

(19)



Europäisches Patentamt
European Patent Office
Office européen des brevets



(11)

EP 1 200 782 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention
of the grant of the patent:

31.03.2004 Bulletin 2004/14

(21) Application number: **00944567.7**

(22) Date of filing: **05.06.2000**

(51) Int Cl.7: **F25D 11/02, F25D 29/00**

(86) International application number:
PCT/TR2000/000034

(87) International publication number:
WO 2000/075582 (14.12.2000 Gazette 2000/50)

(54) **REFRIGERATOR COOLING**

KÜHLUNG EINES KÜHLSCHRANKES

REFROIDISSEMENT DE REFRIGERATEUR

(84) Designated Contracting States:
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU
MC NL PT SE**

Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **04.06.1999 TR 9901264**

(43) Date of publication of application:
02.05.2002 Bulletin 2002/18

(73) Proprietor: **Arçelik K A.S.**
81719 Istanbul (TR)

(72) Inventors:

- **Dingeç, Haldun, Arçelik A.S.**
26540 Eskisehir (TR)
- **ATILLA, Yüksel, Arçelik A.S.**
26540 Eskisehir (TR)
- **Güldali, Yalçın, Arçelik A.S.**
26540 Eskisehir (TR)

(74) Representative: **LOUIS- PÖHLAU- LOHRENTZ**
Postfach 3055
90014 Nürnberg (DE)

(56) References cited:
JP-A- 11 211 312 **US-A- 5 787 718**

Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

EP 1 200 782 B1

Description

[0001] The present invention is related to providing the freezing capacity in the freezer compartment, at least in conformity with the standards, without lowering the interior temperature in the fresh food compartment below the desired level, in two-door type refrigerators having both the freezer and fresh food compartments.

[0002] The "Quick Freeze" operation is used in order to lower the temperature of the food placed in the freezer compartment, rapidly to -18°C . The quick freeze capacity is the maximum amount of food that can be frozen in a certain time period, during the quick freeze process.

[0003] When the quick freeze process is started, the thermostat reaches its highest value and the refrigerator operates at 100% capacity. By delaying the compressor operational period, the freezer compartment can reach the desired freezing capacity. However, in this case the inner temperature of the fresh food compartment drops below the desired level and causes the freezing of the fresh food. In the known technique, in order to avoid this undesired situation the fresh food and freezer compartments are cooled by separate cooling circuits, using two compressors. Furthermore, this problem is solved by reducing the quick freezer capacity. In another known technique, this problem has been solved by changing the dimensions of the evaporator in the fresh food compartment. However this change increases the energy consumption.

[0004] The object of the present invention is to increase the freezing capacity of the double-compartment type refrigerator, the cooling system of which has been designed as a single cooling system with a single compressor and a single control center.

[0005] Another object of the invention is to avoid the freezing of the food in the fresh food compartment, by preventing the inner temperature of the fresh food compartment from falling below the desired level.

[0006] According to the invention, these objects are achieved by a refrigerator as defined in claim 1 or 2.

[0007] An embodiment of the refrigerator cooling, realized in order to attain the objects of the invention is illustrated in the attached drawings, wherein:

Figure 1, is the layout of the evaporator and heater positions;

Figure 2, is the flow chart of the cooling cycle control;

Figure 3, is the graphic showing the refrigerator cooling cycle operating in the quick freezer mode;

Figure 4, is the flow chart of the alternative cooling cycle control;

Figure 5, is the graphic showing the alternative cooling cycle operating in the quick freezer mode.

[0008] The components shown in the drawings have the following numbers;

1. Fresh food compartment
2. Freezer compartment
3. Fresh food compartment evaporator
4. Freezer compartment evaporator
5. Heater
6. Temperature Sensor
7. Compressor
8. Control Unit

[0009] In the cooling system of a two-door type refrigerator with freezer (2) and fresh food compartments (1), the total running time (t_{quick}) of the Quick Freeze is equal to the sum of the quick freeze 100% running time (t_{100}) and the quick freeze cyclic running times (t_{cycle}). The duration and temperature values at which the compressor (7) must be operated for the quick freeze process and the operational period of the heater (5) placed in the fresh food compartment (1) to avoid the decrease of the inner temperature of the fresh food compartment (1) during quick freezing, as well as the temperature value at which the heater has to be operated are determined in the control unit (8).

[0010] An embodiment of the refrigerator quick freeze function is illustrated in Figures 2 and 3, and will be described in detail as follows:

[0011] In the cooling system of a two-door type refrigerator having the freezer (2) and fresh food compartments (1) when the user presses the quick freeze button (101), the quick freeze process starts and during this process, the control unit (8) performs the below explained operations in order to keep the inner temperature of the fresh food compartment (1) within a range ($T_{\text{Max}}, T_{\text{Min}}$), determined by the manufacturer or by the standards. After this initial step (101), the 100% running time (t_{100}) of the quick freeze function and the estimated duration (t_1) of quick freezing, determined by the manufacturer are compared in Step 102. As the result of this comparison, if the 100% running time (t_{100}) of the quick freeze function is greater than the estimated duration (t_1) of quick freezing, determined by the manufacturer, the compressor (7) is operated at 100% capacity during the quick freeze 100% running time (t_{100}), in Step 103.

[0012] In step 104, the temperature sensor (6) placed in the fresh food compartment (1) reads the inner temperature of the said compartment (1) and the control unit (8) compares the values thus obtained, with the upper limit value (T_{Max}) of the required temperature range for the fresh food compartment determined by the manufacturer. If the inner temperature value in fresh food compartment (1) that is read by the sensor (6) is greater than the upper limit value (T_{Max}) of the required temperature range for the fresh food compartment determined by the manufacturer, the electrical heater (5) placed in the refrigerator fresh food compartment (1) to maintain required cooling and to avoid the freezing of the food in case the said compartment (1) is excessively cooled, is closed in Step 105 and Step 108 wherein the cyclic running time (t_{cycle}) of the quick freeze is compared with the

estimated quick freeze operation time (t_1) starts. In Step 108, if the estimated quick freeze operation time (t_1) determined by the manufacturer is greater than the cycle running time (t_{cycle}) of the quick freeze, the quick freeze operation is terminated and normal cooling is carried on. Otherwise, i.e. if the estimated quick freeze operation time (t_1) determined by the manufacturer is smaller than the cyclic running time (t_{cycle}) of the quick freeze, Step 102 starts and the 100% running time (t_{100}) of the quick freeze function and the estimated duration (t_1) of quick freezing, determined by the manufacturer are compared.

[0013] If the inner temperature value in the fresh food compartment (1) that is read by the sensor (6) is smaller than the upper limit value (T_{Max}) of the required temperature range for the fresh food compartment determined by the manufacturer in Step 104 then the inner temperature value in the fresh food compartment (1) that is read by the sensor (6) is compared with the lower limit value (T_{Min}) of the required temperature range for the fresh food compartment determined by the manufacturer in Step 106. In Step 106, if the inner temperature value in the fresh food compartment (1) that is read by the sensor (6) is smaller than the lower limit value (T_{Min}) of the required temperature range for the fresh food compartment determined by the manufacturer, the electrical heater (5) placed in the refrigerator fresh food compartment (1) to maintain required cooling and to avoid the freezing of the food in case the said compartment (1) is excessively cooled, operates in Step 107 then Step 108 starts.

[0014] In Step 102 wherein the 100% running time (t_{100}) of the freeze function and the estimated duration (t_1) of quick freezing, determined by the manufacturer are compared, if the 100% running time (t_{100}) of the quick freeze function is smaller than the estimated duration (t_1) of quick freezing, determined by the manufacturer, step 104 starts and the temperature sensor (6) placed in the fresh food compartment (1) reads the inner temperature of the said compartment (1) and these values are compared with the upper limit value (T_{Max}) of the required temperature range for the fresh food compartment determined by the manufacturer. If the inner temperature of the said compartment (1) is bigger than the upper limit value (T_{Max}) of the required temperature range for the fresh food compartment determined by the manufacturer, the compressor (7) operates in Step 109 and then Step 108 starts. In Step 104, if the inner temperature value in the fresh food compartment (1) that is read by the sensor (6) is smaller than the upper limit value (T_{Max}) of the required temperature range for the fresh food compartment determined by the manufacturer; Step 106 starts and the inner temperature value in the fresh food compartment (1) that is read by the sensor (6) is compared with the lower limit value (T_{Min}) of the required temperature range for the fresh food compartment determined by the manufacturer. In Step 106, if the inner temperature value in the fresh food compart-

ment (1) that is read by the sensor (6) is smaller than the lower limit value (T_{Min}) of the required temperature range for the fresh food compartment determined by the manufacturer, the compressor (7) is kept at "OFF" position in all cases and then Step 108 starts. In step 106, if the inner temperature value in the fresh food compartment (1) that is read by the sensor (6) is greater than the lower limit value (T_{Min}) of the required temperature range for the fresh food compartment determined by the manufacturer, the program determined by the control unit (8) is completed in Step 108 (Fig. 2 and Fig 3).

[0015] Another embodiment of the refrigerator quick freeze function is illustrated in Figures 4 and 5 and will be described in detail as follows:

[0016] In the cooling system of a two-door type refrigerator with freezer (2) and fresh food compartments (1), the control unit (8) maintains the inner temperature of the fresh food compartment (1) within the temperature range (T_{Max} , T_{Min}) as determined by the manufacturer or by the standards, during the quick freeze process by operating the compressor (7) at 100% capacity and by operating the heater (5) cyclically when the quick freeze button (201) is pressed. The process is illustrated in Figure 4. In this case, the total running time (t_{quick}) and 100% capacity running time (t_{100}) of the Quick Freeze are equal. During this period, the compressor (7) works at 100% capacity. The control unit (8) maintains the inner temperature of the fresh food compartment (1) within the temperature range (T_{Max} - T_{Min}) defined by the manufacturer or by the standards, during the quick freeze operation.

[0017] In step 202, the compressor (7) runs at 100% capacity during the 100% capacity running time (t_{100}) of the Quick Freeze; in Step 203, the temperature sensor (6) placed in the fresh food compartment (1) reads the inner temperature of the said compartment (1) and these values are compared with the upper limit value (T_{Max}) of the required temperature range for the fresh food compartment determined by the manufacturer. If the inner temperature value in the fresh food compartment (1) that is read by the sensor (6) is greater than the upper limit value (T_{Max}) of the required temperature range for the fresh food compartment determined by the manufacturer, the electrical heater (5) placed in the refrigerator fresh food compartment (1) to maintain the required cooling and to avoid the freezing of the food in case the said compartment (1) is excessively cooled, is closed in all cases in Step 204 and Step 207; wherein the total running time (t_{quick}) and estimated quick freeze operation time (t_1) determined by the manufacturer are compared, starts. In Step 207, if the estimated quick freeze operation time (t_1) determined by the manufacturer is greater than the total running time (t_{quick}), the quick freeze operation is terminated and normal cooling is carried on. Otherwise, i.e. if the estimated quick freeze operation time (t_1) determined by the manufacturer is smaller than the total running time (t_{quick}), the process returns back to Step 202.

[0018] In Step 203, if the inner temperature value in the fresh food compartment (1) that is read by the sensor (6) is smaller than the upper limit value (T_{Max}) of the required temperature range for the fresh food compartment determined by the manufacturer, step 205 where the inner temperature value in the fresh food compartment (1) that is read by the sensor (6) is compared with the lower limit value (T_{Min}) of the required temperature range for the fresh food compartment determined by the manufacturer, starts.

[0019] In Step 205, if the inner temperature value in the fresh food compartment (1) that is read by the sensor (6) is smaller than the lower limit value (T_{Min}) of the required temperature range for the fresh food compartment determined by the manufacturer, the electrical heater (5) placed in the refrigerator fresh food compartment (1) to maintain the required cooling and to avoid the freezing of the food in case the said compartment (1) is excessively cooled operates in Step 206, then Step 207 starts. In Step 205, if the inner temperature value in the fresh food compartment (1) that is read by the sensor (6) is greater than the estimated quick freeze operation time (t_f) determined by the manufacturer the electrical heater (5) placed in the refrigerator fresh food compartment (1) to maintain the required cooling and to avoid the freezing of the food in case the said compartment (1) is excessively cooled, is closed in Step 204 and then Step 207 starts (Figures 4 and 5).

Claims

1. A two-door type refrigerator having freezer (2) and fresh food compartments (1), a compressor (7), a temperature sensor (6), an electrical heater (5), and a control unit (8) which provides a quick freeze operation, wherein the quick freeze operation comprises two phases, namely operating the compressor (7) at 100% capacity in a first phase and in cyclic periods in a second phase, the control unit (8) further providing: the inner temperature of that fresh food compartment (1) to be continuously measured by the temperature sensor (6) placed in the fresh food compartment (1) when the compressor (7) runs at 100% capacity during the quick freeze 100% operation time (t_{100}); the electrical heater (5), placed in the refrigerator fresh food compartment (1) to maintain the required cooling and to avoid the freezing of the food in case the said compartment (1) is excessively cooled, to be started if the inner temperature value in the fresh food compartment (1) that is read by the sensor (6) is smaller than the lower limit value (T_{Min}) of the required temperature range for the fresh food compartment determined by the manufacturer, the electrical heater (5) to be stopped if the inner temperature value in the fresh food compartment (1) is greater than the upper limit value (T_{Max}) of the required temperature range for

the fresh food compartment determined by the manufacturer and therefore to be operated cyclically during the quick freeze 100% operation time (t_{100}) whereas to be stopped during the quick freeze cyclic running time (t_{cycle}), when the compressor (7) starts cyclic operation at the end of the quick freeze 100% operation time (t_{100}); the inner temperature of the fresh food compartment (1) to be continuously measured by the temperature sensor (6) placed in the fresh food compartment and the compressor (7) to be stopped if the inner temperature value in the fresh food compartment (1) that is read by the sensor (6) is smaller than the lower limit value (T_{Min}) of the required temperature range for the fresh food compartment determined by the manufacturer, whereas the compressor (7) to be started during the cyclic running time (t_{cycle}) if the inner temperature value in the fresh food compartment (1) is greater than the upper limit value (T_{Max}) of the required temperature range for the fresh food compartment determined by the manufacturer.

2. A refrigerator having a fresh food compartment (1), a freezer compartment (2), an electrical heater (5), a temperature sensor (6), a compressor (7) and a control unit (8) which provides a quick freeze operation, wherein the control unit (8) provides: the compressor (7) to run at 100% capacity during the total quick freeze operation time (t_{quick}), whereby the total quick freeze operation time (t_{quick}) is equal to the quick freeze 100% operation time (t_{100}); the inner temperature of the fresh food compartment (1) to be continuously measured by the temperature sensor (6), which is placed in the fresh food compartment (1); the electrical heater (5), which is placed in the refrigerator fresh food compartment (1) to maintain the required cooling and to avoid the freezing of the food in case the said compartment (1) is excessively cooled, to be started if the inner temperature value in the fresh food compartment (1) that is read by the sensor (6) is smaller than the lower limit value (T_{Min}) of the required temperature range for the fresh food compartment, but the electrical heater (5) to be stopped if the inner temperature value in the fresh food compartment (1) is greater than the upper limit value (T_{Max}) of the required temperature range for the fresh food compartment determined by the manufacturer, thereby causing the heater (5) to be operated cyclically during the total quick freeze operation time (t_{quick}).

Patentansprüche

1. Zweitüriger Kühlschrank mit Gefrierfach (2) und Frischhaltefach (1) für Lebensmittel, mit einem Kompressor (7), einem Temperatursensor (6), einem elektrischen Heizgerät (5) und einer Steuer-

einheit (8), die für einen Schnellgefrierbetrieb sorgt, wobei der Schnellgefrierbetrieb zwei Phasen umfasst, nämlich den Betrieb des Kompressors (7) bei 100%-Leistung in einer ersten Phase und in zyklischen Perioden in einer zweiten Phase, wobei die Steuereinheit (8) weiterhin dafür sorgt, dass die Innentemperatur des Frischhaltefachs (1) von dem Temperatursensor (6), der in dem Frischhaltefach angeordnet ist, fortlaufend gemessen wird, wenn der Kompressor (7) bei 100%-Leistung während der 100%-Schnellgefrierbetriebszeit (t_{100}) läuft; dass das elektrische Heizgerät (5), das in dem Frischhaltefach (1) des Kühlschranks angeordnet ist, um die erforderliche Kühlung aufrechtzuerhalten und das Gefrieren der Lebensmittel in dem Fall zu verhindern, wenn dieses Fach (1) übermäßig gekühlt wird, gestartet wird, falls der Innentemperaturwert in dem Frischhaltefach (1), der von dem Sensor (6) gelesen wird, kleiner als der vom Hersteller bestimmte untere Grenzwert (T_{Min}) des für das Frischhaltefach geforderten Temperaturbereichs ist; dass das elektrische Heizgerät (5) gestoppt wird, falls der Innentemperaturwert in dem Frischhaltefach (1) größer als ein vom Hersteller bestimmter oberer Grenzwert (T_{Max}) des für das Frischhaltefach geforderten Temperaturbereichs ist und es deshalb während der 100%-Schnellgefrierbetriebszeit (t_{100}) zyklisch betrieben wird, wohingegen es während der Schnellgefrierzykluslaufzeit (t_{cycle}) gestoppt wird, wenn der Kompressor (7) einen zyklischen Betrieb am Ende der 100%-Schnellgefrierbetriebszeit (t_{100}) beginnt; dass die Innentemperatur des Frischhaltefachs (1) fortlaufend durch den Temperatursensor (6), der in dem Frischhaltefach angeordnet ist, gemessen wird, und dass der Kompressor (7) gestoppt wird, falls der Innentemperaturwert in dem Frischhaltefach (1), der von dem Sensor (6) gelesen wird, kleiner als der vom Hersteller bestimmte untere Grenzwert (T_{Min}) des für das Frischhaltefach geforderten Temperaturbereichs ist, wohingegen der Kompressor (7) während der Zykluslaufzeit (t_{cycle}) gestartet wird, falls der Innentemperaturwert in dem Frischhaltefach (1) größer als der vom Hersteller bestimmte obere Grenzwert (T_{Max}) des für das Frischhaltefach geforderten Temperaturbereichs ist.

2. Kühlschrank mit einem Frischhaltefach (1) für Lebensmittel, einem Gefrierfach (2), einem elektrischen Heizgerät (5), einem Temperatursensor (6), einem Kompressor (7) und einer Steuereinheit (8), die für einen Schnellgefrierbetrieb sorgt, wobei die Steuereinheit (8) dafür sorgt, dass der Kompressor (7) während der gesamten Schnellgefrierbetriebszeit (t_{quick}) bei 100%-Leistung läuft, womit die gesamte Schnellgefrierbetriebszeit (t_{quick}) gleich der 100%-Schnellgefrierbetriebszeit (t_{100}) ist; dass die Innentemperatur des Frischhaltefachs (1) fortlau-

fend von dem Temperatursensor (6), der in dem Frischhaltefach (1) angeordnet ist, gemessen wird; dass das elektrische Heizgerät (5), das in dem Frischhaltefach (1) des Kühlschranks angeordnet ist, um die erforderliche Kühlung aufrechtzuerhalten und das Gefrieren der Lebensmittel zu verhindern, falls dieses Fach (1) übermäßig gekühlt wird, gestartet wird, falls die Innentemperaturwert in dem Frischhaltefach (1), der von dem Sensor (6) gelesen wird, kleiner als der untere Grenzwert (T_{Min}) des für das Frischhaltefach geforderten Temperaturbereichs ist; dass aber das elektrische Heizgerät (5) gestoppt wird, falls der Innentemperaturwert in dem Frischhaltefach (1) größer als ein vom Hersteller bestimmter oberer Grenzwert (T_{Max}) des für das Frischhaltefach geforderten Temperaturbereichs ist, wodurch bewirkt wird, dass das Heizgerät (5) während der gesamten Schnellgefrierbetriebszeit (t_{quick}) zyklisch betrieben wird.

Revendications

1. Un réfrigérateur du type à deux portes comportant un congélateur 2 et des compartiments pour aliments frais 1, un compresseur 7, un palpeur de température 6, un réchauffeur électrique 5 et une unité de contrôle 8 qui assure une fonction de congélation rapide, dans laquelle l'opération de congélation rapide comprend deux phases, à savoir le fonctionnement du compresseur 7 à 100 % de sa capacité dans une première phase, et par périodes cycliques dans une seconde phase, l'unité de contrôle 8 garantissant au surplus que la température intérieure du compartiment pour aliments frais 1 est mesurée de manière continue par le palpeur de température 6, placé dans le compartiment pour aliments frais 1 quand le compresseur 7 tourne à 100 % de sa capacité au cours de la durée de fonctionnement de congélation rapide à 100 % (t_{100}) ; le réchauffeur électrique 5, placé dans le compartiment pour aliments frais du réfrigérateur 1 maintenant le refroidissement nécessaire et évitant la congélation des aliments au cas où ledit compartiment 1 serait refroidi de façon excessive de manière à être mis en route si la valeur de la température intérieure dans le compartiment pour aliments frais 1 qui est lue par le palpeur 6 est plus petite que la valeur limite inférieure (T_{min}) de l'intervalle de température requis pour le compartiment pour aliments frais déterminé par le fabricant, le réchauffeur électrique 5 étant interrompu si la valeur de la température intérieure dans le compartiment pour aliments frais 1 est supérieure à la valeur limite supérieure (T_{max}) de l'intervalle de température requis pour le compartiment pour aliments frais déterminé par le fabricant et par suite est amené à fonctionner de

manière cyclique au cours de la durée du fonctionnement à 100 % de congélation rapide (t_{100}), tandis qu'il est interrompu au cours de la durée de fonctionnement cyclique de congélation rapide (t_{cycle}) quand le compresseur 7 commence son fonctionnement cyclique à la fin de la durée de l'opération à 100 % de congélation rapide (t_{10}), la température intérieure du compartiment pour aliments frais 1 étant mesurée de manière continue par le palpeur de température 6 placé dans le compartiment pour aliments frais et le compresseur 7 étant interrompu si la valeur de la température intérieure dans le compartiment pour aliments frais 1 qui est lue par le palpeur 6 est inférieure à la valeur limite inférieure (T_{min}) de l'intervalle de température requis pour le compartiment pour aliments frais déterminé par le fabricant tandis que le compresseur 7 est mis en route au cours de la durée de fonctionnement cyclique (t_{cycle}) si la valeur de la température intérieure dans le compartiment pour aliments frais 1 est supérieure à la valeur limite supérieure (T_{max}) de l'intervalle de température requis pour le compartiment pour aliments frais déterminé par le fabricant.

l'opération de congélation rapide.

2. Un réfrigérateur comportant un compartiment pour aliments frais 1, un compartiment de congélation 2, un réchauffeur électrique 5, un palpeur de température 6, un compresseur 7, et une unité de contrôle 8, qui détermine un fonctionnement de congélation rapide, dans lequel l'unité de contrôle 8 assure que le compresseur 7 fonctionne à 100 % de sa capacité au cours de la durée totale de l'opération de congélation rapide (t_{rapide}), grâce à quoi la durée totale de l'opération de congélation rapide (t_{rapide}) est égale à la durée de l'opération de congélation rapide à 100 %, la température intérieure du compartiment pour aliments frais 1 étant mesurée de manière continue par le palpeur de température 6 qui est placé dans le compartiment pour aliments frais 1, le réchauffeur électrique 5 qui est placé dans le compartiment pour aliments frais du réfrigérateur 1 maintenant le refroidissement nécessaire pour éviter la congélation des aliments dans le cas où ledit compartiment 1 est refroidi de façon excessive, de manière à être mis en route si la valeur de la température intérieure dans le compartiment pour aliments frais 1 qui est lu par le palpeur 6 est inférieure à la valeur limite inférieure (T_{min}) de l'intervalle de température requis pour le compartiment pour aliments frais, mais le réchauffeur électrique 5 étant stoppé, si la valeur de la température intérieure dans le compartiment pour aliments frais 1 est supérieure à la valeur limite supérieure (T_{max}) de l'intervalle de température requis pour le compartiment pour aliments frais déterminée par le fabricant, en provoquant ainsi le fonctionnement cyclique du réchauffeur 5 au cours de la durée totale de

Figure 1

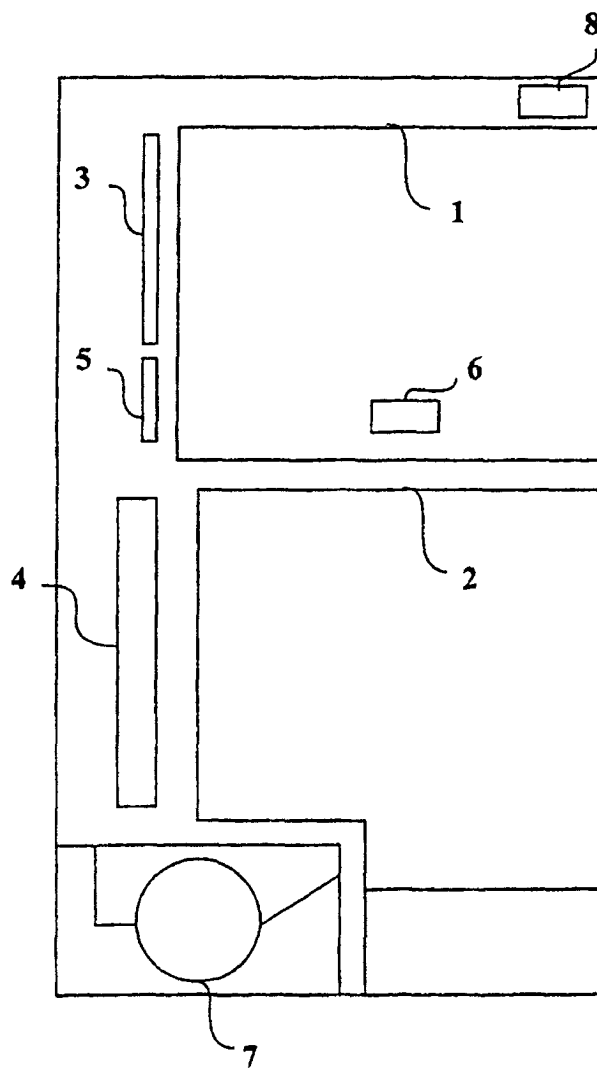


Figure 2

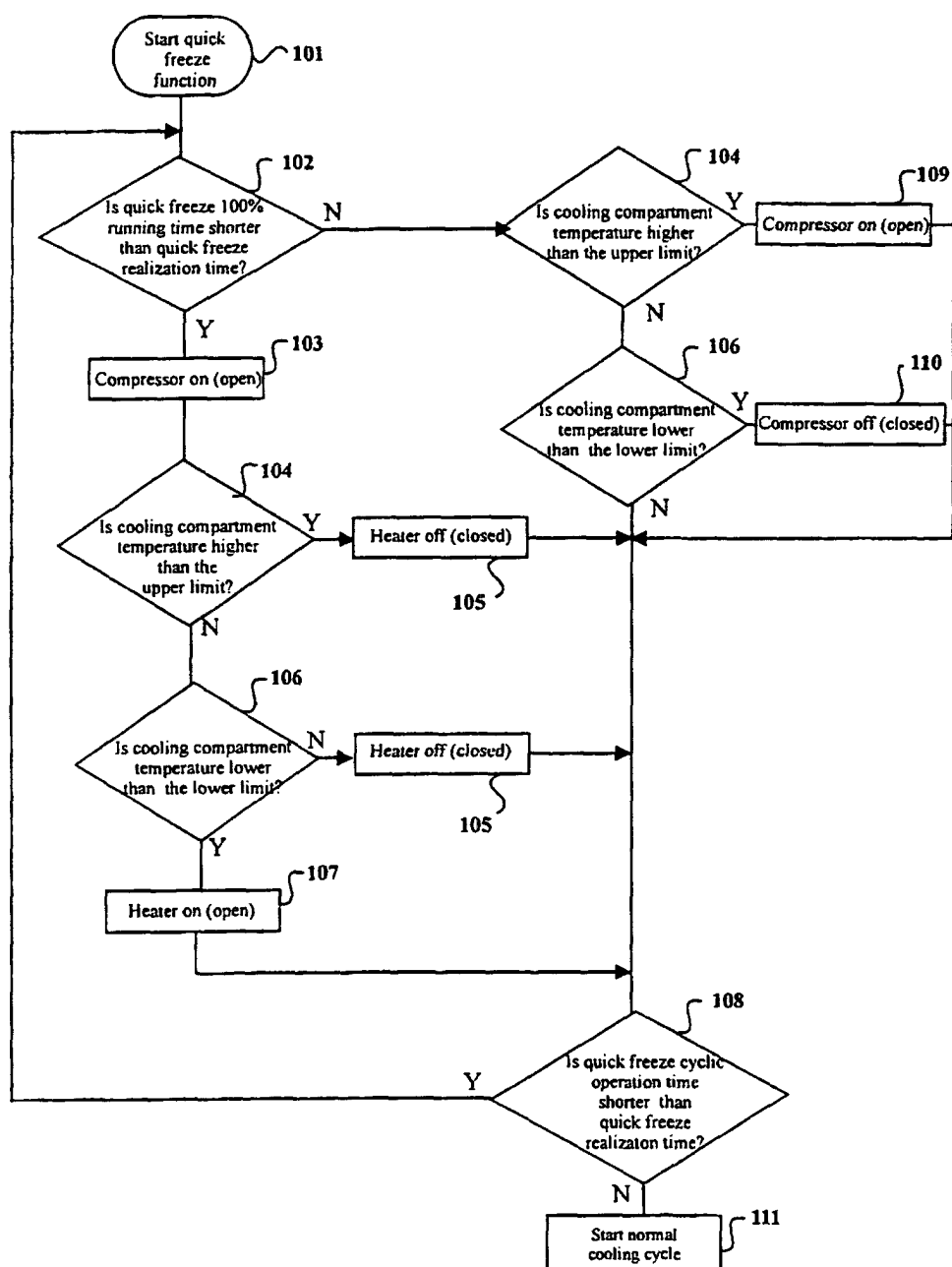


Figure 3

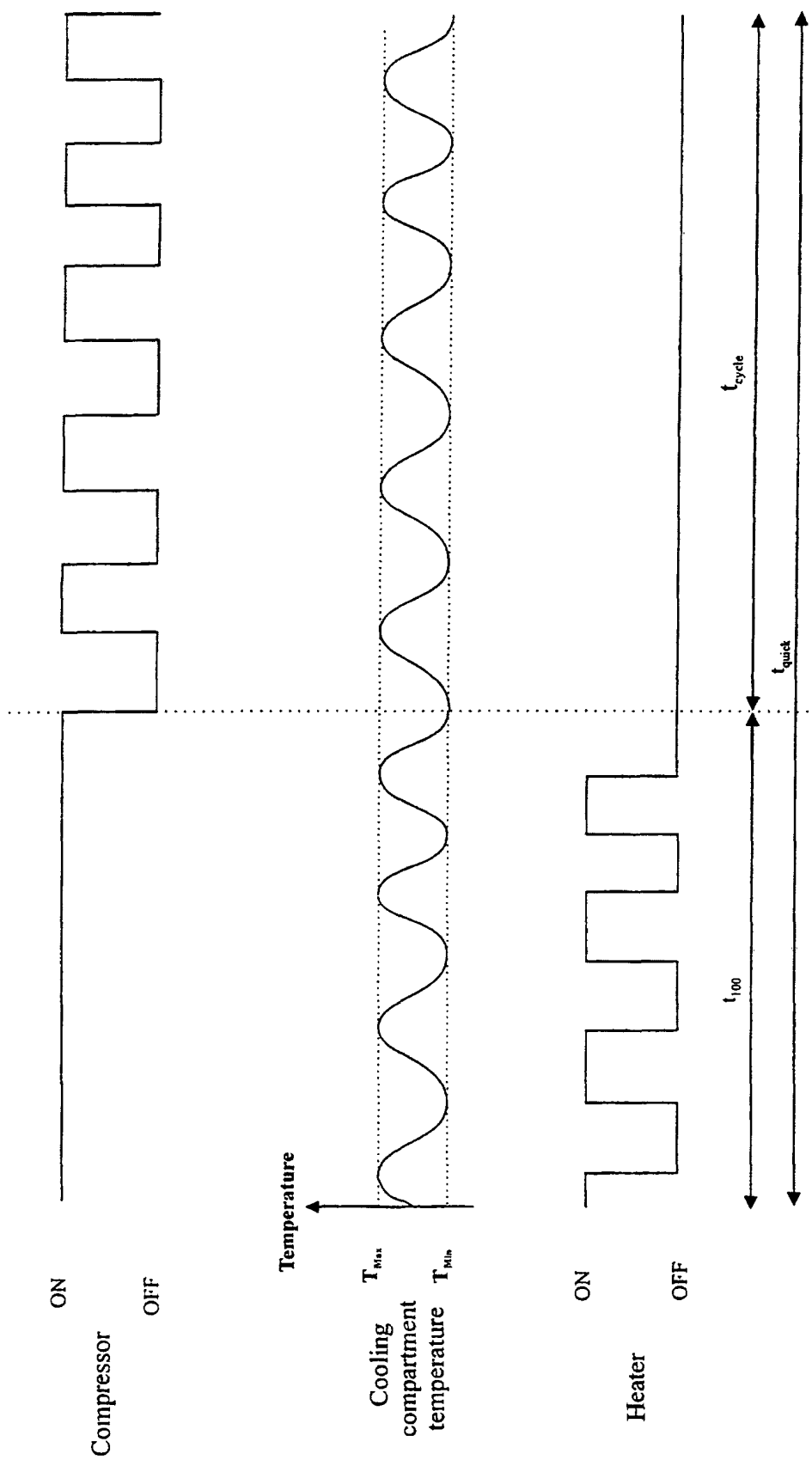


Figure 4

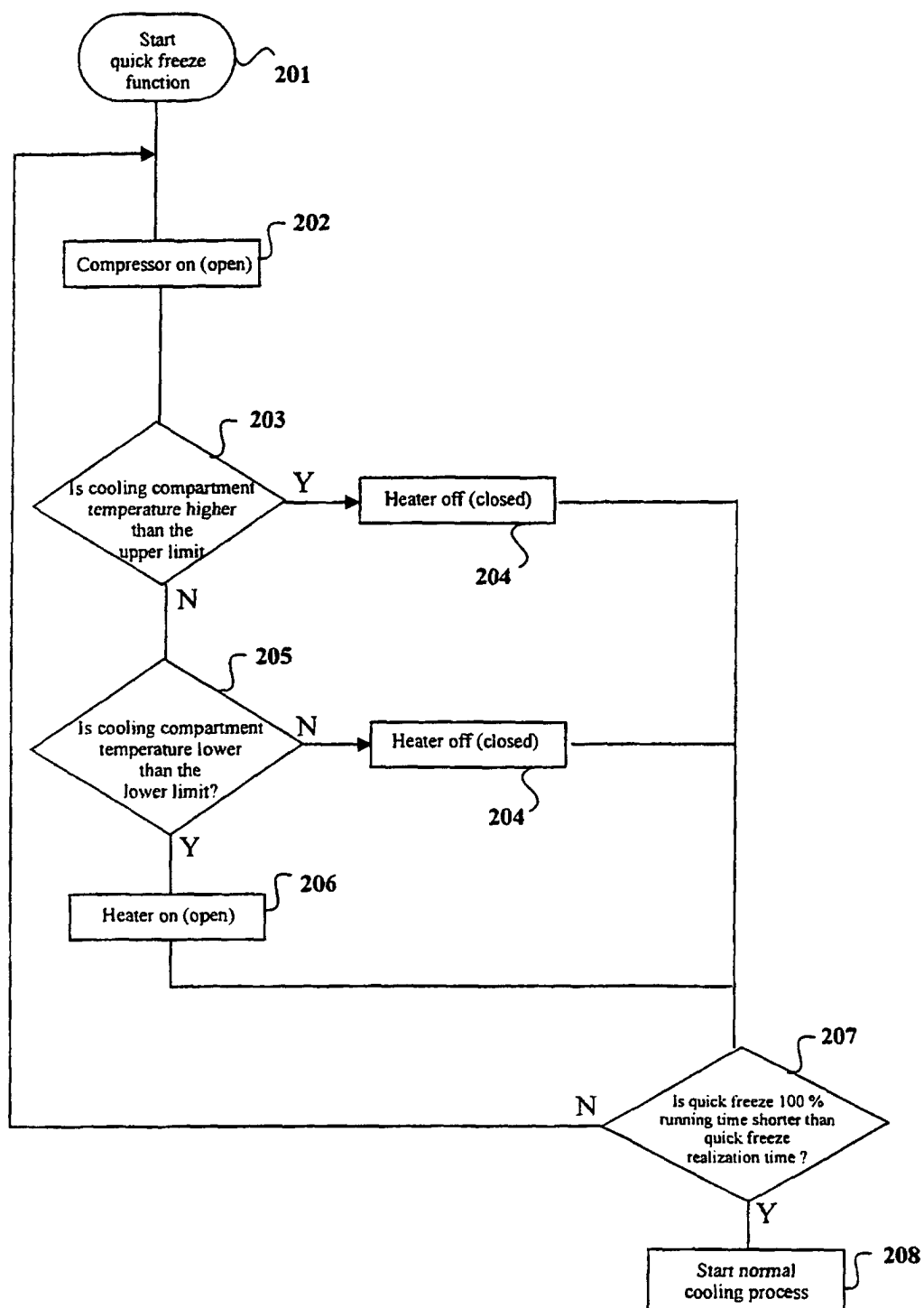


Figure 5

