

DESCRIPTION

Title of Invention

REFRIGERATOR

Technical Field

5 [0001]

The present invention relates to refrigerators, and in particular, relates to a refrigerator that performs a cooling operation using a vapor compression refrigeration cycle.

Background Art

10 [0002]

Related-art refrigerators include a refrigerator that uses a vapor compression refrigeration cycle to provide a refrigerant circuit to cool an object, such as food, while circulating air in the refrigerator. The refrigerant circuit includes a cooler that cools the air in the refrigerator using, for example, evaporation of a refrigerant. In this case, the cooler is a heat exchanger including a plurality of heat transfer tubes through which the refrigerant passes and a plurality of plate-shaped fins for increasing the area of heat transfer.

[0003]

When the cooler of the refrigerator cools the air in the refrigerator, the temperature of the surface of the cooler falls close to -30 degrees C. Consequently, water vapor contained in the air in the refrigerator turns into frost on the surface of the cooler, so that frost deposits on the surface (frost formation). The deposition of frost reduces the spacing between adjacent fins of the cooler, thus causing clogging or the like. Disadvantageously, stack loss increases. Unfortunately, the cooling performance of the refrigerator decreases and the power consumption thereof increases. To remove frost on the cooler, the refrigerator performs a defrosting operation (frost removal) at regular time intervals. During the defrosting operation, additional power for a defrosting heater or the like is needed. Disadvantageously, the power consumption increases with the number of defrosting times.

30 [0004]

Refrigerators intended to reduce the number of defrosting times in order to overcome the above-described disadvantages have recently been developed. For example, one of such refrigerators has a structure in which a cooling chamber is disposed behind a freezing compartment and a crisper, a cooler is disposed so as to extend along both the freezing compartment and the crisper, and an inlet for air returning from a refrigerating compartment to the cooler is separated from an inlet for air returning from the freezing compartment to the cooler. The separation of the inlets allows frost to uniformly deposit on the cooler, thus preventing clogging in the cooler (refer to Patent Literature 1, for example).

[0005]

Another one of the above-described refrigerators includes a refrigerating cooler used only for cooling a refrigerating space, a freezing cooler used only for cooling a freezing space, a refrigerating fan, and a freezing fan. Each fan is used to circulate air between the corresponding cooled space and the corresponding cooler. In this refrigerator, the coolers are arranged close to each other and at least parts of the coolers arranged behind the spaces overlap each other in a front-to-back direction of the refrigerator so that the thickness of a heat insulating layer included in an outer casing of the body of the refrigerator is reduced (refer to Patent Literature 2, for example).

Citation List

Patent Literature

[0006]

Patent Literature 1: Japanese Patent No. 4375220 (Fig. 2)

Patent Literature 2: Japanese Patent No. 4488966 (Fig. 2)

Summary of Invention

Technical Problem

[0007]

For example, the refrigerator disclosed in Patent Literature 1 allows uniform deposition of frost on the cooler. The cooler is disposed between the freezing compartment and the crisper and a freezing compartment return air passage is

disposed in central part of the cooler. Such arrangement results in a reduction of the area of heat transfer in a portion of the cooler through which air returned from the freezing compartment to the cooler passes, leading to insufficient cooling.

[0008]

5 For example, in the refrigerator disclosed in Patent Literature 2, the thickness of the heat insulating layer can be reduced. Since the refrigerator includes the refrigerating cooler and the freezing cooler, however, the capacity of air passages in the refrigerator increases. Disadvantageously, this leads to a reduction in capacity of an interior space of the refrigerator and an increase in cost.

10 [0009]

The present invention provides a highly efficient refrigerator intended to achieve a reduction in cost and prevent clogging due to frost formation.

Solution to Problem

[0010]

15 The present invention has been made to overcome the above-described disadvantages and provides a refrigerator that includes a refrigerating compartment and a freezing compartment, the refrigerator including a cooler that includes a heat transfer tube through which a refrigerant passes and a plurality of fins arranged. The cooler is configured such that the pitch of fins in a portion through which air coming
20 from the refrigerating compartment passes is wider than that in a portion through which air coming from the freezing compartment passes and/or the number of fins in the portion through which the air coming from the refrigerating compartment passes is smaller than that in the portion through which the air coming from the freezing compartment passes, and the portion through which the air coming from the
25 refrigerating compartment passes is closer to the exterior of the refrigerator than the portion through which the air coming from the freezing compartment passes. The cooler exchanges heat between the refrigerant and the air coming from the freezing compartment and the refrigerating compartment to cool the air. The refrigerator further includes a circulating fan that circulates air between the cooler and the

compartments and a dedicated fan that blows air cooled by the cooler to the refrigerating compartment.

Advantageous Effects of Invention

[0011]

5 Since the refrigerator according to the present invention is configured such that the fin pitch is wide and/or the number of fins is small in the portion through which the air coming from the refrigerating compartment passes, stack loss to frost on the cooler of the refrigerator can be reduced. Furthermore, for example, the number of defrosting times can be reduced and defrosting time can be shortened. Accordingly, 10 the refrigerator with high efficiency can be provided. In addition, since the temperature of the air coming from the refrigerating compartment is higher than that of the air coming from the freezing compartment, the portion through which the air coming from the refrigerating compartment passes is disposed adjacent to the exterior of the refrigerator. Consequently, the difference in temperature between the 15 air in the refrigerator and outdoor air can be reduced and the amount of heat entering from the outdoor air can be reduced. Thus, the cooling performance can be increased and the power consumption can be reduced. Since the refrigerator includes the single cooler, a capacity related to the cooler can be reduced and the capacity of an interior space of the refrigerator can be increased.

20 Brief Description of Drawings

[0012]

[Fig. 1] Fig. 1 includes diagrams explaining the appearance and configuration of a refrigerator according to Embodiment 1 of the present invention.

25 [Fig. 2] Fig. 2 is a diagram illustrating the configuration of a refrigerant circuit included in the refrigerator.

[Fig. 3] Fig. 3 is a diagram illustrating a schematic configuration of an evaporator 31 and its surroundings in a related-art refrigerator.

[Fig. 4] Fig. 4 includes diagrams illustrating a change in temperature of freezing compartment return air 37 upon passing through the evaporator 31.

[Fig. 5] Fig. 5 includes diagrams illustrating a cooler 15 in Embodiment 1 of the present invention.

[Fig. 6] Fig. 6 includes diagrams illustrating placement of the cooler 15 in Embodiment 1 of the present invention.

5 [Fig. 7] Fig. 7 includes diagrams illustrating a cooler 15 in Embodiment 2 of the present invention.

[Fig. 8] Fig. 8 includes diagrams illustrating arrangement and the like of a defrosting heater 61.

Description of Embodiments

10 [0013]

Embodiment 1

Embodiments of the present invention will be described below with reference to the drawings.

15 Fig. 1 includes diagrams explaining the appearance and configuration of a refrigerator according to Embodiment 1 of the present invention. Fig. 1(a) is an external view of the refrigerator as seen from the side of doors 12 (or a front surface) of the refrigerator. Fig. 1(b) is a cross-sectional view explaining the interior of the refrigerator. In the refrigerator, for example, an interior space 11 is sealed by the doors 12 and a thermal insulation wall 13, thus achieving thermal insulation between
20 the interior space 11 and the exterior of the refrigerator (or outdoor air).

[0014]

The interior space 11 of the refrigerator includes a plurality of rooms (compartments). In Embodiment 1, the interior space 11 includes a refrigerating compartment and a freezing compartment. The refrigerating compartment is a room
25 for cooling (refrigerating) food and the like (objects to be cooled) by keeping compartment air at, for example, approximately 4 degrees C. The freezing compartment is a room for cooling (freezing) food and the like while keeping compartment air at approximately -18 degrees C. Although Fig. 1 illustrates the refrigerator including the refrigerating compartment and the freezing compartment,
30 another refrigerator that includes a crisper and an ice making compartment in addition

to the above compartments can be allowed to have advantages which will be described below.

[0015]

In the refrigerator according to Embodiment 1, a circulating fan 16 allows air in the interior space 11 (the freezing compartment and the refrigerating compartment) to pass through a cooler 15 and blows the resultant air to the interior space 11. A dedicated fan 17 is a fan that is exclusively for the refrigerating compartment and blows air cooled by the cooler 15 to the refrigerating compartment in cooperation with the circulating fan 16. Since the refrigerator includes the dedicated fan 17, the amount of flow of air circulated between the cooler 15 and the refrigerator can be independently controlled. In this case, the dedicated fan 17 illustrated in Fig. 1 is exclusively for cooling the refrigerating compartment. For example, if the refrigerator includes any other rooms (compartments), the dedicated fan 17 can be used to cool not only the refrigerating compartment but also another room, for example, above the freezing compartment.

[0016]

The refrigerator according to Embodiment 1 performs a cooling operation using a vapor compression refrigeration cycle so as to compensate for heat from the outdoor air upon opening and closing of the doors 12 of the refrigerator and heat entering through the thermal insulation wall 13 from the outdoor air, and keeps an interior temperature in each of the freezing compartment and the refrigerating compartment of the interior space 11.

[0017]

Fig. 2 is a diagram illustrating the configuration of a refrigerant circuit in the refrigerator according to Embodiment 1. In Fig. 2, the refrigerant circuit includes a compressor 14, a pipe group 21, expansion means 22, and the cooler 15 which are connected. As regards a refrigerant circulated through the refrigerant circuit, for example, isobutane is used.

[0018]

The compressor 14 sucks the refrigerant, compresses the refrigerant into a high-temperature high-pressure state, and discharges the resultant refrigerant. The pipe group 21 is disposed within the thermal insulation wall 13. The pipe group 21 functions as a condenser that allows the refrigerant to transfer heat and thus condense and liquefy. The expansion means 22 reduces the pressure of the refrigerant passing therethrough to expand the refrigerant. The expansion means 22 includes a capillary tube.

[0019]

The cooler 15 allows the refrigerant to evaporate and gasify by heat exchange with air 23. In Embodiment 1, the cooler 15 is a finned tube heat exchanger that includes a plurality of plate-shaped fins with flat surfaces arranged parallel to one another and a heat transfer tube extending through the fins in a direction in which the fins are arranged. The refrigerant, circulated through the refrigerant circuit, passes through the heat transfer tube. The configuration and the like of the cooler 15 will be described in more detail later.

[0020]

In the refrigerator according to Embodiment 1, the single cooler 15 cools the air 23 coming from the interior space 11 (the freezing compartment and the refrigerating compartment) to keep the interior temperature of each of the freezing compartment and the refrigerating compartment. The air 23 is air allowed to flow into the cooler 15 from the interior space 11 (the refrigerating compartment and the freezing compartment) by driving of the circulating fan 16 and the dedicated fan 17. After passing through the cooler 15, the air 23 is again sent to the interior space 11 (the refrigerating compartment and the freezing compartment). In the refrigerator according to Embodiment 1, air passages through which air flows into the cooler 15 at least from the interior space 11 are separated, such that air (hereinafter, referred to as "refrigerating compartment return air") coming from the refrigerating compartment and air (hereinafter, referred to as "freezing compartment return air") coming from the freezing compartment pass through different portions of the cooler 15.

[0021]

Operations of the components of the refrigerant circuit during the cooling operation of the refrigerator will now be described in accordance with the flow of the circulated refrigerant. The compressor 14 sucks the refrigerant, compresses the refrigerant into the high-temperature high-pressure state, and discharges the resultant refrigerant. The compressed refrigerant flows to the pipe group 21. In the pipe group 21, the refrigerant transfers heat, so that the refrigerant turns into a liquid refrigerant. The liquid refrigerant flows to the expansion means 22. In the expansion means 22, the refrigerant is reduced in pressure, so that the refrigerant expands into a two-phase gas-liquid refrigerant. In the cooler 15, the two-phase gas-liquid refrigerant exchanges heat with the air 23 supplied from the interior space 11 by rotation of the circulating fan 16 and the dedicated fan 17. The two-phase gas-liquid refrigerant removes heat from the air 23 by heat exchange in the cooler 15, so that the refrigerant evaporates and gasifies. The compressor 14 again sucks the gas refrigerant and discharges the refrigerant.

[0022]

On the other hand, the air 23, which has been reduced in temperature by heat removal through the refrigerant, is again sent to the interior space 11 by the circulating fan 16 and the dedicated fan 17, thus cooling the interior space 11.

[0023]

As regards the air 23 flowing into the cooler 15 in the refrigerator with the above-described configuration, the refrigerating compartment return air significantly differs in air inflow conditions (air temperature, air humidity) from the freezing compartment return air. One of the reasons is that the temperature set in the refrigerating compartment is approximately 4 degrees C and that in the freezing compartment is approximately -18 degrees C. Another reason is that the refrigerating compartment has a larger capacity than the freezing compartment and accordingly has a larger surface area than the freezing compartment, and the amount of heat entering the refrigerating compartment from the outdoor air is therefore larger than that of heat entering the freezing compartment from the outdoor air. Still another reason is that the number of times the doors 12 are opened and closed in the

refrigerating compartment is larger than that in the freezing compartment and the amount of outdoor air, outside the interior space 11, entering the refrigerating compartment is therefore larger than that of outdoor air entering the freezing compartment.

[0024]

5 The inventors measured a temperature T_{in} and a humidity ϕ_{in} of each of the freezing compartment return air and the refrigerating compartment return air and obtained the following results.

(Refrigerating compartment return air) $T_{in} = 5$ degrees C $\phi_{in} = 80\%$

(Freezing compartment return air) $T_{in} = -15$ degrees C $\phi_{in} = 60\%$

10 [0025]

 The inventors calculated the proportion of the contribution of the refrigerating compartment return air to the water content of the air 23 entering the cooler 15 and the contribution of the freezing compartment return air thereto on the basis of the above-described results and the amounts of flow of air returning from the compartments. The result revealed that the water content of the refrigerating compartment return air was seven or more times that of the freezing compartment return air in the air 23. Hence, frost formation on the cooler 15 can be mainly attributed to the refrigerating compartment return air.

[0026]

20 Fig. 3 is a diagram illustrating a schematic configuration of an evaporator 31 and its surroundings in a related-art refrigerator. In Fig. 3, the evaporator 31 functions as a cooler. A return air passage 32 is an air passage for refrigerating compartment return air 36. A defrosting heater 33 is heating means for heating the cooler 15 to defrost the evaporator 31. A drip pan 34 receives drips or the like from the evaporator 31 upon, for example, defrosting. A guide plate 35 guides the refrigerating compartment return air 36 to send the air through openings 35a to the evaporator 31. As described above, the refrigerating compartment return air 36 is air coming from the refrigerating compartment. Furthermore, freezing compartment return air 37 is air coming from the freezing compartment.

[0027]

Fig. 4 includes diagrams illustrating a change in temperature of the freezing compartment return air 37 upon passing through the evaporator 31. As the freezing compartment return air 37 moves in an X direction (toward an outlet of the evaporator) in Fig. 4(a), the temperature of the freezing compartment return air 37 approaches the temperature of the evaporator 31 as illustrated in Fig. 4(b). The temperature of the freezing compartment return air 37 is substantially identical to that of the evaporator 31 in the vicinity of the outlet of the evaporator 31.

[0028]

Accordingly, as long as the amount of flow of the freezing compartment return air 37 is constant and the temperature of the evaporator 31 is constant, the temperature of the freezing compartment return air 37 at the outlet of the evaporator 31 is determined by the size of the evaporator 31 (or a distance in which the freezing compartment return air 37 passes through the evaporator 31). If the evaporator 31 having the same size has a structure in which the freezing compartment return air 37 is allowed to enter the evaporator 31 at a point between the inlet and the outlet of the evaporator 31 , the distance in which the air passes through the evaporator 31 would decrease, so that the temperature of the freezing compartment return air 37 might fail to fully fall at the outlet of the evaporator 31 , leading to insufficient cooling capacity.

[0029]

Fig. 5 includes diagrams illustrating the cooler 15 in Embodiment 1 of the present invention. Fig. 5(a) is a perspective view of the cooler 15 in Embodiment 1. Fig. 5(b) is a top view of the cooler 15. Fig. 5(c) is a front view of the cooler 15 as seen from the interior space of the refrigerator. For example, as illustrated in Fig. 5(b), the cooler 15 in Embodiment 1 includes a portion in which the pitch of fins is wide and the number of fins is small and the portion is adjacent to the rear surface of the refrigerator (or adjacent to the exterior of the refrigerator) as seen from the interior space of the refrigerator. The refrigerating compartment return air containing a high water content is allowed to pass through this portion so that clogging by frost is reduced. Although both the fin pitch and the number of fins are varied in Fig. 5,

clogging can be reduced by varying either one of them (i.e., increasing the fin pitch or reducing the number of fins). The ratio of an air passage (capacity) in the portion having a widened fin pitch or the like to that in the other portion is set to, for example, 1:2 (so that the amount of flow of the refrigerating compartment return air is small), although not particularly limited thereto.

[0030]

In the refrigerator according to Embodiment 1, the distance in which the freezing compartment return air passes through the cooler 15 is identical to the distance in which the refrigerating compartment return air passes through the cooler 15 so that the temperature of the freezing compartment return air can be reduced as much as possible, as described above. This prevents insufficient cooling capacity of the freezing compartment return air. In addition, as described above, the path (air passage) in the cooler 15 through which the refrigerating compartment return air passes is disposed in the portion adjacent to the rear surface of the refrigerator as seen from the interior space (or front surface) of the refrigerator, namely, close to the exterior of the refrigerator. The reason is to reduce the amount of heat entering from outdoor air. For example, as illustrated in Fig. 1, the cooler 15 is thermally insulated from the outdoor air by the thermal insulation wall 13. The thermal insulation wall 13 is typically made of urethane foam or a vacuum insulation material. The amount, Q, of heat entering from the outdoor air can be expressed by Equation (1):

$$Q = A \cdot K \cdot \Delta T \quad \dots (1)$$

where A denotes the area, K denotes the coefficient of overall heat transfer determined by the structure of the thermal insulation wall 13, and ΔT denotes the difference in temperature between the cooler 15 and the outdoor air.

[0031]

According to Equation (1), it is desirable to reduce the temperature difference ΔT in order to reduce the amount of heat entering the interior space 11 from the outdoor air. As the temperature of the cooler 15 is higher, the amount of heat entering can be reduced if the outdoor air is at a constant temperature. As described above, the temperature of the freezing compartment return air is approximately 20

degrees C lower than that of the refrigerating compartment return air. When the freezing compartment return air passes through the portion adjacent to the exterior of the refrigerator, the temperature difference ΔT from the outdoor air temperature increases. According to Embodiment 1, therefore, the refrigerating compartment return air is allowed to pass through the portion of the cooler 15 adjacent to the exterior of the refrigerator. Assuming that the outdoor air temperature is, for example, 30 degrees C, allowing the refrigerating compartment return air to pass through the portion of the cooler 15 adjacent to the exterior of the refrigerator can reduce the amount of heat entering by 45%. If it is unnecessary to circulate air between the cooler 15 and the refrigerating compartment, a damper may be disposed near the air inlet of the cooler 15 and switching may be performed to enable the freezing compartment return air to flow into the portion of the cooler 15 in which, for example, the fin pitch is widened.

[0032]

Fig. 6 includes diagrams illustrating placement of the cooler 15 in Embodiment 1 of the present invention. Fig. 6(a) illustrates the placement as seen from the front of the refrigerator. Fig. 6(b) illustrates the placement as seen from above the refrigerator. Referring to Fig. 6, a refrigerating compartment return inlet 18 is disposed on the front of the cooler 15 so as to be opened vertically relative to the cooler 15, so that the refrigerating compartment return air flows through lower part of the cooler 15 toward the rear surface of the cooler 15. On the other hand, a freezing compartment return inlet (not illustrated) is disposed so as to upwardly extend from the lower part of the cooler 15, so that the freezing compartment return air flows toward the front surface of the cooler 15.

[0033]

As described above, since the fin pitch is widened or the number of fins is reduced in the portion of the cooler 15 through which the refrigerating compartment return air passes, clogging by frost on the fins can be reduced in the refrigerator according to Embodiment 1. Thus, an increase in stack loss caused by frost can be suppressed. In addition, since the path through which the refrigerating compartment

return air flows is disposed in the cooler 15 so as to be adjacent to the exterior of the refrigerator, the temperature difference from the outdoor air temperature can be reduced, thus reducing the amount of heat entering from the outdoor air.

Consequently, the refrigerator with high efficiency can be provided.

5 [0034]

Embodiment 2

Fig. 7 includes diagrams illustrating a cooler 15 in Embodiment 2 of the present invention. Placement and the like of the cooler 15 in a refrigerator are the same as those in the refrigerator according to Embodiment 1. The cooler 15 of Fig. 7 is provided with a defrosting heater 61 that directly heats the cooler 15 while being in contact therewith. Furthermore, many parts of the defrosting heater 61 are arranged adjacent to a portion in which the refrigerating compartment return air, serving as a main cause of frost formation, passes through the cooler 15. Fig. 7(a) is a perspective view of the cooler 15 in Embodiment 2. Fig. 7(b) is a top view of the cooler 15 in Embodiment 2. Fig. 7(c) is an elevation view of the cooler 15 in Embodiment 2 as seen from the side where the freezing compartment return air flows through the cooler 15.

[0035]

As illustrated in Fig. 7(b), the cooler 15 includes a portion in which the fin pitch is wide and the number of fins is small and the portion is on the opposite side of the cooler 15 from the side where the freezing compartment return air flows. In the cooler 15 in Embodiment 2, clogging by frost can be reduced only by increasing the fin pitch or reducing the number of fins. The configuration of the refrigerator including the cooler 15, a refrigerant circuit, and the like in Embodiment 2 are identical to those in Embodiment 1 and only the difference between Embodiment 2 and Embodiment 1 will be described below.

[0036]

Fig. 8 includes diagrams illustrating arrangement and the like of the defrosting heater 61. As illustrated in Fig. 8, the defrosting heater 61 that externally supplies heat to the cooler 15 for defrosting is provided in Embodiment 2. Many parts of the

defrosting heater 61 are arranged in the portion of the cooler 15 through which the refrigerating compartment return air passes and in which the fin pitch is wide and the number of fins is small.

[0037]

5 As described in Embodiment 1, since the water content of the refrigerating compartment return air is larger than that in the freezing compartment return air, the amount of frost on the fins in the portion through which the refrigerating compartment return air passes would be larger than that in a portion through which the freezing compartment return air passes. Accordingly, the defrosting heater 61 is disposed so
10 as to heat the portion through which the refrigerating compartment return air passes in a concentrated manner. Thus, defrosting time can be shortened as compared with that in uniform arrangement of the parts of the heater. Furthermore, the reduction of defrosting time can suppress an increase in temperature of the interior space during defrosting. The refrigerator with high efficiency can therefore be
15 provided.

Industrial Applicability

[0038]

The use of the present invention improves the cooling performance of a refrigerator, thus providing a highly efficient refrigerator. In addition, the power
20 consumption can be reduced by shortening defrosting time.

Reference Signs List

[0039]

11 interior space 12 door 13 thermal insulation wall 14 compressor
15 cooler 16 circulating fan 17 dedicated fan 18 refrigerating compartment
25 return inlet 21 pipe group 22 expansion means 23 air 31 evaporator 32
return air passage 33 defrosting heater 34 drip pan 35 guide plate 35a
opening 36 refrigerating compartment return air 37 freezing compartment
return air 61 defrosting heater

CLAIMS

[Claim 1]

A refrigerator that includes a refrigerating compartment and a freezing compartment, the refrigerator comprising:

- 5 a cooler that includes a heat transfer tube through which a refrigerant can pass and a plurality of fins arranged, the cooler being configured such that a pitch of fins in a first portion through which air coming from the refrigerating compartment can pass is wider than that in a second portion through which air coming from the freezing compartment can pass and/or a number of fins in the first portion is smaller than that in the second portion, and the first portion is closer to an exterior of the refrigerator than
- 10 the second portion, the cooler exchanging heat between the refrigerant and the air coming from the freezing compartment and the refrigerating compartment to cool the air;
- a circulating fan that circulates air between the cooler and an interior space of the refrigerator; and
- a dedicated fan that blows air cooled by the cooler to the refrigerating compartment.

[Claim 2]

- 15 The refrigerator of claim 1, further comprising:
- a damper configured to switch a flow path so as to allow freezing compartment return air to further flow into the first portion of the cooler.

[Claim 3]

- The refrigerator of claim 1 or 2, further comprising:
- 20 heating means for defrosting the cooler,
- wherein the heating means is configured to supply heat to the cooler such that an amount of heat supplied to the portion through which the air coming from the refrigerating compartment can pass is larger than that to the portion through which the air coming from the freezing compartment can pass.

[Claim 4]

- 25 The refrigerator of claim 3, wherein the heating means is disposed in contact with the cooler.

[Claim 5]

The refrigerator of any one of claims 1 to 4,
wherein the refrigerating compartment is disposed above the freezing compartment, and
wherein the dedicated fan is disposed at a level higher than the freezing compartment.

5

[Claim 6]

The refrigerator of any one of claims 3 to 5, wherein the heating means externally supplies heat to
the cooler.

[Claim 7]

10

The refrigerator of any one of claims 1 to 6, wherein the cooler is configured such that a capacity
of the portion through which the air coming from the refrigerating compartment can pass is smaller than a
capacity of the portion through which the air coming from the freezing compartment can pass.