

DESCRIPTION

Title of Invention

REFRIGERATOR

Technical Field

5 [0001]

The present invention relates to a refrigerator.

Background Art

[0002]

10 There is a typical refrigerator including storage chambers, a refrigerant circuit configured such that a compressor, a radiator, a pressure reducer, and a cooler are connected through pipes, a cooling chamber in which the cooler is disposed, and a fan configured to deliver cold air from the cooling chamber to the storage chamber. In the typical refrigerator, the compressor is driven to form a refrigeration cycle. During operation of the compressor, the storage chamber is continuously cooled, and
15 therefore, the temperature of the storage chamber gradually decreases. When the temperature of the storage chamber falls below a predetermined temperature and it is determined that cooling is no longer required, the compressor is stopped such that cooling of the storage chamber is stopped. While the compressor is stopped, the storage chamber is heated by external air around the refrigerator, and therefore, the
20 temperature of the storage chamber gradually increases with time. When the temperature of the storage chamber exceeds a predetermined temperature and it is determined that cooling of the storage chamber is required, the compressor is started such that cooling begins again. In this configuration, start and stop of the compressor are repeated, and for this reason, the temperature of each storage
25 chamber repeatedly increases and decreases.

[0003]

Patent Literature 1 describes a freezer/refrigerator configured to cool a refrigerator chamber while a compressor is stopped. In this freezer/refrigerator, the refrigerator chamber is cooled with the heat capacity of an evaporator while the
30 compressor is stopped. When the heat capacity of the evaporator is not enough for

cooling, cooling is performed by the compressor. However, in the freezer/refrigerator of Patent Literature 1, no control is executed to constantly maintain the temperature of a storage chamber, and for this reason, the temperature of the storage chamber repeatedly increases and decreases.

5 Citation List

Patent Literature

[0004]

Patent Literature 1: Japanese Patent No. 3484131

Summary of Invention

10 Technical Problem

[0005]

Figs. 13(a) to 13(d) are timing charts of an example of a change in the temperature of the storage chamber. Fig. 13(a) illustrates the temperature of the refrigerator chamber, Fig. 13(b) illustrates the temperature of a freezer chamber, Fig. 13(c) illustrates an operation state (ON/OFF) of the compressor, and Fig. 13(d) illustrates the opening degree of a damper for the refrigerator chamber. Control is executed such that the compressor is started when the temperature of the freezer chamber exceeds a predetermined upper temperature limit (time points t3, t6) and that the compressor is stopped when the temperature of the freezer chamber falls below a predetermined lower temperature limit (time points t2, t5). Moreover, control is executed such that the damper for the refrigerator chamber is fully opened when the temperature of the refrigerator chamber exceeds the predetermined upper temperature limit during operation of the compressor (the time points t3, t6) and that the damper for the refrigerator chamber is fully closed when the temperature of the refrigerator chamber falls below the predetermined lower temperature limit (time points t1, t4). With such control, the temperature of the storage chamber repeatedly increases and decreases as illustrated in Figs. 13(a) to 13(d). Accordingly, the temperature of food stored in the storage chamber also repeatedly increases and decreases, leading to a problem that the quality of food tends to deteriorate. In

particular, such a problem is easily caused in a refrigerator chamber where target temperature is set at around 0 degrees C to 10 degrees C.

[0006]

The present invention has been made to solve the above-described problem, and is intended to provide a refrigerator capable of more constantly maintaining the temperature of a storage chamber to prevent deterioration of the quality of food.

Solution to Problem

[0007]

The refrigerator of the present invention includes a refrigerant circuit including a compressor, a radiator, a pressure reducer, and a cooler; a cooling chamber in which the cooler is disposed, the cooling chamber being configured to generate cooling air; at least one storage chamber cooled using the cooling air; an air volume adjustment unit configured to adjust the volume of cooling air delivered from the cooling chamber to the storage chamber; a temperature sensor configured to detect the temperature of the storage chamber; and a controller configured to control the compressor and the air volume adjustment unit. The controller controls the compressor such that operation and stop of the compressor are alternately repeated, and variably controls, at least while the compressor is stopped, the volume of cooling air adjusted by the air volume adjustment unit based on the temperature of the storage chamber.

Advantageous Effects of Invention

[0008]

According to the present invention, while a compressor 1 is stopped, a proper volume of cooling air generated using frost adhering to the cooler and the heat capacity of the cooler itself as a cold heat source can be delivered to the storage chamber. Thus, the temperature of the storage chamber can be more constantly maintained, and deterioration of the quality of food can be prevented.

Brief Description of Drawings

[0009]

[Fig. 1] Fig. 1 is a schematic block diagram of the configuration of a refrigerator of Embodiment 1 of the present invention.

[Fig. 2] Fig. 2 is a block diagram of the configuration of a controller 50 of the refrigerator of Embodiment 1 of the present invention and an example of information input/output to/from the controller 50.

[Fig. 3] Fig. 3 is a flowchart of an example of the flow of constant temperature control processing executed by the controller 50 of the refrigerator of Embodiment 1 of the present invention.

[Fig. 4] Figs. 4(a) to 4(d) are timing charts of an example of operation in the constant temperature control of the refrigerator of Embodiment 1 of the present invention.

[Fig. 5] Fig. 5 is a flowchart of an example of the flow of the constant temperature control processing executed by the controller 50 of the refrigerator of Embodiment 1 of the present invention.

[Fig. 6] Figs. 6(a) to 6(d) are timing charts of an example of operation in the constant temperature control of the refrigerator of Embodiment 1 of the present invention.

[Fig. 7] Fig. 7 is a schematic block diagram of the configuration of a refrigerator of Embodiment 2 of the present invention.

[Fig. 8] Fig. 8 is a schematic block diagram of the configuration of a refrigerator of Embodiment 3 of the present invention.

[Fig. 9] Fig. 9 is a flowchart of an example of the flow of constant temperature control processing executed by a controller 50 of the refrigerator of Embodiment 3 of the present invention.

[Fig. 10] Fig. 10 is a schematic block diagram of the configuration of a refrigerator of Embodiment 4 of the present invention.

[Fig. 11] Fig. 11 is a flowchart of an example of the flow of constant temperature control processing executed by a controller 50 of the refrigerator of Embodiment 4 of the present invention.

[Fig. 12] Figs. 12(a) to 12(d) are timing charts of an example of operation in the constant temperature control of the refrigerator of Embodiment 4 of the present invention.

[Fig. 13] Figs. 13(a) to 13(d) are timing charts of an example of a change in the temperature of a storage chamber.

Description of Embodiments

[0010]

Embodiment 1

A refrigerator of Embodiment 1 of the present invention will be described. The present embodiment is an example in the case where an air volume adjustment unit is placed at an air path to a storage chamber A of a plurality of storage chambers A, B and a damper is used as the air volume adjustment unit. In this example, the preset temperature of the storage chamber A is higher than that of the storage chamber B.

[0011]

Fig. 1 is a schematic block diagram of the configuration of the refrigerator of the present embodiment. Fig. 1 mainly illustrates a flow path of cooling air and a flow path of refrigerant. As illustrated in Fig. 1, the refrigerator of the present embodiment includes a storage chamber A8a (e.g., a refrigerator chamber), a storage chamber B8b (e.g., a freezer chamber) having a preset temperature lower than that of the storage chamber A8a, and a cooling chamber 7 configured to generate cooling air for cooling the storage chamber A8a and the storage chamber B8b. The cooling chamber 7 and the storage chamber A8a communicate with each other through a common air supply path 11 and an air supply path 12, and the common air supply path 11 and the air supply path 12 further communicate with each other through a separately-provided return air path 14 and a separately-provided common return air path 16. The cooling chamber 7 and the storage chamber B8b communicate with each other through the common air supply path 11 and an air supply path 13, and the common air supply path 11 and the air supply path 13 further communicate with each other through a separately-provided return air path 15 and the separately-provided common return air path 16.

[0012]

One end (an upstream end) of the common air supply path 11 is connected to the cooling chamber 7. The other end (a downstream end) of the common air supply path 11 is connected to one end (an upstream end) of each of the air supply paths 12, 13. The other end (a downstream end) of the air supply path 12 is connected to the storage chamber A8a, and the other end (a downstream end) of the air supply path 13 is connected to the storage chamber B8b. That is, the cooling air generated in the cooling chamber 7 first circulates through the common air supply path 11. Then, the cooling air is branched into the air supply paths 12, 13, and then, is discharged into each of the storage chambers A8a, B8b.

[0013]

One end (an upstream end) of the return air path 14 is connected to the storage chamber A8a, and one end (an upstream end) of the return air path 15 is connected to the storage chamber B8b. The other end (a downstream end) of each of the return air paths 14, 15 is connected to one end (an upstream end) of the common return air path 16. The other end (a downstream end) of the common return air path 16 is connected to the cooling chamber 7. That is, the air returning from the storage chambers A8a, B8b first circulates through each of the return air paths 14, 15. Then, the air through the return air path 14 and the air through the return air path 15 join together at the common return air path 16, and then, returns to the cooling chamber 7.

[0014]

A fan 5 configured to deliver the cooling air of the cooling chamber 7 to the storage chambers A8a, B8b is provided in the common air supply path 11. The rotation speed of the fan 5 is variably controlled by, e.g., a later-described controller 50.

[0015]

The air supply path 12 is provided with a damper 6a. The damper 6a includes a plate-shaped member and a rotary shaft. The damper 6a is capable of closing the air supply path 12 and adjusting the opening degree of the damper 6a. The damper

6a adjusts the volume of cooling air passing through the air supply path 12, as well as preventing reverse flow of cooling air. The opening degree of the damper 6a is variably controlled by the later-described controller 50.

[0016]

5 The refrigerator further includes a refrigerant circuit forming a refrigeration cycle. The refrigerant circuit is configured such that a compressor 1, a radiator 2 (e.g., a condenser), a pressure reducer 3, and a cooler 4 (an evaporator) are connected together through refrigerant pipes. The compressor 1 of the present embodiment is configured such that the rotation speed thereof is variably controlled
10 by the controller 50. Moreover, the radiator 2 of the present embodiment is an air heat exchanger or a copper pipe provided along an outer wall surface of the refrigerator. The cooler 4 is disposed in the cooling chamber 7.

[0017]

 Next, the flow of refrigerant in the refrigerant circuit will be described. High-
15 temperature high-pressure gas refrigerant compressed in the compressor 1 and discharged from the compressor 1 flows into the radiator 2. The refrigerant having flowed into the radiator 2 is condensed by transferring heat to external air around the refrigerator. The pressure of the condensed high-pressure liquid refrigerant is reduced in the pressure reducer 3, and then, the condensed high-pressure liquid
20 refrigerant turns into low-pressure two-phase refrigerant. Subsequently, the refrigerant flows into the cooler 4 placed in the cooling chamber 7. In the cooler 4, heat is exchanged between air in the cooling chamber 7 and the refrigerant. Such heat exchange cools the air in the cooling chamber 7, and the refrigerant turns into low-pressure gas refrigerant. The low-pressure gas refrigerant flows into the
25 compressor 1, and is compressed again.

[0018]

 Next, the flow of cooling air will be described. The cooling air cooled in the cooling chamber 7 is delivered by the fan 5, and passes through the common air supply path 11 and the air supply paths 12, 13. Then, the cooling air flows into each
30 storage chamber (in the present embodiment, the storage chamber A8a and the

storage chamber B8b). Each storage chamber is cooled by the inflow cooling air. The temperature of each storage chamber is adjusted by adjustment of the volume of inflow cooling air. The volume of cooling air is, by the later-described controller 50, adjusted in such a manner that the rotation speed of the fan 5 or the opening degree of the damper 6a is controlled, for example. The cooling air having cooled each storage chamber returns to the cooling chamber 7 through the return air paths 14, 15 and the common return air path 16, and then, is cooled again.

[0019]

Next, a sensor group will be described. In the storage chamber A8a, a temperature sensor 21 configured to detect the inner temperature of the storage chamber A8a is placed. In the storage chamber B8b, a temperature sensor 22 configured to detect the inner temperature of the storage chamber B8b is placed. In the example illustrated in Fig. 1, temperature sensors are placed in all of the storage chambers, but the present invention is not limited to such a configuration. The temperature sensor may be placed in at least one or more storage chambers where constant temperature control as described later is executed. Note that the placement positions of the temperature sensors 21, 22 are not limited to those illustrated in Fig. 1. The temperature sensors 21, 22 may be placed at any positions representing the temperature of each storage chamber.

[0020]

Fig. 2 is a block diagram of an example of the configuration of the controller 50 and an example of information input/output to/from the controller 50. The controller 50 includes a microcomputer having a CPU, a memory unit, an input/output unit, a timer, etc., for example. The controller 50 is configured to control the entirety of the refrigerator based on, e.g., detection values of various sensors and preset values. In the example illustrated in Fig. 2, the controller 50 is connected to, e.g., the temperature sensors 21, 22, the compressor 1, the fan 5, and the damper 6a. The controller 50 is configured to control, e.g., the rotation speed of the compressor 1 based on, e.g., the detection temperatures of the temperature sensors 21, 22. The controller 50 of the present embodiment starts the compressor 1 at least when the

detection temperature of the temperature sensor 22 (the temperature of the storage chamber B8b) exceeds a predetermined upper temperature limit, and stops the compressor 1 when the detection temperature falls below a predetermined lower temperature limit. With this configuration, the compressor 1 is controlled such that operation and stop of the compressor 1 are alternately repeated. Moreover, the controller 50 is configured to control, e.g., the rotation speed of the fan 5 and the manipulative variable of the air volume adjustment unit (in the present embodiment, the damper 6a) based on, e.g., the detection temperatures of the temperature sensors 21, 22 and the rotation speed of the compressor 1.

[0021]

Next, the contents of control (hereinafter referred to as "constant temperature control") for maintaining the temperature of the storage chamber (e.g., the storage chamber A8a) to a more constant temperature will be described. First, the constant temperature control by adjustment of the opening degree of the damper 6a will be described as an example of the constant temperature control in the present embodiment. Fig. 3 is a flowchart of an example of the flow of the constant temperature control processing executed by the controller 50. The processing illustrated in Fig. 3 begins with stop of the compressor 1 as a trigger.

[0022]

First, the fan 5 is driven in step S101. When the fan 5 has been already driven, the fan 5 is continuously driven.

[0023]

Next, in step S102, a preset target temperature T_{m_a} of the storage chamber A8a and a detection temperature $T_{_a}$ of the storage chamber A8a by the temperature sensor 21 are obtained. Then, a difference ($T_{m_a} - T_{_a}$) between these temperatures is calculated, and it is determined whether or not the temperature difference ($T_{m_a} - T_{_a}$) is greater than 0. When the temperature difference ($T_{m_a} - T_{_a}$) is greater than 0 ($(T_{m_a} - T_{_a}) > 0$), it is determined that the storage chamber A8a is excessively cooled. Thus, the opening angle of the damper 6a is decreased by $\Delta\theta$ (step S103). Subsequently, the process proceeds to step S106. On the

other hand, when the temperature difference ($T_{m_a} - T_{_a}$) is equal to or less than 0, the process proceeds to step S104.

[0024]

In step S104, it is determined whether or not the temperature difference ($T_{m_a} - T_{_a}$) is less than 0. When the temperature difference ($T_{m_a} - T_{_a}$) is less than 0 (($T_{m_a} - T_{_a}$) < 0), it is determined that the storage chamber A8a is insufficiently cooled. Thus, the opening angle of the damper 6a is increased by $\Delta\theta$ (step S105). Subsequently, the process proceeds to step S106. On the other hand, when the temperature difference ($T_{m_a} - T_{_a}$) is equal to 0, the detection temperature $T_{_a}$ is equal to the target temperature T_{m_a} . Thus, the current opening angle of the damper 6a is maintained, and the process proceeds to step S106.

[0025]

In step S106, it is determined whether or not the compressor 1 is started. When the compressor 1 is started, the process returns to normal control. When the compressor 1 is not started, the process proceeds to step S102. Thus, while the compressor 1 is stopped, the processes of steps S102 to S105 are repeated until the compressor 1 is started. That is, while the compressor 1 is stopped, the opening degree (the opening angle) of the damper 6a is variably controlled at multiple levels or controlled in a non-stepwise manner based on the temperature of the storage chamber A8a. The change amount $\Delta\theta$ of the opening angle of the damper 6a may be a fixed value or a value changing according to the temperature difference ($T_{m_a} - T_{_a}$). Note that the "multiple levels" indicate three or more levels.

[0026]

Next, an operation concept in the above-described constant temperature control will be described. Figs. 4(a) to 4(d) are timing charts of an example of operation in the above-described constant temperature control. Fig. 4(a) illustrates the temperature of the refrigerator chamber (an example of the storage chamber A8a), Fig. 4(b) illustrates the temperature of the freezer chamber (an example of the storage chamber B8b), Fig. 4(c) illustrates an operation state (ON/OFF) of the

compressor 1, and Fig. 4(d) illustrates the opening degree of the damper 6a for the refrigerator chamber.

[0027]

For the freezer chamber, upper and lower temperature limits with respect to a preset temperature (a dashed line in Fig. 4(b)) are set. The following control is executed: the compressor 1 is started when the temperature of the freezer chamber exceeds the upper temperature limit (time points t_3 , t_6), and is stopped when the temperature of the freezer chamber falls below the lower temperature limit (time points t_2 , t_5).

[0028]

During operation of the compressor 1, the damper 6a is controlled based on the temperature of the refrigerator chamber. Specifically, at least a lower temperature limit is set for the refrigerator chamber, and during operation of the compressor 1, control is executed such that the damper 6a is fully closed when the temperature of the refrigerator chamber falls below the lower temperature limit (in the example of Figs. 4(a) to 4(d), a time point t_1). Moreover, control is executed such that the damper 6a is fully opened when the compressor 1 is started (in the example of Figs. 4(a) to 4(d), the time points t_3 , t_6).

[0029]

In the constant temperature control of the present embodiment, while the compressor 1 is stopped, the opening degree of the damper 6a is variably controlled at the multiple levels or controlled in the non-stepwise manner based on the temperature of the refrigerator chamber. Thus, while the compressor 1 is stopped, the temperature of the refrigerator chamber is more constantly maintained. In comparison between Fig. 4(a) and Fig. 13(a), it can be seen that the temperature of the refrigerator chamber is more constantly maintained while the compressor 1 is stopped.

[0030]

Next, the constant temperature control by adjustment of an opening time or a closing time of the damper 6a will be described as another example of the constant

temperature control in the present embodiment. In this example, the damper 6a is controlled at, e.g., two positions of a fully-open position and a fully-closed position, and an open/closed state (fully-open/fully-closed) of the damper 6a is switched every relatively-short time period. At least one (e.g., the opening time) of the opening time for which the damper 6a fully opens and the closing time for which the damper 6a is fully closed is adjusted, and in this manner, a ratio (an opening/closing duty ratio) between the opening time and the closing time is adjusted. Thus, the air volume per unit time in the air supply path 12 provided with the damper 6a is variably adjusted.

[0031]

Fig. 5 is a flowchart of an example of the flow of the constant temperature control processing executed by the controller 50. The processing illustrated in Fig. 5 begins with stop of the compressor 1 as a trigger. Figs. 6(a) to 6(d) are timing charts of an example of operation in the constant temperature control. Fig. 6(a) illustrates the temperature of the refrigerator chamber (an example of the storage chamber A8a), Fig. 6(b) illustrates the temperature of the freezer chamber (an example of the storage chamber B8b), Fig. 6(c) illustrates the operation state (ON/OFF) of the compressor 1, and Fig. 6(d) illustrates the opening degree of the damper 6a for the refrigerator chamber.

[0032]

First, the fan 5 is driven in step S201. When the fan 5 has been already driven, the fan 5 is continuously driven.

[0033]

Next, in step S202, the preset target temperature T_{m_a} of the storage chamber A8a and the detection temperature $T_{_a}$ of the storage chamber A8a by the temperature sensor 21 are obtained. Then, the difference ($T_{m_a} - T_{_a}$) between these temperatures is calculated, and it is determined whether or not the temperature difference ($T_{m_a} - T_{_a}$) is greater than 0. When the temperature difference ($T_{m_a} - T_{_a}$) is greater than 0 ($(T_{m_a} - T_{_a}) > 0$), it is determined that the storage chamber A8a is excessively cooled. Thus, the opening time of the damper 6a is decreased by Δt (step S203). Subsequently, the process proceeds to step S206. On the other

hand, when the temperature difference ($T_{m_a} - T_a$) is equal to or less than 0, the process proceeds to step S204.

[0034]

In step S204, it is determined whether or not the temperature difference ($T_{m_a} - T_a$) is less than 0. When the temperature difference ($T_{m_a} - T_a$) is less than 0 ($(T_{m_a} - T_a) < 0$), it is determined that the storage chamber A8a is insufficiently cooled. Thus, the opening time of the damper 6a is increased by Δt (step S205). Subsequently, the process proceeds to step S206. On the other hand, when the temperature difference ($T_{m_a} - T_a$) is equal to 0, the detection temperature T_a is equal to the target temperature T_{m_a} . Thus, the current opening time of the damper 6a is maintained, and the process proceeds to step S206.

[0035]

In step S206, it is determined whether or not the compressor 1 is started. When the compressor 1 is started, the process returns to the normal control. When the compressor 1 is not started, the process proceeds to step S202. Thus, while the compressor 1 is stopped, the processes of steps S202 to S205 are repeated until the compressor 1 is started. That is, while the compressor 1 is stopped, the opening/closing duty ratio of the damper 6a is variably controlled at multiple levels or controlled in a non-stepwise manner based on the temperature of the storage chamber A8a (see Fig. 6(d)). The change amount Δt of the opening time of the damper 6a may be a fixed value or a value changing according to the temperature difference ($T_{m_a} - T_a$).

[0036]

Next, a principle capable of maintaining the temperature of the storage chamber to a more constant temperature by the constant temperature control in the present embodiment will be described. While the compressor 1 is stopped, the cooling capacity of the refrigeration cycle is zero. For this reason, air cannot be cooled using the refrigeration cycle as a cold heat source. However, frost adhering to the cooler 4 during operation of the compressor 1 and the heat capacity of the cooler 4 itself can be used as the cold heat source, and therefore, air can be cooled

to some extent in the cooling chamber 7 even while the compressor 1 is stopped. With this configuration, a proper volume of cooling air of the cooling chamber 7 can be introduced into the storage chamber to suppress an increase in the temperature of the storage chamber. Thus, while the compressor 1 is stopped, the volume of cooling air delivered to the storage chamber is variably controlled at multiple levels or controlled in a non-stepwise manner based on the temperature of the storage chamber, and therefore, the temperature of the storage chamber can be more constantly maintained as illustrated in Figs. 4(a) and 6(a). As a result, the temperature of food in the storage chamber can be more constantly maintained, and therefore, deterioration of the quality of food can be prevented.

[0037]

Embodiment 2

A refrigerator of Embodiment 2 of the present invention will be described. The present embodiment is an example in the case where an air volume adjustment unit is placed at an air path to each of a plurality of storage chambers A, B and a damper is used as the air volume adjustment unit. In this example, the preset temperature of the storage chamber A is higher than that of the storage chamber B. Fig. 7 is a schematic block diagram of the configuration of the refrigerator of the present embodiment. Note that the same reference numerals are used to represent components having the same functions and features as those of Embodiment 1, and description thereof will not be repeated.

[0038]

As illustrated in Fig. 7, in the configuration of the present embodiment, a damper 6b is provided in an air supply path 13 in addition to a damper 6a provided in an air supply path 12. The damper 6b includes a plate-shaped member and a rotary shaft. The damper 6b is capable of closing the air supply path 13 and adjusting the opening degree of the damper 6b. The damper 6b adjusts the volume of cooling air passing through the air supply path 13, as well as preventing reverse flow of cooling air. The opening degree of the damper 6b is variably controlled by a controller 50.

[0039]

Control similar to that of Embodiment 1 can be used as constant temperature control in the present embodiment. That is, the opening angle of the damper 6a is variably adjusted based on the temperature of a storage chamber A8a so that the constant temperature control of the storage chamber A8a can be executed, and the opening angle of the damper 6b is variably adjusted based on the temperature of a storage chamber B8b so that the constant temperature control of the storage chamber B8b can be executed. Moreover, the opening/closing duty ratio of the damper 6a is variably adjusted based on the temperature of the storage chamber A8a so that the constant temperature control of the storage chamber A8a can be executed, and the opening/closing duty ratio of the damper 6b is variably adjusted based on the temperature of the storage chamber B8b so that the constant temperature control of the storage chamber B8b can be executed.

[0040]

In Embodiment 1 as described above, when the constant temperature control of the storage chamber A8a is executed using the damper 6a, there is a probability that air having a higher temperature than the temperature of the storage chamber B8b flows into the storage chamber B8b. On the other hand, in the present embodiment, the damper 6b capable of adjusting the volume of air flowing into the storage chamber B8b is provided, and therefore, the damper 6b is fully closed so that an increase in the temperature of the storage chamber B8b due to inflow hot air can be prevented. This prevents an increase in the temperature of the storage chamber B8b having a lower temperature than that of the storage chamber A8a, and therefore, a stop time of a compressor 1 can be more stably extended as compared to Embodiment 1. As a result, the average input of the refrigerator can be reduced, leading to energy saving in the refrigerator.

[0041]

Embodiment 3

A refrigerator of Embodiment 3 of the present invention will be described. The present embodiment is an example in the case where an air volume adjustment unit is placed at an air path to a storage chamber B of a plurality of storage chambers A, B

and a damper is used as the air volume adjustment unit. Moreover, in the present embodiment, a fan provided in a common air path of the storage chambers A, B is also used as the air volume adjustment unit. In this example, the preset temperature of the storage chamber A is higher than that of the storage chamber B. Fig. 8 is a schematic block diagram of the configuration of the refrigerator of the present embodiment. Note that the same reference numerals are used to represent components having the same functions and features as those of Embodiment 1, and description thereof will not be repeated.

[0042]

As illustrated in Fig. 8, in the configuration of the present embodiment, a damper 6b is provided in an air supply path 13, but no damper is provided in an air supply path 12.

[0043]

Constant temperature control of a storage chamber B8b by the damper 6b in the present embodiment is similar to that of the storage chamber A8a by the damper 6a in Embodiment 1, and therefore, description thereof will not be repeated.

[0044]

Next, constant temperature control of a storage chamber A8a by the damper 6b and a fan 5 will be described. Fig. 9 is a flowchart of an example of the flow of the constant temperature control processing executed by a controller 50. The processing illustrated in Fig. 9 begins with stop of the compressor 1 as a trigger.

[0045]

First, in step S301, the fan 5 is driven, and the damper 6b is fully closed.

[0046]

Next, in step S302, a preset target temperature T_{m_a} of the storage chamber A8a and a detection temperature $T_{_a}$ of the storage chamber A8a by a temperature sensor 21 are obtained. Then, a difference ($T_{m_a} - T_{_a}$) between these temperatures is calculated, and it is determined whether or not the temperature difference ($T_{m_a} - T_{_a}$) is greater than 0. When the temperature difference ($T_{m_a} - T_{_a}$) is greater than 0 ($(T_{m_a} - T_{_a}) > 0$), it is determined that the storage chamber

A8a is excessively cooled. Thus, the rotation speed of the fan 5 is decreased by Δf (step S303). Subsequently, the process proceeds to step S306. On the other hand, when the temperature difference ($T_{m_a} - T_a$) is equal to or less than 0, the process proceeds to step S304.

5 [0047]

In step S304, it is determined whether or not the temperature difference ($T_{m_a} - T_a$) is less than 0. When the temperature difference ($T_{m_a} - T_a$) is less than 0 ($(T_{m_a} - T_a) < 0$), it is determined that the storage chamber A8a is insufficiently cooled. Thus, the rotation speed of the fan 5 is increased by Δf (step S305).

10 Subsequently, the process proceeds to step S306. On the other hand, when the temperature difference ($T_{m_a} - T_a$) is equal to 0, the detection temperature T_a is equal to the target temperature T_{m_a} . Thus, the current rotation speed of the fan 5 is maintained, and the process proceeds to step S306.

[0048]

15 In step S306, it is determined whether or not the compressor 1 is started. When the compressor 1 is started, the process returns to normal control. When the compressor 1 is not started, the process returns to step S302. Thus, while the compressor 1 is stopped, the processes of steps S302 to S305 are repeated until the compressor 1 is started. That is, while the compressor 1 is stopped, the rotation
20 speed of the fan 5 is variably controlled at multiple levels or controlled in a non-stepwise manner based on the temperature of the storage chamber A8a. The change amount Δf of the rotation speed of the fan 5 may be a fixed value or a value changing according to the temperature difference ($T_{m_a} - T_a$).

[0049]

25 In Embodiment 1 as described above, when the constant temperature control of the storage chamber A8a is executed using the damper 6a, there is a probability that air having a higher temperature than the temperature of the storage chamber B8b flows into the storage chamber B8b. On the other hand, in the present embodiment, the constant temperature control of the storage chamber A8a can be
30 executed with the damper 6b being fully closed, and therefore, an increase in the

temperature of the storage chamber B8b due to inflow hot air can be prevented. Moreover, the constant temperature control of the storage chamber A8a can be executed with less components.

[0050]

5 Embodiment 4

A refrigerator of Embodiment 4 of the present invention will be described. The present embodiment is an example in the case where an air volume adjustment unit is placed at an air path to each of a plurality of storage chambers A, B and a fan is used as the air volume adjustment unit. In this example, the preset temperature of the storage chamber A is higher than that of the storage chamber B. Fig. 10 is a schematic block diagram of the configuration of the refrigerator of the present embodiment. Note that the same reference numerals are used to represent components having the same functions and features as those of Embodiment 1, and description thereof will not be repeated.

15 [0051]

As illustrated in Fig. 10, in the configuration of the present embodiment, a fan 9a is provided in an air supply path 12, a fan 9b is provided in an air supply path 13. The rotation speed of each of the fans 9a, 9b is variably controlled by a controller 50. In the present embodiment, the fans 9a, 9b are driven to deliver cooling air to a storage chamber A8a and a storage chamber B8b, and therefore, the fan 5 provided in the common air supply path 11 in Embodiment 1 may be omitted.

20 [0052]

Next, the flow of cooling air in the present embodiment will be described. The cooling air cooled in a cooling chamber 7 is delivered by the fans 9a, 9b, and passes through a common air supply path 11 and the air supply paths 12, 13. Then, the cooling air flows into the storage chamber A8a and the storage chamber B8b. The storage chamber A8a and the storage chamber B8b are cooled by the inflow cooling air. The volume of cooling air flowing into the storage chamber A8a is adjusted in such a manner that the rotation speed of the fan 9a is controlled by the controller 50. The volume of cooling air flowing into the storage chamber B8b is adjusted in such a

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manner that the rotation speed of the fan 9b is controlled by the controller 50. The cooling air having cooled the storage chamber A8a and the storage chamber B8b returns to the cooling chamber 7 through return air paths 14, 15 and a common return air path 16, and then, is cooled again.

5 [0053]

The controller 50 of the present embodiment is connected to, e.g., temperature sensors 21, 22, a compressor 1, and the fans 9a, 9b. The controller 50 is configured to control, e.g., the rotation speed of each of the fans 9a, 9b based on, e.g., the detection temperatures of the temperature sensors 21, 22 and the rotation speed of the compressor 1.

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[0054]

Next, constant temperature control of the storage chamber in the present embodiment will be described. In the present embodiment, the constant temperature control of the storage chamber A8a by the fan 9a will be described, but the constant temperature control of the storage chamber B8b by the fan 9b can be similarly executed. Fig. 11 is a flowchart of an example of the flow of the constant temperature control processing executed by the controller 50 in the present embodiment. The processing illustrated in Fig. 11 begins with stop of the compressor 1 as a trigger. Figs. 12(a) to 12(d) are timing charts of an example of operation in the above-described constant temperature control. Fig. 12(a) illustrates the temperature of a refrigerator chamber (an example of the storage chamber A8a), Fig. 12(b) illustrates the temperature of a freezer chamber (an example of the storage chamber B8b), Fig. 12(c) illustrates an operation state (ON/OFF) of the compressor 1, and Fig. 12(d) illustrates the rotation speed of the fan 9a for the refrigerator chamber.

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[0055]

First, in step S401, the fan 9a is driven. When the fan 9a has been already driven, the fan 9a is continuously driven.

[0056]

Next, in step S402, a preset target temperature T_{m_a} of the storage chamber A8a and a detection temperature T_a of the storage chamber A8a by the temperature

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sensor 21 are obtained. Then, a difference ($T_{m_a} - T_{a_a}$) between these temperatures is calculated, and it is determined whether or not the temperature difference ($T_{m_a} - T_{a_a}$) is greater than 0. When the temperature difference ($T_{m_a} - T_{a_a}$) is greater than 0 ($(T_{m_a} - T_{a_a}) > 0$), it is determined that the storage chamber A8a is excessively cooled. Thus, the rotation speed of the fan 9a is decreased by Δf (step S403). Subsequently, the process proceeds to step S406. On the other hand, when the temperature difference ($T_{m_a} - T_{a_a}$) is equal to or less than 0, the process proceeds to step S404.

[0057]

In step S404, it is determined whether or not the temperature difference ($T_{m_a} - T_{a_a}$) is less than 0. When the temperature difference ($T_{m_a} - T_{a_a}$) is less than 0 ($(T_{m_a} - T_{a_a}) < 0$), it is determined that the storage chamber A8a is insufficiently cooled. Thus, the rotation speed of the fan 9a is increased by Δf (step S405). Subsequently, the process proceeds to step S406. On the other hand, when the temperature difference ($T_{m_a} - T_{a_a}$) is equal to 0, the detection temperature T_{a_a} is equal to the target temperature T_{m_a} . Thus, the current rotation speed of the fan 9a is maintained, and the process proceeds to step S406.

[0058]

In step S406, it is determined whether or not the compressor 1 is started. When the compressor 1 is started, the process returns to normal control. When the compressor 1 is not started, the process returns to step S402. Thus, while the compressor 1 is stopped, the processes of steps S402 to S405 are repeated until the compressor 1 is started. That is, while the compressor 1 is stopped, the rotation speed of the fan 9a is variably controlled at multiple levels or controlled in a non-stepwise manner based on the temperature of the storage chamber A8a (see Fig. 12(d)). The change amount Δf of the rotation speed of the fan 9a may be a fixed value or a value changing according to the temperature difference ($T_{m_a} - T_{a_a}$).

[0059]

In the present embodiment, the fans 9a, 9b are provided corresponding respectively to the storage chambers A8a, B8b, and therefore, cooling air can be,

unlike Embodiments 1 to 3, delivered with the minimum fan rotation speed. Thus, the constant temperature control can be executed while the compressor 1 is stopped, and the input of the fan can be reduced, leading to energy saving in the refrigerator.

[0060]

5 As described above, the refrigerator of each of the above-described embodiments includes the refrigerant circuit 10 including the compressor 1, the radiator 2, the pressure reducer 3, and the cooler 4; the cooling chamber 7 in which the cooler 4 is disposed, the cooling chamber 7 being configured to generate cooling air; at least one storage chamber (e.g., the storage chamber A8a, the storage chamber B8b) cooled using the cooling air; the air volume adjustment unit (e.g., the dampers 6a, 6b, the fans 5, 9a, 9b) configured to adjust the volume of cooling air delivered from the cooling chamber 7 to the storage chamber; the temperature sensors 21, 22 configured to detect the temperature of the storage chamber; and the controller 50 configured to control the compressor 1 and the air volume adjustment unit. The controller 50 controls the compressor 1 such that operation and stop of the compressor 1 are alternately repeated, and variably controls, at least while the compressor 1 is stopped, the volume of cooling air adjusted by the air volume adjustment unit based on the temperature of the storage chamber.

[0061]

20 In the refrigerator of the above-described embodiments, the air volume adjustment unit includes the dampers 6a, 6b provided in the air supply paths 12, 13 between the cooling chamber 7 and the storage chamber, and the controller 50 variably controls the opening degree of the dampers 6a, 6b based on the temperature of the storage chamber.

[0062]

25 In the refrigerator of the above-described embodiments, the air volume adjustment unit includes the dampers 6a, 6b provided in the air supply paths 12, 13 between the cooling chamber 7 and the storage chamber, and the controller 50 variably controls the ratio (the opening/closing duty ratio) between the opening time

and the closing time of the dampers 6a, 6b based on the temperature of the storage chamber.

[0063]

In the refrigerator of the above-described embodiments, the air volume adjustment unit includes the fans 5, 9a, 9b configured to deliver the cooling air from the cooling chamber 7 to the storage chamber, and the controller 50 variably controls the rotation speed of the fans 5, 9a, 9b based on the temperature of the storage chamber.

[0064]

In the refrigerator of the above-described embodiments, the storage chamber includes the first storage chamber A8a and the second storage chamber B8b having a lower preset temperature than that of the first storage chamber A8a. The air volume adjustment unit adjusts at least the volume of cooling air delivered from the cooling chamber 7 to the storage chamber A8a. The controller 50 controls, based on the temperature of the storage chamber B8b, the compressor 1 such that the operation and the stop of the compressor 1 are alternately repeated, and variably controls, at least while the compressor 1 is stopped, the volume of cooling air delivered to the storage chamber A8a based on the temperature of the storage chamber A8a.

[0065]

In the refrigerator of the above-described embodiments, the air volume adjustment unit is further configured to adjust the volume of cooling air delivered from the cooling chamber 7 to the storage chamber B8b, and at least while the compressor 1 is stopped, the controller 50 variably controls the volume of cooling air delivered to the storage chamber B8b based on the temperature of the storage chamber B8b.

[0066]

Other Embodiments

The present invention is not limited to the above-described embodiments, and various modifications can be made to the present invention.

For example, in the above-described embodiments, the refrigerator including two storage chambers has been described as an example. However, the present invention is applicable to a refrigerator including a single storage chamber or three or more storage chambers.

5 [0067]

Moreover, the above-described embodiments and the variations can be implemented in combination.

Reference Signs List

10 [0068]

1 compressor 2 radiator 3 pressure reducer 4 cooler 5 fan
6a, 6b damper 7 cooling chamber 8a storage chamber A 8b
storage chamber B 9a, 9b fan 10 refrigerant circuit 11 common air supply
path 12, 13 air supply path 14, 15 return air path 16 common return air path
15 21, 22 temperature sensor 50 controller

CLAIMS

[Claim 1]

A refrigerator comprising:

a refrigerant circuit including a compressor, a radiator, a pressure reducer, and
5 a cooler;

a cooling chamber in which the cooler is disposed, the cooling chamber being
configured to generate cooling air;

at least one storage chamber cooled using the cooling air;

an air volume adjustment unit configured to adjust a volume of the cooling air
10 delivered from the cooling chamber to the storage chamber;

a temperature sensor configured to detect a temperature of the storage
chamber; and

a controller configured to control the compressor and the air volume adjustment
unit,

15 wherein the controller

controls the compressor such that operation and stop of the compressor
are alternately repeated, and

variably controls, at least while the compressor is stopped, the volume of
the cooling air adjusted by the air volume adjustment unit based on the temperature
20 of the storage chamber.

[Claim 2]

The refrigerator of claim 1, wherein

the air volume adjustment unit includes a damper provided in an air path
between the cooling chamber and the storage chamber, and

25 the controller variably controls an opening degree of the damper based on the
temperature of the storage chamber.

[Claim 3]

The refrigerator of claim 1, wherein

the air volume adjustment unit includes a damper provided in an air path
30 between the cooling chamber and the storage chamber, and

the controller variably controls a ratio between an opening time and a closing time of the damper based on the temperature of the storage chamber.

[Claim 4]

The refrigerator of any one of claims 1 to 3, wherein

the air volume adjustment unit includes a fan configured to deliver the cooling air from the cooling chamber to the storage chamber, and

the controller variably controls a rotation speed of the fan based on the temperature of the storage chamber.

[Claim 5]

The refrigerator of any one of claims 1 to 4, wherein

the storage chamber includes a first storage chamber and a second storage chamber having a lower preset temperature than that of the first storage chamber,

the air volume adjustment unit adjusts at least the volume of the cooling air delivered from the cooling chamber to the first storage chamber, and

the controller

controls, based on a temperature of the second storage chamber, the compressor such that the operation and the stop of the compressor are alternately repeated, and

variably controls, at least while the compressor is stopped, the volume of the cooling air delivered to the first storage chamber based on a temperature of the first storage chamber.

[Claim 6]

The refrigerator of claim 5, wherein

the air volume adjustment unit is further configured to adjust the volume of the cooling air delivered from the cooling chamber to the second storage chamber, and

at least while the compressor is stopped, the controller variably controls the volume of the cooling air delivered to the second storage chamber based on the temperature of the second storage chamber.