Refrigerating system for a refrigerator including a variable capacity compressor having a varied rate of compressed refrigerant delivery for compressing refrigerant, a condenser for condensing the refrigerant compressed by the variable capacity compressor, a freezing chamber expansion valve for expanding condensed refrigerant, a freezing chamber evaporator for cooling air by using the refrigerant supplied from the freezing chamber expansion valve, two or more than two refrigerating chamber expansion valves having different lengths of refrigerant flow passages, for expanding the condensed refrigerant, two or more than two refrigerating chamber evaporators having different lengths of refrigerant flow passages, for cooling air by using the refrigerant from the refrigerating chamber expansion valves, respectively, and a distributor between the condenser and the expansion valves for selective supply of the refrigerant to the expansion valves according to an operation time period of the refrigerating system, thereby providing a refrigerating system for a refrigerator having a high efficiency.
FIG. 1
REFRIGERATING SYSTEM FOR REFRIGERATOR

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to refrigerating systems for refrigerators, and more particularly, to a method for controlling operation of a refrigerating system.

[0003] 2. Discussion of the Related Art

[0004] In general, the refrigerator cools a space thereof for fresh storage of food therein for a time period while refrigerant (working fluid) repeats a refrigerating cycle of compression-condensing-expansion-evaporation.

[0005] Of the refrigerators, a direct cooling type refrigerator is provided with separate evaporators for a freezing chamber and a refrigerating chamber respectively. The direct cooling type refrigerator will be described in detail with reference to FIG. 1.

[0006] The refrigerating system of the direct cooling type refrigerator is provided with a compressor 11, a condenser 12, an expansion valve 13, a freezing chamber evaporator 14, and a refrigerating chamber evaporator 15. Various units of the refrigerating system are connected with refrigerant pipes 16.

[0007] The compressor 11 compresses low temperature/low pressure refrigerant gas to high temperature/high pressure refrigerant gas. The condenser 12 receives and compresses refrigerant from the compressor 11. The expansion valve 13 receives refrigerant from the condenser 12 and drops a pressure of the refrigerant. The freezing chamber evaporator 14 and the refrigerating evaporator 15 evaporate the refrigerant from the expansion valve 13 in a low pressure state, to absorb heat from air in the vicinity of the evaporators 14, and 15. Air cooled down by the evaporators 14, and 15 is supplied to the freezing chamber and the refrigerating chamber for fresh storage of food. Above cycle is repeated continuously while the refrigerator is operated.

[0008] However, as shown, because of the separate freezing chamber, and refrigerating chamber evaporators 14, and 15, the refrigerating system for a refrigerator has a substantially long total refrigerant flow passage of the refrigerant pipes 16 and other components (evaporators, expansion valves, and so on). For this reason, though the refrigerating system requires a high flow rate of refrigerant when the refrigerating system starts operation, the refrigerating system requires a relatively low flow rate once operation of the refrigerating system is stabilized after a certain time period passes. Such a flow rate of the refrigerant in such a system is substantially dependent on a rate of compressed refrigerant delivery of the compressor and a length of the flow passage of the refrigerant. However, since the related art refrigerating system has a fixed rate of compressed refrigerant delivery of the compressor and a fixed total refrigerant flow passage, the related art refrigerating system consumes power unnecessarily, resulting to have a low operation efficiency.

SUMMARY OF THE INVENTION

[0009] Accordingly, the present invention is directed to a refrigerating system for a refrigerator that substantially obviates one or more problems due to limitations and disadvantages of the related art.

[0010] An object of the present invention is to provide a refrigerating system for a refrigerator which has a low power consumption and a high efficiency.

[0011] Additional advantages, objects, and features of the invention will be set forth in part in the description which follows and in part will become apparent to those having ordinary skill in the art upon examination of the following or may be learned from practice of the invention. The objectives and other advantages of the invention may be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

[0012] To achieve these objects and other advantages and in accordance with the purpose of the invention, as embodied and broadly described herein, a refrigerating system for a refrigerator includes a variable capacity compressor having a varied rate of compressed refrigerant delivery for compressing refrigerant, a condenser for condensing the refrigerant compressed by the variable capacity compressor, a freezing chamber expansion valve for expanding condensed refrigerant, a freezing chamber evaporator for cooling air by using the refrigerant supplied from the freezing chamber expansion valve, two or more than two refrigerating chamber expansion valves having different lengths of refrigerant flow passages, for expanding the condensed refrigerant, two or more than two refrigerating chamber evaporators having different lengths of refrigerant flow passages, for cooling air by using the refrigerant from the refrigerating chamber expansion valves, respectively, and a distributor between the condenser and the expansion valves for selective supply of the refrigerant to the expansion valves according to an operation time period of the refrigerating system.

[0013] The refrigerating chamber expansion valve includes a first refrigerating chamber expansion valve having a relatively short refrigerant flow passage, and a second refrigerating chamber expansion valve having a relatively long refrigerant flow passage. In this case, the refrigerating system further includes a guide valve for selective supply of the refrigerant to one of the refrigerating chamber expansion valves.

[0014] The refrigerating chamber evaporator includes a first refrigerating chamber evaporator having a relatively long refrigerant flow passage, and a second refrigerating chamber evaporator having a relatively short refrigerant flow passage. In this case, the refrigerating system further includes a bypass valve at an inlet of the second refrigerating chamber evaporator for selective supply of the refrigerant passed through the first refrigerating chamber evaporator to the second refrigerating chamber evaporator.

[0015] Preferably, the expansion valves and the evaporators are configured to form a relatively short refrigerant flow passage, and has a relatively high rate of compressed refrigerant delivery when the refrigerating system starts operation. The distributor supplies the refrigerant only to the freezing chamber expansion valve and the freezing chamber evaporator when the refrigerating system starts operation. The refrigerant is supplied to the refrigerating chamber expansion valve having the relatively short flow passage through the distributor additionally when the refrigerating system starts operation.
The expansion valves and the evaporators are configured to form a relatively longer refrigerant flow passage than the refrigerant flow passage at the time of starting the refrigerating system, and the variable capacity compressor has a relatively low rate of compressed refrigerant delivery when the preset time period is passed after starting of the refrigerating system.

The refrigerant is supplied to the freezing chamber expansion valve and the refrigerating chamber expansion valve having the relatively long flow passage through the distributor when the preset time period is passed after starting of the refrigerating system. Moreover, the refrigerant is supplied to all of the refrigerating chamber evaporators when a preset time period is passed after starting of the refrigerating system.

Thus, the refrigerating system of the present invention consumes less power and has a high efficiency.

It is to be understood that both the foregoing general description and the following detailed description of the present invention are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this application, illustrate embodiment(s) of the invention and together with the description serve to explain the principle of the invention. In the drawings;

FIG. 1 illustrates a diagram of a related art refrigerating system for a refrigerator, schematically;

FIG. 2 illustrates a diagram of a refrigerant flow in a refrigerating system for a refrigerator of the present invention when a compressor thereof is operated in a power mode;

FIG. 3 illustrates a diagram of a modification of a refrigerant flow in a refrigerating system for a refrigerator of the present invention when a compressor thereof is operated in a power mode; and

FIG. 4 illustrates a diagram of a refrigerant flow in a refrigerating system for a refrigerator of the present invention when a compressor thereof is operated in a saving mode.

DETAILED DESCRIPTION OF THE INVENTION

Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

FIGS. 2 and 3 illustrate diagrams of a refrigerant flow in a refrigerating system for a refrigerator of the present invention, and a modification thereof respectively when a compressor thereof is operated in a power mode. FIG. 4 illustrates a diagram of a refrigerant flow in a refrigerating system for a refrigerator of the present invention when a compressor thereof is operated in a saving mode.

The refrigerating system for a refrigerator of the present invention includes a compressor 100, a condenser 200, a freezing chamber expansion valve 310, two or more than two refrigerating chamber expansion valves 321 and 322, freezing chamber evaporator 400, two or more than two refrigerating chamber evaporators 510 and 520, and a refrigerant distributor 700. Above units are connected with a refrigerant pipe 600 for enabling refrigerant flow.

The compressor 100 is a variable capacity compressor which can vary a rate of compressed refrigerant delivery. The variable capacity compressor may be a dual capacity compressor which has different rates of compressed refrigerant delivery depending on a direction of rotation of a motor thereof. The Korea Patent Application No. 10-2001-0064083 discloses one example of the dual capacity compressor. Moreover, the variable capacity compressor 100 may be a multi-capacity compressor which has a rate of compressed refrigerant delivery varied with a rotation speed of a motor by an inverter. Other than above examples, various types of variable capacity compressors are applicable to the present invention.

The condenser 200 receives and condenses compressed refrigerant from the variable capacity compressor 100, and has a configuration the same with a general condenser.

The freezing chamber expansion valve 310 reduces a pressure of the refrigerant condensed at the condenser 200, and provides to the freezing chamber evaporator 400.

The refrigerating chamber evaporators 510 and 520 are a first refrigerating chamber evaporator 510 having a relatively long refrigerant flow passage, and a second refrigerating chamber evaporator 520 having a relatively short refrigerant flow passage. The first refrigerating chamber evaporator 510 has a greater cooling capacity compared to the second refrigerating chamber evaporator 520 owing to the relatively long refrigerant flow passage. Therefore, the first refrigerating chamber evaporator 510 is mounted in a main refrigerating chamber for storage of food, and the second refrigerating chamber evaporator 520 is mounted in a supplementary refrigerating chamber, such as a vegetable chamber, which requires a relatively high storage temperature.

Moreover, both an inlet and an outlet of the second refrigerating chamber evaporator 520 are connected to an outlet of the first refrigerating chamber evaporator 510. A bypass valve 810 is mounted at the inlet of the second refrigerating chamber evaporator 520 for making the refrigerant, passed through the first refrigerating chamber evaporator 510, to bypass the second refrigerating chamber evaporator 520. The outlets of the refrigerating chamber evaporators 510 and 520 join with the outlet of the freezing chamber evaporator 400 in a state connected with each other. The refrigerant from the evaporators 400, 510, and 520 is supplied to the variable capacity compressor 100.

The refrigerating chamber expansion valve 321, or 322 drops a pressure of the refrigerant condensed at the condenser 200, and provides to the first refrigerating chamber evaporator 510. The refrigerating chamber expansion valve s 321 and 322 are a first refrigerating chamber expansion valve 321 having a relatively short refrigerant flow passage, and a second refrigerating chamber expansion
valve 322 having a relatively long refrigerant flow passage. An inlet and an outlet of the first refrigerating chamber expansion valve 321 are connected to an inlet and an outlet of the second refrigerating chamber expansion valve 322, respectively. A guide valve 820 is mounted between the inlet of the second refrigerating chamber expansion valve 322 and the inlet of the first refrigerating chamber expansion valve 321, for supplying refrigerant to one of the first, and second refrigerating chamber expansion valve 321, and 322, selectively.

[0034] The distributor 700 is mounted in the refrigerant pipe 600 between the condenser 200 and the expansion valves 310, 321, and 322. The distributor 700 selectively provides refrigerant to the freezing chamber expansion valve 310, and the refrigerating chamber expansion valve 321, and 322 according to an operation time period of the refrigerating system. In more detail, the distributor supplies refrigerant only to the freezing chamber expansion valve 310 at initial stage of operation of the refrigerating system. If a preset time period passes after starting of operation, the distributor 700 supplies refrigerant to the freezing chamber expansion valve 310 as well as the refrigerating chamber expansion valve 321, and 322. Alternatively, if the refrigerating chamber evaporators 510 and 520 are not required to use, for an example, in winter when an environmental temperature is low, the distributor 700 may not supply refrigerant to the refrigerating chamber expansion valves 321, and 322 for making the refrigerating chamber evaporators 510, and 520 inoperative.

[0035] The operation steps of the refrigerating system for a refrigerator of the present invention will be described with reference to related drawings in more detail.

[0036] Referring to FIGS. 2 and 3, upon putting the refrigerating system into operation, the variable capacity compressor 100 is operated in the power mode. The power mode is a mode in which the variable capacity compressor 100 exerts a relatively great rate of compressed refrigerant delivery, preferably, the greatest rate of compressed refrigerant delivery. As described, since the refrigerating system has a substantially long refrigerant flow passage, it is required that a large quantity of refrigerant flows in the refrigerating system for stabilize operation of the refrigerating system as soon as possible when the refrigerating system starts to operate. Accordingly, when the refrigerating system is put into operation, the variable capacity compressor is operated in the power mode for supplying a large quantity of refrigerant to the system.

[0037] Moreover, as known, the torque and voltage required for starting the compressor 110 is dependent on a flow rate of the refrigerant required for starting the refrigerant system, and the flow rate can be varied with a length of the refrigerant flow passage. That is, the torque and voltage of the compressor is dependent on the length of the refrigerant flow passage. Therefore, when operation of the refrigerating system is started, i.e., when the compressor is started, the expansion valves 310, 321, and 322 and the evaporators 400, 510, and 520 are configured to form a relatively short flow passage for reducing the starting torque and voltage of the compressor. In more detail, as shown in FIG. 3, at an initial starting of the refrigerating system, the distributor 700 cuts off the refrigerant flow to the refrigerating chamber evaporators 510, and 520, more specifically, the refrigerating chamber expansion valves 321, and 322. That is, the distributor 700 supplies refrigerant only to the freezing chamber expansion valve 310 and the freezing chamber evaporator 400, to shorten the refrigerant flow passage in the refrigerating system substantially, accordingly. That is, because the refrigerant flows, not to the refrigerating chamber expansion valves 321, and 322 and the refrigerating chamber evaporators 510, and 520, but only to the freezing chamber expansion valve 310 and the freezing chamber evaporator 400, a total flow passage is shortened substantially. According to this, the torque required for the initial starting of the compressor 110 is reduced to the maximum in proportion to the shortened refrigerant flow passage and the reduced flow rate. Moreover, the shortened refrigerant flow passage is effective for fast stabilization of the refrigerating system.

[0038] To shorten the refrigerant flow passage, instead of the freezing chamber expansion valve 310 and the freezing chamber evaporator 400, the refrigerant may be supplied to the refrigerating chamber expansion valves 321, and 322 and the refrigerating chamber evaporators 510, and 520. However, in general, since it is required that a temperature of the freezing chamber is maintained lower than a temperature of the refrigerating chamber, it is required that expanded refrigerant is supplied to the freezing chamber evaporator 140 at first. Under this reason, it is not preferable to cut off an initial refrigerant supply to the freezing chamber evaporator 140 for stable operation of the refrigerating system. Therefore, as described, the cutting off the initial refrigerant supply to the refrigerating chamber evaporator 150 is advantageous both in view of reducing the refrigerating circulating distance, and making the refrigerating system operation stable.

[0039] Alternatively, when the refrigerating system is started, the first refrigerating chamber evaporator 510 may be started in addition to the freezing chamber evaporator 400. In more detail, as shown in FIG. 2, the distributor 700 supplies the refrigerant both to the freezing chamber expansion valve 310 and the refrigerating chamber expansion valves 321, and 322. However, for shortening the refrigerant flow passage, the guide valve 820 supplies refrigerant only to the first expansion valve 321 having a relatively short flow passage, to supply the refrigerant to the first refrigerating chamber evaporator 510 through the first refrigerating chamber expansion valve 321. The refrigerant bypasses the second refrigerant evaporator 520 by the bypass valve 810 for shortening the refrigerant flow passage. As described before, the first refrigerating chamber evaporator 510 cools down the main refrigerating chamber. Therefore, such an additionally operation of the first refrigerating chamber enables to shorten the refrigerant flow passage to some extent for reducing the initial torque of the compressor 100, and, at the same time with this, stabilize an entire refrigerating system, quickly.

[0040] Referring to FIG. 4, as described, if the entire refrigerating system is stabilized after operation for a certain time period, the variable capacity compressor 100 is operated in a saving mode. The saving mode is a mode in which the variable capacity compressor 100 can deliver a rate of compressed refrigerant which is lower than a rate of compressed refrigerant the variable capacity compressor 100 delivers in the power mode, but can prevent operation efficiency of the entire refrigerating system from dropping.
Once stabilized, the refrigerating system requires a relatively lower rate of refrigerant. Therefore, if a preset time period is passed after the refrigerating system is started, the variable capacity compressor 100 is operated in the saving mode so as to deliver a relatively smaller rate of compressed refrigerant to the system.

Moreover, since the smaller rate of compressed refrigerant is supplied in the saving mode, it is required to provide the longest refrigerant flow passage for obtaining the highest heat exchange efficiency. Accordingly, the expansion valves 310, 321, and 322 and the evaporators 400, 510, and 520 are configured to form the longest flow passage for obtaining the highest efficiency. In more detail, as shown in FIG. 4, the distributor 700 supplies refrigerant both to the freezing chamber expansion valve 310 and the refrigerating chamber expansion valves 321, and 322. However, for increasing the refrigerant flow passage, the guide valve 820 supplies refrigerant to the second expansion valve 322 having a relatively long flow passage, to supply the refrigerant to the first refrigerating chamber evaporator 510 through the second refrigerating chamber expansion valve 321. Moreover, in order to increase the refrigerant flow passage, the refrigerant is supplied to the second refrigerating chamber evaporator 520 by the bypass valve 810. Therefore, the refrigerant passes through, not only the freezing chamber evaporator 400, but also the first, and second refrigerating chamber evaporators 510, and 520. According to this, the length of the refrigerant flow passage is maximized, to obtain the highest heat exchange efficiency even with a small flow rate of compressed refrigerant.

As has been described, in the present invention, upon starting the refrigerating system, the variable capacity compressor delivers a high flow rate of compressed refrigerant, and a refrigerant flow passage is shortened, for stabilizing the refrigerating system quickly, and reducing a starting torque and a starting voltage of the compressor. Moreover, once the refrigerating system is stabilized, the variable capacity compressor delivers a relatively small rate of compressed refrigerant for obtaining a high efficiency, and the refrigerant flow passage is extended. Thus, the refrigerating system of the present invention optimizes the flow rate of compressed refrigerant and the refrigerant flow passage taking an operation time period and an operation state into account, thereby consuming power less and obtaining a high efficiency.

It will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the spirit or scope of the inventions. Thus, it is intended that the present invention covers the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

What is claimed is:

1. A refrigerating system for a refrigerator comprising:
   a variable capacity compressor having a varied rate of compressed refrigerant delivery for compressing refrigerant;
   a condenser for condensing the refrigerant compressed by the variable capacity compressor;
   a freezing chamber expansion valve for expanding condensed refrigerant;
   a freezing chamber evaporator for cooling air by using the refrigerant supplied from the freezing-chamber expansion valve;
   two or more than two refrigerating chamber expansion valves having different lengths of refrigerant flow passages, for expanding the condensed refrigerant;
   two or more than two refrigerating chamber evaporators having different lengths of refrigerant flow passages, for cooling air by using the refrigerant from the refrigerating chamber expansion valves, respectively; and
   a distributor between the condenser and the expansion valves for selective supply of the refrigerant to the expansion valves according to an operation time period of the refrigerating system.

2. The refrigerating system as claimed in claim 1, wherein the refrigerating chamber expansion valve includes:
   a first refrigerating chamber expansion valve having a relatively short refrigerant flow passage, and
   a second refrigerating chamber expansion valve having a relatively long refrigerant flow passage.

3. The refrigerating system as claimed in claim 1, further comprising a guide valve for selective supply of the refrigerant to one of the refrigerating chamber expansion valves.

4. The refrigerating system as claimed in claim 1, wherein the refrigerating chamber evaporator includes:
   a first refrigerating chamber evaporator having a relatively long refrigerant flow passage, and
   a second refrigerating chamber evaporator having a relatively short refrigerant flow passage.

5. The refrigerating system as claimed in claim 4, further comprising a bypass valve at an inlet of the second refrigerating chamber evaporator for selective supply of the refrigerant passed through the first refrigerating chamber evaporator to the second refrigerating chamber evaporator.

6. The refrigerating system as claimed in claim 1, wherein the expansion valves and the evaporators are configured to form a relatively short refrigerant flow passage when the refrigerating system is put into operation.

7. The refrigerating system as claimed in claim 1, wherein the variable capacity compressor has a relatively high rate of compressed refrigerant delivery when the refrigerating system starts operation.

8. The refrigerating system as claimed in claim 1, wherein the distributor supplies the refrigerant only to the freezing chamber expansion valve and the freezing chamber evaporator when the refrigerating system starts operation.

9. The refrigerating system as claimed in claim 8, wherein the refrigerant is supplied to the refrigerating chamber expansion valve having the relatively short flow passage through the distributor additionally when the refrigerating system starts operation.

10. The refrigerating system as claimed in claim 1, wherein the expansion valves and the evaporators are configured to form a relatively longer refrigerant flow passage than the refrigerant flow passage at the time of starting the refrigerating system when a preset time period is passed after starting of the refrigerating system.

11. The refrigerating system as claimed in claim 1, wherein the variable capacity compressor has a relatively low rate of compressed refrigerant delivery when the preset time period is passed after starting of the refrigerating system.
12. The refrigerating system as claimed in claim 1, wherein the refrigerant is supplied to the freezing chamber expansion valve and the refrigerating chamber expansion valve having the relatively long flow passage through the distributor when the preset time period is passed after starting of the refrigerating system.

13. The refrigerating system as claimed in claim 1, wherein the refrigerant is supplied to all of the refrigerating chamber evaporators when a preset time period is passed after starting of the refrigerating system.

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