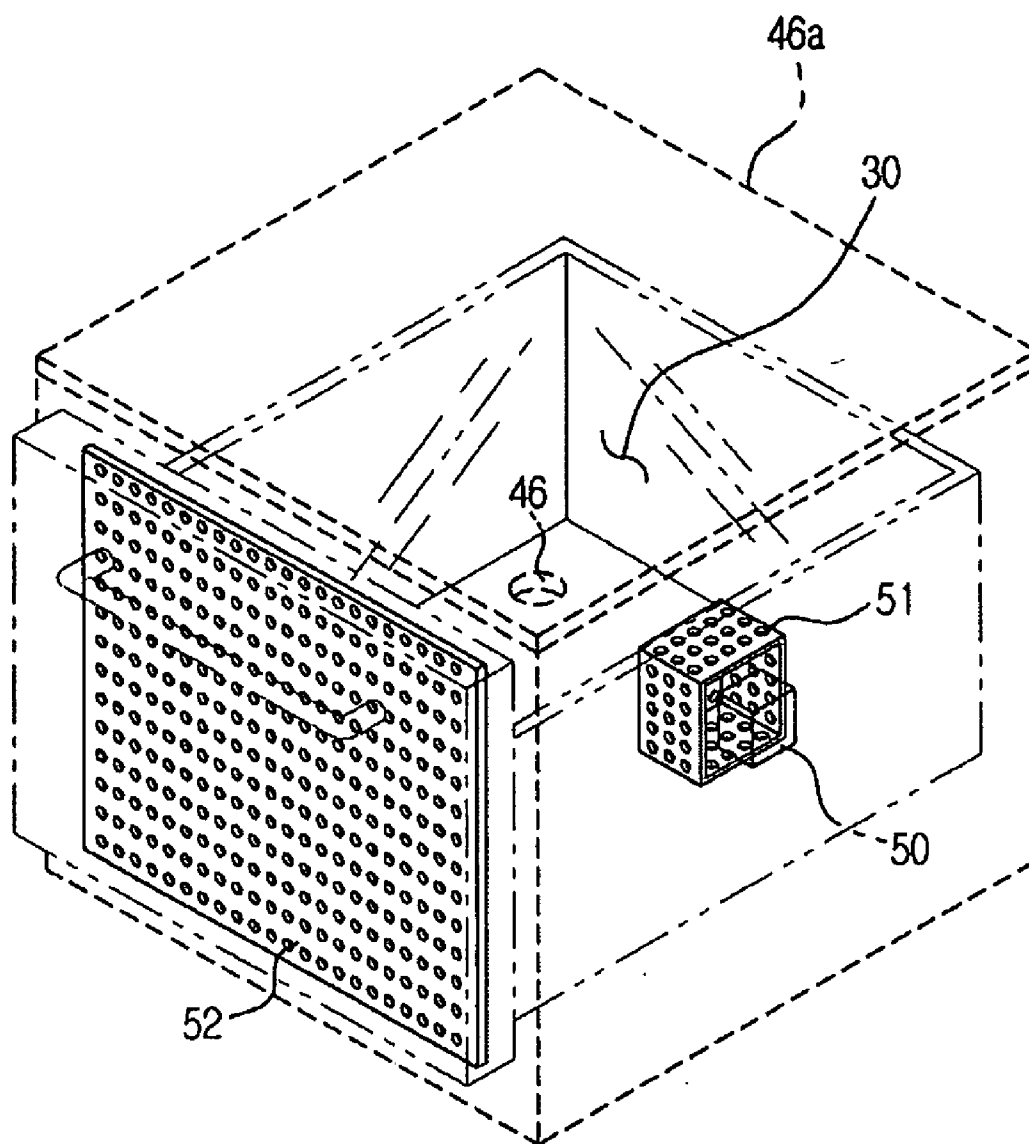


Fig. 7

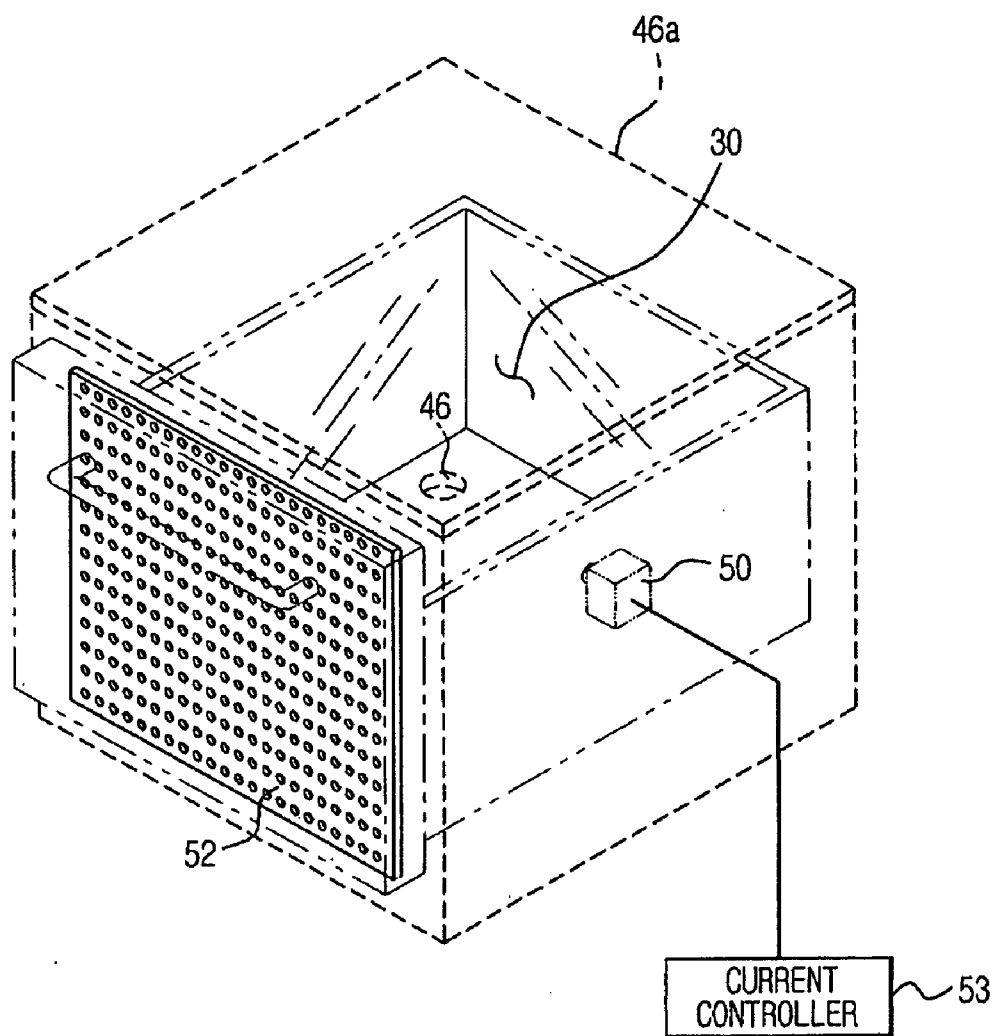


Fig. 8

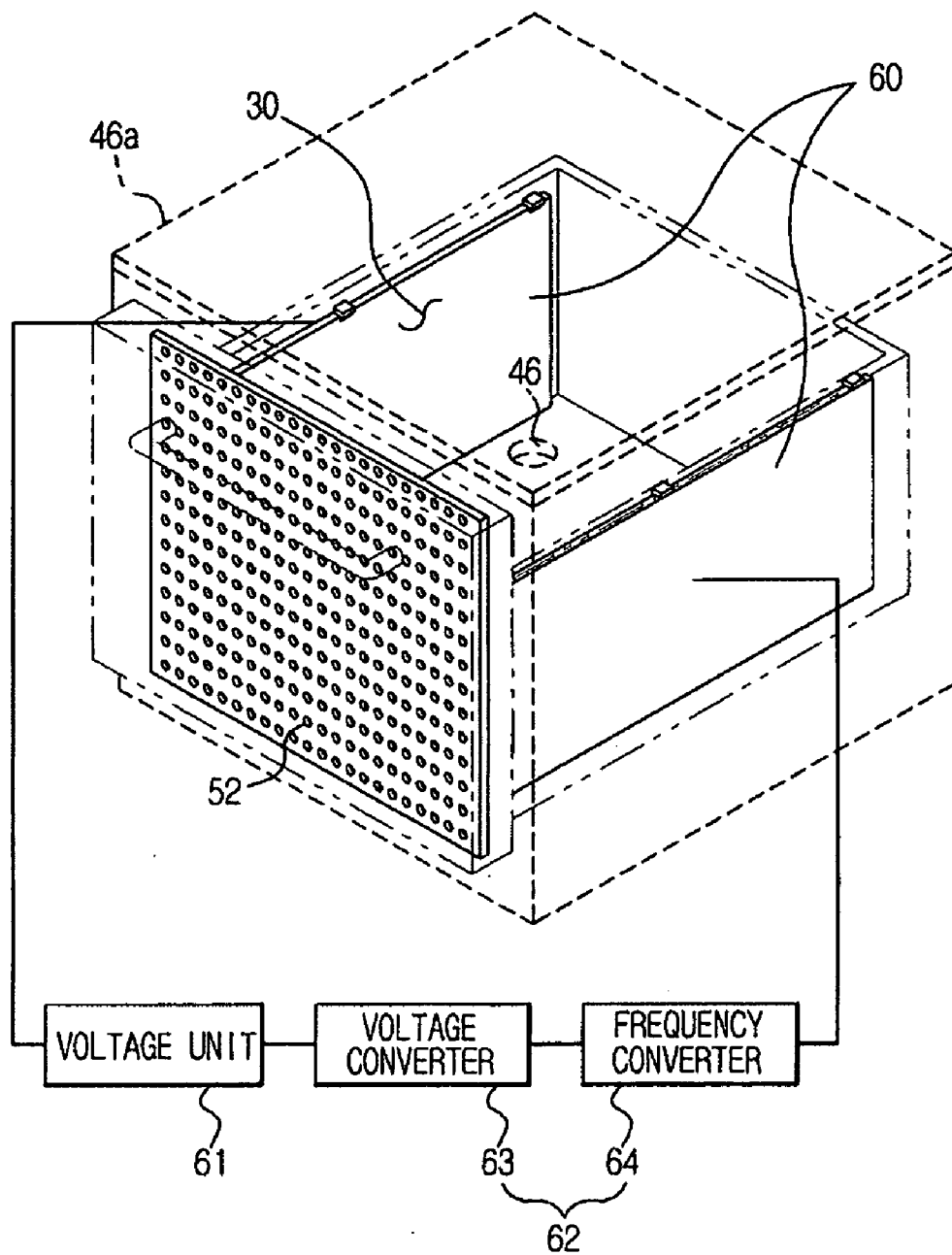


Fig. 9

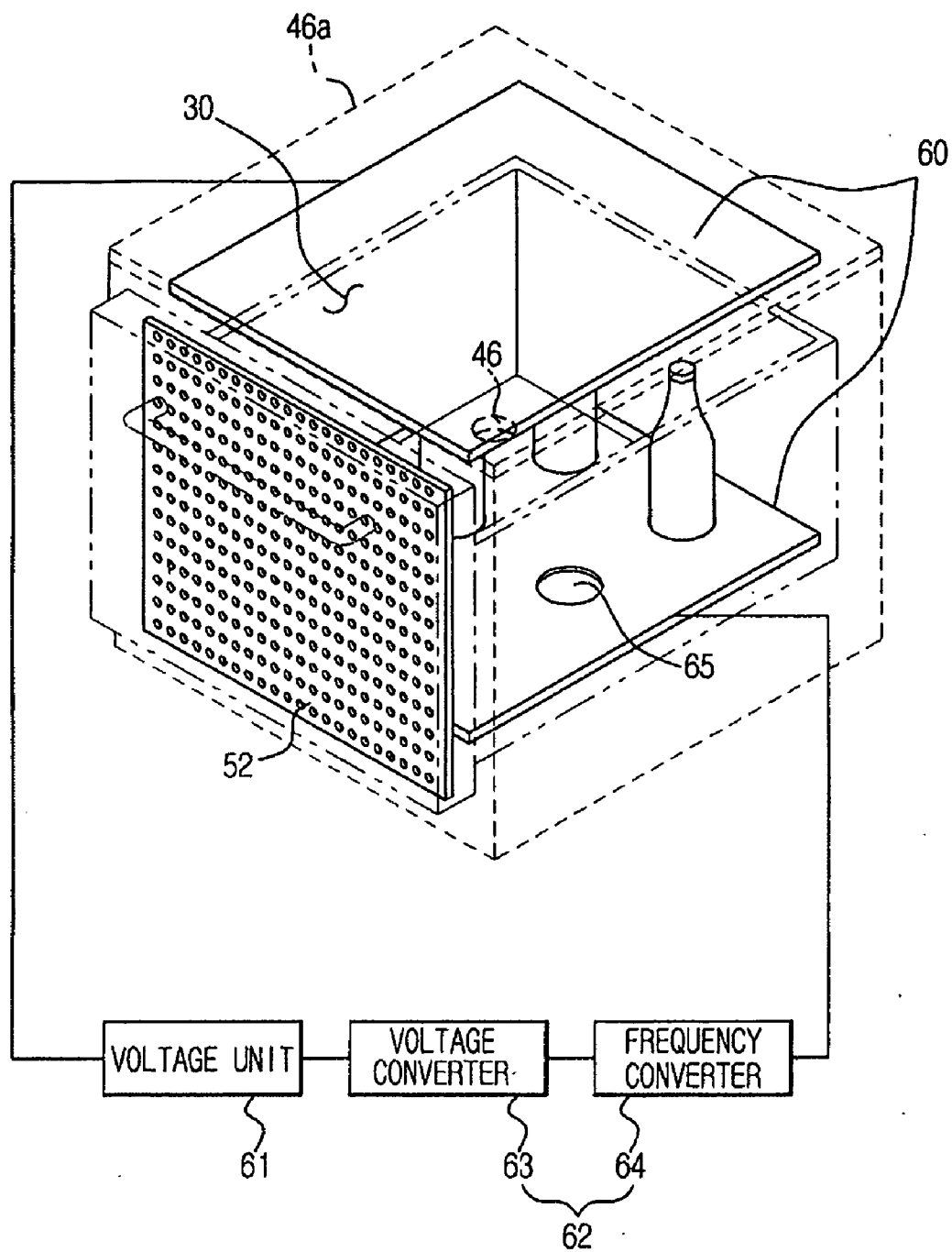


Fig. 10

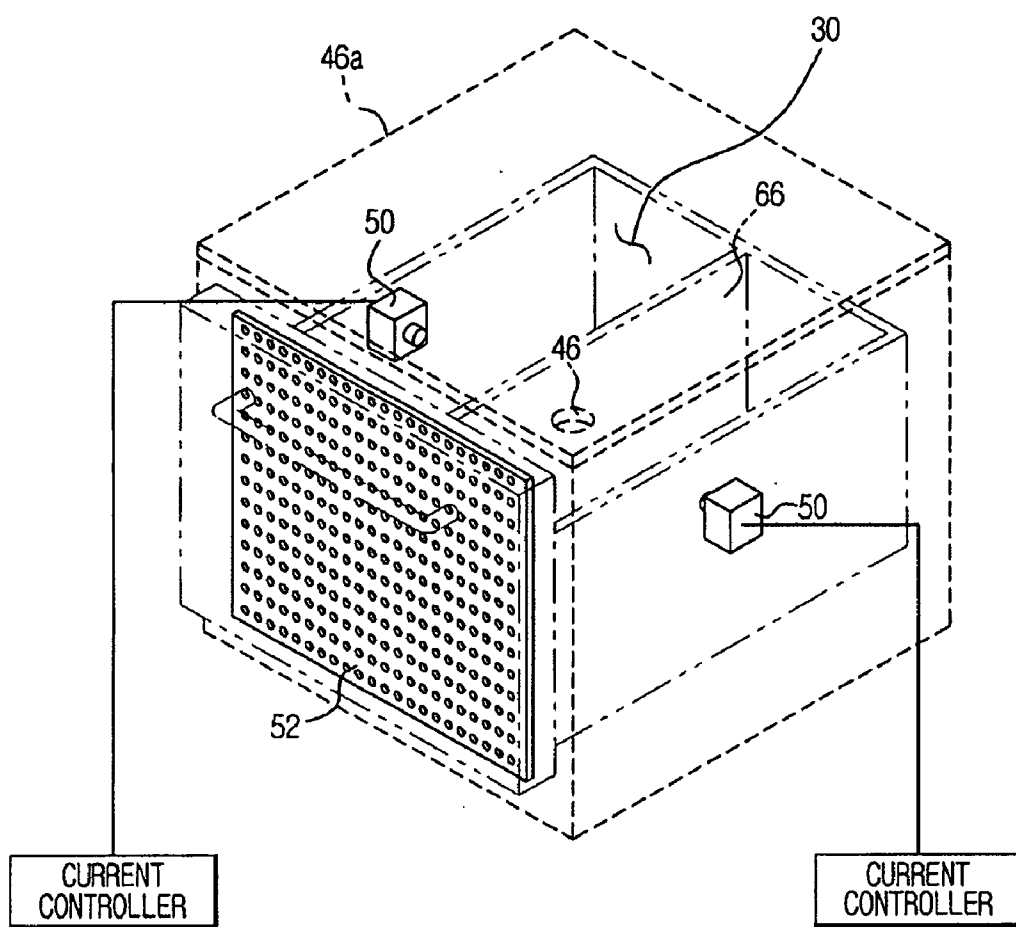
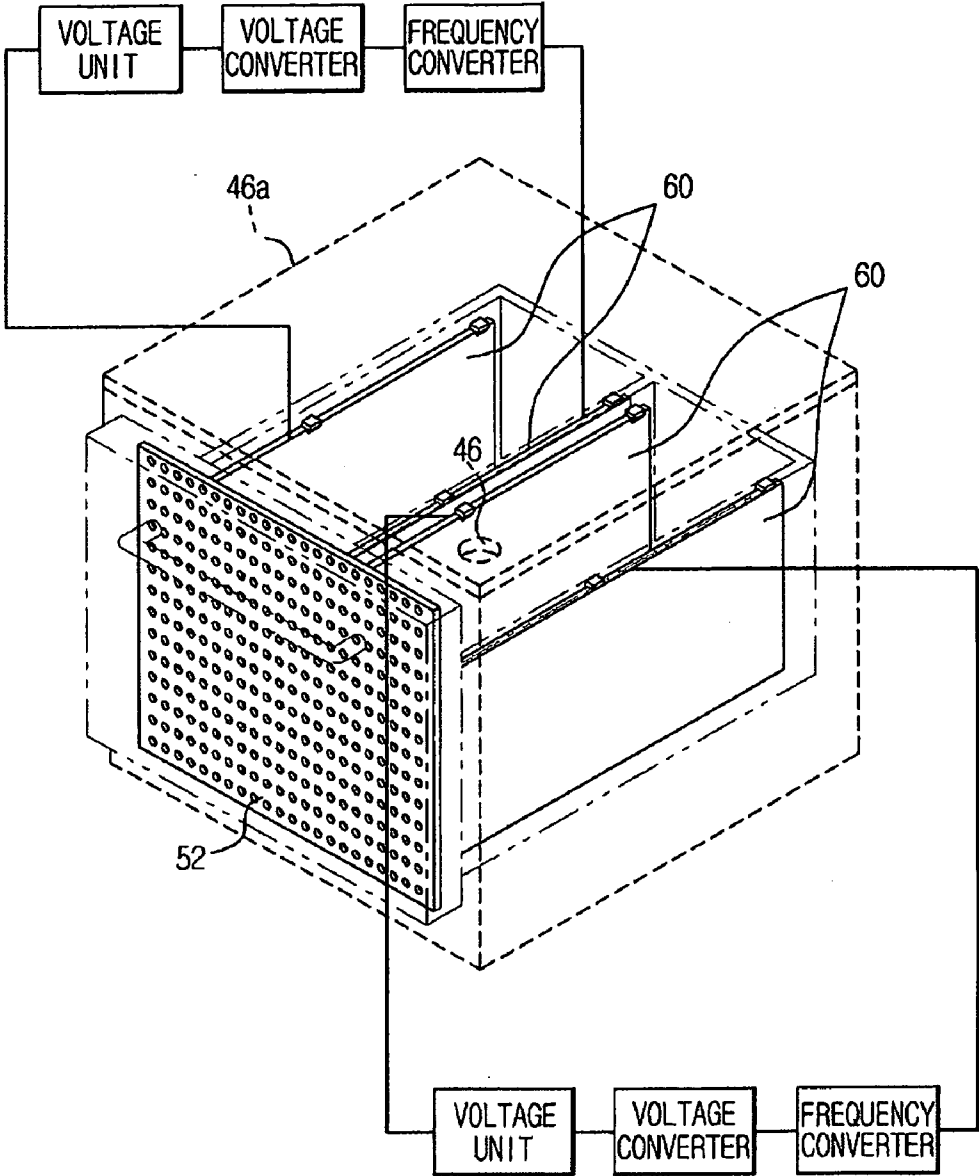


Fig. 11



**METHOD AND APPARATUS MAINTAINING
LIQUID BEVERAGES IN A SUPERCOOLED
STATE**

**CROSS-REFERENCE TO RELATED
APPLICATIONS**

[0001] This application claims the benefit of Korean Patent Application No. 10-2007-0034405, filed on Apr. 6, 2007 in the Korean Intellectual Property Office, the disclosure of which is incorporated herein by reference.

BACKGROUND

[0002] 1. Field

[0003] The present invention relates to a refrigerator, and, more particularly, to a refrigerator including a device to stably maintain liquid-phase beverages in a supercooled state.

[0004] 2. Description of the Related Art

[0005] Generally, liquid-phase beverages change into a solid phase when the temperature of a liquid-phase beverage is lower than the freezing point of the liquid at 1 atmosphere of pressure (for instance, 0° C. for water). In certain circumstances, however, a liquid-phase beverage does not freeze, but rather, becomes supercooled. The supercooled state of a liquid, in which the liquid does not freeze at a temperature below the freezing point of the liquid-phase beverage, is referred to as a metastable state. A supercooled liquid in a metastable state is neither solid nor liquid. For this reason, when the supercooled liquid is disturbed, the supercooled liquid is instantaneously changed into a solid phase. Consequently, when a beverage stored in the supercooled state is poured into a cooled cup, or impact or vibration is applied to the supercooled beverage, a consumer is provided with a beverage which is neither fully frozen nor fully melted. Hereinafter, a supercooled beverage which is changed into a solid state by disturbance will be referred to as slush.

[0006] Japanese Patent Application Publication No. 2003-214753 discusses a supercooling device that is capable of cooling a storage compartment to store beverages in a uniform temperature distribution, the supercooling device being constructed through a modification to the internal structure of a refrigerator. In this conventional art, a cool air supply duct and a cool air suction duct are mounted to opposite sidewalls of the storage compartment, and a connection duct is mounted to the upper wall of the storage compartment to connect the cool air supply duct and the cool air suction duct. The conventional supercooling device continuously circulates cool air through a channel defined by the cool air supply duct, the storage compartment, the cool air suction duct, and the connection duct to maintain the temperature distribution of the storage compartment uniformly.

[0007] It is important to maintain a uniform temperature distribution of the storage compartment to supercool a liquid beverage as in the disclosed conventional art. However, it is more important to maintain the temperature distribution of the storage compartment storing the liquid beverage as uniformly as possible, with the passage of time, to maintain the supercooled state of the liquid beverage and thus provide a consumer with a good-quality slush beverage. Specifically, when the temperature in the storage compartment greatly varies over time while maintaining a uniform average temperature, the beverage, which is in a supercooled state, is

frozen at the time at which the temperature of the storage compartment is the lowest, thus rendering it impossible to provide a slush beverage.

[0008] However, cooling the storage compartment using additionally generated cool air to maintain the supercooled state of the liquid-phase beverage is not efficient. A conventional refrigerator includes a freezer compartment and a refrigeration compartment. When the supercooled storage compartment is provided in this refrigerator, an additional evaporator must be mounted to supercool the beverage, which is inefficient from both a structural and a cost standpoint.

[0009] Consequently, a technology is needed to create and supply cool air suitable to supercool the liquid-phase beverage while utilizing the structure and characteristics of the conventional refrigerator that includes the freezer compartment and the refrigeration compartment.

[0010] However, various mixtures may be contained in a liquid beverage, and the ratios of the mixtures are different for all liquid beverages. As a result, liquid beverages have different freezing points. Specifically, the temperatures required to supercool various liquid beverages are different. For example, consider the instance in which liquid-phase beverages A and B have different freezing points and different critical supercooling temperatures (i.e., the minimum temperature to maintain a certain liquid-phase beverage in a supercooled state; when the temperature of a liquid-phase beverage is lower than the minimum temperature, the liquid-phase beverage is frozen) due to different mixture ratios contained in liquid-phase beverages A and B. When the critical supercooling temperature of liquid-phase beverage A is -12° C. and the critical supercooling temperature of liquid-phase beverage B is -15° C., liquid-phase beverage B is stored in a supercooled state at a temperature of -13° C., whereas liquid-phase beverage A is frozen at a temperature of -13° C.

[0011] Although liquid-phase beverages generally have different critical supercooling temperatures due to the difference of the mixture ratios contained in the liquid-phase beverages, liquid-phase beverages have similar supercooling temperature zones (i.e., the range between the highest temperature and the lowest temperature wherein a liquid-phase beverage is in a supercooled state).

[0012] Manufacturing various refrigerators to supercool various liquid-phase beverages is inefficient from a cost standpoint. For this reason, a technology is needed to create and supply cool air suitable for supercooling various liquid-phase beverages and to maintain the liquid-phase beverages in a supercooled state while utilizing the structure and characteristics of a conventional refrigerator, including a freezer compartment and a refrigeration compartment.

[0013] In addition, when liquid-phase beverages are disturbed, although cool air suitable to supercool liquid-phase beverages is supplied, there is a strong possibility that the liquid-phase beverages are frozen. Consequently, a technology is needed to maintain liquid-phase beverages in a supercooled state, even when the liquid-phase beverages are disturbed.

SUMMARY

[0014] Additional aspects and/or advantages will be set forth in part in the description which follows and, in part, will be apparent from the description, or may be learned by practice of the invention.

[0015] Therefore, it is an aspect of embodiments to provide a refrigerator including a device to restrain the freezing of

liquid-phase beverages, thereby stably maintaining liquid-phase beverages in a supercooled state.

[0016] In accordance with one embodiment, a refrigerator is provided including a main body, a supercooling chamber disposed in the main body such that cool air is supplied to the supercooling chamber, a microwave generator to oscillate microwaves to the supercooling chamber, and a control unit to control the magnitude of the microwaves oscillated from the microwave generator.

[0017] In one aspect, the microwave generator is a magnetron to oscillate microwaves.

[0018] In one aspect, the control unit includes a shielding member to control the transmissivity of microwaves oscillated from the magnetron to control the magnitude of the microwaves.

[0019] In one aspect, the shielding member is made of a metal plate having a lattice structure of a predetermined size.

[0020] In one aspect, the control unit includes a current controller to control current applied to the magnetron to control the magnitude of the microwaves in the supercooling chamber.

[0021] In one aspect, the microwave generator includes an electrode unit to create an electric field in the supercooling chamber and a voltage unit to apply an AC voltage to the electrode unit.

[0022] In one aspect, the electrode unit includes a pair of plates which are mounted to opposite wall sides of the supercooling chamber, respectively.

[0023] In one aspect, the plate mounted at the bottom of the supercooling chamber is provided with holes in which containers containing supercooled water are located.

[0024] In one aspect, the control unit includes a voltage control unit to control the voltage applied from the voltage unit to control the magnitude of the microwaves.

[0025] In one aspect, the voltage control unit includes a voltage converter to convert the magnitude of the voltage applied from the voltage unit and a frequency converter to convert the frequency of the voltage applied from the voltage unit.

[0026] In one aspect, the magnitude of the voltage converted by the voltage converter is 2 kV to 10 kV, and the frequency of the voltage converted by the frequency converter is 100 kHz to 1 MHz.

[0027] In accordance with another aspect of embodiments, a refrigerator is provided including a main body, a supercooling chamber disposed in the main body such that cool air is supplied to the supercooling chamber, at least one partition to divide an inner space of the supercooling chamber, a microwave generator to oscillate microwaves to each space of the supercooling chamber divided by the at least one partition, and a control unit to control the magnitude of the microwaves oscillated from the microwave generator.

[0028] A plurality of partitions may be included.

[0029] Additional aspects and/or advantages of the invention will be set forth in part in the description which follows and, in part, will be obvious from the description, or may be learned by practice of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0030] These and/or other aspects and advantages of the invention will become apparent and more readily appreciated from the following description of the embodiments, taken in conjunction with the accompanying drawings, of which:

[0031] FIG. 1 is a front view illustrating a refrigerator according to the present invention;

[0032] FIG. 2 is a front sectional view of the refrigerator of FIG. 1;

[0033] FIG. 3 is a sectional view taken along line I-I of FIG. 1;

[0034] FIGS. 4A and 4B are views illustrating a mixing unit defined in a mixing chamber of FIG. 3;

[0035] FIG. 5 is a plan sectional view illustrating a supercooling chamber of FIG. 1;

[0036] FIGS. 6 and 7 are perspective views illustrating a first embodiment of the supercooling chamber;

[0037] FIG. 8 is a perspective view illustrating a second embodiment of the supercooling chamber;

[0038] FIG. 9 is a perspective view illustrating a modification of the supercooling chamber according to the second embodiment of the present invention shown in FIG. 8;

[0039] FIG. 10 is a perspective view illustrating a modification of the supercooling chamber according to the first embodiment of the present invention shown in FIGS. 5, 6 and 7; and

[0040] FIG. 11 is a perspective view illustrating another modification of the supercooling chamber according to the second embodiment of the present invention shown in FIGS. 8 and 9.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0041] Reference will now be made in detail to the embodiments of the present invention, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to like elements throughout. The embodiments are described below to explain the present invention by referring to the figures.

[0042] FIG. 1 is a front view illustrating a refrigerator according to an embodiment, FIG. 2 is a front sectional view of the refrigerator of FIG. 1, and FIG. 3 is a sectional view taken along line I-I of FIG. 1.

[0043] As shown in FIGS. 1 to 3, the refrigerator according to the present invention includes a main body 10 which is open at the front. The main body 10 includes an outer liner 11 forming the outer surface of the main body 10 and an inner liner 12 disposed, while being spaced a predetermined distance from the outer liner 11, to define a storage chamber 20 for food storage. The space between the outer liner 11 and the inner liner 12 is filled with a foamed insulation member 13 to prevent cool air from escaping.

[0044] The storage chamber 20 is divided into two parts by a middle partition 14. A refrigeration compartment 21 is located in the right side part of the storage chamber 20 that stores food in a chilled state. A freezer compartment 22 is located in the left side part of the storage chamber 20 that stores food in a frozen state. A cool air generating chamber 15 is located at the rear of the storage chamber 20 that generates cool air, which will be supplied to the storage chamber 20. In the cool air generating chamber 15 is mounted an evaporator (not shown) to perform heat exchange with surrounding air in order to generate cool air. Adjacent to the evaporator is mounted a circulation fan (not shown) to blow the cool air into the storage chamber 20.

[0045] A refrigeration compartment door 21a and a freezer compartment door 22a are hingedly coupled to the front of the

refrigerating compartment 21 and the freezer compartment 22, respectively. Shelves 16 are mounted to the respective doors 21a and 22a.

[0046] The refrigerator further includes a supercooling chamber 30 disposed in the refrigerating compartment 21 to supercool liquid beverages to a temperature below the respective freezing points of the beverages at one atmosphere.

[0047] The minimum temperature at which the liquid-phase beverages are supercooled is decided depending upon various factors, such as the kind of liquid-phase beverages and the material and/or size of that containers store the liquid-phase beverages. However, when experiment data is statistically processed, only the material and/or size of containers typically used for storage of beverages is defined and other factors which are not affected (for example, cooling speed) are ignored, it is possible to decide an appropriate supercooling temperature depending upon the kind of liquid-phase beverages. For example, when the average critical supercooling temperature acquired through repetitive experiments on 200 ml of water contained in a glass container is -9°C ., this temperature or a temperature slightly higher than this temperature may be defined as a set temperature of the supercooling chamber 30 with respect to the water. When experiments are performed for various kinds of beverages in the same manner as the above-described experiment, it can be seen that the appropriate set temperature T of the supercooling chamber 30 for typical containers is approximately -5°C . to -12°C . This supercooling temperature zone (i.e., the range between the maximum temperature and the minimum temperature at which a certain liquid-phase beverage is supercooled) is between the normal temperature (-18°C . to -21°C .) of the freezer compartment 22 and the normal temperature (3°C . to 5°C .) of the refrigeration compartment 21. Consequently, it is possible to produce cool air to supercool the liquid-phase beverages through the appropriate mixing of cool air in the freezer compartment and cool air in the refrigeration compartment.

[0048] According to an embodiment of the present invention, the refrigerator further includes a mixing chamber 40 disposed in the refrigerating compartment 21 to suction and mix cool air from the freezer compartment 22 and the refrigeration compartment 21 to produce cool air which will be supplied to the supercooling chamber 30 and a controller/control unit 54 to control the amount of freezer compartment cool air and refrigeration compartment cool air suctioned into the mixing chamber 40 such that the temperature in the supercooling chamber 30 is maintained at the set temperature.

[0049] The mixing chamber 40 has a first suction, port 41 and a second suction port 42 to suction cool air from the freezer compartment 22 and the refrigeration compartment 21, respectively. When the mixing chamber 40 and the supercooling chamber 30 are disposed in the refrigeration compartment 21, as shown in FIGS. 2 and 3, the first suction port 41 enables air to flow from the freezer compartment 22 to the mixing chamber 40 through the middle partition 14, and the second suction port 42 enables air flow from the refrigeration compartment 21 to the mixing chamber 40 through one side of a partition to partition the mixing chamber 40 and the refrigerating compartment 21 from one another. Blowing fans 44a and 44b are mounted in the first suction port 41 and the second suction port 42, respectively, to provide power necessary to suction freezer compartment cool air and refrigeration compartment cool air into the mixing chamber 40. The first suction port 41 and the second suction port 42 have flaps 45 to

open and close the first suction port 41 or the second suction port 42 based on the operation of the blowing fans 44a and 44b.

[0050] The mixing chamber 40 and the supercooling chamber 30 are adjacent to each other and partitioned from one another by a partition plate 46a. Cool air, mixed in the mixing chamber 40, is directly sprayed into the supercooling chamber 30. The mixing chamber 40 has a cool air supply port 46, which is formed in the partition plate 46a.

[0051] The mixing chamber 40 may include a mixing unit 47 to mix the cool air suctioned through the first suction port 41 and the cool air suctioned through the second suction port 42, while the cool air moves to the cool air supply port 46, such that the cool air is properly mixed. As shown in FIG. 4A, the mixing unit 47 may include a mixing channel 47a located between the first and second suction ports 41 and 42 and the cool air supply port 46. FIG. 4A is a plan sectional view illustrating the mixing channel 47a defined in the mixing chamber of FIG. 3. The mixing channel 47a is formed in a serpentine fashion by at least one channel forming plate 47b. Alternatively, the mixing unit may include a fan 47c rotatable in the mixing chamber 40 to accelerate the mixing of the cool air, as shown in FIG. 4B. The fan 47c is mounted in the mixing chamber 40 without an additional drive unit, such as a motor. The fan 47c is rotated by the flow of the cool air suctioned into the mixing chamber 40 to accelerate the mixing of the cool air from the freezer compartment 22 and the refrigeration compartment 21.

[0052] The supercooling chamber 30 includes a temperature sensor 31 to measure the interior temperature of the supercooling chamber 30. The control unit 54 compares the temperature measured by the temperature sensor 31 with the set temperature of the supercooling chamber 30, and controls the operation of the blowing fans 44a and 44b, based on the result of the comparison in order to control the amount of freezing compartment cool air and refrigerating compartment cool air suctioned by the blowing fans. For example, when the set temperature of the supercooling chamber 30 is -7°C . and the temperature measured by the temperature sensor 31 is -5°C ., the control unit 54 controls the blowing fans 44a and 44b to increase the suction rate of the freezing compartment cool air to lower the temperature of the mixed cool air to -7°C . As shown in FIGS. 4A and 4B, a temperature sensor 48 may be mounted in the mixing chamber 40. Preferably, the temperature sensor 48 is mounted adjacent to the cool air supply port 46 to measure the temperature of the mixed cool air when the mixed cool air is supplied to the supercooling chamber 30.

[0053] The mixing chamber 40 and the supercooling chamber 30 have insulation members 49 and 32 to isolate the mixing chamber 40 and the supercooling chamber 30 from the refrigeration compartment 21 in order to prevent the leakage of cool air so the mixing chamber 40 and the supercooling chamber 30 are not affected by the interior temperature of the refrigeration compartment 21.

[0054] In an embodiment, the air temperature of the supercooling chamber 30 is within the supercooling temperature zone. To prevent liquid-phase beverages in a supercooled state from being frozen in the supercooling chamber 30, it is necessary to consider the effect of disturbances on the liquid-phase beverages, in addition temperature control. For example, the liquid-phase beverages, which are in a metastable state, may be frozen due to disturbance such as vibration generated when the doors 21a and 22a are opened and closed or vibration generated by the operation of a compress-

sor. Consequently, a technology to prevent disturbed liquid-phase beverages from being frozen is required.

[0055] FIG. 5 is a perspective view illustrating a magnetron mounted in the supercooling chamber, FIG. 6 is a perspective view illustrating a shielding member mounted in the supercooling chamber and FIG. 7 is a perspective view illustrating a current controller mounted in the supercooling chamber.

[0056] According to an embodiment, as shown in FIG. 5, a magnetron 50 is mounted at the middle of the sidewall of the supercooling chamber 30 to stably maintain liquid-phase beverages in a supercooled state. Magnetrons, such as the magnetron 50 illustrated in FIG. 5, are often used in microwave ovens. The magnetron 50 may include an anode made of copper, a cathode formed in the shape of a cylindrical coil, and a magnet to maintain a magnetic field at a right angle between the anode and the cathode. Conventional magnetrons are well known to those skilled in the art, so a detailed description thereof is not provided.

[0057] The magnetron 50 oscillates microwaves towards the supercooling chamber 30. The microwaves apply vibration energy to the molecular structure of the liquid beverages to prevent the molecular structure of the liquid beverages from being stabilized, thereby preventing the liquid-phase beverages from freezing. The magnitude of the microwaves must be sufficiently low so as to prevent the liquid-phase beverages from being overly heated. To this end, the refrigerator is provided with control units 51 and 53 to control the magnitude of the microwaves.

[0058] As shown in FIG. 6, a shielding member 51 is used to control the transmissivity and magnitude of microwaves oscillated from the magnetron 50. The shielding member 51 is constructed from a metal plate having lattice holes of a predetermined size. The shielding member 51 may be formed in the shape of an approximately regular hexahedron open at one side. The magnetron 50 is located within the shielding member 51. The shielding member 51 allows some of the microwaves oscillated from the magnetron 50 to pass through, thereby controlling the transmissivity of the microwaves.

[0059] As shown in FIG. 7, a current controller 53 may be used to control the frequency of microwaves oscillated from the magnetron 50. It is possible to control the frequency of microwaves oscillated from the magnetron 50 by controlling the current applied to the magnetron 50 via the current controller 53.

[0060] When designing or operating the shielding member 51 or the current controller 53, only an amount of vibration energy sufficient to prevent freezing of the liquid-phase beverages should be transmitted to the liquid-phase beverages. When the vibration energy transmitted to the liquid beverages is too large, the liquid-phase beverages do not freeze, but the liquid-phase beverages may be heated due to the friction between the molecules of the liquid-phase beverages, and the temperature of the liquid-phase beverages may climb out of the supercooling temperature zone.

[0061] When the magnetron 50 is mounted in the supercooling chamber 30, a shielding film 52 is mounted to the inner wall of the supercooling chamber 30 at the side of the refrigeration compartment door 21a to prevent transmitted microwaves from reaching a user from being affected by the microwaves transmitted from the supercooling chamber 30 through the refrigeration compartment door 21a. Also, a reflection plate (not shown) is mounted to the inner wall of the

supercooling chamber 30 where the shielding film 52 is not mounted such that the microwaves are easily transmitted to the liquid-phase beverages.

[0062] When the set temperature of the supercooling chamber 30 is decided depending upon the kind of beverages to be supercooled, the blowing fans 44a and 44b are operated such that cool air from the freezer compartment 22 is introduced into the mixing chamber 40 through the first suction port 41 and cool air from the refrigeration compartment 21 is introduced into the mixing chamber 40 through the second suction port 42. The cool air from the freezer compartment and the cool air from the refrigeration compartment are suctioned into the mixing chamber 40 and heat-exchanged with each other while passing through the mixing channel 47a, resulting in balancing of the cool air from the freezer compartment and the cool air from the refrigeration compartment. Subsequently, the balanced cool air is supplied to the supercooling chamber 30 through the cool air supply port 46 to supercool the liquid-phase beverages stored in the supercooling chamber 30.

[0063] The temperature sensor 31 mounted in the supercooling chamber 30 measures the temperature of the supercooling chamber 30 and transmits the measured temperature data to the control unit 54. The control unit 54 compares the temperature measured by the temperature sensor 31 with the set temperature of the supercooling chamber 30 and controls the operation of the blowing fans 44a and 44b based on the comparison. The amount of cool air suctioned from the freezer compartment and the amount of cool air suctioned from the refrigeration compartment is controlled such that the temperature of the cool air mixed in the mixing chamber 40 approximates the set temperature of the supercooling chamber 30. Consequently, the supercooling chamber 30 is maintained at the set temperature.

[0064] In addition, the magnitude of the microwaves is controlled by the shielding member 51 or the current controller 53, and the microwaves are continuously oscillated from the magnetron 50 while the cool air is supplied to the supercooling chamber 30. This prevents the liquid-phase beverages from freezing, even when the supercooled liquid-phase beverages are disturbed. Thus, the liquid-phase beverages are stably maintained in a supercooled state.

[0065] FIG. 3 illustrates the mixing chamber 40 and the supercooling chamber 30 as being mounted in the refrigerating compartment 21. Alternatively, the mixing chamber 40 and the supercooling chamber 30 may be mounted in the freezing compartment 22. In this case, the second suction port for suctioning refrigeration compartment cool air communicates with the refrigerating compartment through the middle partition.

[0066] According to another embodiment, the refrigerator further includes a supercooling chamber 30 disposed in the refrigerating compartment 21 to supercool liquid-phase beverages below the freezing point and a microwave generator to oscillate microwaves in order to stably maintain the liquid-phase beverages in a supercooled state.

[0067] The mixing chamber 40 that mixes cool air supplied from the freezer compartment 22 with cool air supplied from the refrigeration compartment 21 and the control of the temperature of the supercooling chamber 30 are as described above. Consequently, only the microwave generator will be described below.

[0068] FIG. 8 is a perspective view illustrating an electrode unit mounted in the supercooling chamber.

[0069] As shown in FIG. 8, the refrigerator further includes an electrode unit 60 to create an electric field in the supercooling chamber 30 such that the liquid-phase beverages are maintained in the supercooled state and a voltage unit 61 to apply an AC voltage to the electrode unit 60. The electrode unit 60 includes a pair of plates which are mounted to opposite walls of the supercooling chamber 30, respectively. A voltage control unit 62 is provided to control the voltage unit 61, which applies voltage to the electrode unit 60, in order to control the magnitude of the microwaves.

[0070] The voltage control unit 62 is a control device of the refrigerator according to the second embodiment of the present invention. The voltage control unit 62 includes a voltage converter 63 to convert the magnitude of the voltage applied from the voltage unit 61 and a frequency converter 64 to convert the frequency of the voltage applied from the voltage unit 61. The voltage converter 63 amplifies the magnitude of the voltage applied from the voltage unit 61 and the frequency converter 64 amplifies the frequency of the voltage applied from the voltage unit 61 to a higher frequency.

[0071] The microwaves in the supercooling chamber 30 are related to the electric field created in the supercooling chamber 30. The electric field is related to the area of the plates mounted to the wall of the supercooling chamber 30 and the distance between the plates. In order to oscillate microwaves necessary to stably maintain the supercooled state of the liquid-phase beverages, the amplification degree of the voltage converter 63 and the frequency converter 64 is decided based upon the area of the plates and the distance between the plates. For example, when the horizontal length of each plate is approximately 40 cm, the vertical length of each plate is approximately 50 cm, and the distance between the plates is approximately 50 cm, the magnitude of the voltage converted by the voltage converter 63 must be between 2 kV and 10 kV and the frequency of the voltage converted by the frequency converter 64 must be between 100 kHz and 1 MHz. The microwaves created when the AC voltage is applied to the electrode unit 60 apply vibration energy to the molecular structure of the liquid-phase beverages to prevent the liquid-phase beverages from freezing.

[0072] FIG. 9 is a perspective view illustrating holes formed in the electrode unit.

[0073] As shown in FIG. 9, an electrode unit 60 includes a pair of plates, which are mounted at the upper and lower wall sides of the supercooling chamber 30. The plate mounted at the bottom of the supercooling chamber 30 is provided with holes 65 in which containers containing liquid-phase beverages are located. When the containers are located in respective holes 65, the sensitivity of the liquid-phase beverages to disturbances such as vibration is lowered.

[0074] The construction of the microwave generator to oscillate the microwaves to the supercooling chamber 30 and the construction of the control unit to control the magnitude of the microwaves were previously described in detail with reference to FIG. 8, and therefore, a detailed description thereof will not be given.

[0075] FIGS. 10 and 11 are perspective views illustrating a partition to divide the inner space of the supercooling chamber.

[0076] As shown in FIG. 10, a partition 66 is mounted in the middle of the supercooling chamber 30. A magnetron 50 is mounted in each divided space of the supercooling chamber 30. Consequently, as shown in FIGS. 5 to 7, the magnetron 50 is controlled by the shielding member 51 or the current con-

troller 53 such that microwaves having different magnitudes are oscillated to the respective divided spaces of the supercooling chamber 30.

[0077] As shown in FIG. 11, a partition 66 is mounted in the middle of the supercooling chamber 30. An electrode unit 60, including a pair of plates, is mounted in each divided space of the supercooling chamber 30. Consequently, as shown in FIG. 8, the magnitude of the electric field created by the electrode units 60 is controlled by the voltage control unit 62 such that microwaves having different magnitudes are oscillated to the respective divided spaces of the supercooling chamber 30.

[0078] A plurality of partitions 66 may be provided to stably maintain various liquid-phase beverages in a supercooled state.

[0079] When the critical supercooling temperatures and the supercooling temperature zones of various liquid-phase beverages are different from each other and the liquid-phase beverages cannot be placed in the supercooling chamber together, it is possible to separately store the liquid beverages based on the critical supercooling temperatures and the supercooling temperature zones of the respective liquid-phase beverages. For example, when liquid-phase beverage A has a critical supercooling temperature of -12°C . and a supercooling temperature zone of -5°C . to -12°C ., and liquid-phase beverage B has a critical supercooling temperature of -15°C . and a supercooling temperature zone of -10°C . to -125°C ., liquid-phase beverage A and liquid-phase beverage B are stored in different partitions of the supercooling chamber 30, and microwaves having different magnitudes are oscillated so as to stably maintain liquid-phase beverage A and liquid-phase beverage B in a supercooled state.

[0080] In addition, the microwave generator, which oscillates the microwaves, is mounted in the supercooling chamber, as described in detail with reference to FIGS. 5 to 9, whereby the microwaves prevent the liquid-phase beverages from freezing even when the temperature of the supercooling chamber becomes lower than the set temperature (-5°C . to -12°C .) of the supercooling chamber, and therefore, the supercooled degree of the liquid-phase beverages (the degree in which the supercooled liquid-phase beverages become stable or slush) is increased. For example, an additional fan (not shown) may be mounted in the supercooling chamber 30 to lower the temperature of the supercooling chamber 30 below the set temperature of the supercooling chamber 30.

[0081] Generally, the liquid-phase beverages are frozen when the liquid-phase beverages are out of the supercooling temperature zone. However, the freezing of the liquid-phase beverages is restrained when the microwaves are oscillated to the supercooling chamber 30 such that the liquid-phase beverages are maintained in a supercooled state. In this case, the supercooled state of the liquid-phase beverages is maintained at a lower temperature, and therefore, the supercooled degree of the liquid-phase beverages is increased.

[0082] As apparent from the above description, the refrigerator has the effect of restraining the freezing of liquid-phase beverages using the microwave generator, thereby stably maintaining liquid-phase beverages in a supercooled state.

[0083] In addition, the microwave generator, which oscillates the microwaves, is mounted in the supercooling chamber, and the microwaves prevent the liquid beverages from freezing, even when the temperature of the supercooling chamber is lower than the set temperature (-5°C . to -12°C .)

of the supercooling chamber, thereby increasing the supercooled degree of the liquid-phase beverages.

[0084] Furthermore, a microwave generator is mounted in each of the divided spaces of the supercooling chamber, and therefore, it is possible to stably maintain liquid-phase beverages in a supercooled state, even when the liquid-phase beverages have different supercooling temperature zones.

[0085] Although a few embodiments of the present invention have been shown and described, it would be appreciated by those skilled in the art that changes may be made in the embodiments without departing from the principles and spirit of the invention, the scope of which is defined in the claims and their equivalents.

What is claimed is:

- 1. A refrigerator, comprising:
 - a main body;
 - a supercooling chamber disposed in the main body such that cool air is supplied to the supercooling chamber;
 - a microwave generator to oscillate microwaves to the supercooling chamber; and
 - a control unit to control the magnitude of the microwaves oscillated from the microwave generator.
- 2. The refrigerator according to claim 1, wherein the microwave generator is a magnetron.
- 3. The refrigerator according to claim 2, wherein the control unit includes a shielding member to control the transmissivity of microwaves oscillated by the magnetron to control the magnitude of the microwaves.
- 4. The refrigerator according to claim 3, wherein the shielding member is made of a metal plate having a lattice structure of a predetermined size.
- 5. The refrigerator according to claim 2, wherein the control unit includes a current controller to control current applied to the magnetron to control the magnitude of the microwaves in the supercooling chamber.
- 6. The refrigerator according to claim 1, wherein the microwave generator includes an electrode unit to create an electric field in the supercooling chamber and a voltage unit to apply an AC voltage to the electrode unit.
- 7. The refrigerator according to claim 6, wherein the electrode unit includes a pair of plates which are mounted to opposite walls of the supercooling chamber, respectively.
- 8. The refrigerator according to claim 7, wherein the plate mounted at the bottom of the supercooling chamber is provided with holes in which containers containing supercooled water are located.

9. The refrigerator according to claim 6, wherein the control unit includes a voltage control unit to control the voltage applied by the voltage unit to control the magnitude of the microwaves.

10. The refrigerator according to claim 9, wherein the voltage control unit includes a voltage converter to convert the magnitude of the voltage applied by the voltage unit and a frequency converter to convert the frequency of the voltage applied by the voltage unit.

11. The refrigerator according to claim 10, wherein the magnitude of the voltage converted by the voltage converter is 2 kV to 10 kV, and the frequency of the voltage converted by the frequency converter is 100 kHz to 1 MHz.

12. A refrigerator, comprising:

- a main body;
- a supercooling chamber disposed in the main body such that cool air is supplied to the supercooling chamber;
- at least one partition to divide an inner space of the supercooling chamber;
- a microwave generator to oscillate microwaves to each space of the supercooling chamber divided by the at least one partition; and
- a control unit to control a magnitude of the microwaves oscillated by the microwave generator.

13. The refrigerator according to claim 12, wherein the at least one partition includes a plurality of partitions.

14. A method, comprising:

- mixing air from a refrigeration compartment and a freezer compartment so a temperature of the mixed air reaches a predetermined temperature;
- directing the mixed air into a supercooling chamber; and
- oscillating microwaves through the supercooling chamber, thereby preventing one or more supercooled beverages stored in the supercooling chamber from freezing despite agitation.

15. The method according to claim 14, further comprising: controlling a magnitude of the oscillated microwaves to attain the desired supercooled degree of the supercooled beverages.

16. The method of claim 14, wherein the supercooling chamber is partitioned into multiple partitions, the magnitude of the microwaves oscillated through each partition controlled to supercool beverages stored in each partition based on the appropriate set temperature for beverages in the respective partitions.

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