

DESCRIPTION

Title of Invention

REFRIGERATOR

Technical Field

5 [0001]

The present invention relates to a refrigerator including a drain passage.

Background Art

[0002]

10 In some conventional refrigerators, a water receiver (drip tray) is installed below a cooler, and a drain passage passing through a thermal insulation wall is provided below the drip tray (e.g., see Patent Literature 1 and Patent Literature 2). Patent Literature 1 discloses a drain passage provided vertically below a cooler, and Patent Literature 2 discloses a configuration in which a drain passage outlet protrudes from a ceiling of a machine compartment provided below a cooler compartment.

15 When the drain passage with the shortest distance is to be ensured, configurations such as those in the above patent literatures are suitable.

[0003]

20 Meanwhile, the refrigerator is required to be space-saving and capacious, and have energy-saving properties. Hence in some refrigerators, a vacuum thermal insulator having excellent thermal insulation properties is used for a part of the thermal insulation wall.

Citation List

Patent Literature

[0004]

25 Patent Literature 1: Japanese Unexamined Patent Application Publication No. 2003-56972

Patent Literature 2: Japanese Unexamined Patent Application Publication No. 2003-83668

Summary of Invention

30 Technical Problem

[0005]

In a refrigerator of Patent Literature 2, particularly, the machine compartment is provided in the lower portion of the rear face and a cooler compartment is disposed immediately above the machine compartment, so that in a thermal insulation wall partitioning the space into two spaces with the largest difference in temperature, thermal insulation performance may significantly deteriorate caused by the drain passage, leading to a decrease in cooling capacity. To deal with this, it is conceivable that the thermal insulation performance is ensured by using the above vacuum thermal insulator for a part of the thermal insulator, but in this case, the drain passage from the drip tray is largely curved to avoid the vacuum thermal insulator. This makes it necessary to provide a junction in the drain passage, inside a foamed thermal insulator filled in the periphery of the vacuum thermal insulator. Even in the configuration to ensure the drain passage with the shortest distance as in Patent Literature 1, the drain passage may be formed by connecting a plurality of parts due to molding easiness or other reasons. In the configuration that the junction is provided in the middle of the drain passage as thus described, melt water adhering to the junction inside the drain passage gradually permeates into the foamed thermal insulator by capillary phenomenon, when a refrigerator has been in use for a long time. Then, the foamed thermal insulator changes its state, over time, into a swollen state of internally holding moisture. The moisture inside the thermal insulator does not evaporate spontaneously, and as a result, the thermal capacity of the swollen foamed thermal insulator increases due to the moisture. This brings the temperature of the swollen foamed thermal insulator equivalent to a refrigeration temperature, thereby freezing the moisture adhering to the junction in the drain passage, and with the frozen moisture as a core, ice gradually grows to block the drain passage. As a result, melt water generated by defrosting operation may not be discharged to the machine compartment but discharged into the refrigerator to cause water leakage in the refrigerator.

[0006]

As thus described, in the drain passage having the junction in the thermal insulator, the melt water generated at the time of defrosting permeates into the thermal insulator from the junction and freezing occurs in the drain passage. In addition, when the drain passage is present between the drip tray below the cooler and the machine compartment in the lower portion of the rear face of the refrigerator, the vacuum thermal insulator cannot be installed inside the thermal insulator, thereby causing deterioration in thermal insulation performance on the boundary between the cooler and the machine compartment, where thermal insulation is required most. As a result, the energy-saving properties of the refrigerator deteriorates, or dew condensation on the ceiling face of the machine compartment or other problems occur.

[0007]

The present invention has been made to solve the problem as described above, and it is an object of the present invention to provide a refrigerator with performance and quality both favorable.

Solution to Problem

[0008]

A refrigerator according to an embodiment of the present invention is provided with: a thermal insulation box body including an inner box, an outer box, and a thermal insulator installed in a space between the inner box and the outer box; a machine compartment that is formed by a lower portion of a rear face of the thermal insulation box body recessing inward and in which a compressor is disposed; a cooler compartment that is formed in the thermal insulation box body above the machine compartment and in which a cooler that generates cool air is disposed; a water receiver provided below the cooler in the cooler compartment and receiving water from the cooler; and a drain passage having an inlet provided at the water receiver, passing through a thermal insulation wall interposed between the cooler compartment and the machine compartment to cause the cooler compartment and the machine compartment to communicate with each other, and having an outlet protruding into the machine compartment, wherein the drain passage on the inlet side has a shape in

which a sectional area decreases and a central position of a cross section approaches the rear face side in a downstream direction, and the drain passage is integrally formed from the inlet to the outlet.

Advantageous Effects of Invention

5 [0009]

According to the refrigerator of the embodiment of the present invention, the inner diameter of the drain passage from the inlet to the outlet decreases, while the central position thereof approaches the rear face side of the refrigerator, so that in the thermal insulation wall between the cooler compartment and the machine
10 compartment, a region in a forward direction from the drain passage is ensured to be wide, and a vacuum thermal insulator can be installed in the ensured region. Hence in the refrigerator, the thermal insulation performance can be enhanced by an area for installation of the vacuum thermal insulator being increased. Further, with the drain passage being integrally formed from the inlet to the outlet, permeation of moisture
15 from the drain passage into the thermal insulator can be reduced, thereby lowering the establishment that the drain passage is blocked. As thus described, in the refrigerator, it is possible to improve drainage properties while maintaining thermal insulation properties.

Brief Description of Drawings

20 [0010]

[Fig. 1] Fig. 1 is an external perspective view illustrating a refrigerator according to Embodiment 1 of the present invention.

[Fig. 2] Fig. 2 is a schematic view illustrating a refrigerant circuit and an air cycle passage of the refrigerator according to Embodiment 1 of the present invention.

25 [Fig. 3] Fig. 3 is a side sectional view illustrating the refrigerator according to Embodiment 1 of the present invention.

[Fig. 4] Fig. 4 is a schematic configuration view of a machine compartment on the rear face of the refrigerator according to Embodiment 1 of the present invention.

30 [Fig. 5] Fig. 5 is a partial sectional view illustrating a configuration of a thermal insulation box body according to Embodiment 1 of the present invention.

[Fig. 6] Fig. 6 is a partial sectional view illustrating a member of the thermal insulation box body when it is fixed according to Embodiment 1 of the present invention.

5 [Fig. 7] Fig. 7 is a partial sectional view illustrating a first example of the configuration of the thermal insulation box body according to Embodiment 1 of the present invention.

[Fig. 8] Fig. 8 is a partial sectional view illustrating a second example of the configuration of the thermal insulation box body according to Embodiment 1 of the present invention.

10 [Fig. 9] Fig. 9 is a partial explanatory view illustrating a third example of the configuration of the thermal insulation box body according to Embodiment 1 of the present invention.

[Fig. 10] Fig. 10 is an explanatory view illustrating a periphery of a lower portion of the refrigerator according to Embodiment 1 of the present invention.

15 [Fig. 11] Fig. 11 is a side sectional view illustrating a configuration of a periphery of a vegetable compartment according to Embodiment 1 of the present invention.

[Fig. 12] Fig. 12 is a front sectional view illustrating a rear-face wall viewed from the inside of the vegetable compartment according to Embodiment 1 of the present invention.

20 [Fig. 13] Fig. 13 is an explanatory view illustrating a blow air passage of a refrigerator compartment and a return air passage of the refrigerator compartment 2 of the refrigerator according to Embodiment 1 of the present invention.

[Fig. 14A] Fig. 14A is a front view illustrating an installation example of an air-passage heater of the refrigerator according to Embodiment 1 of the present invention.

25 [Fig. 14B] Fig. 14B is a front view illustrating another installation example of the air-passage heater of the refrigerator according to Embodiment 1 of the present invention.

[Fig. 15] Fig. 15 is an explanatory view illustrating a blow air passage of an ice-making compartment and a return air passage of the ice-making compartment of the refrigerator according to Embodiment 1 of the present invention.

[Fig. 16] Fig. 16 is an explanatory view illustrating a blow air passage of a versatile compartment and a return air passage of the versatile compartment of the refrigerator according to Embodiment 1 of the present invention.

[Fig. 17] Fig. 17 is an explanatory view illustrating a blow air passage of a freezer compartment and a return air passage of the freezer compartment 6 of the refrigerator according to Embodiment 1 of the present invention.

[Fig. 18] Fig. 18 is a schematic sectional view illustrating a first example of a configuration of a storage compartment partition according to Embodiment 1 of the present invention.

[Fig. 19] Fig. 19 is a schematic sectional view illustrating a second example of the configuration of the storage compartment partition according to Embodiment 1 of the present invention.

[Fig. 20] Fig. 20 is a side sectional view illustrating a first example of a configuration of a wall face on the periphery of the vegetable compartment according to Embodiment 1 of the present invention.

[Fig. 21] Fig. 21 is a side sectional view illustrating a second example of the configuration of the wall face on the periphery of the vegetable compartment according to Embodiment 1 of the present invention.

[Fig. 22] Fig. 22 is a side sectional view illustrating a third example of the configuration of the wall face on the periphery of the vegetable compartment according to Embodiment 1 of the present invention.

[Fig. 23A] Fig. 23A is a front sectional view illustrating a first example of the rear-face wall viewed from the inside of the vegetable compartment according to Embodiment 1 of the present invention.

[Fig. 23B] Fig. 23B is a front sectional view illustrating a second example of the rear-face wall viewed from the inside of the vegetable compartment according to Embodiment 1 of the present invention.

[Fig. 24] Fig. 24 is a schematic view illustrating placement of a thermal heater of the vegetable compartment according to Embodiment 1 of the present invention.

[Fig. 25] Fig. 25 is a schematic view illustrating placement of a heat rejection pipe of the vegetable compartment according to Embodiment 1 of the present invention.

[Fig. 26] Fig. 26 is a schematic view illustrating the relation of connection between the heat rejection pipe of the vegetable compartment and the refrigerant circuit according to Embodiment 1 of the present invention.

[Fig. 27] Fig. 27 is a diagram illustrating a flow-rate characteristic on the outlet pipe side not connected to the heat rejection pipe extending into the vegetable compartment, at a flow switching three-way valve according to Embodiment 1 of the present invention.

[Fig. 28] Fig. 28 is a schematic configuration view of the flow switching three-way valve according to Embodiment 1 of the present invention.

[Fig. 29] Fig. 29 is an explanatory view illustrating flow formation states relative to STEPs of a rotary gear at the flow switching three-way valve according to Embodiment 1 of the present invention.

[Fig. 30] Fig. 30 is a partial side sectional view illustrating a configuration of a part of a cooler compartment and the machine compartment according to Embodiment 1 of the present invention.

[Fig. 31A] Fig. 31A is a schematic plan view illustrating a first example of a configuration of a drip tray according to Embodiment 1 of the present invention.

[Fig. 31B] Fig. 31B is a schematic plan view illustrating a second example of the configuration of the drip tray according to Embodiment 1 of the present invention.

[Fig. 32] Fig. 32 is a rear view illustrating a configuration of the inside of the machine compartment according to Embodiment 1 of the present invention.

[Fig. 33] Fig. 33 is a front view illustrating another configuration example of the rear-face wall viewed from the inside of the vegetable compartment of the refrigerator according to Embodiment 1 of the present invention.

[Fig. 34] Fig. 34 is a partial side sectional view illustrating a configuration of a part of a cooler compartment and a machine compartment according to Embodiment 2 of the present invention.

Description of Embodiments

[0011]

Embodiment 1

A configuration of a refrigerator 1 will be described based on Figs. 1 to 4. Fig. 1 is an external perspective view illustrating the refrigerator according to Embodiment 1 of the present invention. Fig. 2 is a schematic view illustrating a refrigerant circuit and an air cycle passage of the refrigerator according to Embodiment 1 of the present invention. Fig. 3 is a side sectional view illustrating the refrigerator according to Embodiment 1 of the present invention. Fig. 4 is a schematic configuration view of a machine compartment on a rear face of the refrigerator according to Embodiment 1 of the present invention.

[0012]

As illustrated in Figs. 1 and 3, the refrigerator 1 is provided with a thermal insulation box body 19 configured in a vertically long cuboid shape, and a plurality of storage compartments are formed in the thermal insulation box body 19. In the refrigerator 1, storage compartments are arranged in the following order from the top: a refrigerator compartment 2, an ice-making compartment 3 on the left side, a temperature versatile compartment 4 on the right side of the ice-making compartment 3, a vegetable compartment 5, and a freezer compartment 6, and a partition is provided between each storage compartment.

[0013]

The thermal insulation box body 19 is made up of an upper face portion, a bottom face portion, a right side-face portion, a left side-face portion, a rear face portion, and doors provided each on the front face sides of the storage compartments. Further, as illustrated in Fig. 3, a cooler compartment 27 is formed in the thermal insulation box body 19, and the cooler compartment 27 is located on the rear faces of the ice-making compartment 3, the temperature versatile compartment

4, and the vegetable compartment 5. The refrigerator 1 also includes, in the lower portion of the rear face, a machine compartment 90 that is formed outside the thermal insulation box body 19 by a part of a wall portion 19a of the thermal insulation box body 19 recessing inward. The machine compartment 90 is located on the rear face of the freezer compartment 6, and a machine compartment cover, not illustrated, is provided on the rear face side of the machine compartment 90.

[0014]

As illustrated in Fig. 2, the refrigerator 1 is provided with a refrigerant circuit 7 in which refrigerant circulates and an air cycle passage 36 in which air circulates, and the inside of the refrigerator 1 is cooled by thermal exchange between the refrigerant and the air. In Figs. 2, a solid arrow shows the flow direction of the refrigerant flowing in the refrigerant circuit 7, and a broken arrow shows the flow direction of the cool air flowing in the air cycle passage.

[0015]

Fig. 4 illustrates the inside of the machine compartment 90 as viewed from the back without the machine compartment cover. As illustrated in Figs. 2 and 4, the refrigerant circuit 7 is formed in such a way that a compressor 8, an air-cooled condenser 9, a heat rejection pipe 10, a dew condensation preventive pipe 11, a dryer 12, a decompression device 13, a cooler 14, and other parts are connected through pipes. The compressor 8 compresses the refrigerant to circulate the compressed refrigerant in the refrigerant circuit 7 and is installed in the machine compartment 90. A machine compartment fan 95 is installed in the machine compartment 90, the fan taking outside air into the machine compartment 90 and circulates the air in the machine compartment 90 to cool the compressor 8 and other devices. The air-cooled condenser 9 is an air-cooled heat exchanger that is disposed in the machine compartment 90 and rejects the heat of the refrigerant to the air sent from the machine compartment fan 95. The heat rejection pipe 10 is a pipe installed inside urethane of the body of the refrigerator 1 and naturally rejects the heat of the refrigerant to the air outside the refrigerator 1. The dew condensation preventive pipe 11 is stretched around each storage compartment on the front face of the

refrigerator 1 to prevent dew condensation on the front face. As thus described, the air-cooled condenser 9, the heat rejection pipe 10, and the dew condensation preventive pipe 11 have the function of condensing the refrigerant in the refrigerant circuit 7. The dryer 12 removes moisture in the refrigerant to prevent freezing due to the moisture. The decompression device 13 is configured including a capillary, for example, to decompress the refrigerant. The cooler 14 is disposed in the cooler compartment 27, and an air-sending device 15 for circulating the air in the refrigerator 1 is also disposed in the cooler compartment 27. The cooler 14 is a heat exchanger that removes the heat of the refrigerant to the air sent by the air-sending device 15. That is, the cooler 14 has the function of evaporating the refrigerant.

[0016]

Further, the refrigerator 1 is provided with: an air passage for introducing cool air cooled by the cooler compartment 27 to each storage compartment; air volume control devices 18a, 18b, 18c (hereinafter, these may be collectively referred to as an air volume control device 18), each of which is provided in the air passage and regulates a volume of cool air flowing in each storage compartment; and other parts. The air volume control device 18 is, for example, formed of a dumper with its opening degree variable. Further, the refrigerator 1 is provided with a control board 17, a plurality of temperature sensors, and other parts, as illustrated in Fig. 3. Each of temperature sensors 16a, 16b, 16c, 16d (hereinafter, these may be collectively referred to as a temperature sensor 16) is formed of a thermistor, for example, and installed in each storage compartment to detect an air temperature or a temperature of stored food in the storage compartment in which each temperature sensor is installed. In Fig. 3, the temperature sensor 16a is installed in the refrigerator compartment 2, the temperature sensor 16b is installed in the temperature versatile compartment 4, the temperature sensor 16c is installed in the vegetable compartment 5, and the temperature sensor 16d is installed in the freezer compartment 6. The control board 17 is built in the upper portion of the rear face of the refrigerator 1. The control board 17 includes, for example, a microcomputer, an electronic component, and other components, and performs various control of the refrigerator 1.

For example, depending on temperature information having been input from the temperature sensor 16, the control board 17 controls the opening degree of the air volume control device 18 installed in the air passage, a driving frequency of the compressor 8, a blast volume of the air-sending device 15, and others.

5 [0017]

In the refrigerant circuit 7, the refrigerant discharged from the compressor 8 passes through the air-cooled condenser 9, the heat rejection pipe 10, and the dew condensation preventive pipe 11 in this order, and during the passage, the refrigerant rejects heat and is condensed. The refrigerant flowing out of the dew condensation preventive pipe 11 flows into the dryer 12, in which moisture is removed, and the refrigerant then flows into the decompression device 13. The refrigerant flowing into the decompression device 13 is decompressed and flows into the cooler 14. In the cooler 14, the air-sending device 15 causes the refrigerant to remove heat from the air circulating in the refrigerator 1 and to evaporate. At this time, the air on the periphery of the cooler 14 is cooled. The refrigerant having evaporated in the cooler 14 exchanges heat with refrigerant flowing in the decompression device 13 to increase its temperature at the time of passing through a suction tube connecting the cooler 14 with the compressor 8, and the refrigerant returns to the compressor 8.

[0018]

20 Meanwhile, the cool air generated by heat exchange of the air in the refrigerator 1 with the refrigerant flowing in the cooler compartment 27 is sent by the air-sending device 15 to each storage compartment through the air passage to cool each storage compartment. The temperature of each storage compartment is detected by the temperature sensor 16 installed in each storage compartment and is held at an appropriate temperature by the control board 17 operating the air volume control device 18 or other devices so that the detected temperature reaches a preset temperature. The cool air having cooled each storage compartment is returned by the air-sending device 15 to the cooler compartment 27 through the air passage.

[0019]

As illustrated in Fig. 3, in the cooler compartment 27, the position of the cooler 14 may be set such that its lower end 14a is located below a position F of the floor face of the vegetable compartment 5. When such a configuration is formed, a larger space can be ensured in the upper portion of the cooler 14 to increase the flexibility in size of the air-sending device 15 that sends cool air to each storage compartment and ensure the space for placement of the air volume control device 18.

[0020]

Next, the configuration of the thermal insulation box body 19 of the refrigerator 1 will be described based on Figs. 5 to 9. Fig. 5 is a partial sectional view illustrating the configuration of the thermal insulation box body according to Embodiment 1 of the present invention. Fig. 6 is a partial sectional view illustrating a member of the thermal insulation box body when it is fixed according to Embodiment 1 of the present invention. Fig. 7 is a partial sectional view illustrating a first example of the configuration of the thermal insulation box body according to Embodiment 1 of the present invention. Fig. 8 is a partial sectional view illustrating a second example of the configuration of the thermal insulation box body according to Embodiment 1 of the present invention. Fig. 9 is a partial explanatory view illustrating a third example of the configuration of the thermal insulation box body according to Embodiment 1 of the present invention.

[0021]

As illustrated in Fig. 5, the thermal insulation box body 19 is made up of an outer box 21 and an inner box 22 that constitute an outer shell, a thermal insulator 23 disposed between the outer box 21 and the inner box 22, and other parts, and the thermal insulation box body 19 prevents entry of heat from the outside. The inner box 22 is a part of the outer shell of the thermal insulation box body 19 and constitutes an inner wall of each storage compartment. For the thermal insulator 23, a urethane foamed member 23a or other members is used.

[0022]

As illustrated in Fig. 6, in the case of installation of a drawer-type storage compartment provided with a frame structure 25a, a rail structure 25b to receive the

frame structure 25a is installed on the inner box 22 side of the thermal insulation box body 19. In the position where a support 25c of the rail structure 25b is installed, the thermal insulation box body 19 has a shape corresponding to the shape of the support 25c, and the support 25c is fixed by the surrounding inner box 22 and urethane foamed member 23a. In the other place of the thermal insulation box body 19, various internally installed members, such as an enforcement member for correcting distortion of the refrigerator 1, components of the refrigerant circuit 7, and electric wiring components, are fixed by the urethane foamed member 23a.

[0023]

As illustrated in Fig. 7, the thermal insulator 23 of the thermal insulation box body 19 may be made up of the urethane foamed member 23a and the vacuum thermal insulator 23b. In this case, the vacuum thermal insulator 23b is disposed in a part of the space between the outer box 21 and the inner box 22, and the remaining space is filled with the urethane foamed member 23a. In Fig. 7, the vacuum thermal insulator 23b is stuck to the wall face of the outer box 21. As thus described, the vacuum thermal insulator 23b is used for a part of the thermal insulator 23, whereby the thermal insulation box body 19 can further reduce an amount of heat entering the refrigerator 1.

[0024]

Further, as illustrated in Fig. 8, the vacuum thermal insulator 23b may be configured to be disposed by a spacer 26 in an intermediate position between the wall face of the outer box 21 and the wall face of the inner box 22 depending on a position where the vacuum thermal insulator 23b is installed inside the thermal insulation box body 19. Alternatively, as illustrated in Fig. 9, the vacuum thermal insulator 23b may be stuck to the wall face of the inner box 22. In the configuration of Fig. 9, the vacuum thermal insulator 23b may be installed not to interfere with the internally installed members described above. Note that the position and the range in which the vacuum thermal insulator 23b is installed in the thermal insulation box body 19 are not limited to the above configuration, but the vacuum thermal insulator 23b may only be installed such that the casing strength of the refrigerator 1 can be ensured.

The vacuum thermal insulator 23b is mounted in the refrigerator 1, whereby the distance (thermal insulation thickness) between the outer box 21 and the inner box 22 can be reduced to increase the inner volume of the refrigerator 1.

[0025]

5 Next, the air passage formed in the refrigerator 1 will be described. The air passage is made up of an air passage connected to the cooler compartment 27 and a part of the storage-compartment air passage, a blow air passage through which a cool air blows to each storage compartment, a return air passage through which the cool air returns from each storage compartment, and other air passages.

10 [0026]

 Fig. 10 is an explanatory view illustrating the periphery of the lower portion of the refrigerator according to Embodiment 1 of the present invention. (a) is a front sectional view, and (b) is a side sectional view, when the door is removed. As illustrated in Fig. 10, a return air passage 30a from the refrigerator compartment 2 is formed on the right side of the cooler 14, and a return air passage 30c from the temperature versatile compartment 4 and a blow air passage 29d to the vegetable compartment 5 are formed in front of the return air passage 30a. A rear-face wall 31 serving as a partition from the space in the vegetable compartment 5 is formed in front of each of the cooler 14, the return air passage 30c, and the blow air passage 29d.

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[0027]

 Fig. 11 is a side sectional view illustrating a configuration of the periphery of the vegetable compartment according to Embodiment 1 of the present invention. The rear-face wall 31 separating the vegetable compartment 5 from the cooler compartment 27 is formed on the rear face of the vegetable compartment 5. The rear-face wall 31 is a thermal insulation wall and made up of a thermal-insulation-wall outer shell 38 on the vegetable compartment 5 side, a thermal-insulation-wall outer shell 42 on the cooler compartment 27 side, a vacuum thermal insulator 39, a foamed thermal insulator 40 disposed around the vacuum thermal insulator 39, and other members. The foamed thermal insulator 40 of the rear-face wall 31 is provided with

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an air passage 28, through which cool air is sent to the storage compartments such as the freezer compartment 6 and the refrigerator compartment 2. The arrangement in front of and behind the air passage 28 is as follows from the back: the cooler 14, the insulation-wall outer shell 42, the foamed thermal insulator 40 with the air
5 passage 28 formed therein, the vacuum thermal insulator 39, and the thermal-insulation-wall outer shell 38 on the vegetable compartment 5 side. The foamed thermal insulator 40 having the air passage configuration is also provided with the function of holding the air volume control device 18.

[0028]

10 A ceiling wall 32 of the vegetable compartment 5 serves as a partition between the vegetable compartment 5, and the ice-making compartment 3 as well as the temperature versatile compartment 4, and a bottom wall 35 of the vegetable compartment 5 serves as a partition between the vegetable compartment 5 and the freezer compartment 6. Each of the ceiling wall 32 and the bottom wall 35 is formed
15 of a thermal insulation wall to prevent transfer of heat between the storage compartments with different setting temperatures. Each of the ceiling wall 32 and the bottom wall 35 has, for example, the outer shell made of an injection molding member and the inside made up of a urethane foamed member 35a and a vacuum thermal insulator 35b. The viscosity of the urethane foamed member 35a and the
20 width of the flow passage are ensured, whereby the vacuum thermal insulator 35b can be installed in the middle of the partition outer-shell wall face and the whole can be wrapped by the vacuum thermal insulator 35b, to prevent further deterioration. When the vacuum thermal insulator 35b is disposed on the storage compartment side at a low temperature as illustrated in Fig. 11, it is possible to easily maintain the
25 temperature in the storage compartment set at the low temperature. In Fig. 11, the vacuum thermal insulator 35b is disposed on the ice-making compartment 3 side and the temperature versatile compartment 4 side in the ceiling wall 32, and disposed on the freezer compartment 6 side in the bottom wall 35.

[0029]

Fig. 12 is a front sectional view illustrating a rear-face wall portion viewed from the inside of the vegetable compartment according to Embodiment 1 of the present invention. As illustrated in Fig. 12, an air outlet 44, from which cool air blows out into the vegetable compartment 5, is formed in the right-side upper portion in the inner wall of the rear-face wall 31 of the vegetable compartment 5. The air outlet 44 for the cool air is located outside the projection plane in the front-back direction of the vacuum thermal insulator 39 installed in the rear-face wall 31. Further, a return inlet 45, to which the cool air returns from the vegetable compartment 5, is formed in the left-side lower portion, diagonal to the air outlet 44, in the rear-face wall 31. The return inlet 45 is located outside the projection plane in the front-back direction of the vacuum thermal insulator 39. The air outlet 44 supplies cool air, generated in the cooler 14, by using the air-sending device 15 installed above the cooler 14 via the air volume control device 18 (e.g., air volume control device 18c) provided above the cooler compartment 27. The cool air blown out from the air outlet 44 into the vegetable compartment 5 cools the inside of the vegetable compartment 5, and is then discharged from the return inlet 45 for the cool air and guided to the cooler compartment 27, to be cooled again by the cooler 14.

[0030]

Fig. 13 is an explanatory view illustrating the blow air passage of the refrigerator compartment and the return air passage of the refrigerator compartment 2 of the refrigerator according to Embodiment 1 of the present invention. (a) is a partial front view of the refrigerator 1 when the door is removed, (b) is a side sectional view of the refrigerator 1 along the blow air passage 29a of the refrigerator, and (c) is a partial side sectional view of the refrigerator 1 along the return air passage 30a of the refrigerator compartment 2.

[0031]

As illustrated in Fig. 13, the blow air passage 29a of the refrigerator compartment 2 is formed by connecting a plurality of air passages, through each of which cool air passes after being discharged from the air-sending device 15 installed above the cooler 14. The plurality of air passages are, for example, the air passage

28 in the rear-face wall 31, an air passage toward the refrigerator compartment 2 in the foamed thermal insulator above the cooler compartment 27, an air passage in the thermal insulation wall partitioning between the refrigerator compartment 2 and the ice-making compartment 3 as well as the temperature versatile compartment 4, an air
5 passage molded in the foamed thermal insulator and installed on the rear face side of the refrigerator compartment 2, and other air passages. Note that the air volume control device 18a for regulating an amount of cool air supplied to the refrigerator compartment 2 is installed, for example, in the middle of the blow air passage 29a of the refrigerator compartment 2. The return air passage 30a of the refrigerator
10 compartment 2 is installed on the right side from the cooler 14 with use of the foamed thermal insulator to obtain necessary thermal insulation. The discharge port of the return air passage 30a of the refrigerator compartment 2 is connected to a drip tray 80 from the right side below the cooler 14 in the cooler compartment 27, the drip tray 80 receiving melt water generated during defrosting.

15 [0032]

When the necessary thermal insulation is not ensured in the return air passage 30a of the refrigerator compartment 2, an air-passage heater for avoiding blockage of the air passage due to frosting may be provided in the return air passage 30a. Fig. 14A is a front view illustrating an installation example of the air-passage heater of the
20 refrigerator according to Embodiment 1 of the present invention. Fig. 14B is a front view illustrating another installation example of the air-passage heater of the refrigerator according to Embodiment 1 of the present invention. Figs. 14A and 14B illustrate the periphery of the lower portion of the refrigerator when the door is removed.

25 [0033]

In Fig. 14A, an air-passage heater 33a is installed in the return air passage 30a of the refrigerator compartment 2 and generates heat when necessary. The air-passage heater 33a is installed at an arbitrary position in the return air passage 30a in the longitudinal direction of the air passage, and for example, may be installed in a
30 range not smaller than dimensions with which the cooler 14 is projected in the vertical

direction. In Fig. 14B, the air-passage heater 33b is installed in the vicinity of the drip tray 80. The air-passage heater 33b may, for example, be provided in a vertical range of about 100 mm, with a joint between the return air passage 30a and the drip tray 80 at the center, to go along the flowing direction of the returned cool air.

5 [0034]

Fig. 15 is an explanatory view illustrating a blow air passage of the ice-making compartment and a return air passage of the ice-making compartment in the refrigerator according to Embodiment 1 of the present invention. (a) is a partial front view of the refrigerator 1 when the door is removed, and (b) is a perspective view of the inside of the ice-making compartment 3.

10 [0035]

As illustrated in Fig. 15, a blow air passage 29b of the ice-making compartment 3 is formed by connecting a plurality of air passages, through each of which the cool air passes after being discharged from the air-sending device 15 installed above the cooler 14. The plurality of air passages are, for example, an air passage in the foamed thermal insulator above the cooler compartment 27, an air passage molded in the foamed thermal insulator installed on the rear face side of the ice-making compartment 3, and other air passages. Note that an air volume control device, not illustrated, for regulating an amount of cool air supplied to the ice-making compartment 3 is installed, for example, in the middle of the blow air passage 29b of the ice-making compartment 3. In the ice-making compartment 3, an air outlet 70 for cool air is provided in an arbitrarily position on the rear face of the ice-making compartment 3, and the cool air blown out from the air outlet 70 flows into an ice-making mechanism 71. A return air passage 30b of the ice-making compartment 3 is installed from the front face of the cooler 14 and on the ice-making compartment 3 side from the center of the refrigerator 1 within the total width of the cooler 14 as well as within the projection width in the front-back direction of the ice-making compartment 3. The return air passage 30b of the ice-making compartment 3 is made up of a return inlet 72 arbitrarily installed in the rear-face wall of the ice-making compartment 3, the rear side of the outer shell on the front face of the ice-making

compartment, a part of the foamed thermal insulator adjacent to the outer shell of the front face of the ice-making compartment 3, and other portions. A discharge port of the return air passage 30b of the ice-making compartment 3 merges in the vicinity of a return inlet 74 for cool air from the freezer compartment 6. For avoiding a pressure drop due to the merge, the return inlet 74 from the freezer compartment 6 may be formed in the vicinity of the discharge port for the cool air from the ice-making compartment 3, to have a dimension not smaller than a lateral width of the return air passage 30b of the ice-making compartment 3. Note that the return air passage 30b of the ice-making compartment 3 may be directly returned into the cooler compartment 27 in a position above the return inlet 74 for cool air from the freezer compartment 6.

[0036]

Fig. 16 is an explanatory view illustrating a blow air passage of the versatile compartment and a return air passage of the versatile compartment of the refrigerator according to Embodiment 1 of the present invention. (a) is a partial front view of the refrigerator 1 when the door is removed, and (b) is a partial side sectional view of the refrigerator 1.

[0037]

As illustrated in Fig. 16, a blow air passage 29c for the cool air to the temperature versatile compartment 4 is formed by connecting a plurality of air passages, through each of which a cooled vessel passes after being discharged from the air-sending device 15 installed above the cooler 14. The plurality of air passages are an air passage in the foamed thermal insulator above the cooler compartment 27, an air passage molded in the foamed thermal insulator installed on the rear face side of the temperature versatile compartment 4, and other air passages. Note that the air volume control device 18b (cf. Fig. 3) that regulates an amount of cool air supplied to the temperature versatile compartment 4 is installed, for example, in the middle of the blow air passage 29c of the temperature versatile compartment 4. Further, the return air passage 30c of the versatile compartment is made up of a cool-air return inlet arbitrarily installed on the rear-face wall of the temperature versatile

compartment 4, the rear side of the outer shell on the front face of the temperature versatile compartment 4, a part of the foamed thermal insulator adjacent to the outer shell of the front face of the temperature versatile compartment 4, and other portions. The discharge port of the return air passage 30c is provided on the right side of the return air passage 30e from the freezer compartment 6.

[0038]

Fig. 17 is an explanatory view illustrating a blow air passage of the freezer compartment and a return air passage of the freezer compartment 6 of the refrigerator according to Embodiment 1 of the present invention. (a) is a partial front view of the refrigerator 1 when the door is removed, and (b) is a partial side sectional view of the refrigerator 1.

[0039]

As illustrated in Fig. 17, a blow air passage 29e of the freezer compartment 6 is formed by connecting a plurality of air passages, through each of which the cool air passes after being discharged from the air-sending device 15 installed above the cooler 14. The plurality of air passages are, for example, the air passage 28 in the rear-face wall 31, an air passage provided on the bottom wall 35 of the vegetable compartment 5, and other air passages. The cool air having passed through the blow air passage 29e of the freezer compartment 6 is guided into storing cases piled in a plurality of stages in the freezer compartment 6 by a guide portion provided on the ceiling on the rear side of the freezer compartment 6, to cool stored items in the freezer compartment 6. Further, the return air passage 30e of the freezer compartment 6 is made up of an air passage provided from the inside of the freezer compartment 6 toward the back of the bottom wall 35 of the vegetable compartment 5. The return air passage 30e is formed in a lateral range of the cooler 14. The discharge port of the return air passage 30e of the freezer compartment 6 is connected to the drip tray 80 from the right side below the cooler 14 in the cooler compartment 27 in the same manner as the return air passage 30a of the refrigerator compartment 2. Note that the above guide portion may be provided with two guides arranged in the front-back direction of the refrigerator 1, and the blow-side guide into

the freezer compartment 6 may be disposed in the front, while the return-side guide from the freezer compartment 6 may be disposed in the back.

[0040]

Fig. 18 is a schematic sectional view illustrating a first example of a configuration of a storage compartment partition according to Embodiment 1 of the present invention. Fig. 19 is a schematic sectional view illustrating a second example of the configuration of the storage compartment partition according to Embodiment 1 of the present invention. The case has been described in Fig. 11 above where the vacuum thermal insulator 35b in the bottom wall 35 of the vegetable compartment 5 is disposed on the storage compartment side (freezer compartment 6 side) at a low temperature, but the vacuum thermal insulator 35b can be disposed in an arbitrary position in the bottom wall 35 as illustrated in Figs. 18 and 19. As illustrated in Fig. 19, when the vacuum thermal insulator 35b is disposed on the vegetable compartment 5 side of the outer shell wall face, it is possible to increase a covering ratio relative to the inner wall face of the vegetable compartment 5 and reduce an amount of heat that enters.

[0041]

Further, the vacuum thermal insulator 39 can be disposed in an arbitrary position also in the rear-face wall 31 of the vegetable compartment 5. Fig. 20 is a side sectional view illustrating a first example of a configuration of the wall face on the periphery of the vegetable compartment according to Embodiment 1 of the present invention. Fig. 21 is a side sectional view illustrating a second example of the configuration of the wall face on the periphery of the vegetable compartment according to Embodiment 1 of the present invention. Fig. 22 is a side sectional view illustrating a third example of the configuration of the wall face on the periphery of the vegetable compartment according to Embodiment 1 of the present invention.

[0042]

In Fig. 20, the rear-face wall 31 is configured in the following order from the back close to the cooler 14 to the front: the thermal-insulation-wall outer shell 42, the foamed thermal insulator 40 formed with the air passage 28, the vacuum thermal

insulator 39, the foamed thermal insulator 40, and the thermal-insulation-wall outer shell 38 on the vegetable compartment 5 side. In Fig. 21, for ensuring the effect of the vacuum thermal insulator 39, the vacuum thermal insulator 39 is stuck to the inner wall of the thermal-insulation-wall outer shell 42 on the cooler 14 side. In the configuration example illustrated in Fig. 21, with restraints on the position of the outlet or the size of the outlet for the cool air discharged from the air-sending device 15, the height dimension of the vacuum thermal insulator 39 may be reduced. In a configuration where the foamed thermal insulator 40 is not disposed around the vacuum thermal insulator 39, accelerated deterioration in the vacuum thermal insulator 39 is concerned, but as illustrated in Fig. 22, the vacuum thermal insulator 39 is protected by the foamed thermal insulator 40 being installed between the thermal-insulation-wall outer shell 42 and the vacuum thermal insulator 39. The size of the vacuum thermal insulator 39 is set to be larger than an area of the cooler 14 projected forward, whereby an amount of primary transfer of heat that passes through the rear-face wall 31 can be minimized.

[0043]

Further, the air outlet 44 and the return inlet 45 formed on the rear face of the vegetable compartment 5 may be disposed on either of the right side and the left side. Fig. 23A is a front sectional view illustrating a first example of a rear-face wall portion viewed from the inside of the vegetable compartment according to Embodiment 1 of the present invention. Fig. 23B is a front sectional view illustrating a second example of the rear-face wall portion viewed from the inside of the vegetable compartment according to Embodiment 1 of the present invention.

[0044]

When the air outlet 44 and the return inlet 45 are disposed on the left side as in Fig. 23A or disposed on the right side as in Fig. 23B, the air passage does not need to be disposed on the right side or the left side, whereby extended installation of the vacuum thermal insulator 39 is enabled. With such a configuration, the covering ratio of the vacuum thermal insulator 39 of the vegetable compartment 5 increases to enhance the thermal insulation properties. That is, it is possible to prevent transfer

of heat from the vegetable compartment 5 to another storage compartment, or transfer of cooling energy from another storage compartment, the cooler compartment 27, or other places, to the vegetable compartment 5. In addition, entry of heat from the outside of the refrigerator 1 into the vegetable compartment 5 is prevented.

[0045]

On the other hand, when the covering ratio of the vacuum thermal insulator is set to be large, the average temperature of the vegetable compartment 5 tends to be lowered. For this reason, the refrigerator 1 may have a configuration to hold the temperature inside the vegetable compartment 5.

[0046]

Fig. 24 is a schematic view illustrating placement of a thermal heater of the vegetable compartment according to Embodiment 1 of the present invention. Fig. 24 illustrates an example where a thermal heater 46 using electric resistance is installed to keep the temperature inside the vegetable compartment 5 when necessary. The thermal heater 46 is installed in an arbitrary position on the floor face, the rear face, the left-side face, and the right-side face of the vegetable compartment 5, particularly at a point where the temperature inside the vegetable compartment 5 is relatively low, and with an arbitrary capacity of 3 W or smaller, and about 10 W, for example. The thermal heater 46 is energized at a duty factor on the time basis (a ratio of energization time to reference time) according to an outside air temperature and the temperature inside the vegetable compartment 5.

[0047]

Fig. 25 is a schematic view illustrating placement of the heat rejection pipe of the vegetable compartment according to Embodiment 1 of the present invention. Fig. 26 is a schematic view illustrating the relation of connection between the heat rejection pipe of the vegetable compartment and the refrigerant circuit according to Embodiment 1 of the present invention. Fig. 25 illustrates a configuration in which a heat rejection pipe 47 is disposed, in place of the above thermal heater 46, inside the urethane foamed member 23a in each of the right and left side walls of the vegetable

compartment 5 and inside the outer shell of the bottom wall 35 on the thermal insulator side. The heat rejection pipe 47 causes the refrigerant for use in the cooler 14 to flow to reject heat into the vegetable compartment 5. As illustrated in Fig. 26, the decompression device 13 in the refrigerant circuit 7 is made up of, for example, a flow switching three-way valve 48 and two capillaries (a capillary 51a, a capillary 51b, etc.). On the refrigerant circuit 7 described above, after connection to the dryer 12 via the dew condensation preventive pipe 11, the connections downstream of the flow switching three-way valve 48 are switched. An outlet pipe 50 out of two outlet pipes 49, 50 downstream of the flow switching three-way valve 48 is connected to one end of the capillary 51a via the heat rejection pipe 47 described above. On the other hand, the outlet pipe 49 is connected to one end of the capillary 51b. The capillary 51b, to which the outlet pipe 49 is connected, may be configured such that an amount of depression can be changed.

[0048]

With such a configuration, when the heat rejection pipe 47 rejects the heat of the refrigerant into the vegetable compartment 5, the heat rejection acts to increase a load on the air side, and increase a condensing capacity of the refrigerant on the refrigeration cycle side. As a result, the efficiency of the refrigeration cycle is improved to enable reduction in power consumption as compared to the case of using the thermal heater 46.

[0049]

The configuration of regulating the flow rate of the refrigerant flowing in the heat rejection pipe 47 will be described based on Figs. 27 to 29. Fig. 27 is a diagram illustrating a flow-rate characteristic on the outlet pipe side not connected to the heat rejection pipe extending into the vegetable compartment, at the flow switching three-way valve according to Embodiment 1 of the present invention. Fig. 28 is a schematic configuration view of the flow switching three-way valve according to Embodiment 1 of the present invention. Fig. 29 is an explanatory view illustrating flow formation states relative to STEPs of a rotary gear at the flow switching three-way valve according to Embodiment 1 of the present invention.

[0050]

As illustrated in Fig. 28, for the flow switching three-way valve 48, for example, an electronic control expansion valve such as a linear electronic expansion valve is used, and the flow rate of the refrigerant discharged from the outlet pipe 49
5 connected to the capillary 51b is regulated stepwise. The flow switching three-way valve 48 is roughly made up a low-voltage four-phase stepping motor 52, a valve body 53, and other parts. The valve body 53 internally has, as main parts, a magnetizing rotor 54, a center gear 55, a rotary gear 56, a rotary pad 57, a valve seat 58, an outer shell case 59, a floor plate 60, and other parts. The flow switching
10 three-way valve 48 performs unipolar drive on the four-phase stepping motor 52 by one and two-phase excitation to cause the magnetizing rotor 54 to rotate. The magnetizing rotor 54 is directly connected to the center gear 55, and when the magnetizing rotor 54 rotates, the center gear 55 rotates the same amount in the same direction as the magnetizing rotor 54.

[0051]

Further, as illustrated in Fig. 29, the center gear 55 and the rotary gear 56 are directly joined, and hence the rotary pad 57 fixed to the rotary gear 56 receives the rotary drive of the center gear 55 with reference to a central axis provided in the valve seat 58 to rotate. In the rotary pad 57, orifices 61, 62, 63 with different inner
20 diameters are provided at three places. When any of the orifices 61, 62, 63 at the three places overlaps with an output orifice 64 in the valve seat 58 by the rotation of the rotary pad 57, a predetermined flow rate of the refrigerant flows out. Figs. 29(a) to 29(g) illustrate flow formation states relative to different STEPs of the rotary gear 56. As illustrated in Fig. 27, on the outlet pipe 49 side, the configuration is in such a
25 way that the flow rate control in five stages of full close, an expansion flow rate A, an expansion flow rate B, an expansion flow rate C, and full open can be switched. In the flow formation states of Fig. 29, a state (b) corresponds to the full close, a state (c) to the expansion flow rate A, a state (d) to the expansion flow rate B, a state (e) to the expansion flow rate C, and a state (f) to the full open.

[0052]

With such a configuration, in the refrigerator 1, it is possible to reduce the amount of power consumption while ensuring the temperature of the vegetable compartment 5. In the case of using the thermal heater 46 that uses electric resistance for heat retention of the vegetable compartment 5, a two-way valve where, out of the two outlets, one that can control the flow rate is left may be used in place of the flow switching three-way valve.

[0053]

Based on Figs. 30 through 31B, the drain passage provided from the cooler compartment 27 to the machine compartment 90 will be described. Fig. 30 is a partial side sectional view illustrating a configuration of the cooler compartment and a part of the machine compartment according to Embodiment 1 of the present invention. Fig. 31A is a schematic plan view illustrating a first example of a configuration of the drip tray according to Embodiment 1 of the present invention. Fig. 31B is a schematic plan view illustrating a second example of the configuration of the drip tray according to Embodiment 1 of the present invention.

[0054]

As illustrated in Fig. 30, below the cooler compartment 27, there are provided a defrosting unit 67 that melts frost on the cooler 14, and the drip tray 80 that guides moisture such as melt water, generated during the defrosting operation, from the cooler compartment 27 to the machine compartment 90.

[0055]

The defrosting unit 67 is formed of a glass tube heater, for example. The glass tube heater is made up of a nichrome wire, glass tube for protecting the nichrome wire, and other members, and at the time of defrosting the cooler 14, the nichrome wire generates heat by electric resistance. The defrosting unit 67 may be installed within the vertical projection plane of an inlet of the drain passage, described later, below the cooler 14 in the cooler compartment 27.

[0056]

The drip tray 80 is formed of a thermal insulation wall 99 interposed between the vegetable compartment 5 and the machine compartment 90 and provided at a

position lower than the floor face of the vegetable compartment 5. The thermal insulation wall 99 represents, for example, a rear portion (hereinafter referred to as a wall portion 34) of the thermal insulation wall constituting the bottom wall 35 of the vegetable compartment 5, and a wall portion 19a that forms the machine compartment 90 in the thermal insulation box body 19. The wall portion 34 has, for example, an upper face 34a integrally molded with the floor face of the vegetable compartment 5, and a lower face 34b integrally molded with the ceiling face of the freezer compartment 6. A thermal insulator 34c is installed between the upper face 34a and the lower face 34b of the wall portion 34, and the lower face 34b is molded at an offset distance from the upper face 34a.

[0057]

The drip tray 80 includes a water receiver 81 that receives moisture dropped from the cooler 14, and a tubular drain passage 82 through which water received in the water receiver 81 passes. The water receiver 81 is formed of the upper face 34a of the wall portion 34, and has a shape inclined downward to an inlet 83 of the drain passage 82 to guide moisture to the drain passage 82. The drain passage 82 passes through the thermal insulator of the thermal insulation wall 99, and the outlet 84 protrudes into the machine compartment 90. The inner diameter of the drain passage 82 is smaller at the outlet 84 than at the inlet 83. The drain passage 82 is jointless inside the thermal insulation wall 99 and integrally molded from the inlet 83 to the outlet 84. Further, the drain passage 82 is integrally molded with the water receiver 81 at the inlet 83. For example, when the water receiver 81 and the drain passage 82 are formed of the outer shell, which is the upper face 34a of the wall portion 34, moisture is guided from the cooler compartment 27 to the machine compartment 90 without passing through a junction.

[0058]

As illustrated in Figs. 31A and 31B, the inlet 83 is, for example, disposed in the substantially central portion of the drip tray 80 in the lateral direction, and formed in a shape of a groove with a width of 50 mm or smaller from an arbitrary position in the front in the front-back direction. The cross-sectional shape of the inlet 83 is, for

example, a circular shape, an elliptical shape, an oval shape, a shape in combination of a half ellipse and a rectangle, or a shape in combination of a half oval and a rectangle, and the back side of the inlet 83 almost reaches the backmost portion of the water receiving face of the drip tray 80. The outlet 84 of the drain passage 82 is, for example, formed in a shape which cross-section is substantially circular having an inner diameter of 20 mm or smaller.

[0059]

As illustrated in Figs. 30, 31A, and 31B, the drain passage 82 has a substantially funnel shape in the downward direction from the inlet 83 of the drain passage 82 and gradually narrowing backward. That is, on the inlet 83 side of the drain passage 82 (hereinafter referred to as an upstream portion 82a), the sectional area decreases and the front position of the cross section approaches the rear face side in the downstream direction. On the outlet 84 side, the drain passage 82 (hereinafter referred to as a downstream portion 82b) is formed in a tubular shape having a substantially constant inner diameter and having a length such that the drain passage 82 protrudes into the machine compartment 90. The cross section of the upstream portion 82a changes from the cross-sectional shape of the inlet 83 to the circular shape of the downstream portion 82b. As illustrated in Fig. 30, the upstream portion 82a is formed passing through the wall portion 34, and the downstream portion 82b is formed passing through the wall portion 19a. Note that a lid structure may be provided at the outlet of the drain passage 82 to prevent a high-moisture air in the machine compartment 90 from flowing backward into the refrigerator 1 via the drain passage 82.

[0060]

Each of Figs. 31A and 31B illustrates a cross-section center Oa of the upstream portion 82a and a cross-section center Ob of the upstream portion 82a, and the cross-section center Oa of the upstream portion 82a shifts closer to the back of the refrigerator 1 while shifting downstream and reaches the cross-section center Ob of the downstream portion 82b. The drain passage 82 is provided such that, from

the inlet 83 to the outlet 84, the backmost portion of the drain passage 82 goes along the rear face of the refrigerator 1.

[0061]

Further, as illustrated in Fig. 30, the urethane foamed member 23a and the vacuum thermal insulator 23b are provided in the wall portion 19a. As described above, the drain passage is provided such that its sectional area is smaller in the downstream portion 82b, formed in the wall portion 19a, than in the upstream portion 82a and that the backmost portion of the drain passage goes along the rear face of the refrigerator 1. Hence the vacuum thermal insulator 23b can be installed close to the rear face of the refrigerator 1 in the wall portion 19a.

[0062]

Moreover, as illustrated in Fig. 30, a passage heater 85 may further be installed in the upstream portion 82a of the drain passage 82. The passage heater 85 is formed of, for example, a cord heater having a silicon coating, or other heaters, and is installed in the thermal insulator 34c of the wall portion 34. The passage heater 85 melts ice that has not melted into water during defrosting and has dropped into the inlet 83 of the drain passage 82, by heat generation to prevent clogging of the drain passage 82.

[0063]

A metal tray 89 molded using metal is installed on the face where the inlet 83 is formed. In Fig. 30, the metal tray 89 is installed in the water receiver 81 and the upstream portion 82a of the drain passage 82 to facilitate melting of ice having dropped into the drip tray 80 while transmitting radiant heat of the defrosting unit 67 onto the face of the drip tray 80.

[0064]

The metal tray 89 may be configured to have a dimension equivalent to or larger than the length of the defrosting unit 67, installed above the metal tray 89, in the lateral direction, and have a dimension equal to or larger than one-half of the front-back width of the drip tray 80 in the front-back direction. In addition, a region

outside the region covered with the metal tray 89 in the drip tray 80 may be covered with a metal tape or other materials.

[0065]

The metal tray 89 is formed along the water receiver 81 and the upstream
5 portion 82a to have a substantially identical shape as the shape of the inlet 83 of the drain passage 82, and promotes conduction of heat generated from the passage heater 85 installed inside the thermal insulator 34c.

[0066]

Melt water having been generated by the defrosting unit 67 melting a part and
10 dropped from the cooler 14 into the water receiver 81 of the drip tray 80 is guided to the inlet 83 of the drain passage 82 by the inclination of the water receiver 81. The melt water guided to the inlet 83 flows into the drain passage 82, is further melted by the passage heater 85 while passing through the upstream portion 82a, and flows into the downstream portion 82b having a smaller inner diameter. With no junction being
15 provided in the drain passage 82, the melt water passing therethrough is discharged into the machine compartment 90 from the outlet 84 protruding into the machine compartment 90, without permeating into the thermal insulation wall 99.

[0067]

Fig. 32 is a rear view illustrating a configuration of the inside of the machine
20 compartment according to Embodiment 1 of the present invention. In the machine compartment 90, a water tray (drain pan 91) is installed to receive moisture discharged from the outlet 84 of the drain passage 82 into the machine compartment 90, and a heating pipe 92 is installed in the drain pan 91. The heating pipe 92 is formed of, for example, a refrigerant tube through which high-temperature refrigerant
25 flows.

[0068]

The melt water having passed through the drain passage 82 is discharged from the outlet 84 into the drain pan 91 of the machine compartment 90 and stored in the drain pan 91. The melt water stored in the drain pan 91 is urged to evaporate by the
30 heating pipe 92 and cooling air that cools the air-cooled condenser 9, the compressor

8, and other devices installed in the machine compartment 90, and by other units.

With such a configuration, evaporation of melt water previously generated is completed before the next defrosting operation starts.

[0069]

5 Note that the air passage, the air outlet, and the return inlet of the refrigerator 1 are not limited to the configurations described above. Fig. 33 is a front view illustrating another configuration example of the rear-face wall viewed from the inside of the vegetable compartment of the refrigerator according to Embodiment 1 of the present invention. As illustrated in Fig. 33, it may be configured such that returned
10 cool air from the refrigerator compartment 2 flows into the vegetable compartment 5. In this case, for example, the air outlet, from which the returned cool air from the refrigerator compartment 2 blows out into the vegetable compartment 5, namely a refrigeration return inlet 75, is formed in the right-side upper portion on the inner wall of the rear-face wall 31 of the vegetable compartment 5, and the return inlet 45 from
15 the vegetable compartment 5 is formed in the substantially central portion in the lower portion of the rear face of the vegetable compartment 5. Then, it is configured such that the return air passage of the refrigerator compartment 2 and the return air passage of the vegetable compartment merges on the lower side of the rear face of the vegetable compartment 5, and return to the cooler compartment 27 from between
20 laterally divided return air passages 30e of the freezer compartment 6. A return air passage 76 of the refrigerator compartment 2, installed in the rear-face wall 31 of the vegetable compartment 5, does not have the function to insulate heat from the vegetable compartment 5, and is separated by the inner wall face molded by injection molding. Thus, a plurality of holes 77 may be provided in the inner wall face
25 separating the return air passage 76 of the refrigerator compartment 2 from the inside of the vegetable compartment 5 to regulate the temperature in the vegetable compartment 5. Further, a slider 78 for freely opening and closing the plurality of holes 77 may be provided. When the slider 78 is slid in the vertical direction indicated by an arrow, the number of holes 77 to be closed is regulated, so that a user
30 can arbitrarily regulate the temperature in the vegetable compartment 5 by moving

the slider 78. With such a configuration, the temperature can be regulated in the vegetable compartment 5, and there is thus no need to install the air volume control device 18c described above in the air passage, the air volume control device 18c being configured to regulate an amount of cool air supplied into the vegetable compartment 5.

[0070]

As described above, in Embodiment 1, the refrigerator 1 is provided with: the thermal insulation box body 19 that includes the inner box 22, the outer box 21, and thermal insulator 23 installed in the space between the inner box 22 and the outer box 21; the machine compartment 90 that is formed by the lower portion of the rear face of the thermal insulation box body 19 recessing inward and in which the compressor 8 is disposed; the cooler compartment 27 that is formed in the thermal insulation box body 19 above the machine compartment 90 and in which the cooler 14 that generates cool air is disposed; the water receiver 81 that is provided below the cooler 14 in the cooler compartment 27 and receives water from the cooler 14; and the drain passage 82 that has the inlet 83 installed in the water receiver 81, passes through the thermal insulation wall 99 interposed between the cooler compartment 27 and the machine compartment 90 to cause the cooler compartment 27 and the machine compartment 90 to communicate with each other, and has the outlet 84 protruding into the machine compartment 90, wherein the drain passage 82 on the inlet 83 side has a shape in which the sectional area decreases and the central position (cross section center Oa) of the cross section approaches the rear face side in the downstream direction, and the drain passage 82 is integrally formed from the inlet 83 to the outlet 84.

[0071]

Hence the drain passage 82 has a shape in which the inner diameter of the drain passage 82 decreases from the inlet 83 to the outlet 84 and the cross-section center Oa approaches the rear face side of the refrigerator 1, so that the vacuum thermal insulator (e.g., vacuum thermal insulator 23b) can be installed in the thermal insulation wall 99 between the cooler compartment 27 and the machine compartment

90. Hence in the refrigerator 1, the thermal insulation performance can be ensured. Further, unlike the conventional configuration in which the junction is provided in the thermal insulator, the drain passage 82 is integrally molded from the inlet 83 to the outlet 84, whereby permeation of moisture from the drain passage 82 into the thermal insulation wall 99 is prevented. Thus, in the refrigerator 1, it is possible to reduce occurrence of a water leakage in the refrigerator or other problems due to blockage of the drain passage 82.

[0072]

Further, the drain passage 82 has the wall face vertically extending on the rear face side or a part of the rear face side in a plan view. That is, the drain passage 82 is provided such that a place closest to the rear face of the refrigerator 1 in the plan view goes along, for example, the rear face of the refrigerator 1 in the vertical direction of the refrigerator 1. It is thereby possible to extend the range in which the vacuum thermal insulator (e.g., vacuum thermal insulator 23b) is installed to the rear face side of the refrigerator 1 in the thermal insulation wall 99 interposed between the cooler compartment 27 and the machine compartment 90. Thus, in the refrigerator 1, the area covered with the vacuum thermal insulator 23b can be increased particularly in a position where thermal insulation is necessary. As a result, dew condensation on the ceiling face of the machine compartment 90 is reduced to improve the energy-saving properties.

[0073]

Further, the drain passage 82 is integrally formed with the water receiver 81. Thus, no junction is provided on the passage through which melt water dropping from the cooler 14 passes, whereby it is possible to further enhance the reliability for discharge of the melt water from the cooler 14 into the machine compartment 90.

[0074]

Further, the cross-sectional shape of the inlet 83 of the drain passage 82 is an elliptical or oval shape. This facilitates integral molding of the drain passage in the drip tray 80. Meanwhile, the inlet of the drain passage provided on the water receiving face of the drip tray has hitherto been formed in a substantially circular

shape. When such a shape is to be maintained and a length with which the drain passage protrudes into the machine compartment is to be ensured, due to the drain passage having an elongated shape, the inner diameter of the outlet of the drain passage is made extremely small to ensure demolding properties in product manufacturing and the molding process. Hence in the conventional drain passage, the possibility is high that the drainage properties deteriorate and the blockage occurs caused by a foreign matter. On the other hand, for the drain passage 82, the inlet 83 is configured in the shape as described above, thereby facilitating integral molding of the water receiver 81 and the drain passage 82. This enables the drain passage 82 with stable quality to be obtained in the refrigerator 1.

[0075]

The refrigerator 1 further includes the defrosting unit 67 that melts frost on the cooler 14 with a heater or high-temperature refrigerant. Thereby, the defrosting unit 67 melts frost on the cooler 14 to remove the frost from the cooler 14, thereby enabling the performance of the cooler 14 to be maintained.

[0076]

The refrigerator 1 further includes the drain pan 91 installed below the outlet 84 in the machine compartment 90, and the heating pipe 92 is disposed inside the drain pan 91. The moisture discharged into the machine compartment 90 can thus be evaporated in the drain pan 91 to protect equipment installed in the machine compartment 90 and other equipment.

[0077]

The refrigerator 1 further includes a first storage compartment (e.g., vegetable compartment 5) formed in the thermal insulation box body 19, and the water receiver 81 and the drain passage 82 are formed by extending the floor face of the first storage compartment (e.g., vegetable compartment 5) to the cooler compartment 27, and are disposed in positions lower than the floor face. Therefore, in the refrigerator 1, it is possible to obtain the drip tray 80 not provided with a junction on the passage through which melt water passes, while cutting down the parts for separately constituting the drip tray 80.

[0078]

The refrigerator 1 further includes a second storage compartment (e.g., freezer compartment 6) formed below the first storage compartment (e.g., vegetable compartment 5) and in front of the machine compartment 90, and set to a temperature lower than that of the first storage compartment (vegetable compartment 5), and the thermal insulation wall 99 is the bottom wall 35 of the first storage compartment (vegetable compartment) and the wall portion 19a forming the machine compartment of the thermal insulation box body 19. Accordingly, in the refrigerator 1, the thermal insulation properties can be ensured also between the second storage compartment (freezer compartment 6) that is set to a low temperature and the machine compartment 90 formed outside the thermal insulation box body 19, thereby improving the energy-saving properties. In particular, the downstream portion 82b of the drain passage has a smaller inner diameter than that of the upstream portion 82a and is located on the rear face side, so that in the refrigerator 1, the thermal insulation between the machine compartment 90 and the second storage compartment (freezer compartment 6) as well as the cooler compartment 27 can be enhanced by extending the vacuum thermal insulator 23b in the wall portion 19a.

[0079]

Embodiment 2

In Embodiment 1, the drain passage has been provided such that the backmost portion goes along the rear face of the refrigerator from the inlet to the outlet. In Embodiment 2, the configuration of a drain passage being inclined on the outlet side will be described. Hereinafter, only the difference from Embodiment 1 will be described, and the other configurations are assumed to be the same as those of Embodiment 1.

[0080]

Fig. 34 is a partial side sectional view illustrating a configuration of a part of a cooler compartment and a machine compartment according to Embodiment 2 of the present invention. An inlet 183 of a drain passage 182 is, for example, a circular shape, an elliptical shape, an oval shape, a shape in combination of a half ellipse and

a rectangle, or a shape in combination of a half oval and a rectangle, and the back side of the inlet 183 almost reaches the backmost portion of the water receiving face. The outlet 184 is, for example, formed in a shape which cross-section is substantially circular. As illustrated in Fig. 34, on the inlet 183 side of the drain passage 182 (hereinafter referred to as an upstream portion 182a), the sectional area decreases and the front position of the cross section approaches the rear face side in the downstream direction. On the outlet 184 side, the drain passage 182 (hereinafter referred to as a downstream portion 182b) is formed in a tubular shape having a substantially constant inner diameter and having a length such that the drain passage 182 protrudes into the machine compartment 90. The drain passage 182 is integrally formed from the inlet 183 to the outlet 184, and the cross section of the upstream portion 182a changes from the cross-sectional shape of the inlet 183 to the circular shape of the downstream portion 182b.

[0081]

In Embodiment 2, the downstream portion 182b of the drain passage 182 is formed to be inclined from a direction along the rear face of the refrigerator 1 (e.g., perpendicularly downward direction) to the rear face side. That is, the position of the downstream portion 182b shifts closer to the back of the refrigerator 1 when being closer to the outlet 184. An angle forming the downstream portion 182b is set to be an angle at which the moldability of the drain passage 182 and the ease for discharge of melt water are not impaired, or no foreign matters are accumulated. For example, it may be configured such that the inclination angle of the outlet 184 has a downward elevation angle (angle θ) equal to or larger than 7 degrees relative to a depth horizontal direction of the refrigerator 1, the angle being an angle at which a droplet falls under its own weight. In addition, the upper limit of the elevation angle (angle θ) may, for example, be set to smaller than 90 degrees so that the flow of the melt water from the upstream portion 182a of the drain passage 182 is not prevented.

[0082]

As described above, in Embodiment 2, in the same manner as in Embodiment 1, the drain passage 182 is formed such that the inner diameter is reduced and the

central position approaches the rear face of the refrigerator 1 from the inlet 183 to the outlet 184, and the drain passage 182 is integrally formed from the inlet 183 to the outlet 184. Therefore, in the same manner as in Embodiment 1, in the refrigerator 1, it is possible to avoid the blockage of the drain passage 182 while ensuring the thermal insulation performance of the thermal insulation wall 99, and to prevent occurrence of a water leakage in the refrigerator or other problems.

[0083]

Moreover, the inclination angle of the outlet 184 of the drain passage 182 has a downward elevation angle (angle θ) equal to or larger than 7 degrees relative to the depth horizontal direction. Hence the outlet 184 of the drain passage 182 is formed facing the rear face of the refrigerator 1 and a region in which the vacuum thermal insulator can thus be installed in the thermal insulation wall 99 is ensured to be wide, and in the refrigerator, it is possible to increase the area covered with the vacuum thermal insulator and enhance the thermal insulation performance.

[0084]

Note that the embodiment of the present invention is not limited to the above embodiments, and various changes can be made. For example, in Embodiment 1, the heater that generates heat by energization has been used as the defrosting unit 67, but it may be configured such that frost is melted using high-temperature refrigerant in place of the heater.

Reference Signs List

[0085]

1 refrigerator 2 refrigerator compartment 3 ice-making compartment 4 temperature versatile compartment 5 vegetable compartment 6 freezer compartment 7 refrigerant circuit 8 compressor 9 air-cooled condenser 10 heat rejection pipe 11 dew condensation preventive pipe 12 dryer 13 decompression device 14 cooler 14a lower end 15 air-sending device 16 (16a, 16b, 16c, 16d) temperature sensor 17 control board 18 (18a, 18b, 18c) air volume control device 19 thermal insulation box body 19a wall portion 21 outer box 22 inner box

23 thermal insulator 23a urethane foamed member 23b vacuum
thermal insulator 25a frame structure 25b rail structure 25c support 26
spacer 27 cooler compartment 28 air passage 29a, 29b, 29c, 29d, 29e
blow air passage 30a, 30b, 30c, 30e return air passage 31 rear-face wall 32
5 ceiling wall 33a, 33b air-passage heater 34 wall portion 34a upper face
34b lower face 34c thermal insulation wall 35 bottom wall 35a
urethane foamed member 35b vacuum thermal insulator 36 air cycle
passage 38 thermal-insulation-wall outer shell 39 vacuum thermal insulator 40
foamed thermal insulator 42 thermal-insulation-wall outer shell 44 air outlet 45
10 return inlet 46 thermal heater 47 heat rejection pipe 48 flow switching
three-way valve 49, 50 outlet pipe 51a, 51b capillary 53 valve body 54
magnetizing rotor 55 center gear 56 rotary gear 57 rotary pad 58
valve seat 59 outer shell case 60 floor 61 orifice 62 orifice 63
orifice 64 outlet orifice 67 defrosting unit 70 air outlet 71 ice-making
15 mechanism 72 return inlet 74 cool-air return inlet 75 refrigeration return inlet
76 return air passage 77 hole 78 slider 80 drip tray 81
water receiver 82, 182 drain passage 82a, 182a upstream portion 82b,
182b downstream portion 83, 183 inlet 84, 184 outlet 85 passage
heater 89 metal tray 90 machine compartment 91 drain pan 92
20 heating pipe 95 machine compartment fan 99 thermal insulation wall Oa, Ob
cross-section center θ angle

CLAIMS

[Claim 1]

A refrigerator comprising:

5 a thermal insulation box body including an inner box, an outer box, and a thermal insulator installed in a space between the inner box and the outer box;
a machine compartment that is formed by a lower portion of a rear face of the thermal insulation box body recessing inward and in which a compressor is disposed;
a cooler compartment that is formed in the thermal insulation box body above the machine compartment and in which a cooler that generates cool air is disposed;
10 a water receiver provided below the cooler in the cooler compartment and receiving water from the cooler; and
a drain passage having an inlet provided at the water receiver, passing through a thermal insulation wall interposed between the cooler compartment and the machine compartment to cause the cooler compartment and the machine
15 compartment to communicate with each other, and having an outlet protruding into the machine compartment,
wherein the drain passage on the inlet side has a shape in which a sectional area decreases and a central position of a cross section approaches the rear face side in a downstream direction, and
20 the drain passage is integrally formed from the inlet to the outlet.

[Claim 2]

The refrigerator of claim 1, wherein the drain passage has a wall face vertically extending on the rear face side or a part of the rear face side in a plan view.

[Claim 3]

25 The refrigerator of claim 1, wherein an inclination angle of the outlet of the drain passage is a downward elevation angle equal to or larger than 7 degrees relative to a depth horizontal direction.

[Claim 4]

30 The refrigerator of any one of claims 1 to 3, wherein the drain passage is integrally formed with the water receiver.

[Claim 5]

The refrigerator of any one of claims 1 to 4, wherein a cross-sectional shape of the inlet of the drain passage is an elliptical or oval shape.

[Claim 6]

5 The refrigerator of any one of claims 1 to 5, further comprising a defrosting unit melting frost on the cooler with a heater or high-temperature refrigerant.

[Claim 7]

10 The refrigerator of any one of claims 1 to 6, further comprising a water tray installed below the outlet in the machine compartment,
 wherein a heating pipe is disposed inside the water tray.

[Claim 8]

15 The refrigerator of any one of claims 1 to 7, further comprising a first storage compartment formed in the thermal insulation box body,
 wherein the water receiver and the drain passage are formed by extending a floor face of the first storage compartment to the cooler compartment, and are disposed in positions lower than the floor face.

[Claim 9]

20 The refrigerator of claim 8, further comprising a second storage compartment formed below the first storage compartment and in front of the machine compartment, and set to a temperature lower than that of the first storage compartment,
 wherein the thermal insulation wall is a bottom wall of the first storage compartment and a wall portion forming the machine compartment of the thermal insulation box body.