

DESCRIPTION

Title of Invention

REFRIGERATOR

Technical Field

5 [0001]

The present disclosure relates to a refrigerator including a cooler.

Background Art

[0002]

10 Hitherto, there is known a refrigerator including a cooler behind storage compartments. The refrigerator includes the cooler and a fan in an air passage defined by walls. Cold air generated by the cooler is sent into the refrigerator including the storage compartments by the fan. That is, the refrigerator has a cold air circulation passage in which the temperature of the cold air flowing through the cooler increases by heat loads of respective parts and the air returns to the cooler (see, for example, Patent
15 Literature 1).

[0003]

20 In the refrigerator described above, frost is formed when the cold air returns to the cooler while containing a large amount of moisture due to, for example, moisture evaporated from foods stored in the refrigerator or moisture in air that enters the refrigerator when doors are opened and closed. The frost formation is a phenomenon in which moisture in air condenses into ice crystals and the ice crystals are deposited on the surface of the cooler when the surface temperature of the cooler in contact with the air is lower than a dew-point temperature. In general, a large amount of moisture is contained in cold air returning from a refrigerator compartment among other storage
25 compartments. When frost is formed to grow on the surface of the cooler, clogging occurs between fins of the cooler to increase air passage resistance. Thus, the cooling performance decreases.

[0004]

30 Incidentally, the refrigerator of Patent Literature 1 has a vegetable compartment provided at the bottom, and a freezer compartment provided above the vegetable

compartment. Further, a storage-compartment return port through which air returns from the vegetable compartment to the cooler is provided in the ceiling of the vegetable compartment, and a freezer-compartment return port through which air returns from the freezer compartment to the cooler is provided in a rear wall of the freezer compartment.

Citation List

Patent Literature

[0005]

Patent Literature 1: Japanese Unexamined Patent Application Publication No. 2008-202823

Summary of Invention

Technical Problem

[0006]

In the refrigerator of Patent Literature 1, however, when the vegetable compartment and the freezer compartment are reversely disposed, the storage-compartment return port is provided in a rear wall of the vegetable compartment and the freezer-compartment return port is provided in the ceiling of the freezer compartment. Then, cold air returning from the vegetable compartment whose humidity and temperature are relatively high flows into the cooler at a part above the lower end of the cooler, and cold air returning from the freezer compartment whose humidity and temperature are relatively low flows into the cooler at a part below the lower end of the cooler. Therefore, the cold air returning from the vegetable compartment and the cold air returning from the freezer compartment mix with each other at an upper part of the cooler to form frost on the fins. Due to the frost formation, a problem arises in that the air passage resistance increases and the cooling performance decreases. Further, the problem arises not only when the vegetable compartment is provided above the freezer compartment but also when any other storage compartment being configured to have a temperature range set higher than the temperature range of the freezer compartment is provided above the freezer compartment.

[0007]

The present disclosure has been made to solve the problem described above and the refrigerator of the present disclosure aims to provide a refrigerator in which the cooling performance of a cooler is improved though a storage compartment being configured to have a temperature range higher than the temperature range of a freezer compartment is provided above the freezer compartment.

Solution to Problem

[0008]

A refrigerator according to an embodiment of the present disclosure includes a body having a refrigerator compartment, a freezer compartment provided below the refrigerator compartment, and a storage compartment provided between the refrigerator compartment and the freezer compartment, the storage compartment being configured to have a temperature range set higher than a temperature range of the freezer compartment, and having a rear storage-compartment wall at a rear of the storage compartment, and a cooler disposed in an air passage between the rear storage-compartment wall and a rear body wall at a rear of the body and configured to cool air inside the body. The body has a refrigerator-compartment return port through which air in the refrigerator compartment returns to the cooler, a storage-compartment return port through which air in the storage compartment returns to the cooler, and a freezer-compartment return port through which air in the freezer compartment returns to the cooler along an air passage provided in the rear storage-compartment wall. The refrigerator-compartment return port and the storage-compartment return port are provided below a lower end of the cooler. The freezer-compartment return port is provided at a part within a range between the lower end of the cooler and an upper end of the cooler.

Advantageous Effects of Invention

[0009]

According to the embodiment of the present disclosure, the refrigerator-compartment return port and the storage-compartment return port are provided below the lower end of the cooler, and the freezer-compartment return port communicating with the air passage in the rear storage-compartment wall is provided above the lower

end of the cooler. Therefore, air containing a relatively large amount of moisture from the refrigerator compartment and the vegetable compartment can flow into the cooler at its lower part, and air from the freezer compartment can flow into the cooler at a part above its lower end. Thus, the cooling performance of the cooler can be improved though the storage compartment being configured to have a temperature range higher than the temperature range of the freezer compartment is provided above the freezer compartment.

Brief Description of Drawings

[0010]

[Fig. 1] Fig. 1 is a perspective view illustrating an example of the appearance of a refrigerator according to Embodiment 1 of the present disclosure.

[Fig. 2] Fig. 2 is a front view illustrating the refrigerator of Fig. 1 including doors and drawers.

[Fig. 3] Fig. 3 is a schematic sectional view defined along a line A-A in Fig. 2.

[Fig. 4] Fig. 4 is a refrigerant circuit diagram of the refrigerator of Fig. 1.

[Fig. 5] Fig. 5 is a schematic view illustrating a cooling chamber of Fig. 3 and a structure around the cooling chamber.

[Fig. 6] Fig. 6 is a schematic sectional view defined along a line B-B in Fig. 5.

[Fig. 7] Fig. 7 is an explanatory view illustrating a flow of cold air in a vegetable compartment of Fig. 1.

[Fig. 8] Fig. 8 is a schematic sectional view illustrating an example of a structure around a cooling chamber of a refrigerator according to Embodiment 2 of the present disclosure.

Description of Embodiments

[0011]

Embodiment 1.

Fig. 1 is a perspective view illustrating an example of the appearance of a refrigerator according to Embodiment 1 of the present disclosure. Fig. 2 is a front view illustrating the refrigerator of Fig. 1 including doors and drawers. The overall structure of a refrigerator 10 of Embodiment 1 is described with reference to Fig. 1 and Fig. 2. In

Fig. 1 and Fig. 2, a fore-and-aft direction of the refrigerator 10 corresponds to an x-axis direction, a lateral direction of the refrigerator 10 corresponds to a y-axis direction, and a vertical direction of the refrigerator 10 corresponds to a z-axis direction. That is, a forward direction of the refrigerator 10 corresponds to a positive x-axis direction and an upward direction of the refrigerator 10 corresponds to a positive z-axis direction.

[0012]

The refrigerator 10 includes a body 20 having a plurality of storage compartments to be cooled. The body 20 has a refrigerator compartment 1 and a freezer compartment 5 provided below the refrigerator compartment 1. The body 20 also has a vegetable compartment 4 as a storage compartment provided between the refrigerator compartment 1 and the freezer compartment 5 and being configured to have a temperature range set lower than the temperature range of the freezer compartment 5. More specifically, the refrigerator 10 illustrated in Fig. 1 has the refrigerator compartment 1, an ice-making compartment 2, a versatile compartment 3, the vegetable compartment 4, and the freezer compartment 5 as the plurality of storage compartments.

[0013]

The refrigerator compartment 1 is provided at the top of the body 20 and the temperature range of the refrigerator compartment 1 is set to a refrigerating temperature range. The freezer compartment 5 is provided at the bottom of the body 20 and the temperature range of the freezer compartment 5 is set to a freezing temperature range. The vegetable compartment 4 is provided above the freezer compartment 5 and the temperature range of the vegetable compartment 4 is set slightly higher than the refrigerating temperature range. The ice-making compartment 2 and the versatile compartment 3 are provided between the refrigerator compartment 1 and the vegetable compartment 4. In the example of Fig. 1, the ice-making compartment 2 is disposed on the left and the versatile compartment 3 is disposed on the right in front view.

[0014]

The temperature range of the ice-making compartment 2 is set to the freezing temperature range and an ice storage case 2a stores ice automatically made by an

automatic ice maker (not illustrated). The set temperature of the versatile compartment 3 may be changed in a wide range including the freezing temperature range and the refrigerating temperature range. That is, the cooling temperature range of the versatile compartment 3 can be changed to various temperature ranges such as a freezing temperature range of about -18 degrees Celsius, a refrigerating temperature range of about 3 degrees Celsius, a chilling temperature range of about 0 degrees Celsius, and a soft-freezing temperature range of about -7 degrees Celsius.

[0015]

A refrigerator compartment door 11 to be used for opening or closing the refrigerator compartment 1 is provided at the front of the refrigerator compartment 1. In Fig. 1, the refrigerator compartment door 11 is a double-panel, double-hinged (biparting) door including a first door 11a and a second door 11b. Note that the refrigerator compartment door 11 is not limited to the double-panel, double-hinged door but may be a single-panel, single-hinged door.

[0016]

The ice-making compartment 2, the versatile compartment 3, the vegetable compartment 4, and the freezer compartment 5 are opened or closed by moving drawers. That is, an ice-making compartment drawer 12 to be used for opening or closing the ice-making compartment 2 is provided at the front of the ice-making compartment 2. A versatile compartment drawer 13 to be used for opening or closing the versatile compartment 3 is provided at the front of the versatile compartment 3. A vegetable compartment drawer 14 to be used for opening or closing the vegetable compartment 4 is provided at the front of the vegetable compartment 4. A freezer compartment drawer 15 to be used for opening or closing the freezer compartment 5 is provided at the front of the freezer compartment 5. In each drawer, a frame fixed to a drawer panel slides along horizontal rails on right and left inner walls of the storage compartment so that the drawer moves in the fore-and-aft direction of the refrigerator (depth direction) to open or close the storage compartment.

[0017]

Fig. 3 is a schematic sectional view defined along a line A-A in Fig. 2. The inside of the refrigerator 10 is thermally insulated from the outside, that is, outside air, by the refrigerator compartment door 11, the ice-making compartment drawer 12, the versatile compartment drawer 13, the vegetable compartment drawer 14, the freezer compartment drawer 15, and a heat insulating wall 21. The heat insulating wall 21 includes a rear body wall 22 at the rear of the body 20. A rear storage-compartment wall 24 serving as a rear wall of the vegetable compartment 4 is provided at the rear of the vegetable compartment 4. In Embodiment 1, the rear storage-compartment wall 24 serves as rear walls of the ice-making compartment 2, the versatile compartment 3, and the vegetable compartment 4.

[0018]

A partition plate 25 is provided between the refrigerator compartment 1 and the ice-making compartment 2 and between the refrigerator compartment 1 and the versatile compartment 3. A partition plate 26 is provided between the ice-making compartment 2 and the vegetable compartment 4 and between the versatile compartment 3 and the vegetable compartment 4. A partition plate 27 is provided between the vegetable compartment 4 and the freezer compartment 5.

[0019]

Further, the refrigerator 10 includes a cooler 30, a circulation fan 40, a heater 51, and a compressor 61. For example, the cooler 30 is a fin-and-tube heat exchanger and cools air sent from each storage compartment. The circulation fan 40 sends the air cooled by the cooler 30 to each storage compartment in the refrigerator 10. The air cooled by the cooler 30 is sent to each storage compartment by the circulation fan 40. That is, the circulation fan 40 contributes to keeping the low temperature in the refrigerator 10. The air cooled by the cooler 30 and sent to each storage compartment returns from the storage compartment to the cooler 30 and is cooled again by the cooler 30. That is, the air in the refrigerator 10 circulates through an air passage communicating between the cooler 30 and each storage compartment.

[0020]

For example, the heater 51 is a radiant heater and is provided below and out of contact with the cooler 30. The heater 51 is a defroster provided to defrost the cooler 30. The heater 51 removes frost on the cooler 30 by heating. The compressor 61 is provided at the bottom of the rear of the refrigerator 10. The compressor 61 is a component of a refrigeration cycle of the refrigerator 10 and has a refrigerant compressing function. The cooler 30 and the heater 51 are provided in an air passage between the rear storage-compartment wall 24 and the rear body wall 22. That is, the cooler 30 and the heater 51 are housed in a cooling chamber 100 between the rear storage-compartment wall 24 and the rear body wall 22. In the cooling chamber 100, air flows through the cooler 30 from bottom to top. The air cooled in the cooling chamber 100 flows through a duct and is supplied to each storage compartment through an air outlet provided in the storage compartment.

[0021]

An outer wall above the freezer compartment 5 has a freezer-compartment inlet 5a through which freezer-compartment return cold air C_5 flows from the freezer compartment 5 to the cooling chamber 100. The rear storage-compartment wall 24 has a freezer-compartment return port 5b at a part facing the cooling chamber 100 and air in the freezer compartment 5 returns to the cooler 30 through the freezer-compartment return port 5b. As illustrated in Fig. 3, the freezer-compartment inlet 5a is provided below the lower end of the cooler 30. The freezer-compartment return port 5b is provided at a part within a range between the upper and lower ends of the cooler 30. The freezer-compartment inlet 5a and the freezer-compartment return port 5b communicate with each other in the rear storage-compartment wall 24.

[0022]

That is, a freezer-compartment air returning passage P_5 is formed between the freezer-compartment inlet 5a and the freezer-compartment return port 5b. The freezer-compartment return cold air C_5 flows into the freezer-compartment air returning passage P_5 through the freezer-compartment inlet 5a and flows out of the freezer-compartment air returning passage P_5 through the freezer-compartment return port 5b. Thus, the freezer-compartment return cold air C_5 flows into the freezer-compartment air returning

passage P₅ through the freezer-compartment inlet 5a provided below the lower end of the cooler 30. Then, the freezer-compartment return cold air C₅ flows through the freezer-compartment air returning passage P₅, flows out of the freezer-compartment air returning passage P₅ through the freezer-compartment return port 5b provided above the lower end of the cooler 30, and flows into the cooler 30 at a part above its lower end.

[0023]

The rear storage-compartment wall 24 has a cold air sending port 5c at a part facing the cooling chamber 100 and above the upper end of the cooler 30. The outer wall above the freezer compartment 5 has an air outlet 5d on a forward side of the freezer-compartment inlet 5a. The cold air sending port 5c and the air outlet 5d communicate with each other in the rear storage-compartment wall 24. That is, a freezer-compartment air sending passage Q₅ is formed between the cold air sending port 5c and the air outlet 5d and cold air to be sent from the cooling chamber 100 to the freezer compartment 5 flows through the freezer-compartment air sending passage Q₅.

[0024]

When the door or drawer (11 to 15) of each storage compartment is opened and closed, outside air containing a large amount of moisture may enter the storage compartment. In general, the refrigerator compartment 1 is opened and closed by a user more frequently than the freezer compartment 5. Therefore, the amount of moisture in refrigerator-compartment return cold air C₁, which returns from the refrigerator compartment 1 to the cooler 30, is generally larger than the amount of moisture in the freezer-compartment return cold air C₅. Thus, frost may adhere to the surface of the cooler 30 when the refrigerator 10 operates for a long time and the refrigerator-compartment return cold air C₁ containing a large amount of moisture exchanges heat with the cooler 30.

[0025]

Fig. 4 is a refrigerant circuit diagram of the refrigerator of Fig. 1. As illustrated in Fig. 4, the refrigerator 10 includes a refrigerant circuit 60 through which refrigerant such as isobutane circulates. The refrigerant circuit 60 is formed by connecting the

compressor 61, a pipe unit 62, an expander 63, and the cooler 30 via refrigerant pipes 60a.

[0026]

The compressor 61 compresses refrigerant into high-temperature and high-pressure gas refrigerant by adiabatic compression. The high-temperature and high-pressure gas refrigerant flowing out of the compressor 61 flows into the pipe unit 62 embedded in the heat insulating wall 21 of the refrigerator box and rejects heat in the pipe unit 62 to turn into liquid refrigerant. Then, the liquid refrigerant flowing out of the pipe unit 62 is expanded by the expander 63 such as a capillary tube to turn into low-temperature two-phase gas-liquid refrigerant. The two-phase gas-liquid refrigerant expanded by the expander 63 exchanges heat with return air C from each storage compartment of the refrigerator 10 when the refrigerant flows through the cooler 30. During the heat exchange with the return air C, the two-phase gas-liquid refrigerant flowing into the cooler 30 is gasified by removing heat from the return air C and returns to the compressor 61. The air whose temperature decreases by the heat removal in the cooler 30 is sent into the refrigerator 10 by the circulation fan 40. Thus, the refrigerant circuit 60 of the refrigerator 10 performs a cooling operation in which air in the refrigerator 10 is cooled by circulation. Note that the return air C includes the refrigerator-compartment return cold air C₁, storage-compartment return cold air C₄, and the freezer-compartment return cold air C₅.

[0027]

Fig. 5 is a schematic view illustrating the cooling chamber of Fig. 3 and a structure around the cooling chamber. That is, Fig. 5 is a front view of the cooler 30 and a structure around the cooler 30. Further, Fig. 6 is a schematic sectional view defined along a line B-B in Fig. 5. A structure related to the cooler 30 and the air passages is described in detail with reference to Fig. 5 and Fig. 6. As described above, the cooling chamber 100 is a space between the rear storage-compartment wall 24 and the rear body wall 22 and houses the circulation fan 40, the cooler 30, and the heater 51.

[0028]

As illustrated in Fig. 5, the body 20 has a refrigerator-compartment air returning passage P_1 on one side of the cooling chamber 100 and the refrigerator-compartment return cold air C_1 flows through the refrigerator-compartment air returning passage P_1 . Further, the body 20 has a refrigerator-compartment return port 1b through which air in the refrigerator compartment 1 returns to the cooler 30. The refrigerator-compartment return port 1b is provided on one side of the cooling chamber 100 in the lateral direction at a part below the lower end of the cooler 30. That is, the refrigerator-compartment return cold air C_1 flows out through the refrigerator-compartment return port 1b and flows through the cooler 30 from bottom to top.

[0029]

Further, the body 20 has a storage-compartment return port 4b through which air in the vegetable compartment 4 returns to the cooler 30. The storage-compartment return port 4b is provided on the other side of the cooling chamber 100 in the lateral direction at a part below the lower end of the cooler 30. Therefore, the storage-compartment return cold air C_4 flowing out through the storage-compartment return port 4b flows through the cooler 30 from bottom to top.

[0030]

On the other hand, the freezer-compartment return port 5b is provided at a part within the range between the upper and lower ends of the cooler 30 as described above. Therefore, the freezer-compartment return cold air C_5 flowing out through the freezer-compartment return port 5b flows into the cooler 30 at a part above its lower end and then flows upward through the cooler 30. That is, in the cooling chamber 100, the refrigerator-compartment return cold air C_1 and the storage-compartment return cold air C_4 containing a relatively large amount of moisture do not easily mix with the freezer-compartment return cold air C_5 having a relatively low temperature. Therefore, frost formation on the cooler 30 can be suppressed. Thus, an increase in air passage resistance due to the frost formation on the cooler 30 can be suppressed and accordingly the cooling performance of the cooler 30 can be increased.

[0031]

Further, the refrigerator-compartment return port 1b is provided on one side surface side of the body 20 and the storage-compartment return port 4b is provided on the other side surface of the body 20. That is, the storage-compartment return port 4b is provided on a side surface of the body 20 opposite the side surface having the refrigerator-compartment return port 1b. Therefore, frost formation due to moisture contained in the refrigerator-compartment return cold air C₁ can be concentrated at one of the right and left of the cooler 30 and frost formation due to moisture contained in the storage-compartment return cold air C₄ can be concentrated at the other one of the right and left of the cooler 30. Thus, imbalance in the frost formation on the cooler 30 can be prevented. In the example of Fig. 5, the frost formation due to the refrigerator-compartment return cold air C₁ can be concentrated at a positive side on the y-axis and the frost formation due to the moisture contained in the storage-compartment return cold air C₄ can be concentrated at a negative side on the y-axis.

[0032]

The cooler 30 has a tube part 35 in which one or more heat transfer tubes 33 are disposed in a plurality of rows in the vertical direction. In the tube part 35 illustrated in Fig. 6, three heat transfer tubes 33 arranged in the fore-and-aft direction are disposed in eight rows in the vertical direction. The tube part 35 has a plurality of coupling pipes 34 each formed into a U-shape. That is, in the tube part 35, the plurality of heat transfer tubes 33 are arranged in the fore-and-aft direction and in the vertical direction and the ends of two vertically adjacent heat transfer tubes 33 on one side in the lateral direction are coupled by the coupling pipe 34. Thus, one continuous tube part 35 is formed as illustrated in Fig. 5.

[0033]

Further, the cooler 30 has a fin unit 32 in which a plurality of fins 31 arranged with intervals in the lateral direction to form a plurality of stages in the vertical direction. In the fin unit 32, the plurality of fins 31 through which the heat transfer tubes 33 in one or two rows run are disposed in the plurality of stages in the vertical direction. Fig. 5 and Fig. 6 illustrate, as an example, the fin unit 32 in which the plurality of fins 31 through which the heat transfer tubes 33 in one row run, that is, three heat transfer tubes 33

arranged in the fore-and-aft direction run are disposed in eight stages in the vertical direction.

[0034]

In the fin unit 32, the plurality of fins 31 arranged in the lateral direction in each stage are disposed to have a constant fin pitch therebetween. In the cooler 30, the heat transfer area is increased and the cooling performance is improved by keeping the constant distance between the fins 31.

[0035]

In Embodiment 1, a lower fin pitch is larger than an upper fin pitch in the fin unit 32. That is, a fin pitch of a lower stage is larger than a fin pitch of an upper stage in the fin unit 32. The fin unit 32 of Embodiment 1 has two types of fin pitch and a fin pitch of at least one lower stage is relatively large.

[0036]

In the fin unit 32 illustrated in Fig. 5, fin pitches of two lower stages are larger than fin pitches of six upper stages. That is, as illustrated in Fig. 5, the fin unit 32 includes an upper fin unit 32a disposed in an upper region Ra of the cooler 30, and a lower fin unit 32b disposed in a lower region Rb of the cooler 30. Further, the distance between the fins 31 in the upper fin unit 32a is larger than the distance between the fins 31 in the lower fin unit 32b.

[0037]

When the distances between the fins 31 are adjusted as described above, clogging between the fins 31 due to frost formation is reduced at the lower part of the cooler 30 even if the refrigerator-compartment return cold air C_1 and the storage-compartment return cold air C_4 containing a large amount of moisture flow into the lower part of the cooler 30. Therefore, the increase in the air passage resistance can be suppressed. Further, in Embodiment 1, the freezer-compartment return port 5b faces a lower part of the upper fin unit 32a of the fin unit 32, in which the fin pitch is relatively small. Therefore, frost formation on the lower part of the cooler 30 can be suppressed and the region in the cooler 30 through which the freezer-compartment return cold air C_5 flows can be secured. Thus, the heat exchange efficiency can be improved.

[0038]

Further, the refrigerator 10 includes a plurality of transfer heaters 52 as defrosters in addition to the heater 51. For example, the transfer heater 52 is a cord heater and is provided in close contact with the fins 31 of the cooler 30. The transfer heaters 52 are disposed at the front and rear of the cooler 30. The transfer heater 52 is inserted into a space between the fins 31 of the cooler 30 in the vertical direction and is in close contact with the fins 31 to heat the fins 31 mainly by thermal conduction.

[0039]

Thus, the refrigerator 10 can melt frost adhering to the cooler 30 by causing the heater 51 and the transfer heaters 52 to generate heat simultaneously. Note that the refrigerator 10 is not limited to the refrigerator in which the heater 51 and the transfer heaters 52 generate heat simultaneously. The heater 51 or the transfer heaters 52 may generate heat depending on the condition of the frost formed on the cooler 30.

[0040]

In the example of Fig. 6, the transfer heaters 52 of the upper fin unit 32a are disposed at both the front and rear of the cooler 30 with intervals corresponding to two stages. That is, the transfer heaters 52 are disposed between two fins 31 arranged in the vertical direction and other two fins 31 arranged in the vertical direction. Further, the transfer heaters 52 of the lower fin unit 32b are disposed at both the front and rear of the cooler 30 with intervals corresponding to one stage. That is, the transfer heaters 52 are disposed between a fin 31 and another fin 31 that are arranged in the vertical direction. Note that the disposition intervals between the transfer heaters 52 are not limited to the intervals in the example of Fig. 6, but may be changed as appropriate. Further, the transfer heaters 52 at the front of the cooler 30 and the transfer heaters 52 at the rear of the cooler 30 may be staggered. Further, the transfer heaters 52 may be disposed at the front or rear of the cooler 30.

[0041]

Incidentally, during the defrosting, water may drop from the cooler 30 onto the heater 51. Therefore, a heater roof 51a is disposed above the heater 51, that is, between the cooler 30 and the heater 51. By providing the heater roof 51a, it is

possible to prevent the occurrence of a case where water drops from the cooler 30 directly onto the heater 51. The water dropping from the cooler 30 is received by a drain pan 55 at a lower part of the cooling chamber 100 and is drained through a drain conduit 56.

5 [0042]

The rear storage-compartment wall 24 is made of a heat insulator 24a and a vacuum heat insulator 24b. That is, the freezer-compartment air returning passage P_5 is covered with the heat insulator 24a of the rear storage-compartment wall 24. As illustrated in Fig. 6, the freezer-compartment return cold air C_5 flows in through the
10 freezer-compartment inlet 5a, flows through the freezer-compartment air returning passage P_5 , flows into the cooler 30 through the freezer-compartment return port 5b, flows through the cooler 30 from bottom to top, and is sent to each storage compartment by the circulation fan 40.

[0043]

15 The freezer-compartment air returning passage P_5 has a clearance 5n so that water generated, for example, when frost in the air passage is melted drops onto the drain pan 55. If the clearance 5n is wide, the freezer-compartment return cold air C_5 flows into the cooling chamber 100 through the clearance 5n. Then, the refrigerator-compartment return cold air C_1 and the storage-compartment return cold air C_4
20 containing a relatively large amount of moisture and the freezer-compartment return cold air C_5 having a relatively low temperature may mix with each other at the lower part of the cooler 30. Thus, frost may be formed on the cooler 30.

[0044]

In view of the above, the refrigerator 10 of Embodiment 1 includes a metal cold
25 air separation plate 70 in the clearance 5n as a component separate from the rear storage-compartment wall 24. In the refrigerator 10, the inflow of the freezer-compartment return cold air C_5 into the cooling chamber 100 is suppressed by reducing the clearance 5n with the cold air separation plate 70.

[0045]

Incidentally, the cold air separation plate 70 is disposed at a part where heat of the heater 51 is transferred. In this respect, the material for the cold air separation plate 70 of the refrigerator 10 is a metal and therefore deformation of the cold air separation plate 70 due to the heat of the heater 51 is suppressed. Since the cold air separation plate 70 is made of a metal and heat is easily transferred, frost is easily melted. Thus, even if frost is formed, the cold air separation plate 70 is promptly defrosted by the heat of the heater 51.

[0046]

As illustrated in Fig. 6, the partition plate 27 has multiple layers of a heat insulator 27a and a vacuum heat insulator 27b. The partition plate 25 and the partition plate 26 are formed similarly to the partition plate 27. The rear body wall 22 has multiple layers of a heat insulator 22a and a vacuum heat insulator 22b.

[0047]

Fig. 7 is an explanatory view illustrating a flow of cold air in the vegetable compartment of Fig. 1. The flow of cold air in the vegetable compartment 4 is described with reference to Fig. 7. The rear storage-compartment wall 24 has an air outlet 4c on a front or side surface at an upper part of the rear storage-compartment wall 24 and air cooled in the cooling chamber 100 flows in through the air outlet 4c. Note that Fig. 7 illustrates an example in which the air outlet 4c is provided on the front surface at the upper part of the rear storage-compartment wall 24. Further, the rear storage-compartment wall 24 has a storage-compartment return port 4a on a side surface at a lower part of the rear storage-compartment wall 24 and air in the vegetable compartment 4 returns to the cooling chamber 100 through the storage-compartment return port 4a. That is, cold air flows into the vegetable compartment 4 through the air outlet 4c in the rear storage-compartment wall 24 and air in the vegetable compartment 4 is cooled to the set temperature. Then, the air that cools the vegetable compartment 4 returns to the cooling chamber 100 through the storage-compartment return port 4a as the storage-compartment return cold air C₄.

[0048]

As described above, in the refrigerator 10 of Embodiment 1, the refrigerator-compartment return port 1b and the storage-compartment return port 4b are provided below the lower end of the cooler 30, and the freezer-compartment return port 5b communicating with the air passage in the rear storage-compartment wall 24 is provided above the lower end of the cooler 30. Therefore, cold air flowing out through the refrigerator-compartment return port 1b and the storage-compartment return port 4b flows through the cooler 30 from bottom to top. Further, cold air flowing out through the freezer-compartment return port 5b flows into the cooler 30 at a part above its lower end and then flows upward through the cooler 30. Therefore, the refrigerator-compartment return cold air C_1 and the storage-compartment return cold air C_4 containing a relatively large amount of moisture do not easily mix with the freezer-compartment return cold air C_5 having a relatively low temperature though the vegetable compartment 4 is provided above the freezer compartment 5. Thus, the increase in the air passage resistance due to the frost formation on the cooler 30 can be suppressed and accordingly the cooling performance can be improved.

[0049]

Further, the refrigerator-compartment return port 1b is provided on one side surface side of the body 20 and the storage-compartment return port 4b is provided on the other side surface of the body 20. That is, the refrigerator-compartment return cold air C_1 flows through the refrigerator-compartment air returning passage P_1 and flows into the cooler 30 through the refrigerator-compartment return port 1b. Further, the storage-compartment return cold air C_4 flows into the cooler 30 through the storage-compartment return port 4a on the side surface opposite the side surface having the refrigerator-compartment return port 1b in the cooling chamber 100. Then, the refrigerator-compartment return cold air C_1 and the storage-compartment return cold air C_4 flow through the cooler 30 from bottom to top and is sent to each storage compartment by the circulation fan 40. Therefore, the part of the cooler 30 where frost is formed due to the refrigerator-compartment return cold air C_1 can be separated from the part of the cooler 30 where frost is formed due to the storage-compartment return

cold air C₄. Thus, imbalance in the frost formation on the cooler 30 can be prevented and accordingly the cold air can flow into the cooler 30 with good balance.

[0050]

Incidentally, in the cooler of Patent Literature 1, the lower fin pitch is smaller than the upper fin pitch in a height direction. Therefore, frost formation is concentrated at the lower part so that frost formation on the upper fins is prevented. In the refrigerator of Patent Literature 1, however, when the frost formation is concentrated at the lower part of the cooler, the lower part is clogged due to the frost formation and the air passage resistance to air flowing into the lower part increases. Further, in the refrigerator of Patent Literature 1, a bypass air passage is formed on at least one of a forward side and a rearward side of the cooler. Therefore, cold air is sent to the upper part of the cooler even if the lower part of the cooler is clogged due to frost formation. In the refrigerator of Patent Literature 1, however, the air passage resistance at the lower part of the cooler increases due to the clogging caused by the frost formation and therefore a wide bypass air passage is required. Thus, a majority of air to be sent to the cooler from the bottom flows into the bypass air passage and cannot sufficiently exchange heat with the cooler. Accordingly, a problem arises in that the cooling performance decreases.

[0051]

In this respect, in Embodiment 1, the lower fin pitch is larger than the upper fin pitch in the cooler 30. Therefore, the lower part of the cooler 30 is hardly affected by frost formation. That is, clogging between the fins 31 due to the frost formation is reduced at the lower part of the cooler 30 even if a relatively heavy frost is formed on the lower part of the cooler 30. Thus, the increase in the air passage resistance can be suppressed. Further, the fin pitch of at least one lower stage of the fin unit 32 is relatively large. Therefore, the air passage at the lower part of the cooler 30 can be secured even if frost is formed on the cooler 30 due to the refrigerator-compartment return cold air C₁ and the storage-compartment return cold air C₄.

[0052]

Here, in the refrigerator 10, the refrigerator-compartment return cold air C_1 and the storage-compartment return cold air C_4 containing a relatively large amount of moisture flow into the lower part of the cooler 30 and therefore a heavier frost is formed at the lower part of the cooler 30 than at the upper part of the cooler 30. In this respect, the refrigerator 10 includes the heater 51 below the cooler 30 in the air passage between the rear storage-compartment wall 24 and the rear body wall 22. Therefore, the refrigerator 10 can remove the frost on the lower part of the cooler 30 with priority by causing the heater 51 to generate heat. Thus, the increase in the air passage resistance can further be suppressed.

[0053]

In addition, the refrigerator 10 includes the transfer heaters 52 provided in close contact with the fins 31 and configured to heat the fins 31. Thus, the refrigerator 10 can efficiently melt the frost adhering to the cooler 30 by causing at least one of the heater 51 and the transfer heaters 52 to generate heat.

[0054]

Further, the cold air separation plate 70 configured to prevent the inflow of the freezer-compartment return cold air C_5 into the lower part of the cooler 30 is provided in the freezer-compartment air returning passage P_5 at a part at least below the cooler 30. Therefore, the inflow of the freezer-compartment return cold air C_5 into the cooling chamber 100 can be suppressed by reducing the clearance 5n. Further, the cold air separation plate 70 is made of a metal. Thus, deformation of the cold air separation plate 70 due to the heat of the heater 51 can be suppressed. Further, even if frost adheres to the cold air separation plate 70, the adhering frost can promptly be removed by a good thermal conductivity of the metal.

[0055]

Embodiment 2.

Fig. 8 is a schematic sectional view illustrating an example of a structure around a cooling chamber of a refrigerator according to Embodiment 2 of the present disclosure. The overall structure of the refrigerator of Embodiment 2 is similar to the

structure in Embodiment 1. Therefore, equivalent components are represented by the same reference signs and description of those components is omitted.

[0056]

The refrigerator 10 of Embodiment 2 has a bypass air passage 80 in at least one of the rear body wall 22 and the rear storage-compartment wall 24 and the refrigerator-compartment return cold air C_1 and the storage-compartment return cold air C_4 flow through the bypass air passage 80.

[0057]

Fig. 8 illustrates an example in which the bypass air passage 80 is formed between the cooler 30 and the rear body wall 22. That is, the refrigerator 10 has a bypass groove 81 provided partially in a region in the rear body wall 22 that faces the cooler 30. Thus, the clearance between the cooler 30 and the rear body wall 22 is widened and the bypass air passage 80 is secured.

[0058]

More specifically, the bypass groove 81 has a lower inclined surface 81a, a flat surface 81b, and an upper inclined surface 81c. The lower inclined surface 81a is provided at a part facing the lower end of the cooler 30 and is inclined from front to rear. The flat surface 81b is provided above the lower inclined surface 81a and runs along the rear surface of the cooler 30. The upper inclined surface 81c is provided above the flat surface 81b and below the upper end of the cooler 30 and is inclined from rear to front.

[0059]

As described above, the refrigerator 10 of Embodiment 2 has the bypass air passage 80 by providing the bypass groove 81. Therefore, even if clogging occurs between the fins 31 due to frost formation on the lower part of the cooler 30 and the air passage resistance increases, the refrigerator-compartment return cold air C_1 and the storage-compartment return cold air C_4 can flow through the bypass air passage 80. Thus, the decrease in the cooling performance can be prevented.

[0060]

Here, Fig. 8 illustrates the example in which the bypass groove 81 is provided in the rear body wall 22, but the bypass groove 81 is not limited to the groove in this example. The bypass groove 81 may be provided in the rear storage-compartment wall 24 or in each of the rear body wall 22 and the rear storage-compartment wall 24.

That is, the bypass air passage 80 may be provided in at least one of the rear body wall 22 and the rear storage-compartment wall 24.

[0061]

Note that Embodiments 1 and 2 are preferred specific examples of the refrigerator and the technical scope of the present disclosure is not limited to Embodiments 1 and 2. For example, the above description is directed to the example in which the refrigerator 10 has five storage compartments, but the refrigerator 10 is not limited to the refrigerator in this example. The refrigerator 10 may only have the refrigerator compartment 1, the vegetable compartment 4, and the freezer compartment 5 as the plurality of storage compartments. Further, the refrigerator 10 need not have at least one of the ice-making compartment 2 and the versatile compartment 3. Still further, the refrigerator 10 may have four storage compartments or have six or more storage compartments. In this case, the structures and disposition of the storage compartments other than the refrigerator compartment 1, the vegetable compartment 4, and the freezer compartment 5 may be selected variously.

[0062]

Further, the vegetable compartment 4 is described above as an example of the storage compartment provided between the refrigerator compartment 1 and the freezer compartment 5 and being configured to have a temperature range set lower than the temperature range of the freezer compartment 5, but this storage compartment is not limited to the vegetable compartment 4. That is, the storage compartment provided between the refrigerator compartment 1 and the freezer compartment 5 and being configured to have a temperature range set lower than the temperature range of the freezer compartment 5 may be any storage compartment to be used for a purpose other than storage of vegetables.

[0063]

Fig. 6 and Fig. 8 illustrate, as an example, the fin unit 32 in which the plurality of fins 31 through which the heat transfer tubes 33 in one row run are disposed in the plurality of stages in the vertical direction, but the fin unit 32 is not limited to this fin unit. In the fin unit 32, the plurality of fins 31 through which the heat transfer tubes 33 in one row run may be disposed in the plurality of stages in the vertical direction. Further, the above description is directed to the example in which the fin unit 32 has two types of fin pitch, but the fin pitches are not limited to the two types of fin pitch. The fin unit 32 may have three or more types of fin pitch. In this case, it is appropriate that the fin pitch increase toward the lower stage. For example, if the fin unit 32 has three types of fin pitch, it is appropriate that the fin pitch of the lower stage be largest and the fin pitch of the upper stage be smallest. In addition, the above description is directed to the example in which the tube part 35 has the plurality of heat transfer tubes 33 and the plurality of coupling pipes 34, but the tube part 35 is not limited to this tube part. The tube part 35 may have the plurality of heat transfer tubes 33 and the plurality of coupling pipes 34 integrated together.

Reference Signs List

[0064]

1 refrigerator compartment 1b refrigerator-compartment return port 2 ice-making compartment 2a ice storage case 3 versatile compartment 4 vegetable compartment 4a storage-compartment return port 4b storage-compartment return port 4c air outlet 5 freezer compartment 5a freezer-compartment inlet 5b freezer-compartment return port 5c cold air sending port 5d air outlet 5n clearance 10 refrigerator 11 refrigerator compartment door 11a first door 11b second door 12 ice-making compartment drawer 13 versatile compartment drawer 14 vegetable compartment drawer 15 freezer compartment drawer 20 body 21 heat insulating wall 22 rear body wall 22a heat insulator 22b vacuum heat insulator 24 rear storage-compartment wall 24a heat insulator 24b vacuum heat insulator 25 partition plate 26 partition plate 27 partition plate 27a heat insulator 27b vacuum heat insulator 30 cooler 31 fin 32 fin unit 32a upper fin unit 32b lower fin unit 33 heat transfer tube

34 coupling pipe 35 tube part 40 circulation fan 51 heater 51a heater roof
 52 transfer heater 55 drain pan 56 drain conduit 60 refrigerant circuit 60a
 refrigerant pipe 61 compressor 62 pipe unit 63 expander 70 cold air
 separation plate 80 bypass air passage 81 bypass groove 81a lower inclined
 5 surface 81b flat surface 81c upper inclined surface 100 cooling chamber C
 return air C₁ refrigerator-compartment return cold air C₄ storage-compartment
 return cold air C₅ freezer-compartment return cold air P₁ refrigerator-
 compartment air returning passage P₅ freezer-compartment air returning passage
 Q₅ freezer-compartment air sending passage Ra, Rb region.

CLAIMS

[Claim 1]

A refrigerator, comprising:

5 a body comprising a refrigerator compartment, a freezer compartment provided below the refrigerator compartment, and a storage compartment provided between the refrigerator compartment and the freezer compartment, the storage compartment being configured to have a temperature range set higher than a temperature range of the freezer compartment and having a rear storage-compartment wall at a rear of the storage compartment; and

10 a cooler disposed in an air passage between the rear storage-compartment wall and a rear body wall at a rear of the body and configured to cool air inside the body,

wherein the body comprises:

a refrigerator-compartment return port through which air in the refrigerator compartment returns to the cooler;

15 a storage-compartment return port through which air in the storage compartment returns to the cooler; and

a freezer-compartment return port through which air in the freezer compartment returns to the cooler along an air passage provided in the rear storage-compartment wall,

20 wherein the refrigerator-compartment return port and the storage-compartment return port are provided below a lower end of the cooler, and

wherein the freezer-compartment return port is provided at a part within a range between the lower end of the cooler and an upper end of the cooler.

[Claim 2]

25 The refrigerator of claim 1,

wherein the refrigerator-compartment return port is provided on one side surface side of the body, and

wherein the storage-compartment return port is provided on an other side surface side of the body.

[Claim 3]

The refrigerator of claim 1 or 2,
wherein the cooler comprises a fin unit in which a plurality of fins arranged with
intervals in a lateral direction to form a plurality of stages in a vertical direction, and
wherein a fin pitch being a distance between the fins of the fin unit is larger in
5 lower stages than in upper stages.

[Claim 4]

The refrigerator of claim 1 or 2,
wherein the cooler comprises:

a tube part in which one or more heat transfer tubes are disposed in a
10 plurality of rows in a vertical direction; and

a fin unit in which a plurality of fins through which the heat transfer tubes in
one or two rows run are disposed to form a plurality of stages in the vertical direction,
and

wherein a fin pitch being a distance between the fins of the fin unit is larger in
15 lower stages than in upper stages.

[Claim 5]

The refrigerator of claim 3 or 4,
wherein the fin unit has two types of distance between the plurality of fins, and
wherein the fin pitch is relatively large in at least one of the lower stages.

20 [Claim 6]

The refrigerator of claim 5, wherein the freezer-compartment return port faces a
lower part of the fin unit, the lower part being located below a part in which the fin pitch
is relatively small.

[Claim 7]

25 The refrigerator of any one of claims 3 to 6, further comprising a transfer heater
provided in close contact with the fins and configured to heat the fins.

[Claim 8]

The refrigerator of any one of claims 1 to 7, further comprising a heater provided
below the cooler in the air passage between the rear storage-compartment wall and the
30 rear body wall, and configured to defrost the cooler.

[Claim 9]

The refrigerator of any one of claims 1 to 8, further comprising a cold air separation plate provided in a freezer-compartment air returning passage at a part at least below the cooler, one end of the freezer-compartment air returning passage being a freezer-compartment inlet formed above the freezer compartment and an other end being the freezer-compartment return port, the cold air separation plate being configured to prevent an inflow of freezer-compartment return cold air into a lower part of the cooler, the freezer-compartment return cold air flowing out through the freezer-compartment return port.

[Claim 10]

The refrigerator of claim 9, wherein the cold air separation plate is made of a metal.

[Claim 11]

The refrigerator of any one of claims 1 to 10, further comprising a bypass air passage formed in at least one of the rear storage-compartment wall and the rear body wall, and configured to pass therethrough

refrigerator-compartment return cold air flowing out through the refrigerator-compartment return port, and

storage-compartment return cold air flowing out through the storage-compartment return port.