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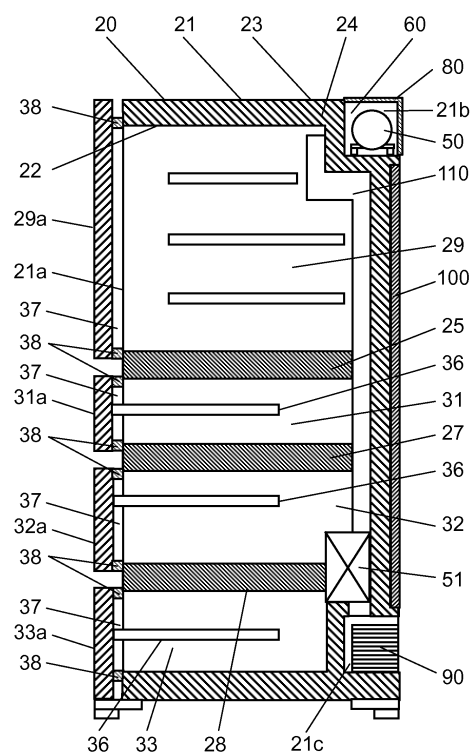
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(54) **REFRIGERATOR**

(57) A refrigerator (300) includes a heat insulation box (21) having a heat insulation wall, a machine compartment (60) disposed on a back surface side of the heat insulation box (21), a refrigeration cycle including at least a compressor (50), and a controller which controls operation of the compressor (50). The compressor (50) and the controller are disposed in the machine compartment (60), the machine compartment (60) is disposed opposed to a storage compartment with the heat insulation wall interposed therebetween, the storage compartment being set to a cooling temperature zone. Accordingly, it is possible to reduce an amount of consumed power at low cost without investing in a mold or adding a new member.

FIG. 2



300

Description

TECHNICAL FIELD

5 **[0001]** The present invention relates to a refrigerator, and more particularly, to a structure of a heat insulation box of the refrigerator.

BACKGROUND ART

10 **[0002]** In conventional refrigerator 500, an accommodating section for a substrate such as a control circuit substrate is formed in an intermediate portion of a back surface portion of a heat insulation box of refrigerator 500 in the vertical direction (see PTL 1 for example).

[0003] FIG. 6 is a side sectional view showing an internal structure of conventional refrigerator 500.

15 **[0004]** Heat insulation box 102 of body 101 of refrigerator 500 is formed by foaming and charging heat insulation material 105 between outer box 103 made of steel plate and inner box 104 made of resin.

[0005] Machine compartment 106 is formed in a lower portion on a far side of heat insulation box 102 by entirely notching a portion of a bottom surface portion of heat insulation box 102 in the lateral direction as viewed from rear. Machine compartment 106 is provided with compressor 107 which constitutes a portion of a refrigeration cycle.

20 **[0006]** Heat insulation box 102 is divided into storage compartments by partition wall 108 and the like. As the storage compartments, there are formed refrigerating compartment 109 at an uppermost portion of heat insulation box 102, vegetable compartment 110 under refrigerating compartment 109, ice-making compartment 111 and a switching compartment (not shown) laterally arranged side by side under vegetable compartment 110, and freezing compartment 113 at a lowermost portion of heat insulation box 102.

25 **[0007]** Storage set temperatures of refrigerating compartment 109 and vegetable compartment 110 are set to a cooling temperature zone. Storage set temperatures of ice-making compartment 111 and freezing compartment 113 are set to a freezing temperature zone. For the switching compartment, one of temperature zones of a plurality of storage set temperatures from the cooling temperature zone to the freezing temperature zone is selected and set.

[0008] Substrate accommodating section 114 is formed in a back surface portion of vegetable compartment 110, with heat insulation material 105 interposed therebetween, by denting a portion of heat insulation box 102.

30 **[0009]** Control circuit substrate 115 which electrically controls compressor 107 and the like is disposed in substrate accommodating section 114.

[0010] In such a configuration, to enhance heat insulation performance of heat insulation box 102, assume that a vacuum heat insulation panel having smaller thermal conductivity than that of heat insulation material 105 is disposed on a back surface portion of heat insulation box 102. In this case, since substrate accommodating section 114 exists at a central portion, it is necessary to divide the vacuum heat insulation panel in the vertical direction and dispose the divided panels, or to dispose the vacuum heat insulation panel entirely and form a through hole in a portion where substrate accommodating section 114 is disposed. Hence, a degree of enhancement of the heat insulation performance becomes small.

35 **[0011]** As another method, substrate accommodating section 114 may be disposed at an uppermost portion of heat insulation box 102. In this case, it is not necessary to divide the vacuum heat insulation panel and dispose the divided panels. However, if an inverter compressor which requires DC power is used as compressor 107 to further reduce an amount of consumed power, for example, refrigerator 500 is likely to receive electromagnetic interference since a distance between compressor 107 and control circuit substrate 115 is increased.

40 **[0012]** Hence, there is a possibility that electromagnetic problems occur. For example, an additional EMC (Electro-Magnetic Compatibility) measure needs to be taken, or a loss at the time of energization is increased.

45 **[0013]** As yet another method, a heat insulation wall may be made thick by increasing outer box 103 in size or reducing inner box 104 in size, so that the heat insulation performance is enhanced, and the amount of consumed power is reduced. In this case, however, costs such as material costs and mold costs are increased.

50 **[0014]** According to the configuration of refrigerator 500, since freezing compartment 113 and compressor 107 which is subjected to high temperature are opposed to each other, there is a problem that an amount of heat entering from machine compartment 106 to freezing compartment 113 is large.

Citation List

55 Patent Literature

[0015] PTL 1: Unexamined Japanese Patent Publication No. 2002-81855

SUMMARY OF THE INVENTION

[0016] The present invention has been made in view of the above problems, and provides a refrigerator capable of reducing an amount of consumed power at low cost without investing in a mold or adding a new member.

[0017] A refrigerator of the present invention includes a heat insulation box having a heat insulation wall, a machine compartment disposed on a back surface side of the heat insulation box, a refrigeration cycle including at least a compressor, and a controller which controls operation of the compressor. The compressor and the controller are disposed in the machine compartment, the machine compartment is disposed opposed to a storage compartment with the heat insulation wall interposed therebetween, the storage compartment being set to a cooling temperature zone.

[0018] According to this configuration, since a temperature difference between the compressor and the storage compartment can be made small, an amount of heat entering into the storage compartment becomes small.

[0019] Hence, according to the refrigerator of the present invention, it is possible to reduce an amount of consumed power at low cost without investing in a mold or adding a new member.

BRIEF DESCRIPTION OF DRAWINGS

[0020]

FIG. 1 is a front view of a refrigerator according to a first embodiment of the present invention.

FIG. 2 is a side sectional view showing an internal structure of the refrigerator in the first embodiment of the present invention.

FIG. 3 is a rear view of essential portions of the refrigerator in the first embodiment of the present invention.

FIG. 4 is a side sectional view showing an internal structure of a refrigerator in a second embodiment of the present invention.

FIG. 5 is a rear view of essential portions of the refrigerator in the second embodiment of the present invention.

FIG. 6 is a side sectional view showing an internal structure of a conventional refrigerator.

DESCRIPTION OF EMBODIMENTS

Embodiments of the present invention will be described below with reference to the drawings. Note that the present invention is not limited to the embodiments.

FIRST EXEMPLARY EMBODIMENT

FIG. 1 is a front view of refrigerator 300 in a first embodiment of the present invention, FIG. 2 is a side sectional view showing an internal structure of refrigerator 300, and FIG. 3 is a rear view of essential portions of refrigerator 300.

Refrigerator 300 includes heat insulation box 21 having a heat insulation wall, machine compartment 60 disposed on a back surface side of heat insulation box 21, a refrigeration cycle having at least compressor 50, and controller 70 which controls operation of compressor 50.

Compressor 50 and controller 70 are disposed in machine compartment 60. Machine compartment 60 is disposed opposed to a storage compartment with the heat insulation wall interposed therebetween. The storage compartment is set to a cooling temperature zone.

Refrigerator 300 includes heat insulation box 21 in refrigerator body 20. Heat insulation box 21 is formed from inner box 22 made of resin, outer box 23 made of a metal magnetic material such as a steel plate, and a heat insulation wall formed by charging heat insulation material 24 between inner box 22 and outer box 23.

Heat insulation box 21 has front surface opening 21a. Heat insulation box 21 is heat-insulated and partitioned by partition walls 25, 26, 27 and 28, and a plurality of storage compartments, i.e., refrigerating compartment 29, ice-making compartment 30, first freezing compartment 31, second freezing compartment 32, and vegetable compartment 33 are formed in this order from above. In this embodiment, ice-making compartment 30 and first freezing compartment 31 are laterally arranged side by side.

Storage set temperatures of refrigerating compartment 29 and vegetable compartment 33 is set to a cooling temperature zone. The storage set temperatures of ice-making compartment 30, first freezing compartment 31, and second freezing compartment 32 are set to a freezing temperature zone.

The storage compartments are provided with refrigerating compartment door 29a, ice-making compartment door 30a, first freezing compartment door 31a, second freezing compartment door 32a, and vegetable compartment door 33a. Each of the doors closes front surface opening 21a when the door is closed, is connected to heat insulation box 21, and has a heat insulation wall.

Upper and lower ends of a right side of refrigerating compartment door 29a as viewed from front are turnably

connected to heat insulation box 21 by upper hinge 34 and lower hinge 35 each having a rotation axis. The storage compartment doors other than refrigerating compartment door 29a are drawer-type doors, and these doors are connected to heat insulation box 21 such that the doors can open in the longitudinal direction by rail members 36 provided to the storage compartments.

[0030] Rail members 36, for example, rail member 36 of ice-making compartment 30 having a relatively small capacity and rail member 36 of vegetable compartment 33 having a large capacity, may be different members or may be formed at different positions depending on drawer capacities, drawer lengths, and the like of the storage compartments.

[0031] When the doors are closed, spaces 37 of about 5 mm are created in the longitudinal direction between front surface opening 21a and surfaces of the storage compartment doors on the heat insulation box 21 side. Gaskets 38 having magnets are disposed in spaces 37 on four upper, lower, left, and right sides of the surfaces of the storage compartment doors on the heat insulation box 21 side. Since gaskets 38 are attracted and brought into close contact with front surface opening 21a by magnetic forces of gaskets 38, the storage compartments are substantially hermetically sealed.

[0032] The refrigeration cycle which cools refrigerator body 20 at the time of operation is disposed in heat insulation box 21. The refrigeration cycle includes compressor 50, a condenser (not shown), a decompressor (not shown), evaporator 51, and a series of refrigerant paths.

[0033] As a refrigerant of the refrigeration cycle, it is possible to use a combustible hydrocarbon-based refrigerant, e.g., isobutane. A density of isobutane is higher than that of air.

[0034] Upper and lower portions of heat insulation box 21 on the back surface side are provided with upper concave portion 21b and lower concave portion 21c, respectively.

[0035] Upper concave portion 21b is formed by notching portions of an upper surface portion and a back surface portion of heat insulation box 21 such that upper concave portion 21b faces refrigerating compartment 29 with heat insulation material 24 interposed therebetween.

[0036] Machine compartment 60 is disposed in upper concave portion 21b. Compressor 50 and controller 70 are disposed in machine compartment 60. An upper surface and a back surface of machine compartment 60 are integrally covered by machine compartment cover 80 which is made of a material having excellent thermal conductivity such as a steel plate.

[0037] Compressor 50 includes discharge pipe 50a from which a high-temperature and high-pressure gas refrigerant is discharged and suction pipe 50b into which a low-temperature and low-pressure gas refrigerant flows. Discharge pipe 50a and suction pipe 50b are respectively provided in both left and right ends of compressor 50 as viewed from front, and these pipes are connected to other parts which form the refrigeration cycle.

[0038] Pressure of the refrigerant at the time of operation is several atmospheres in discharge pipe 50a and 1 atmosphere or lower in suction pipe 50b.

[0039] Compressor 50 is a reciprocating-type compressor in which a piston reciprocates in a cylinder to compress the refrigerant. Compressor 50 electrically converts DC power into AC power, and is inverter-controlled.

[0040] It is possible to stepwisely switch a drive frequency of compressor 50 between a plurality of predetermined values by inverter control, and to efficiently cool the storage compartments.

[0041] Controller 70 controls operations of electric components of refrigerator body 20 such as compressor 50. Controller 70 is connected to the electric components through cables (not shown). Controller 70 is disposed close to suction pipe 50b of compressor 50.

[0042] In this embodiment, as shown in FIG. 3, controller 70, suction pipe 50b, compressor 50, and discharge pipe 50a are disposed in this order from the left as viewed from a back surface of refrigerator body 20.

[0043] Machine compartment cover 80 includes ventilation ports 80a. Ventilation ports 80a are provided on a back surface side of machine compartment cover 80. In the vicinity of suction pipe 50b of compressor 50 and controller 70, lower portions of the back surface of machine compartment cover 80 are opened so that ventilation ports 80a are formed. In the vicinity of discharge pipe 50a, upper portions of the back surface of machine compartment cover 80 are opened so that ventilation ports 80a are formed. In this manner, ventilation ports 80a are formed roughly in two groups in the vicinity of left and right ends on the back surface side of machine compartment 60. Accordingly, even if a combustible refrigerant having greater specific gravity than that of air leaks, the refrigerant can be prevented from staying in the vicinity of controller 70 by utilizing natural convection, and it is possible to secure safety of refrigerator 300.

[0044] Since compressor 50 generates heat when it is operated, ventilation ports 80a are desirably opened widely, but in this case, there is a possibility that a problem of noise occurs by an operating sound of compressor 50. However, by providing ventilation ports 80a in the lower portion in the vicinity of controller 70 and in the upper portion in the vicinity of compressor 50, air whose specific gravity becomes small by waste heat of compressor 50 is discharged from ventilation ports 80a in the vicinity of compressor 50. Accordingly, outside air is naturally sucked from ventilation ports 80a in the vicinity of controller 70, and it is possible to ventilate entire machine compartment 60 by natural convection without having to add new ventilating means such as a machine compartment fan.

[0045] As shown in FIG. 2, lower concave portion 21c is formed by notching portions of a bottom surface portion and

a back surface portion of heat insulation box 21 such that lower concave portion 21c is opposed to vegetable compartment 33 with heat insulation material 24 interposed therebetween. In lower concave portion 21c, there is disposed defrosting water processor 90 which forcibly evaporates defrosting water generated at the time of defrosting operation of evaporator 51 by using a heat source and by blowing air.

[0046] A height of the notched portion of the back surface portion of lower concave portion 21c is smaller than a height of the notched portion of upper concave portion 21b.

[0047] Vacuum heat insulation panel 100 is disposed in heat insulation material 24 between upper concave portion 21b and lower concave portion 21c in a back surface portion of outer box 23.

[0048] Vacuum heat insulation panel 100 integrally covers, by a predetermined thickness, a substantially entire flat surface portion of the back surface portion of outer box 23 between upper concave portion 21b and lower concave portion 21c. Vacuum heat insulation panel 100 is disposed on the back surface side of evaporator 51 and the storage compartments with heat insulation material 24 interposed therebetween. Vacuum heat insulation panel 100 is opposed to substantially entire duct 110 through which low-temperature air is circulated into the storage compartments.

[0049] Thermal conductivity of vacuum heat insulation panel 100 is lower than thermal conductivity of heat insulation material 24.

[0050] Operation and effect of refrigerator 300 having the above-described configuration will be described below.

[0051] When the refrigeration cycle is operated, a high-temperature and high-pressure refrigerant discharged by compressing action of compressor 50 exchanges heat with surrounding air by the condenser and dissipates heat. The refrigerant which is condensed and liquefied by the heat radiation is decompressed in the decompressor, and then, the refrigerant exchanges heat with air in the storage compartment and evaporates in evaporator 51.

[0052] At this time, temperature of air around evaporator 51 becomes low by the evaporation. This air is made to circulate into the storage compartments through duct 110, thereby cooling and holding the storage compartments to the set temperature zone.

[0053] Since vacuum heat insulation panel 100 is disposed, an amount of heat entering from the back surface portion of heat insulation box 21 can be reduced as compared with a case where the back surface portion is formed of only heat insulation material 24.

[0054] Since vacuum heat insulation panel 100 is disposed outside evaporator 51 and duct 110, it is possible to reduce the amount of heat entering into evaporator 51 and duct 110 having the lowest temperature in refrigerator body 20. In particular, since a heat-receiving loss when low-temperature air passes through duct 110 can be reduced, it is possible to greatly enhance heat insulation performance when refrigerator body 20 is operated.

[0055] A reduction effect of the heat-receiving loss becomes higher as an area of a path of duct 110 is wider. Therefore, a particularly high effect is obtained in a large refrigerator having a large storage compartment capacity.

[0056] It is possible to further enhance the heat insulation performance of heat insulation box 21 by adding vacuum heat insulation panels 100 to both side surface portions or upper and lower surface portions of heat insulation box 21 as viewed from front. However, it is possible to enhance the heat insulation performance most efficiently by disposing vacuum heat insulation panel 100 on a back surface portion of heat insulation box 21 which is opposed to evaporator 51 and duct 110.

[0057] In this embodiment, the description has been made of the example in which vacuum heat insulation panel 100 is integrally formed. If vacuum heat insulation panel 100 is divided or a hole is formed in vacuum heat insulation panel 100, a side area of vacuum heat insulation panel 100 in its thickness direction adversely increases, and the amount of heat entering from the back surface of outer box 23 to heat insulation material 24 adversely increases. Hence, in view of conditions such as material costs and mass production construction methods of vacuum heat insulation panel 100 and refrigerator body 20, it is possible to further enhance the heat insulation performance if vacuum heat insulation panel 100 is integrally formed to a maximum extent.

[0058] In refrigerator 300 of this embodiment, refrigerating compartment 29 and machine compartment 60 are disposed opposed to each other. Accordingly, as compared with a case where machine compartment 60 is opposed to the storage compartment in the freezing temperature zone, it is possible to reduce a temperature difference between air in the storage compartment and warm air in machine compartment 60 generated when compressor 50 is operated. Therefore, it is possible to reduce the amount of heat entering into the storage compartment. Accordingly, it is possible to reduce consumed power of refrigerator 300.

[0059] In refrigerator 300 of this embodiment, the lowermost storage compartment is vegetable compartment 33 which is set to the cooling temperature zone. Hence, even if machine compartment 60 is disposed in lower concave portion 21c, for example, a reducing effect of the amount of heat entering from machine compartment 60 into the storage compartment can be obtained in the same manner. However, waste heat of compressor 50 discharged from ventilation port 80a of machine compartment cover 80 provided at the lower portion rises along the back surface portion of heat insulation box 21. Hence, when waste heat rises, there is a possibility that heat from the back surface enters the storage compartments other than vegetable compartment 33. Therefore, it is more desirable that machine compartment 60 is disposed in upper concave portion 21b.

[0060] When machine compartment 60 is provided in upper concave portion 21b, a storage space in an upper portion of the back surface of refrigerating compartment 29 is adversely reduced. However, particularly in a large refrigerator having a high overall height, a user's hand cannot easily reach the upper portion of the back surface and usability is poor. Hence, even if the storage space in this portion is reduced, the usability of refrigerator body 20 is not deteriorated.

[0061] Further, in this embodiment, a notch height of lower concave portion 21c is smaller than a notch height of the back surface portion of upper concave portion 21b. Vegetable compartment 33 which is the lowermost storage compartment is provided with rail member 36 to form the drawer door. Accordingly, a depth of vegetable compartment 33 is increased, usability is enhanced, and food products to be cooled can be easily taken in and out from vegetable compartment 33.

[0062] In this embodiment, compressor 50 and controller 70 are disposed close to each other, so that electromagnetic interference can be suppressed. When inverter control is carried out, household AC power is first converted into high voltage DC power, and the DC power is again electrically converted into AC power. At this time, since voltage and the like of compressor 50 are controlled at intervals of a few thousandths of a second, there is a possibility that even very small electromagnetic interference may cause malfunction or an operation loss.

[0063] Hence, it is absolutely necessary to take countermeasures against electromagnetic interference. If compressor 50 and controller 70 are disposed close to each other, a range where the countermeasures should be taken also becomes narrow, and it is possible to easily take the countermeasures against electromagnetic interference.

[0064] The above-described countermeasures against electromagnetic interference is necessary for the inverter control, but since the number of rotations of compressor 50 can be changed in accordance with a cooled state of the storage compartment, it is possible to greatly reduce the amount of consumed power of refrigerator body 20.

[0065] In this embodiment, machine compartment cover 80 is provided with ventilation ports 80a. Accordingly, even if heat in machine compartment 60 or a refrigerant leaks in machine compartment 60, the refrigerant can be discharged to outside air without staying in machine compartment 60.

[0066] Heat in machine compartment 60 is generated mainly from compressor 50 and controller 70. If compressor 50 and controller 70 have high temperatures, efficiency and reliability thereof are deteriorated. Therefore, it is necessary to suppress the temperature rise thereof by ventilation.

[0067] In this embodiment, machine compartment cover 80 is made of a material having excellent thermal conductivity. Accordingly, in addition to the ventilation from ventilation ports 80a, heat radiation can be carried out also by thermal conduction of machine compartment cover 80. For example, even when refrigerator body 20 is installed in a state where it is in close contact with a wall or ventilation ports 80a are clogged with dust or the like when the refrigerator is used for a long term, it is possible to suppress deterioration in efficiency and reliability of compressor 50 and controller 70.

[0068] To prevent heat from staying in machine compartment 60, it is necessary to utilize natural convection. It is also possible to dispose a machine compartment fan in machine compartment 60. However, the amount of consumed power and costs of refrigerator body 20 will be increased. In addition, in a small refrigerator, it is difficult to dispose the machine compartment fan in addition to compressor 50 and controller 70 in machine compartment 60.

[0069] In this embodiment, ventilation ports 80a are provided in the upper portion of machine compartment cover 80 in the vicinity of discharge pipe 50a of compressor 50 having the highest temperature, thereby discharging air. Ventilation ports 80a are also provided in the lower portion of machine compartment cover 80 in the vicinity of relatively-low-temperature suction pipe 50b and a relatively-low-temperature controller 70, thereby sucking air. In this manner, the natural convection is facilitated by providing ventilation ports 80a in the portions having a large temperature difference.

[0070] In this embodiment, compressor 50 and controller 70 are disposed in the lateral direction as viewed from front of refrigerator body 20, and ventilation ports 80a are disposed in the vicinity of both left and right ends of machine compartment 60. Accordingly, convection can be generated inside entire machine compartment 60.

[0071] Positions of ventilation ports 80a are not absolutely limited to the above-described ranges, and it is desirable that wide ventilation ports 80a are secured for heat radiation and for preventing the refrigerant from staying. For example, ventilation ports 80a may be provided in an upper surface portion or the like of machine compartment cover 80. In particular, when the upper portion of discharge pipe 50a is provided with ventilation ports 80a, it is possible to obtain an extremely excellent heat radiation effect.

[0072] However, not only in a small refrigerator with a small height but also in a large refrigerator with a large height, items to be cooled are placed and stored on an upper surface portion of refrigerator body 20. Hence, when such a configuration is employed, it is necessary that ventilation ports 80a of the upper surface are not closed.

[0073] Even when a combustible refrigerant leaks in machine compartment 60, since suction pipe 50b of compressor 50 is disposed in the vicinity of controller 70, it is possible to prevent the leaked refrigerant from being sprayed toward controller 70. The combustible refrigerant generally has greater specific gravity than that of air. Accordingly, even when compressor 50 stops and natural convection is not easily generated, the refrigerant is naturally discharged to outside air without staying since the lower portion of controller 70 is provided with ventilation ports 80a.

[0074] Suction pipe 50b into which the refrigerant flows is disposed close to controller 70 than discharge pipe 50a from which the combustible refrigerant circulating through the refrigeration cycle is discharged. Accordingly, even if the

combustible refrigerant leaks in machine compartment 60, a risk that the combustible refrigerant leaks in the vicinity of controller 70 can be reduced. Accordingly, it is possible to secure safety of refrigerator body 20. Even if the refrigerant leaks on the side of suction pipe 50b, a large amount of refrigerant does not leak in a short time since pressure of the refrigerant is weak.

[0075] In this embodiment, the amount of consumed power of refrigerator body 20 is reduced by using compressor 50 which carries out the inverter control, vacuum heat insulation panel 100, and the like. However, the present invention is not limited to this example. For example, in accordance with a required value of the amount of consumed power, it is possible to use a compressor which is normally controlled, or to insulate heat using only heat insulation material 24 without using vacuum heat insulation panel 100.

[0076] In this case, it is necessary to add and replenish heat insulation material 24 of an amount corresponding to a volume of vacuum heat insulation panel 100. However, heat insulation material 24 can be added only by changing the setting of equipment, and additional costs such as changing costs of compressor 50 and investment in a mold are not generated.

[0077] As described above, in this embodiment, compressor 50 and controller 70 are disposed in machine compartment 60. Machine compartment 60 is disposed opposed to refrigerating compartment 29 with heat insulation material 24 interposed therebetween. The storage set temperature of refrigerating compartment 29 is the cooling temperature zone.

[0078] According to this configuration, the back surface portion of heat insulation box 21 can be widely formed using the same surface. When vacuum heat insulation panel 100 is disposed on the back surface portion, it is possible to integrally and widely dispose an area of vacuum heat insulation panel 100. Accordingly, it is possible to greatly enhance heat insulation performance of heat insulation box 21, and to reduce the amount of consumed power of refrigerator body 20.

[0079] Further, since a temperature difference between compressor 50 and refrigerating compartment 29 becomes smaller than a temperature difference between compressor 50 and the freezing compartment, the amount of heat entering into refrigerating compartment 29 becomes small, and it is possible to further reduce the amount of consumed power of refrigerator body 20.

[0080] In this embodiment, compressor 50 and controller 70 are disposed in machine compartment 60. Hence, even when an inverter compressor which requires DC power is used as compressor 50, electromagnetic interference is not received, and a loss at the time of energization is not increased. Therefore, it is possible to reduce the amount of consumed power of refrigerator body 20 by using the inverter compressor without taking new countermeasures against the electromagnetic problem.

[0081] Conventionally, controller 70 is provided at a position of the back surface portion of heat insulation box 21 which is different from machine compartment 60. However, in this embodiment, controller 70 is disposed in machine compartment 60. Accordingly, an area of the back surface portion of refrigerator 300 increases. Hence, when vacuum heat insulation panel 100 is disposed on the back surface portion, it is possible to integrally and widely dispose the area of vacuum heat insulation panel 100. Accordingly, it is possible to greatly enhance the heat insulation performance of heat insulation box 21, and to reduce the amount of consumed power of refrigerator 300.

[0082] Further, in accordance with the required amount of consumed power, vacuum heat insulation panel 100 may be added or omitted, or compressor 50 may be changed to the specification which is driven by AC power. Hence, it is not necessary to newly develop heat insulation box 21 by investing in a mold.

[0083] Accordingly, the present invention can also be applied to types of refrigerators having a plurality of functions and different capacities. As described above, it is possible to greatly change the heat insulation performance of heat insulation box 21 and the amount of consumed power of refrigerator body 20 without investing in a mold or adding a new member for taking countermeasures against the problem.

[0084] In this embodiment, machine compartment 60 is disposed in an upper portion of the back surface of heat insulation box 21. Accordingly, since the upper portion of heat insulation box 21 in which usability is poor in the conventional technique is utilized as machine compartment 60, it is possible to reduce the amount of heat entering from machine compartment 60 into refrigerating compartment 29 without deteriorating user's usability.

[0085] Assume that the combustible refrigerant is used as the refrigerant which circulates through the refrigeration cycle. In this case as well, since suction pipe 50b is disposed close to controller 70 than discharge pipe 50a in machine compartment 60, a risk that the combustible refrigerant leaks in the vicinity of controller 70 can be reduced even if combustible refrigerant leaks in machine compartment 60. Hence, it is possible to secure safety of refrigerator body 20.

[0086] Machine compartment cover 80 is provided at least on a back surface of machine compartment 60. Ventilation ports 80a which communicate inside and outside of machine compartment 60 are provided in the lower portion of machine compartment cover 80 at least in the vicinity of controller 70, and provided in the upper portion of machine compartment cover 80 in the vicinity of compressor 50. Accordingly, the refrigerant can be prevented from staying in the vicinity of controller 70 even if the combustible refrigerant leaks, and thus, it is possible to secure the safety of refrigerator body 200.

SECOND EXEMPLARY EMBODIMENT

[0087] Next, refrigerator 400 of a second embodiment of the present invention will be described.

[0088] FIG. 4 is a side sectional view showing an internal structure of refrigerator 400 in the second embodiment of the present invention, and FIG. 5 is a rear view of essential portions of the refrigerator.

[0089] Assume that refrigerator body 200 of refrigerator 400 of this embodiment is a small refrigerator having an outer shape smaller than that of refrigerator 300 of the first embodiment. However, the present invention is not limited to a small refrigerator.

[0090] Refrigerator 400 includes heat insulation box 201 having a heat insulation wall, machine compartment 230 disposed on a back surface side of heat insulation box 201, a refrigeration cycle including at least compressor 220, and controller 240 which controls operation of compressor 220.

[0091] Compressor 220 and controller 240 are disposed in machine compartment 230, and machine compartment 230 is disposed opposed to a storage compartment with a heat insulation wall interposed therebetween. The storage compartment is set to a cooling temperature zone.

[0092] Heat insulation box 201 of refrigerator body 200 is configured by inner box 202 made of resin, outer box 203 made of a metal magnetic material such as a steel plate, and a heat insulation wall formed by charging heat insulation material 204 between inner box 202 and outer box 203.

[0093] Heat insulation box 201 includes front surface opening 201a. Heat insulation box 201 is heat-insulated and partitioned by partition wall 205, and refrigerating compartment 206, freezing compartment 207, and a plurality of storage compartments are formed in this order from above.

[0094] A storage set temperature of refrigerating compartment 206 is set to a cooling temperature zone. A storage set temperature of freezing compartment 207 is set to a freezing temperature zone.

[0095] The storage compartments are provided with refrigerating compartment door 206a and freezing compartment door 207a which close front surface opening 201a when the doors are closed. Refrigerating compartment door 206a and freezing compartment door 207a are connected to heat insulation box 201 and respectively include heat insulation walls.

[0096] Upper and lower ends of right sides of refrigerating compartment door 206a and freezing compartment door 207a are turnably connected to heat insulation box 201 by upper hinge 208, middle hinge 209, and lower hinge 210, each having a rotation axis.

[0097] When the storage compartment doors are closed, spaces 211 of about 5 mm in the longitudinal direction are formed between front surface opening 201a and surfaces of the storage compartment doors on the side of heat insulation box 201. Gaskets 212 having magnets are disposed in spaces 211 on four upper, lower, left, and right sides of a surface of heat insulation box 201 of each of the storage compartment doors. Gaskets 212 can be attracted to front surface opening 201a and brought into close contact with front surface opening 201a by magnetic forces of gaskets 212. Therefore, it is possible to substantially hermetically seal the storage compartments.

[0098] Heat insulation box 201 includes a refrigeration cycle which cools refrigerator body 200 at the time of operation. The refrigeration cycle includes compressor 220, a condenser (not shown), a decompressor (not shown), and evaporator 221 in this order. The refrigeration cycle further includes a series of refrigerant flow paths.

[0099] As the refrigerant of the refrigeration cycle, it is possible to use a combustible hydrocarbon-based refrigerant, e.g., isobutane. A density of isobutane is higher than that of air.

[0100] Upper concave portion 201b and lower concave portion 201c are respectively formed in upper and lower ends of heat insulation box 201 on the back surface side.

[0101] Upper concave portion 201b is formed by notching portions of an upper surface portion and a back surface portion of heat insulation box 201 such that upper concave portion 201b is opposed to refrigerating compartment 206 with heat insulation material 204 interposed therebetween. Machine compartment 230 is disposed in upper concave portion 201b. Compressor 220 and controller 240 are disposed in machine compartment 230.

[0102] A back surface of machine compartment 230 is covered by machine compartment cover 250 which is made of a material having excellent thermal conductivity such as a steel plate. An upper surface of heat insulation box 201 and an upper surface of machine compartment 230 are integrally covered by upper surface plate 260 made of resin having a heatproof temperature of 100°C or higher. Accordingly, it is possible to prevent reduction in an area of the upper surface of heat insulation box 201 caused by disposing machine compartment 230 on an upper portion of the back surface of heat insulation box 201.

[0103] In particular, in a small refrigerator having a small height, its upper surface portion is often used as a space for installing a microwave oven or the like. In this embodiment, since upper surface plate 260 is placed on the upper surface portion, it is not necessary to make a depth of heat insulation box 201 large for securing the space for installing the microwave oven or the like.

[0104] Since the upper surface of machine compartment 230 is covered by upper surface plate 260, it is possible to suppress the operation sound of compressor 220 from leaking toward an upper portion of refrigerator body 200. Further,

it is possible to suppress exhaust heat of compressor 220 from affecting the microwave oven or the like placed on the upper surface portion. An aesthetic design of outer appearance of refrigerator 400 as viewed from above is also enhanced. Therefore, quality of refrigerator 400 can be enhanced.

[0105] Compressor 220 includes discharge pipe 220a from which a high-temperature and high-pressure gas refrigerant is discharged and suction pipe 220b into which a low-temperature and low-pressure gas refrigerant flows. Discharge pipe 220a and suction pipe 220b are respectively provided to left and right ends as viewed from front of compressor 220, and are connected to other parts which form the refrigeration cycle.

[0106] Pressure of the refrigerant at the time of operation is several atmospheres in discharge pipe 220a, and 1 atmosphere or lower in suction pipe 220b.

[0107] Compressor 220 is a reciprocating-type compressor in which a piston reciprocates in a cylinder to compress the refrigerant. Compressor 220 is inverter-controlled using AC power which is obtained by electrically converting DC power.

[0108] By the inverter control, drive frequency of compressor 220 can be stepwisely switched between a plurality of predetermined values, and thus, it is possible to efficiently cool the storage compartments.

[0109] Controller 240 controls operations of electric components of refrigerator body 200 such as compressor 220. Controller 240 is connected to the electric components through cables (not shown), and disposed on the side of suction pipe 220b of compressor 220.

[0110] In this embodiment, controller 240, suction pipe 220b, compressor 220, and discharge pipe 220a are disposed in this order from the left when refrigerator body 200 is viewed from the back surface.

[0111] Machine compartment cover 250 is provided with ventilation ports 250a which communicate inside and outside of machine compartment 230. In the vicinity of suction pipe 220b of compressor 220 and controller 240, ventilation ports 250a are formed by opening a lower portion of machine compartment cover 250. In the vicinity of discharge pipe 220a, ventilation ports 250a are formed by opening an upper portion of machine compartment cover 250. Thus, ventilation ports 250a are formed roughly in two groups in the vicinity of both left and right ends on the back surface side of machine compartment 230. Accordingly, even if a combustible refrigerant having greater specific gravity than that of air leaks, the refrigerant can be prevented from staying in the vicinity of controller 240, and it is possible to secure safety of refrigerator 400. In this embodiment, a ventilation opening is not formed in upper surface plate 260.

[0112] Since compressor 220 generates heat when it is operated, it is desirable that ventilation ports 250a are widely open, but in this case, a problem of noise may occur by the operating sound of compressor 220. However, by forming ventilation ports 250a in the lower portion in the vicinity of controller 240 and in the upper portion in the vicinity of compressor 220, air whose specific gravity becomes small by waste heat of compressor 220 is discharged from ventilation ports 250a in the vicinity of compressor 220. Accordingly, outside air is naturally sucked from ventilation ports 250a in the vicinity of controller 240, and it is possible to ventilate entire machine compartment 230 by natural convection without newly adding ventilating means such as a machine compartment fan.

[0113] As shown in FIG. 4, lower concave portion 201c is formed by notching portions of a bottom surface portion and a back surface portion of heat insulation box 201 such that lower concave portion 201c is opposed to freezing compartment 207 with heat insulation material 204 interposed therebetween. In lower concave portion 201c, there is disposed defrosting water processor 270 which forcibly evaporates defrosting water generated at the time of defrosting operation of evaporator 221 by using a heat source and by blowing air.

[0114] A height of the notched portion of the back surface portion of lower concave portion 201c is smaller than a height of the notched portion of upper concave portion 201b.

[0115] Vacuum heat insulation panel 280 is disposed in heat insulation material 204 between upper concave portion 201b and lower concave portion 201c in a back surface portion of outer box 203.

[0116] Vacuum heat insulation panel 280 integrally covers, by a predetermined thickness, a substantially entire flat surface portion of the back surface portion of outer box 203 between both the concave portions. Vacuum heat insulation panel 280 is disposed on the side of evaporator 221 and back surfaces of the storage compartments with heat insulation material 204 interposed therebetween. Vacuum heat insulation panel 280 is opposed to substantially entire duct 290 through which a low-temperature air is circulated into the storage compartments.

[0117] Operation and effect of refrigerator 400 having the above-described configuration will be described below.

[0118] First, when the refrigeration cycle is operated, a high-temperature and high-pressure refrigerant discharged by compressing action of compressor 220 exchanges heat with surrounding air in the condenser and dissipates heat. The refrigerant which is condensed and liquefied by the heat radiation reaches the decompressor and is decompressed therein, and the refrigerant exchanges heat with the air in the storage compartment in evaporator 221 and evaporates.

[0119] At this time, a temperature of air around evaporator 221 becomes low by the evaporation. This air is made to circulate into the storage compartment through duct 290, thereby cooling and holding the storage compartment to its set temperature zone.

[0120] When vacuum heat insulation panel 280 is used, an amount of heat entering from a back surface portion of heat insulation box 201 becomes smaller than a case where only heat insulation material 204 is used on the back surface

portion.

[0121] Further, since it is possible to reduce the amount of heat entering into duct 290 and evaporator 221 having the lowest temperature in refrigerator body 200, it is possible to greatly enhance the heat insulation performance particularly when refrigerator body 200 is operated. It is possible to reduce the heat-receiving loss caused when the low-temperature air ventilates duct 290.

[0122] In this embodiment, refrigerating compartment 206 and machine compartment 230 are opposed to each other. Accordingly, as compared with a case where machine compartment 230 and the storage compartment in the freezing temperature zone are opposed to each other, a temperature difference between air in the storage compartment and warm air generated when compressor 220 in machine compartment 230 is operated becomes small. Accordingly, it is possible to reduce the amount of heat entering the storage compartment.

[0123] Since compressor 220 and controller 240 are disposed close to each other, electromagnetic interference can be suppressed. In particular, when inverter control is carried out, household AC power is converted into high voltage DC power, and the DC power is again electrically converted into AC power. At this time, since voltage and the like of compressor 220 are controlled at intervals of a few thousandths of a second, there is a possibility that even very small electromagnetic interference may cause malfunction or an operation loss.

[0124] Hence, when inverter control is carried out, it is absolutely necessary to take countermeasures against electromagnetic interference. In this embodiment, by disposing compressor 220 and controller 240 close to each other, a range where the countermeasures should be taken also becomes narrow, and a simple configuration can be realized.

[0125] Since it is possible to change the number of rotations of compressor 220 in accordance with a cooled state of the storage compartment by the inverter control, it is possible to greatly reduce the amount of consumed power of refrigerator body 200.

[0126] As described above, refrigerator 400 of this embodiment is a small refrigerator. Therefore, the above-described reducing effect of the heat-receiving loss, the reducing effect of the amount of consumed power and the influence on electromagnetic interference become smaller than those of refrigerator 300 described in the first embodiment.

[0127] However, concerning the reducing effect of the heat-receiving loss and the reducing effect of the amount of consumed power, it is possible to enhance the heat insulation performance most efficiently by disposing vacuum heat insulation panel 280 on the back surface portion of heat insulation box 201 as in the first embodiment. If vacuum heat insulation panel 280 is disposed on the back surface portion of heat insulation box 201, a barycenter of refrigerator body 200 moves toward the back surface. Therefore, even if heavy compressor 220 is disposed on an upper portion of heat insulation box 201, it is possible to prevent refrigerator body 200 from overturning and to enhance the safety.

[0128] In this embodiment, refrigerating compartment door 206a and freezing compartment door 207a are pivoted doors. As compared with the drawer door, forward movement of a barycenter of refrigerator body 200 when the door is opened can be reduced in the pivoted door. Accordingly, it is possible to further enhance safety against overturning.

[0129] In the case of compressor 220 of this embodiment which is inverter-controlled, as compared with a compressor which is driven by AC power, the same freezing performance can be obtained even if efficiency at the time of operation is slightly deteriorated. Hence, the compressor can be made lighter in weight by simplifying a driving part of compressor 220, and it is possible to further enhance the safety against overturning.

[0130] Since machine compartment cover 250 is provided with ventilation ports 250a, it is possible to discharge, to outside air, heat in machine compartment 230 and a refrigerant if the refrigerant leaks in machine compartment 230 without allowing the heat and the refrigerant to stay in machine compartment 230 as in the first embodiment.

[0131] In this embodiment, the description has been made of the example in which upper surface plate 260 is not provided with ventilation openings. However, the present invention is not limited to this example, and upper surface plate 260 may be provided with the ventilation openings. However, in the case of a small refrigerator, an electric device such as a microwave oven or food products not to be cooled may be placed on an upper surface of the refrigerator. In such a case, if liquid such as beverage or small crumbs on the upper surface enter machine compartment 230, there is a possibility that compressor 220 and controller 240 are adversely affected. Hence, it is desirable that upper surface plate 260 is not provided with ventilation openings as much as possible.

[0132] Further, in the case of the small refrigerator, a height position of upper surface plate 260 is close to ears of a user as compared with a large refrigerator. Hence, if ventilation openings are provided, the user may hear the operation sound of compressor 220 more loudly. From this aspect also, it is desirable that upper surface plate 260 is not provided with ventilation openings.

[0133] If it is necessary to provide upper surface plate 260 with ventilation openings by any means, the ventilation openings should be formed behind heat insulation box 201 as much as possible. An installation surface in which a space for installing the electronic device is secured is set lower than the ventilation openings. Thus, the liquid and the crumbs are less likely to enter, and usability is not deteriorated.

[0134] To solve these problems, it is also possible to cover a front portion of heat insulation box 201 with upper surface plate 260, and to form machine compartment cover 250 on the upper surface portion of machine compartment 230. In this configuration, it should be noted that dust or the like is likely to be accumulated at a connected portion between

upper surface plate 260 and machine compartment cover 250. Further, in order to secure the installation surface on which the electronic device is placed at a front portion, heat insulation box 201 may need to be increased in size.

[0135] As described above, vacuum heat insulation panel 280 is disposed on the back surface portion of heat insulation box 201 in this embodiment. Accordingly, the heat insulation performance of heat insulation box 201 is greatly enhanced, and it is possible to reduce the amount of consumed power of refrigerator body 200.

[0136] Compressor 220 is disposed opposed to refrigerating compartment 206 which is set to the cooling temperature zone. Accordingly, a temperature difference between compressor 220 and refrigerating compartment 206 becomes smaller than a temperature difference between compressor 220 and freezing compartment 207. Therefore, the amount of heat entering refrigerating compartment 206 is reduced. Hence, it is possible to reduce the amount of consumed power of refrigerator body 200.

[0137] In this embodiment, compressor 220 and controller 240 are disposed in machine compartment 230. Hence, even if an inverter compressor which requires DC power is used as compressor 220, electromagnetic interference is not received and a loss at the time of energization is not increased. Accordingly, the inverter compressor can be used without newly taking countermeasures against the electromagnetic problem, and it is possible to reduce the amount of consumed power of refrigerator body 200.

[0138] Conventionally, controller 240 is provided at a position of the back surface portion of heat insulation box 201 which is different from machine compartment 230. In this embodiment, however, controller 240 is disposed in machine compartment 230. Accordingly, an area of the back surface portion of refrigerator 400 is increased. Hence, when vacuum heat insulation panel 280 is disposed on the back surface portion, it is possible to integrally widely dispose the area of vacuum heat insulation panel 280. Accordingly, it is possible to greatly enhance the heat insulation performance of heat insulation box 201, and to reduce the amount of consumed power of refrigerator 400.

[0139] Further, in accordance with the required amount of consumed power, vacuum heat insulation panel 280 may be added or omitted, or compressor 220 may be changed to the specification which is driven by AC power. Hence, it is not necessary to newly develop heat insulation box 201 by investing in a mold. Accordingly, the present invention can also be applied to refrigerators having a plurality of functions and different capacities. As described above, it is possible to greatly change the heat insulation performance of heat insulation box 201 and the amount of consumed power of refrigerator body 200 without investing in a mold or adding a new member for taking countermeasures against the problem.

[0140] In this embodiment, the upper surface of heat insulation box 201 and the upper surface of machine compartment 230 are integrally covered by upper surface plate 260. Hence, even when machine compartment 230 is disposed on the upper portion of the back surface of heat insulation box 201, user's usability is not deteriorated and it is not necessary to increase the depth of heat insulation box 201.

[0141] Suction pipe 220b into which refrigerant flows is disposed close to controller 240 than discharge pipe 220a from which the combustible refrigerant circulating through the refrigeration cycle is discharged. Accordingly, even if the combustible refrigerant leaks in machine compartment 230, a risk that the combustible refrigerant leaks in the vicinity of controller 240 is reduced. Accordingly, it is possible to secure the safety of refrigerator body 200. Even if the refrigerant leaks on the side of suction pipe 220b, a large amount of refrigerant does not leak in a short time since pressure of the refrigerant is weak.

[0142] Machine compartment cover 250 is provided on at least a back surface of machine compartment 230, ventilation ports 250a are provided in the lower portion of machine compartment cover 250 at least in the vicinity of controller 240, and ventilation ports 250a are provided in the upper portion of machine compartment cover 250 in the vicinity of compressor 220. Accordingly, the combustible refrigerant can be prevented from staying in the vicinity of controller 240 even if the combustible refrigerant leaks, and it is possible to secure the safety of refrigerator body 200.

INDUSTRIAL APPLICABILITY

[0143] As described above, the refrigerator of the present invention can exert a special effect that an amount of consumed power can be reduced at low cost without investing in a mold or adding a new member. Hence, the present invention can be applied not only to the refrigerator but also to devices having other storages, e.g., a freezer and a heat insulating device.

REFERENCE MARKS IN THE DRAWINGS

[0144]

20, 200	refrigerator body
21, 201	heat insulation box
21a, 201a	front surface opening
21b, 201b	upper concave portion

	21c, 201c	lower concave portion
	22, 202	inner box
	23, 203	outer box
	24, 204	heat insulation material
5	25, 26, 27, 28, 205	partition wall
	29, 206	refrigerating compartment
	29a, 206a	refrigerating compartment door
	30	ice-making compartment
	30a	ice-making compartment door
10	31	first freezing compartment
	31a	first freezing compartment door
	32	second freezing compartment
	32a	second freezing compartment door
	33	vegetable compartment
15	33a	vegetable compartment door
	34, 208	upper hinge
	35, 210	lower hinge
	36	rail member
	37, 211	space
20	38, 212	gasket
	50, 220	compressor
	50a, 220a	discharge pipe
	50b, 220b	suction pipe
	51, 221	evaporator
25	60, 230	machine compartment
	70, 240	controller
	80, 250	machine compartment cover
	80a, 250a	ventilation port
	90, 270	defrosting water processor
30	100, 280	vacuum heat insulation panel
	110, 290	duct
	207	freezing compartment
	207a	freezing compartment door
	209	middle hinge
35	260	upper surface plate
	300, 400	refrigerator

Claims

- 40
1. A refrigerator comprising:

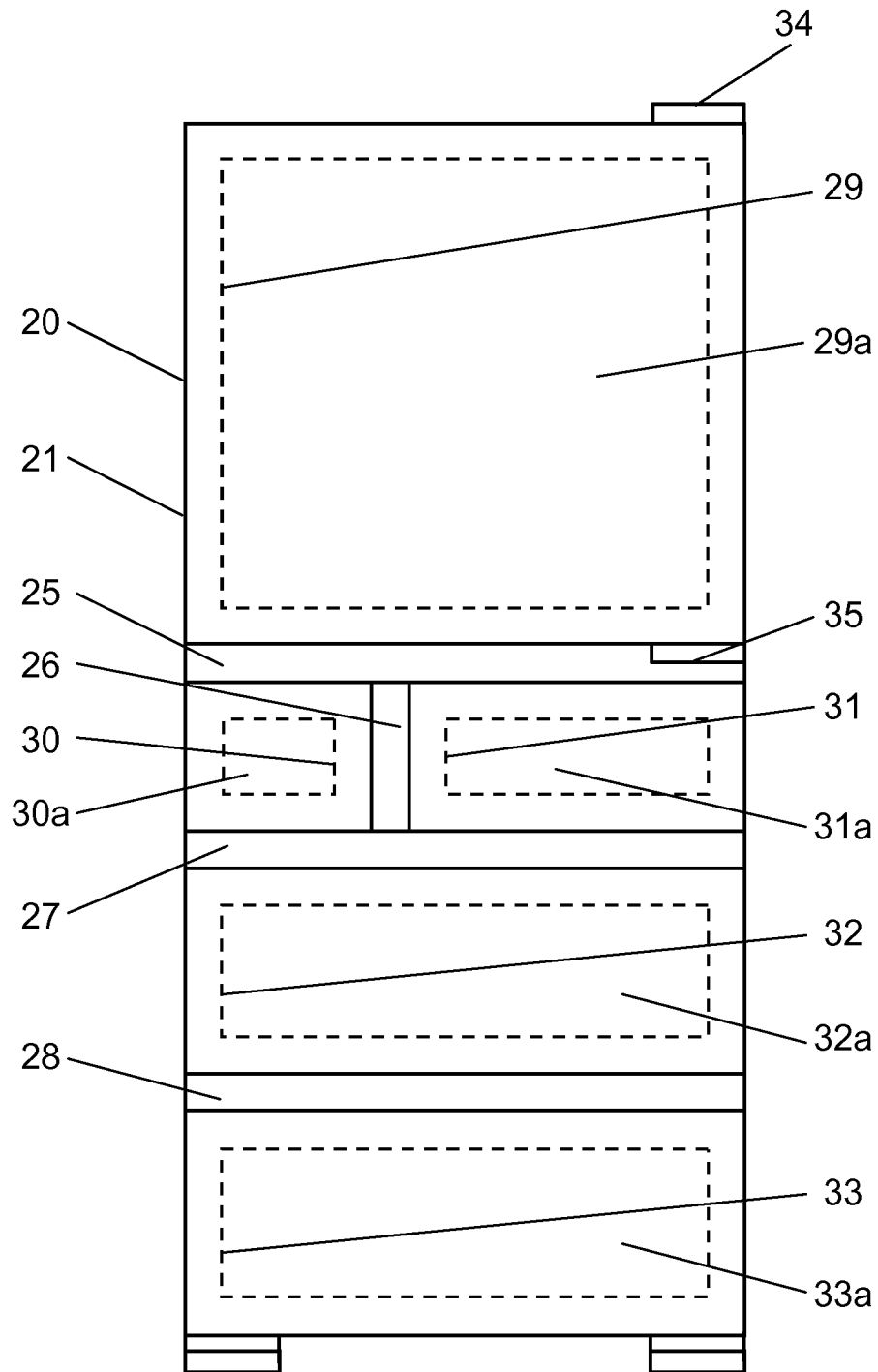
45

a heat insulation box having a heat insulation wall;
 a machine compartment disposed on a back surface side of the heat insulation box;
 a refrigeration cycle including at least a compressor; and
 a controller which controls operation of the compressor,
 wherein the compressor and the controller are disposed in the machine compartment, and
 the machine compartment is disposed opposed to a storage compartment with the heat insulation wall interposed
 therebetween, the storage compartment being set to a cooling temperature zone.

50
 2. The refrigerator according to claim 1, further comprising a plurality of the storage compartments,
 wherein the storage compartment disposed at an uppermost portion of a refrigerator body is set to the cooling
 temperature zone, and
 the machine compartment is disposed on an upper portion of a back surface of the storage compartment disposed
 at the uppermost portion.
 3. The refrigerator according to claim 1 or 2, wherein
 the compressor is inverter-controlled by the controller.
- 55

4. The refrigerator according to claim 1 or 2, wherein
a combustible refrigerant is used as a refrigerant that circulates through the refrigeration cycle,
the compressor includes a discharge pipe from which a high-temperature and high-pressure refrigerant is discharged
and a suction pipe into which the refrigerant flows, and
the suction pipe is disposed closer to the controller than the discharge pipe in the machine compartment.
- 5.
5. The refrigerator according to claim 1 or 2, wherein
a machine compartment cover is provided on at least a back surface of the machine compartment,
the machine compartment cover has ventilation openings which communicate inside and outside of the machine
compartment, and
the ventilation openings are provided at least in a lower portion of the machine compartment cover on a back surface
side of the controller and in an upper portion of the machine compartment cover on a back surface side of the
compressor.
- 10.
6. The refrigerator according to claim 2, further comprising an upper surface plate disposed on an upper surface portion
of the heat insulation box,
wherein the upper surface plate covers the upper surface portion of the heat insulation box and an upper surface
portion of the machine compartment.

FIG. 1



300

FIG. 2

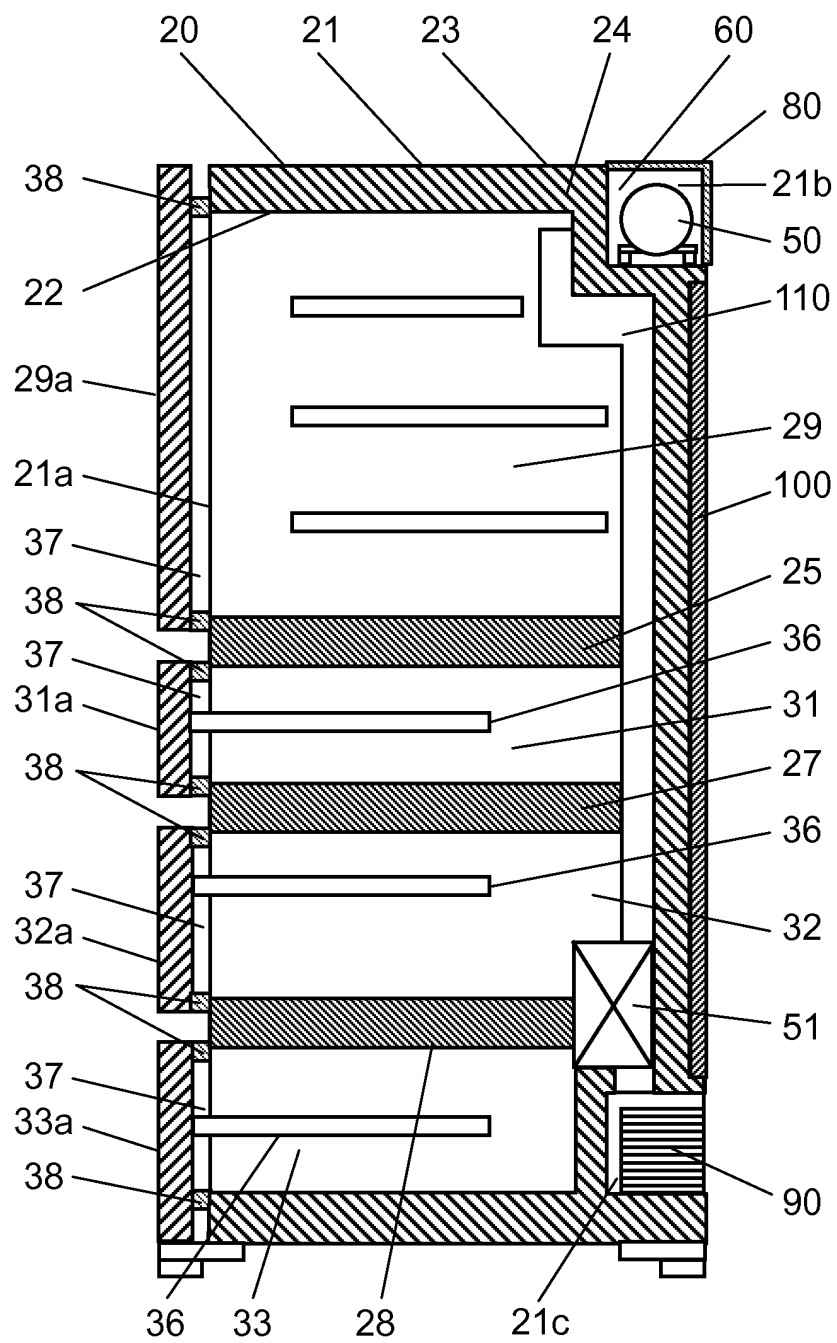
300

FIG. 3

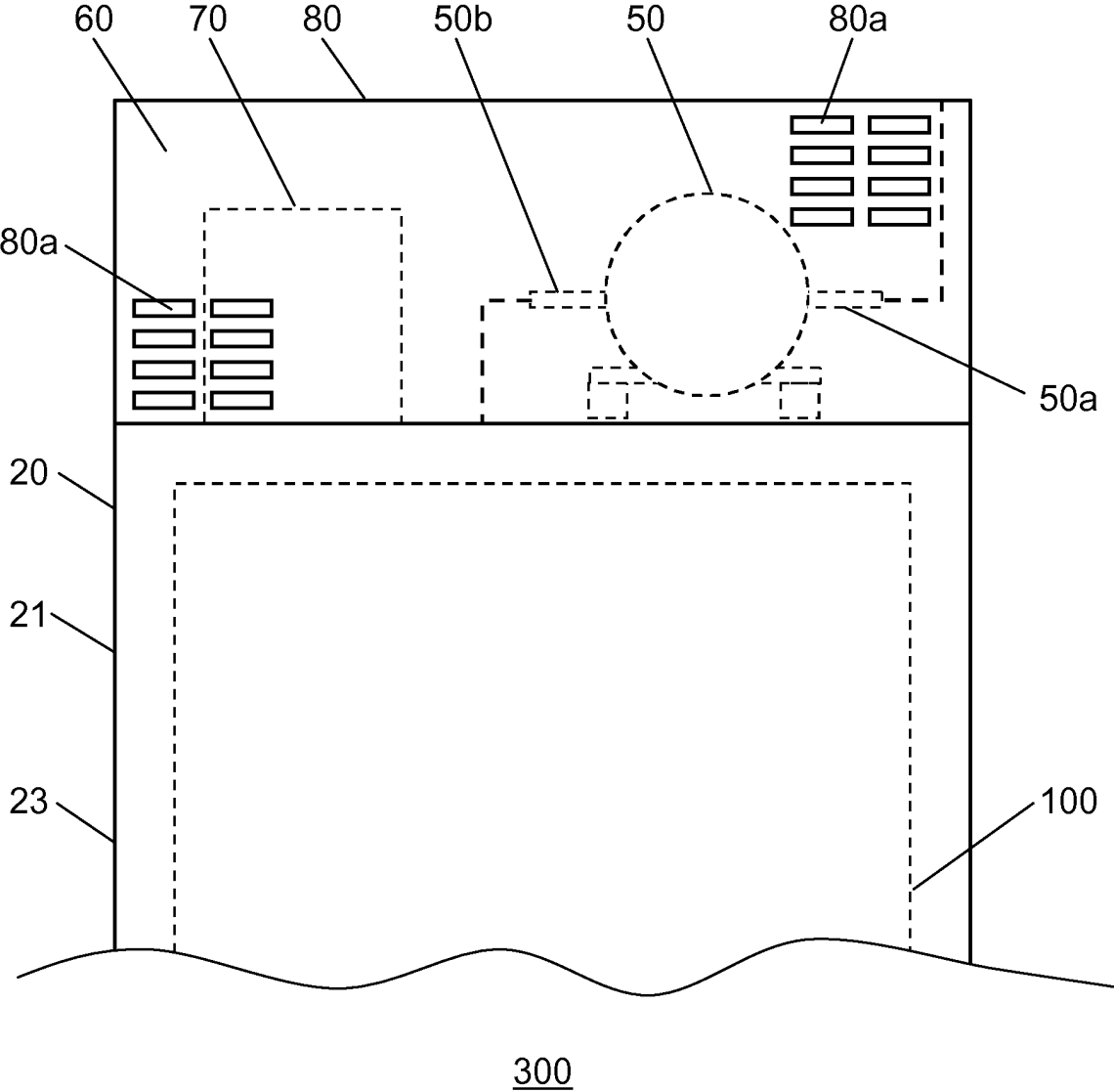


FIG. 4

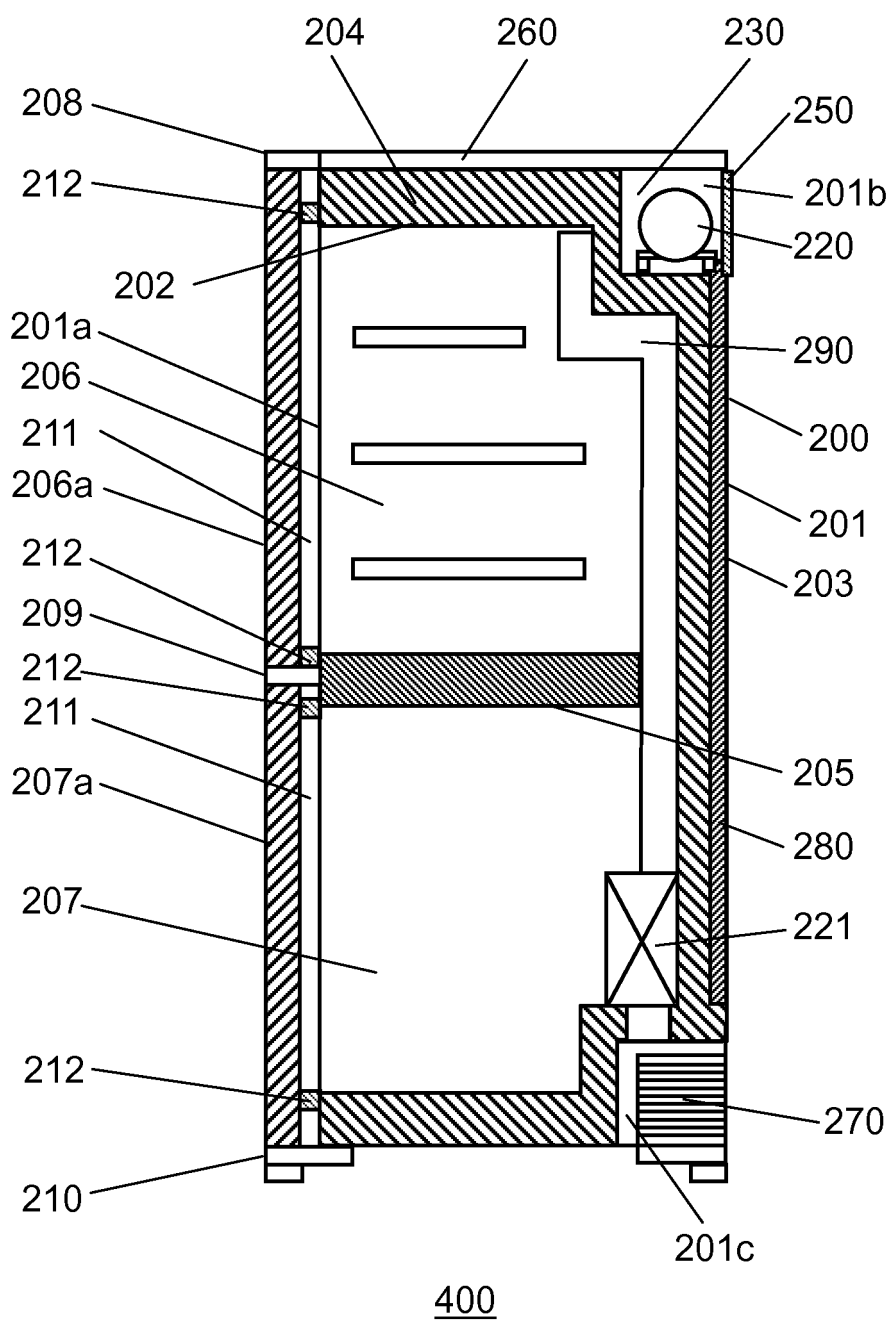


FIG. 5

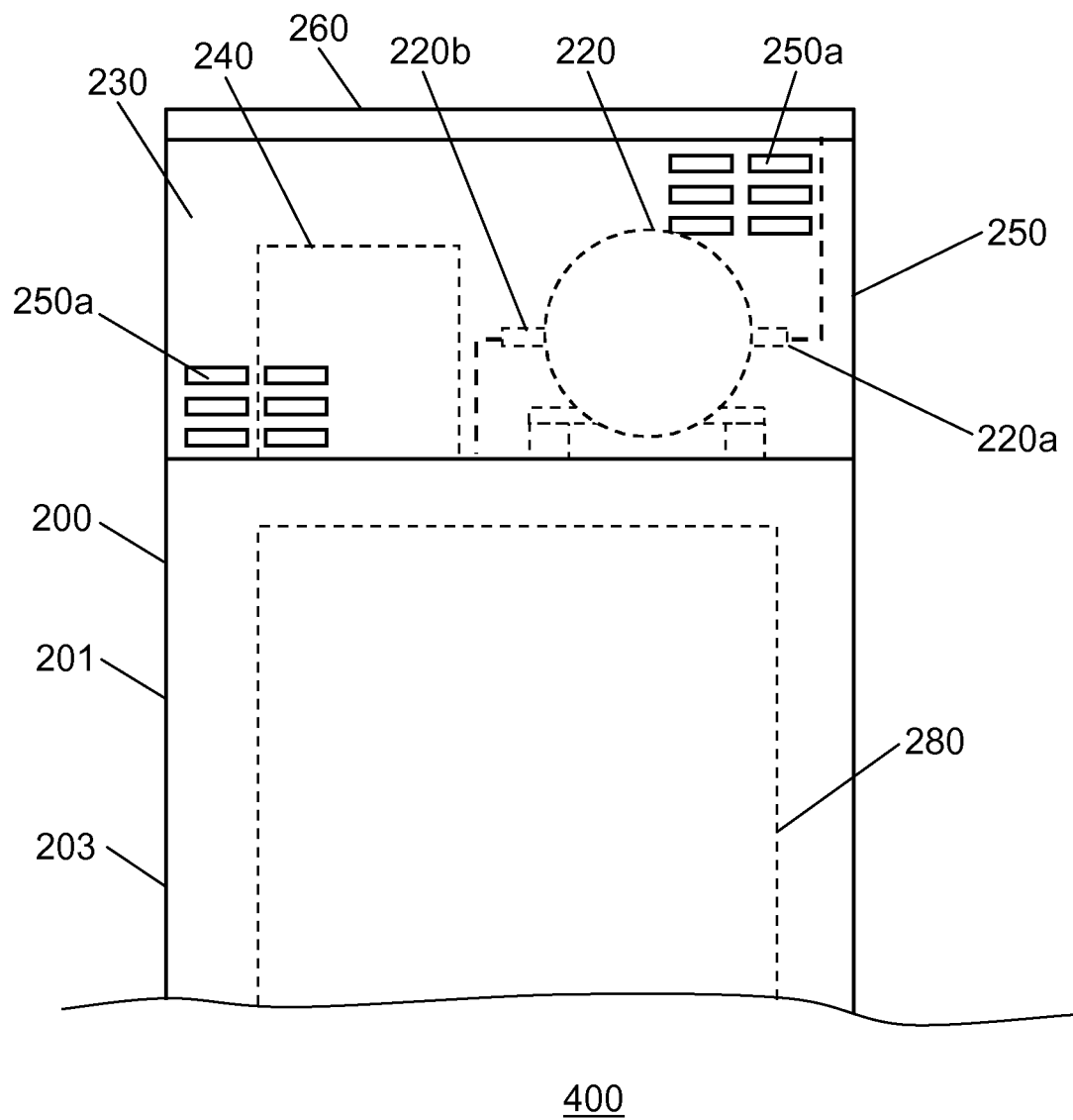
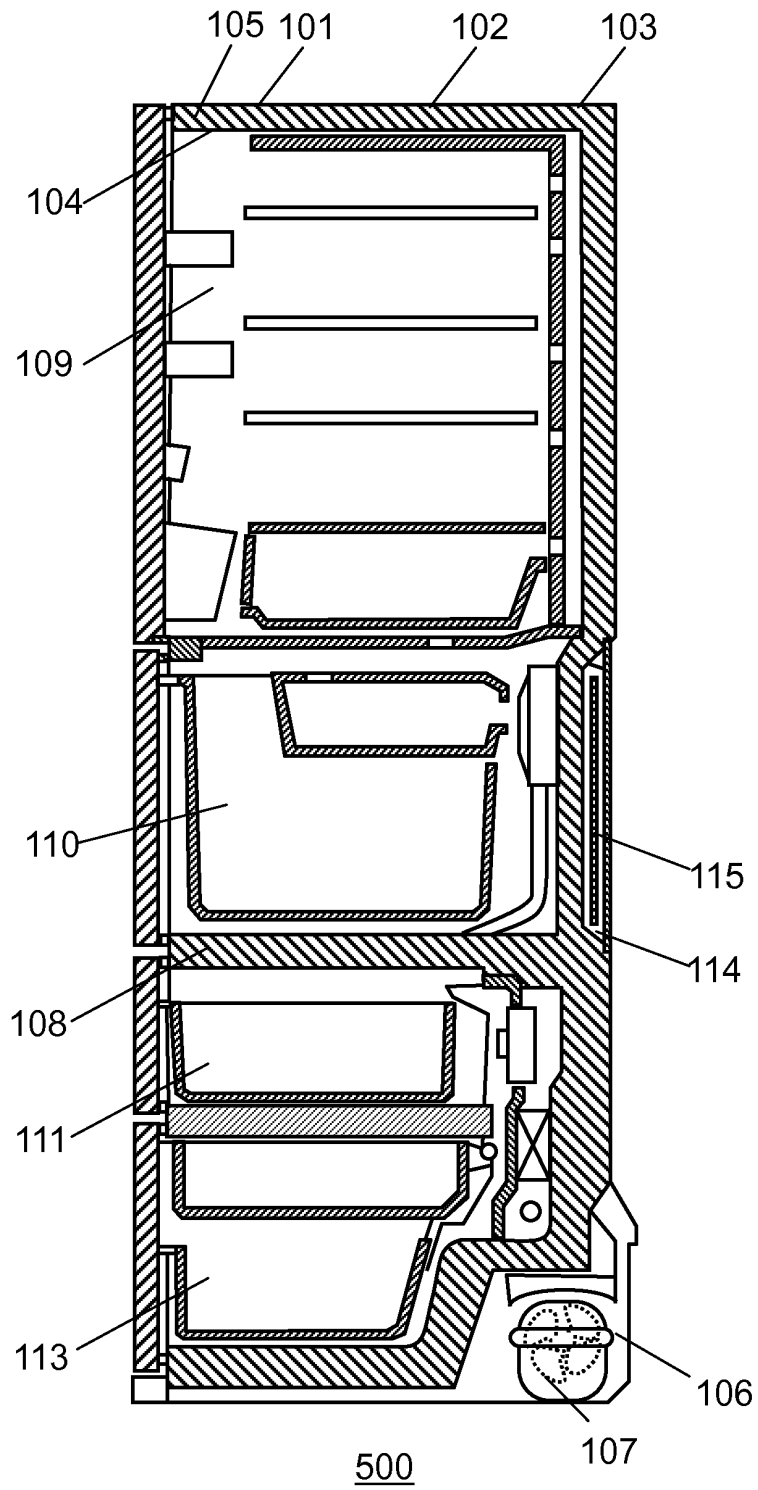


FIG. 6



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2012/004323

A. CLASSIFICATION OF SUBJECT MATTER

F25D19/00 (2006.01) i, F25D23/06 (2006.01) 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)

F25D19/00, F25D23/06

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2012
Kokai Jitsuyo Shinan Koho	1971-2012	Toroku Jitsuyo Shinan Koho	1994-2012

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2006-98042 A (Matsushita Electric Industrial Co., Ltd.), 13 April 2006 (13.04.2006), entire text; all drawings (particularly, paragraphs [0011], [0039], [0045]; fig. 1, 3, 5, 6) & JP 2006-98043 A & JP 3722153 B	1-3

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

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"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

"I" 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
13 September, 2012 (13.09.12)Date of mailing of the international search report
25 September, 2012 (25.09.12)Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

Facsimile No.

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2012/004323

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:
See extra sheet.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
1-3

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet (2)) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2012/004323

Continuation of Box No.III of continuation of first sheet(2)

Document 1 (JP 2006-98042 A (Matsushita Electric Industrial Co., Ltd.), 13 April 2006 (13.04.2006), entire text; all drawings (particularly, paragraphs [0011], [0039], [0045]; fig. 1, 3, 5, 6) discloses "a refrigerator, wherein a compressor and a control unit are arranged inside a machinery room, and the machinery room is arranged so as to face a storeroom set to a refrigerating temperature range through an adiabatic wall".

Therefore, the invention of claim 1 does not have a special technical feature in the light of the invention disclosed in the document 1.

Consequently, a group of inventions in claims (claims 1-6) have no technical relationship involving a same or corresponding special technical feature, and therefore cannot be considered to be so linked as to form a single general inventive concept.

As a result of judging special technical features with respect to claims dependent on claim 1, it is considered that the following four inventions are involved.

Meanwhile, the invention of claim 1 having no special technical feature is classified into invention 1.

(Invention 1) the inventions of claims 1-3

(Invention 2) the invention of claim 4

(Invention 3) the invention of claim 5

(Invention 4) the invention of claim 6

REFERENCES CITED IN THE DESCRIPTION

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

Patent documents cited in the description

- JP 2002081855 A [0015]