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(54) **MULTI-TEMPERATURE CONTROL REFRIGERATOR COMPRISING AN ICE MACHINE**

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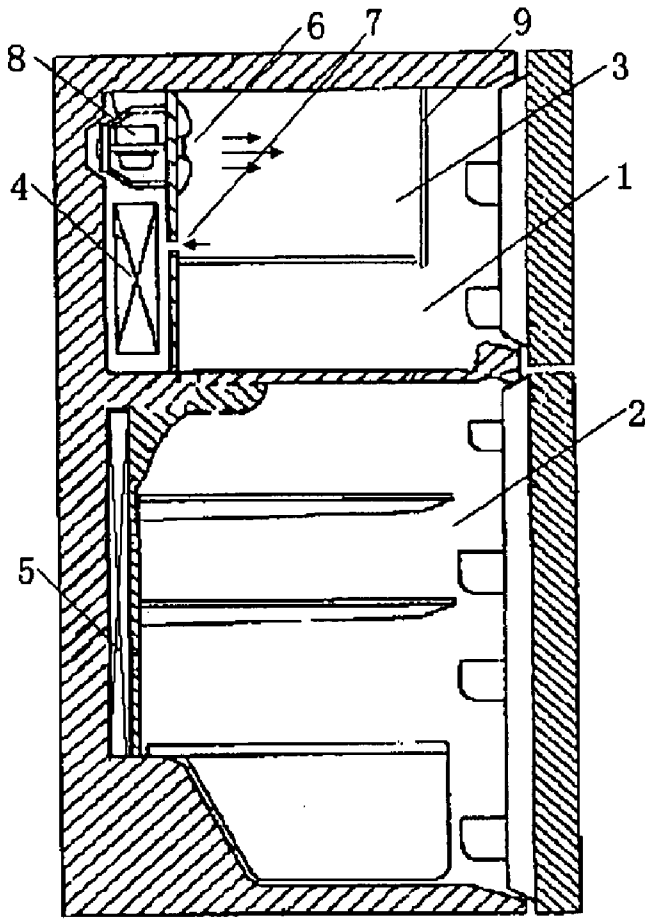
(57) **ABSTRACT**

The present invention relates to a multi-temperature control refrigerator, in which an ice machine is installed and the cooling mode of the refrigerator is a mixed air-cooling and direct cooling mode. Particularly, the present invention relates to a refrigerator having ice-making function, in which the refrigeration cycle is a dual cycle and two different evaporators are included. Due to that the ice making room of the of the refrigerator of the present invention adopts a mixed air-cooling and direct cooling mode, and that impulse solenoid valves and dual temperature control device are introduced to the dual cycle system, the energy is optimally distributed and utilized, the fluctuation of temperature is small and the ice making efficiency of the ice making room and the quality of the ice cubes are much improved. And the whole refrigerator makes less noise, consumes fewer refrigerants and makes ice of good quality rapidly.



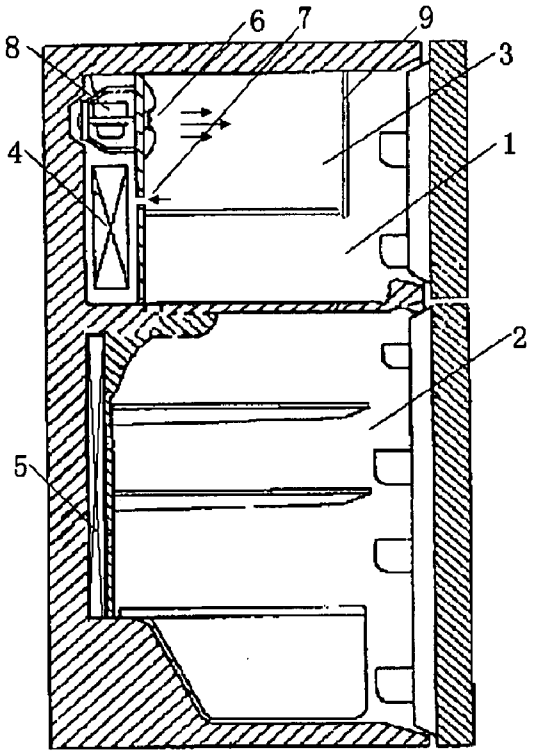


FIG. 1(a)

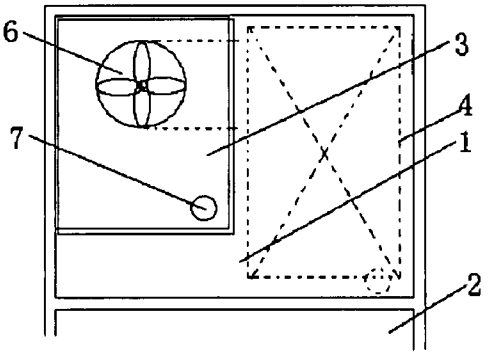
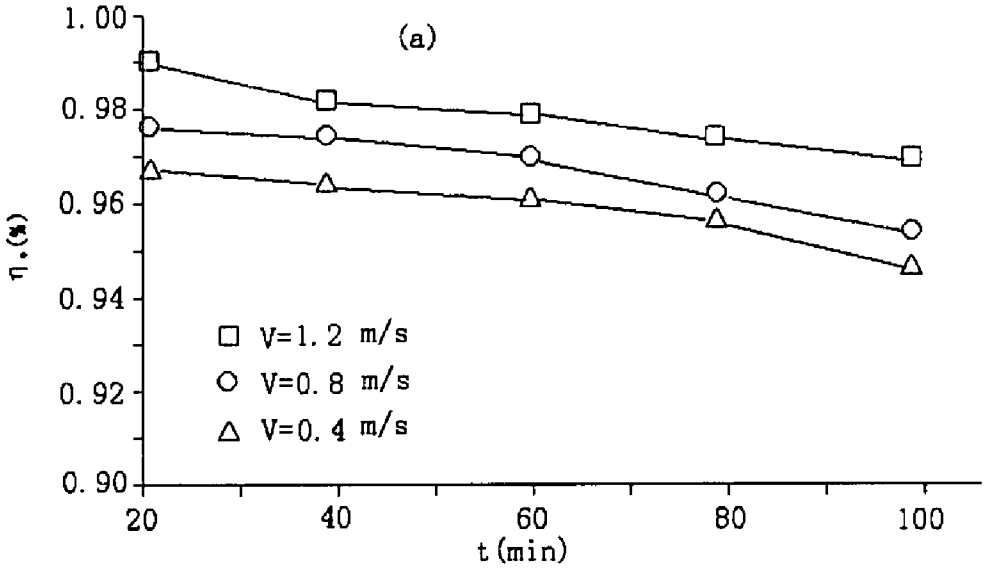


FIG. 1(b)


(a)
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0.90
η.(%)
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V=0.4 m/s
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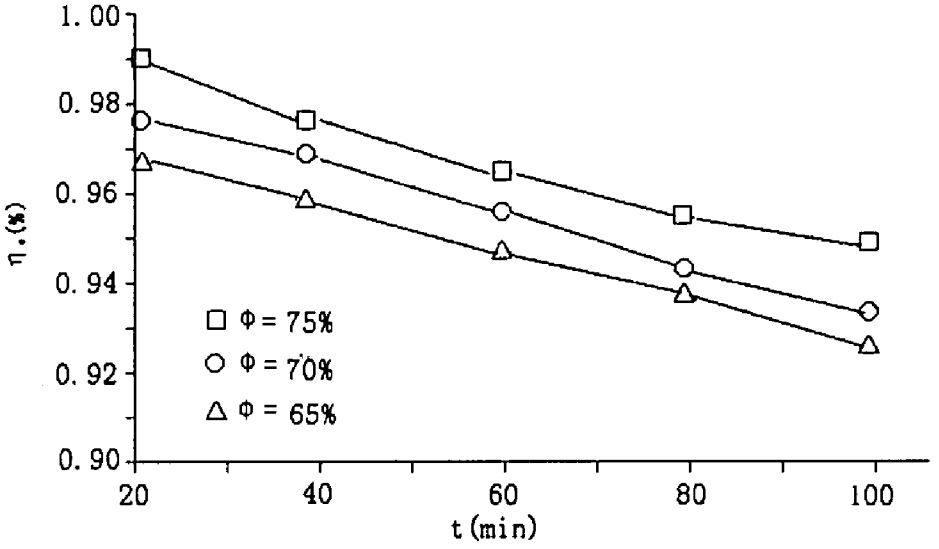
40
60
80
100
t(min)

FIG.2(a)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0.94
0.92
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η.(%)
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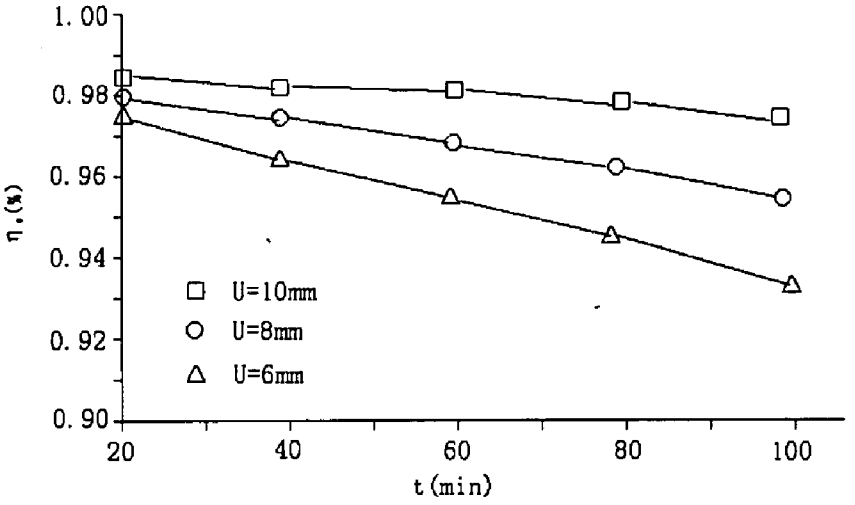
40
60
80
100
t(min)

FIG.2(b)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0.94
0.92
0.90
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U=8mm
U=6mm
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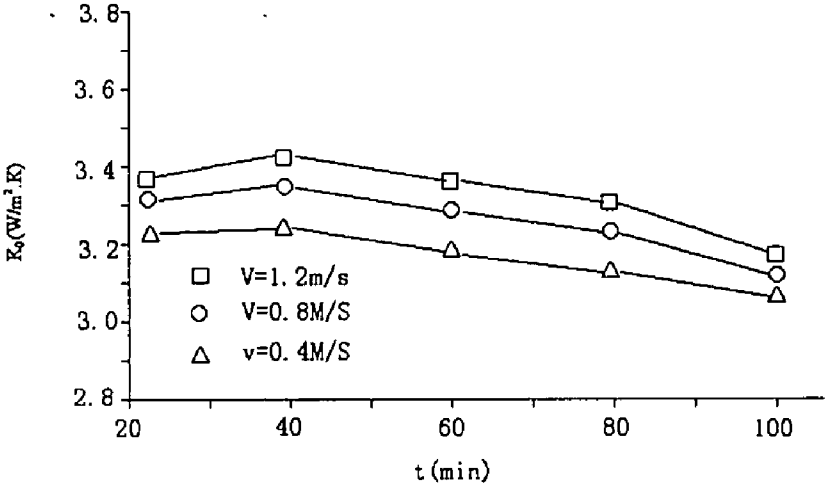
80
100
t(min)

FIG.2(c)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3.6
3.4
3.2
3.0
2.8
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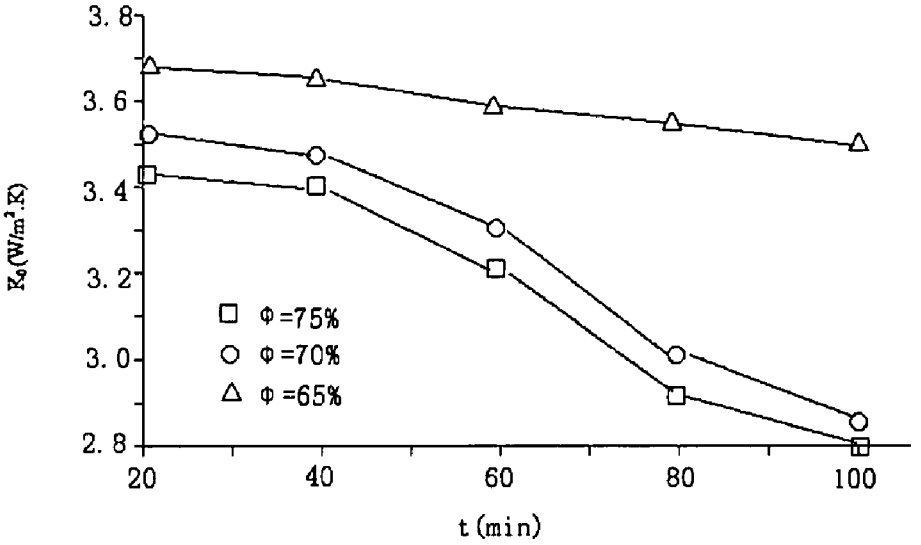
V=0.8M/S
v=0.4M/S
20
40
60
80
100
t(min)

FIG.2(d)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3.4
3.2
3.0
2.8
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20
40
60
80
100
t(min)

FIG.2(e)

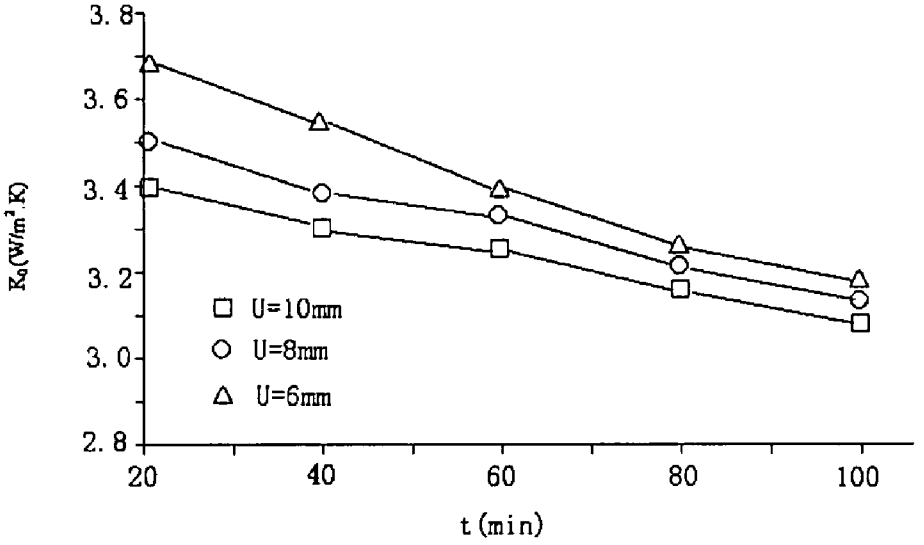
3.8
3.6
3.4
3.2
3.0
2.8
K_0(W/m^2.K)
U=10mm
U=8mm
U=6mm
20
40
60
80
100
t(min)

FIG.2(f)

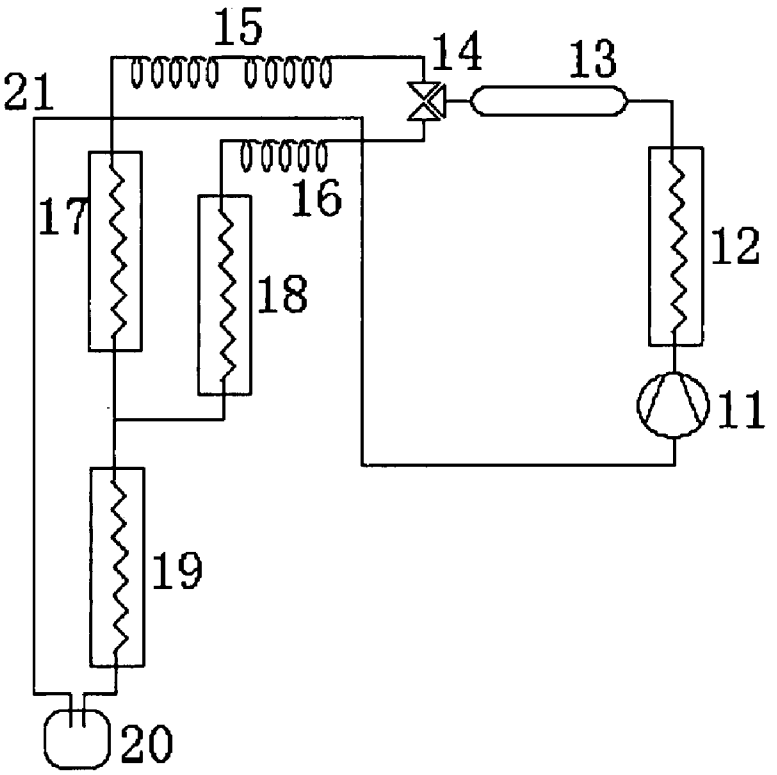

FIG.3

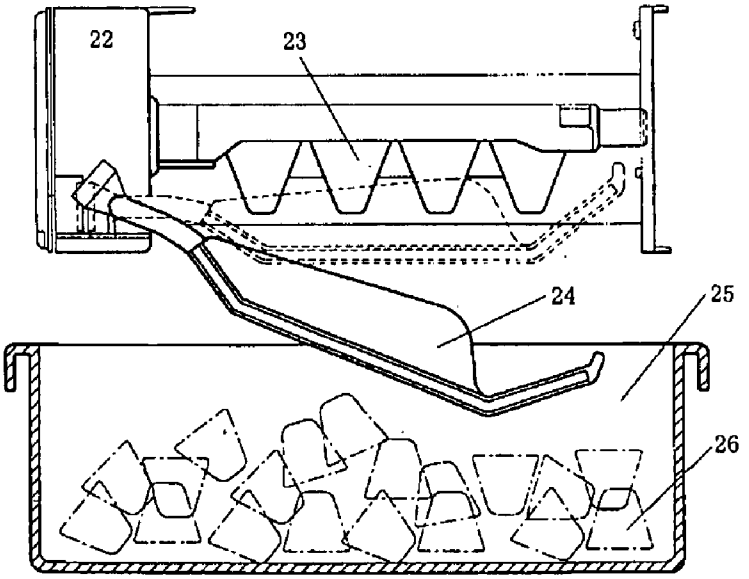

FIG.4

MULTI-TEMPERATURE CONTROL REFRIGERATOR COMPRISING AN ICE MACHINE

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a multi-temperature control refrigerator, in which an ice machine is installed and the cooling mode of the refrigerator is a mixed air-cooling and direct cooling mode. Particularly, the present invention relates to a multi-temperature control refrigerator having ice-making function, in which the refrigeration cycle is a dual cycle and the cooling mode is a mixed air-cooling and direct cooling mode.

[0003] 2. Description of the Related Art

[0004] While living standards are improved with each passing day, ice cubes are required more and more in our daily lives. The fact that a major part of the operation of ice is machines in the past involves manual work is not satisfactory but automatic ice machines facilitate the use of ice cubes greatly, because the whole ice-making process of an automatic ice machine doesn't involve any manual intervention.

[0005] Automatic ice machines in the prior art can be divided into two types, which are specified as follows:

[0006] The control device of the first type ice machine is integrated into itself and there is no need to implement the control of the ice-making system separately through the main control panel of the refrigerator. The installation method of the first type ice machine is such that ice machine is an integrated and independent accessory of the refrigerator, which can be installed at any time if there are preserved joints and space for the ice machine in the refrigerator and there is no need to make molds for plastic components. The ice is removed from the first type ice machine by heating. Tap water is fed into the first type ice machine through water valve. It is also possible to hold water in a water storage device and utilize a pump to feed the water into the first type ice machine. This type of ice machines have an integrated ice-making system and need only the electric supply of 220V or 115V is needed for operation. They can also be mounted in mechanical refrigerators and other advantages are that no extra control unit is required; no extra molds are needed to be made; the installation of the ice machine requires only two screws; it is very simple to use and it is also highly reliable. But the disadvantages are that the volume of the ice machine is bulky and too much space is taken up. Please refer to the drawing for the first type ice machine, wherein ice machine **22**, ice making box **23**, ice detecting lever **24**, ice storage box **25** and ice cubes **26** are comprised. A substantially sealed ice-making room is installed in the refrigerator. The ice machine **22**, under which the ice making box **23** is placed, is screwed onto an appropriate place of the inner wall of the ice-making room. Freezing is carried out after water is injected from the water storage device to the ice making box. When the water in the ice making box **23** is turned into ice, ice cubes **26** are forced down into the ice storage box **25** by using a lever or reversing the ice making box. The ice storage box **25** is deemed full when the ice detecting lever is raised to a height due to the ice cubes **26** and the ice machine stops working. Ice storage box is taken out when ice cubes are needed.

[0007] The second type ice machine is only an ice removing mechanism, wherein all the control means are implemented through the main control panel of the refrigerator. It is necessary to design the installation structure of the ice machine and other plastic components such as the ice making box due to that the ice machine is only an ice removing mechanism. The ice is removed from the second type ice machine by torque force. The water source of this type of refrigerator is the water held beforehand in a water tank inside the refrigerator compartment, which is fed by pumps and it is also achievable to use tap water according to requirements. This type of ice machine is actually a mere ice removing mechanism and requires the addition of many components, a control circuit and a testing circuit before automatic ice-making can be achieved. The structure of this type of ice machine is complex and many parts and components are involved and the reliability is low. But the volume of the ice machine is smaller and less space is occupied.

[0008] The present invention is an improvement to the first type ice machine. Particularly, the present invention is an improvement to the refrigerator where the first type ice machine is installed. In such a refrigerator, ice machine is often placed in the freezer compartment and, in order to prevent tainting by odor or due to other reasons, it is also feasible to set up a relatively isolated space in the freezer compartment, i.e. ice-making room, to install the ice machine. Generally, such an ice-making room comprises a door to separate the space of different functions. But it is hard to coordinate the interrelationship between the temperature of the freezer compartment and the refrigerating effect of the ice-making room when the requirement of the freezer compartment and that of the ice machine are different, because the freezing process of the ice machine set inside the freezer compartment adopts the refrigeration system of the freezer compartment. In order to overcome the defects existed in the prior art, the present invention is proposed.

SUMMARY OF THE INVENTION

[0009] The primary object of the present invention is to provide a refrigerator with an ice machine where an independent ice making room is comprised.

[0010] Another object of the present invention is to provide a refrigerator where a refrigerating source is solely provided for the independent ice making room.

[0011] It is yet another object of the present invention to provide a refrigerator where two different cooling modes, i.e. air-cooling mode and direct cooling mode, are provided to the two rooms of the freezer compartment using one evaporator.

[0012] The objects of the present invention can be achieved according to the following description. Said refrigerator can be divided into freezer compartment **1** and refrigerator compartment **2**. In the freezer compartment **1**, an ice making room is usually set at the upper-left part when the door of the refrigerator is opened to the left. Said ice making room is installed with a door **9** so as to prevent the flow of the refrigerating effect and the tainting by odor. An ice machine is mounted in the ice making room and an ice storage box is arranged below said ice machine. Both the freezer compartment and refrigerator compartment adopt direct cooling mode and an air inlet and an air outlet connected with the ice making room are set in the space where the evaporator of the freezer compartment is presented. The ice making room is deep cooled using air-cooling mode when needed.

[0013] Particularly, the present invention involves a triple-temperature control refrigerator comprising an ice machine where the cooling mode is a mixed air-cooling and direct cooling mode.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] By referring to the description of the drawings set out as below and in combination with the following detailed description, a more clarified appreciation of the present invention can be obtained, wherein

[0015] FIG. **1**(*a*) illustrates a schematic diagram of the refrigerator of the present invention where an ice machine is comprised;

[0016] FIG. **1**(*b*) illustrates a cutaway view of the refrigerator of the present invention where the cooling mode is a mixed air-cooling and direct cooling mode and multi-temperature control function is enabled;

[0017] FIG. **2**(*a*) illustrates the effect of the velocity of the air flow on the efficiency of the fin type evaporator;

[0018] FIG. **2**(*b*) illustrates the effect of the relative humidity of the air on the efficiency of the fin type evaporator;

[0019] FIG. **2**(*c*) illustrates the effect of the space between the fins on the efficiency of the fin type evaporator;

[0020] FIG. **2**(*d*) illustrates the effect of the velocity of the air flow on the average heat exchange coefficient of the air side;

[0021] FIG. **2**(*e*) illustrates the effect of the relative humidity of the air on the average heat exchange coefficient of the air side;

[0022] FIG. **2**(*f*) illustrates the effect of the space between the fins on the average heat exchange coefficient of the air side;

[0023] FIG. **3** illustrates a schematic diagram of the dual cycle refrigerating system of the present invention;

[0024] FIG. **4** illustrates a cutaway view of the ice machine of the present invention.

BRIEF DESCRIPTION OF REFERENCE NUMERAL

[0025] Freezer compartment **1**; refrigerator compartment **2**; ice making room **3**; evaporator **4**; plate type evaporator **5**; air inlet **6**; air outlet **7**; fan **8**; door of ice making room **9**; compressor **11**; condenser **12**; desiccation filter **13**; three-way solenoid valve **14**; main capillary tube **15**; bypass capillary tube **16**; freezing evaporator **17**; refrigerating evaporator **18**; **19**; water storage apparatus **20**; ice machine **22**; ice making box **23**; ice detecting lever **24**; ice storage box **25** and ice cubes **26**.

DETAILED DESCRIPTION OF THE INVENTION

[0026] The working mode and the each constitutional component of the multi-temperature control refrigerator comprising an ice machine, in which the cooling mode is a mixed air-cooling and direct cooling mode, are described as follows:

[0027] The refrigerator of the present invention comprises a freezer compartment **1** and a refrigerator compartment **2**, wherein an ice making room is set inside the freezer compartment **1**. Said ice making room is installed with a door **9** so as to prevent the flow of the refrigerating effect and the tainting by odor. An ice machine is mounted in the ice making room and an ice storage box is arranged below said ice machine. Both the freezer compartment and refrigerator compartment adopt direct cooling mode and an air inlet **6** and an air outlet **7** connected with the ice making room are set in the space where the evaporator of the freezer compartment is presented. The ice making room is deep cooled using air-cooling mode when needed.

[0028] A door that can be open and shut by turning can be mounted on the air inlet **6** and/or the air outlet **7** of the ice making room so as to shut said door when the ice making room is used as a normal space of the freezer compartment. In such case, the freezer compartment also adopts the direct cooling mode to achieve freezing. If the ice making room is changed into a deep freezing room, i.e. no ice machine is installed in the ice making room **3**, said refrigerator is actually a triple-temperature control refrigerator with two evaporators where the cooling mode is a mixed air-cooling and direct cooling mode, i.e. the refrigerating effect of the refrigerator compartment, the freezer compartment and the ice making room can be controlled separately according to requirements.

[0029] The direct cooling of the refrigerator compartment of the refrigerator of the present invention adopts a plate type evaporator, which sticks to the upper part of the back wall of the inner liner of the refrigerator compartment by press bonding process. Refrigeration are achieved by natural convection and when the temperature in the compartment reaches the preset temperature, refrigerating temperature control unit will send an impulse signal to the impulse solenoid valve which takes action to switch off the refrigeration cycle of the refrigerant.

[0030] Said plate type evaporator sticks to the inner liner of the refrigerator compartment. The advantages are that the evaporator is hided so as not to affect the appearance and the refrigeration is uniform and causes little frostbite to articles, etc.

[0031] The refrigerator compartment adopts plate type evaporator, which keeps the humidity at a relatively high level in the compartment.

[0032] Please refer to FIG. **1**. FIG. **1**(*b*) illustrates a cutaway view of the multi-temperature control refrigerator of the present invention where the cooling mode is a mixed air-cooling and direct cooling mode. The position of the components and their connecting means can be viewed clearly in the figure.

[0033] The freezer compartment of the refrigerator of the present invention also adopts direct cooling mode and one side of the evaporator also sticks to the inner liner of the freezer compartment. But, behind the other side of the evaporator there is a gap, through which the air from the ice making room flows upward, gets cooled again and enters into the ice making room. The ice making room adopts air-cooling mode, which makes the cooling speed of ice making room much faster than that using only direct cooling mode.

[0034] Thus, the ice making room adopts a mixed air-cooling and direct cooling mode, which is equivalent to having two controllable temperature zones.

[0035] The freezer compartment adopts a mixed air-cooling and direct cooling mode and in order to improve the refrigerating efficiency of the ice making room, the evaporator of the freezer compartment is a fin type evaporator. In order to prevent the inadequacy of the refrigerating effect of the fin type evaporator when compared with the requirement of the freezer compartment, the whole or part of the ice making room uses materials that are high in thermal conductivity as baffle plate, e.g. aluminum. In this way, the refrigerating effect of the ice making room can be exchanged through the baffle plate and due to that the ice making room is pref-

erably set in the upper part of the freezer compartment, the cold air near the outer wall of the ice making room goes down and forms a cycle having a heat exchange process.

[0036] The multi-temperature control function of the present invention means that the refrigerant flows through the impulse solenoid valve to the freezer or refrigerator compartment according to the requirement of refrigerating effect of the freezer or refrigerator compartment. The temperatures of the two compartments are detected by the temperature sensing units of the temperature control apparatus of each compartment and the controller of the refrigerator controls the action sensor set inside the ice making room, or connecting the circuit of the ice making room to the main control circuit of the refrigerator, to sense the working conditions of the ice machine.

[0037] The working method for the refrigerator of the present invention is described in the following paragraphs.

[0038] When determining whether the ice making process is to be carried out or not and if the ice making process is to be commenced, the evaporator of the freezer compartment is started and the fan is also started to cool the ice making room quickly to an ice-making quick-freezing temperature.

[0039] When determining the ice making room is at a temperature-maintaining state or not and if the temperature doesn't reach the preset ice-making maintaining temperature, the evaporator of the freezer compartment is started and the fan is also started to cool the ice making room quickly to the ice-making maintaining temperature.

[0040] Because the preset temperature and the maintaining temperature of the ice making room are lower than the preset temperature of the freezer compartment, the temperature of the freezer compartment should be kept lower than the preset temperature in such circumstance.

[0041] Preferably, the maintaining temperature of the ice making room is set the same as the preset temperature of the freezer compartment. When the temperature of the freezer compartment doesn't reach the preset temperature and needs to be cooled, the refrigerant enters the main cycle. Because the area of the main evaporator in the refrigerator compartment is relatively small, the cold energy released by the evaporator of the refrigerator compartment is minor and the drop in temperature is very small. When metal baffle plate is used in the ice making room, the heat in the ice making room and the freezer compartment is substantially exchanged.

[0042] In order to improve the ice making efficiency of the ice making room, i.e. to maintain a lower temperature as long as possible in the ice making room than in the freezer compartment, a baffle plate with good thermal insulation property is used between the ice making room and the freezer compartment and the quick-freezing temperature and the maintaining temperature of the ice making room are set distinctively below the preset temperature of the freezer compartment. In this condition, the ice making room forms a deep freezing compartment when no ice machine is mounted in the ice making room.

[0043] When the freezer compartment has reached the preset temperature and the refrigerator compartment hasn't, the bypass circuit is turned on. The main evaporator of the refrigerator compartment of the main circuit, which has a relatively small area for evaporation, is combined with an additional evaporator of the refrigerator compartment, which has a relatively larger area for evaporation, and forms an evaporator of the refrigerator compartment that has very large evaporation area so as to adjust the temperature of the refrigerator compartment rapidly.

[0044] The refrigerator of the present invention comprises compressor, condenser, desiccation filter, capillary tube, freezing evaporator, freezer compartment, refrigerating evaporator and air intake tube.

[0045] In the present invention, plate type evaporator is used in the refrigerator compartment and fin type evaporator is used in the freezer compartment.

[0046] The mode of the refrigeration system is discussed in the following paragraphs. The parallel evaporators configuration (independent-dual cycle) or an additional circuit in the series connection configuration of the conventional evaporators have been disclosed in the prior art. The two configurations enable the separate control of the freezer compartment and the refrigerator compartment but the irreversible loss of the thermodynamics is huge and the condensation of moisture will happen on the external surface of the air intake tube.

[0047] The present invention provides that an evaporator that is large in area is connected to the bypass circuit of the bypass dual refrigeration cycle refrigerator as an additional evaporator of the refrigerator compartment. Hence the area of the evaporator of the refrigerator compartment is very large and the bypass capillary tube can adopt a shorter design because even if the flow is large, the refrigerant will be fully evaporated in the evaporator due to large area of the evaporator of the refrigerator compartment and almost no liquid state refrigerant enters the air intake tube. When the refrigerator compartment doesn't need refrigerating effect and the freezer compartment needs, the refrigerant circulates in the main circuit and because the area of the evaporator of the refrigerator compartment is small, the released refrigerating effect is small and the drop of the temperature in the refrigerator compartment is small, too.

[0048] Thus, the refrigerating effect of the refrigerator compartment is mainly from the bypass circuit and due to that the bypass capillary tube in the bypass circuit is relatively short and that the evaporating temperature is high, the irreversible loss of the thermodynamics is small and the COP of the system is high.

[0049] The dual refrigeration cycle refrigerator of the present invention comprises compressor **11**, condenser **12**, desiccation filter **13**, three-way solenoid valve **14**, main capillary tube **15**, bypass capillary tube **16**, freezing evaporator **17**, refrigerating evaporator **19** and water storage apparatus **20**, wherein an additional refrigerating evaporator **18** is comprised in the said bypass circulating circuit. The outlet of the compressor **11** is connected to the inlet of the condenser **12**; the outlet of the condenser **12** is connected to the inlet of the desiccation filter **13**; the outlet of the desiccation filter **13** is connected to the three-way solenoid valve **14**; one outlet of the three-way solenoid valve **14** is connected to the inlet of the main capillary tube **15**, the other outlet is connected to the inlet of the bypass capillary tube **16**; The outlet of the main capillary tube **15** is connected to the inlet of the freezing evaporator **17**; The outlet of the bypass capillary tube **16** is connected to the inlet of the additional refrigerating evaporator **18**; the outlets of the freezing evaporator **17** and the additional refrigerating evaporator **18** are both connected to the inlet of the refrigerating evaporator **19**; the outlet of the refrigerating evaporator **19** is connected to the inlet of the water storage apparatus **20** and; the outlet of the water storage

apparatus **20** is connected to one end of the air intake tube and the other end is connected to the inlet of the compressor **11**.

[0050] When compared with single refrigeration cycle system, the refrigeration system of the present invention is provided with the following advantages:

[0051] The impact of temperature of the environment to the temperature in the freezer compartment and in the refrigerator compartment is avoided and the optimal distribution and utilization of the energy is achieved.

[0052] Thanks to the dual cycle refrigeration system that can independently control the temperature of the refrigerator compartment and the freezer compartment, the freezing ability is far greater than that of normal refrigerators using single cycle refrigeration system. The fluctuation range of the temperature in the refrigerating/freezer compartment in the refrigeration process of the dual refrigeration cycle refrigerators is far less than that of the single cycle refrigerators and relatively small fluctuation range will favor the reservation and preservation of food.

[0053] When designing a dual cycle refrigeration system, a relatively large refrigerating evaporator can be chosen so as to satisfy the high temperature requirement and while in a low environment temperature, the refrigerator can be run normally without any heating compensation as long as the preset temperature of the refrigerator compartment is lower than the environment temperature.

[0054] The present invention provides a bypass dual refrigeration cycle refrigerator with a variable refrigerating evaporation area. Researchers believe that the main factors that affect the energy saving of the bypass dual refrigeration cycle refrigerator with a variable refrigerating evaporation area are the functional relations between the load of the refrigerator compartment, the load of the bypass circuit, the system COP of the main cycle and the bypass cycle, etc. and the energy saving effects. If such functional relations are applied, and in the actual operating conditions of the refrigerators at the present time, the refrigerator of the present invention saves 12% more energy than the single cycle refrigerators with evaporators connected in series.

[0055] The compressor of refrigerator of the present invention is steam compressor, comprising compressor **11**, condenser **12**, capillary tube **15** **16**, desiccation filter **13**, three-way solenoid valve **14**, evaporator **17** **18**, **19**. Said steam compress refrigeration cycle is a continuous circular process of compressing, condensing, throttling and evaporating. The refrigerant changes its state periodically from steam to liquid and from liquid to steam and thus transfer the heat from inside the refrigerator to the outside so as to achieve refrigeration.

[0056] In the refrigerator of the present invention adopts the refrigerant R134a. Other refrigerants in the prior art may also be used in the embodiments that are not most preferred.

[0057] When designing the refrigerator of the present invention, the researchers investigate in detail the configuration of the refrigeration system, the evaporator and the specific configuration of the evaporator and make a conclusion that due to the configuration of the arts in existence, the refrigerator of the present invention has reduced noise and improved thermal efficiency, specified as follows:

[0058] First, the prior art shows that plate type evaporator (direct cooling mode) bring down the temperature by the low-temperature natural convection near its surface and the advantages are that the humidity and the performance of preservation is favorable, energy is saved and the effective volume is larger when volume is the same. Fin type evaporators (air-cooling mode) force a circulation by blowing forcibly cooled air through air ducts into refrigerators and the advantages are automatic defrosting and homogeneous temperature while the disadvantages are low humidity in the freezer compartment and the food easily air dried and dehydrated, high energy consuming and low effective volume.

[0059] The characteristics of the refrigerator of the present invention are that both freezing and refrigerating adopt direct cooling mode, the direct cooling in the freezer compartment adopts fin type evaporator, the deficit of refrigerating effect in the freezer compartment is remediated by the thermal transfer through the baffle plate of the ice making room and the ice making room adopts air-cooling mode. As described before, the refrigerating effect of the ice making room adopting air-cooling mode can also be transferred through the baffle plate to cool the freezer compartment.

[0060] With respect to the characteristics of the present invention, if conventional fin type evaporator is used in the freezing room as direct cooling, certain problems will arise. The researchers of the present invention further investigate the fin type evaporators and the results show that various factors may affect the efficiency of the fin type evaporators. Please refer to FIG. **2**(*a*) to FIG. **2**(*f*).

[0061] The conclusion is that the relative humidity of the air has great effect on the performance of the evaporator, especially in a circumstance of high humidity. The efficiency of the evaporator (η_0) and the average heat exchange coefficient on the air side (K_0) drop abruptly along with the extended operating time of the evaporator. Thus, the control of the relative humidity of the air has great effects on the evaporator.

[0062] In addition, the fin pitch also affects the performance of the evaporator greatly. The performance of the evaporator that has a wide fin pitch evidently excels that of the evaporator that has a close fin pitch. When the fin pitch is about 4 mm, the performance of the evaporator drops sharply. The fin pitch of over 6 mm is always adopted under a low temperature operating condition. A fin pitch of 6-8 mm of the evaporator is preferred.

[0063] Whereas the air-cooling mode is characterized as a rapid refrigeration means, a high humidity in the ice making room may result in the drop of efficiency of the evaporator. In the light of the conflict, a fin type evaporator is adopted in the freezer compartment and parameters relating to the fins of the evaporator etc. are chosen so that a relatively perfect balance is achieved.

[0064] In order to select further, the researchers make a selection as to the shape of the fins of the evaporator. Please refer to FIGS. **3**, **4**. The geometry parameters of the three types of the evaporator are listed as follows.

		Fin types		
		Discrete flat fins (1)	Continuous flat fins (2)	Spiral fins (3)
Tube arrangement method		coaxial	staggered	coaxial
No. of rows of tubes		7	10	5
No. of layers of tubes		2	2	2
External diameter(mm)		8.5	7.9	9.4
Heat exchanger dimension(mm)	width	260	310	300
	thickness	62	55	65
	height	220	200	150

-continued

		Fin types		
		Discrete flat fins (1)	Continuous flat fins (2)	Spiral fins (3)
Heat exchange area on the air side(mm)	tubes	0.097	0.16	0.085
	fins	0.7	0.9	0.5
	total	0.8	1	0.6

[0065] The conclusion shows that the efficiency of evaporator (**3**) excels that of the other two evaporators as the mixed air-cooling and direct cooling mode of the freezer compartment of the present invention and thus is a preferred embodiment in the present invention.

[0066] In order that a optimal efficiency is achieved, the freezer compartment and the refrigerator compartment of the present invention adopt two different kind of evaporator, wherein:

[0067] Said freezer compartment of the refrigerator adopts fin type evaporator; the freezer compartment is operated in direct cooling mode while the refrigeration in the ice making room is achieved by a forced convection of air in the room by a chilling fan. When the preset temperature of the ice making room is reached, the chilling fan stops. If the preset temperature of the freezer compartment hasn't been reached, the evaporator of the freezer compartment keeps on working and when the preset temperature is reached in the freezer compartment, the temperature control unit will send an impulse signal to the impulse solenoid valve which takes action to switch off the refrigeration cycle of the refrigerant.

[0068] A heating filament is set on said fin type evaporator. In case defrosting is needed, the timer controls the heater and the heater is heated up to melt the ice formed on the fins.

[0069] Said fin type evaporator is installed closely to the liner of the freezer compartment, in charge of the refrigeration of the freezer compartment and the ice making room. A clearance is formed on the other side of the evaporator in the freezer compartment and the air in the ice making room is circulated and cooled by the chilling fan. The characteristics of the ice making room are rapid refrigeration, fast temperature drop rate and that the ice cubes are transparent and bright.

[0070] Thus, the selection of refrigeration system of the present invention is completed. Hereinafter the design of the ice making machine is described.

[0071] The automatic ice making of the refrigerator of the present invention is to realize in control and structure an integrated ice making process which the ice making system can accomplish automatically and cycle, so as to achieve automatic ice making of the refrigerator. Please refer to FIG. **4** for the process.

1) Ice check: determine whether the ice has been made or not by temperature.

2) Ice removing: remove the ice from the ice making box to the ice storage box.

3) Water intake: inject water into the ice making box by pump or valve.

4) Delay and wait for the changing of the water in the ice making box into ice.

EMBODIMENTS

Embodiment 1

[0072] Please refer to FIG. **4**. The ice machine of the present invention comprises the following parts: (1) The control box comprises a motor, a reduction gear, an axis of rotation, and copper tinsels. The copper tinsels are mounted in the plow grooves in the body, which is similar to the mechanical timer aforetime. When the ice machine is electrified, the motor rotates and the copper tinsels form different connections and disconnections which form different connections of circuits so as to achieve various travels of the ice machine. (2) Intermediate connection box, the main function of which is connecting the control box and the ice making box. A dual-tinsel temperature controller is mounted on the body of the box, which controls the ice making time and the heating time of the heater. (3) The ice making box comprises an ice detecting lever, an ice removing lever, an ice tray and a heater. When the ice storage box which is set under the ice machine is full of ice cubes, the ice cubes push up the ice detecting lever and the power of the ice machine is cut and the ice machine stops working. The ice detecting lever may also be used to stop the ice machine manually. The ice removing lever is an ice separation device which can be turned. When the ice cubes have been made, the heater is electrified and starts heating and the ice cubes are detached from the ice tray. The ice removing lever turns a certain degree to push the ice cubes out of the ice making box.

Embodiment 2

[0073] As an embodiment of the present invention, a defrosting process is provided, wherein evaporator, fins and a heating tube is involved. An electric heating filament is set inside the heating tube and the space between the heating filament and the heating tube is filled with insulating material. The form of the heating tube is determined according to the form of the evaporator, in which all modes used in the prior art can be adopted in the present invention.

Embodiment 3

[0074] This embodiment provides that the freezer compartment adopts a mixed air-cooling and direct cooling mode while the refrigerator compartment adopts direct cooling mode. FIG. **1** can be referred to for details.

Embodiment 4

[0075] This embodiment is the same as embodiment 3 provided that in order to form a lower temperature in the ice making room, the air inlet and air outlet **6**, **7** is mounted with air doors, which can be opened and closed when necessary.

Embodiment 5

[0076] This embodiment is the same as embodiment 3 provided that said freezer compartment adopting a mixed air-cooling and direct cooling mode is mounted with an ice machine. FIG. **1** can be referred to for details.

Embodiment 6

[0077] This embodiment is the same as embodiment 3 provided that the heater for defrosting the evaporator in the freezer compartment is in contact with the water inlet of the ice machine. When it is detected that the water inlet is jammed due to low temperature, the heater is started to clear the malfunction of the water inlet.

What is claimed is:

1. A multi-temperature control refrigerator, in which an ice machine is installed and the cooling mode of the refrigerator

is a mixed air-cooling and direct cooling mode, comprises a refrigerator compartment and a freezer compartment which further comprises an ice making room, wherein said refrigerator compartment and freezer compartment adopt direct cooling mode for refrigeration and said ice making room adopts a mixed air-cooling and direct cooling mode for refrigeration.

2. A refrigerator as claimed in claim **1**, wherein said freezer compartment adopts fin type evaporator; the fin pitch of said fin type evaporator is over 6 mm, preferably 6-8 mm; said fin is preferably spiral fins.

3. A refrigerator as claimed in claim **1**, wherein said ice making room is mounted with a door which encloses the space of the ice making room; said ice making room is set at the upper part of the freezer compartment.

4. A refrigerator as claimed in claim **1**, wherein in the space where the evaporator of said freezer compartment presents, a air inlet (**6**) and air outlet (**7**) connecting the ice making room are installed; a door is preferably installed at the air outlet (**7**) and/or the air inlet (**6**) of the ice making room.

5. A refrigerator as claimed in claim **1**, wherein said refrigerator compartment adopts plate type evaporator which sticks to the inner liner of the refrigerator compartment; said freezer compartment adopts a mixed air-cooling and direct cooling mode and one side of the evaporator also sticks to the inner liner of the freezer compartment while behind the other side there is a gap; a heating tube is preferably set on the evaporator of the freezer compartment and the form of the heating tube is determined according to the form of the evaporator.

6. A refrigerator as claimed in claim **1**, wherein the heater for defrosting the evaporator in said freezer compartment is in contact with the water inlet of the ice machine.

7. A refrigerator as claimed in claim **1**, wherein said freezer compartment and refrigerator compartment is each installed with temperature sensing units and an action sensor is set inside the ice making room.

8. A refrigerator as claimed in claim **1**, wherein said refrigerator adopts dual cycle refrigeration system and an evaporator that is large in area is connected to the bypass circuit as an additional evaporator of the refrigerator compartment.

9. A refrigerator as claimed in claim **1**, wherein said refrigerator comprises an additional evaporator for the refrigerator compartment; the outlet of the compressor is connected to the inlet of the condenser; the outlet of the condenser is connected to the inlet of the desiccation filter; the outlet of the desiccation filter is connected to the three-way solenoid valve; one outlet of the three-way solenoid valve is connected to the inlet of the main capillary tube, the other outlet is connected to the inlet of the bypass capillary tube; the outlet of the main capillary tube is connected to the inlet of the freezing evaporator; the outlet of the bypass capillary tube is connected to the inlet of the additional refrigerating evaporator; the outlets of the freezing evaporator and the additional refrigerating evaporator are both connected to the inlet of the refrigerating evaporator; the outlet of the refrigerating evaporator is connected to the inlet of the water storage apparatus and; the outlet of the water storage apparatus is connected to one end of the air intake tube and the other end is connected to the inlet of the compressor.

10. A working method for the refrigerator as claimed in claim **1**, wherein whether the ice making process is to be carried out or not is determined when the refrigerator is operating and if the ice making process is to be commenced, the evaporator of the freezer compartment is started and the fan is also started to cool the ice making room quickly to an ice-making quick-freezing temperature; when determining the ice making room is at a temperature-maintaining state or not and if the temperature doesn't reach the preset ice-making maintaining temperature, the evaporator of the freezer compartment is started and the fan is also started to cool the ice making room quickly to the ice-making maintaining temperature.

11. A method as claimed in claim **10**, wherein the quick-freezing temperature and the maintaining temperature of the ice making room are set below the preset temperature of the freezer compartment; preferably, the maintaining temperature of the ice making room is the same as the preset temperature of the freezer compartment.

12. A method as claimed in claim **11**, wherein the quick-freezing temperature and the maintaining temperature of the ice making room are set distinctively below the preset temperature of the freezer compartment.

13. A method as claimed in claim **10**, wherein when the freezer compartment has reached the preset temperature and the refrigerator compartment hasn't, the bypass circuit is turned on; the main evaporator of the refrigerator compartment of the main circuit, which has a relative small area for evaporation, is combined with an additional evaporator of the refrigerator compartment, which has a relative larger area for evaporation, and forms an evaporator of the refrigerator compartment that has very large evaporation area so as to adjust the temperature of the refrigerator compartment rapidly.

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