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(54) Title: A COOLING DEVICE COMPRISING AN ICE MAKING COMPARTMENT AND THE CONTROL METHOD THEREOF

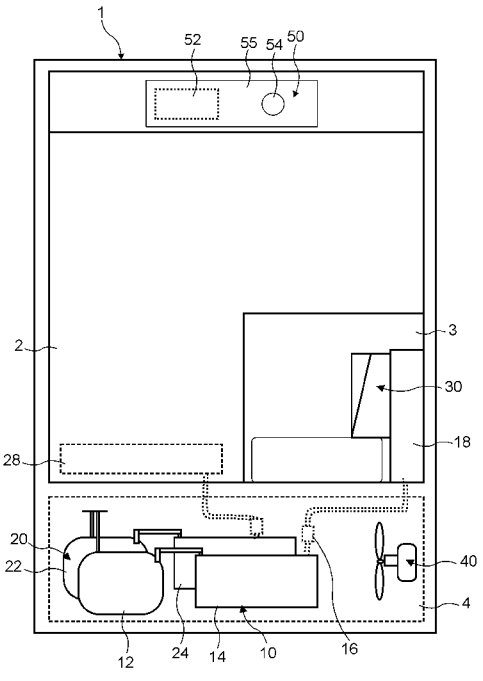


Figure 1

(57) Abstract: A cooling device comprising a refrigeration compartment (2) and an ice making compartment (3) provided in a thermally-insulated cabin (1); a first evaporator (18) that is provided in the ice making compartment (3) and that is configured to be activated when an ice making cycle (10) is started; a second evaporator (28) that is provided in the refrigeration compartment (2) so as to provide cooling air and that is configured to be activated when a refrigeration cycle (20) is started, and a condenser assembly (14, 24) that is connected to the first evaporator (18) and the second evaporator (28) so as to provide refrigerant transmission, a cooling fan (40) that delivers the cooling air to the condenser assembly (14, 24) and a control unit (50) that adjusts the rotational speed of the cooling fan (40).

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Description

A COOLING DEVICE COMPRISING AN ICE MAKING COMPARTMENT AND THE CONTROL METHOD THEREOF

[0001] The present invention relate to cooling device, in particular domestic refrigerators, having automatic ice making compartments and to the control methods thereof.

[0002] In refrigerators, ice cubes are obtained by means of automatic ice making machines that are disposed in a separate compartment or that are associated with an evaporator directly used for ice production. During the ice production process, while the refrigeration compartments of the refrigerators are operated to carry out the functions thereof by means of an algorithm controlling the refrigeration cycle, a separate control method is used for the ice making machine.

[0003] The Patent Publication No. US20100326093A discloses a method of controlling temperature for forming ice within an icemaker compartment of a refrigerator. The method includes the steps of activating at least one of the compressor and the coolant pump during an icemaking cycle to make ice at a first rate in the icemaker compartment, and increasing operation of at least one of the compressor and the coolant pump to make ice at a second rate, which is faster than the first rate.

[0004] The aim of the present invention is to improve the energy efficiency of cooling devices with an ice making function.

[0005] The present invention realized in order to attain the said aim is a cooling device comprising a refrigeration compartment and an ice making compartment provided in a thermally-insulated cabin; a first evaporator that is provided in the ice making compartment and that is configured to be activated when an ice making cycle is started; a second evaporator that is provided in the refrigeration compartment so as to provide cooling air and that is configured to be activated when a refrigeration cycle is started, and a condenser assembly that is connected to the first evaporator and the second evaporator so as to provide refrigerant transmission. The cooling device comprises a cooling fan that delivers the cooling air to the condenser assembly and a control unit that controls the state of the ice

making cycle and the refrigeration cycle and adjusts the rotational speed of the cooling fan to a predetermined active rotational speed value in accordance with the heating amount of the condenser assembly. The control unit adapts the active rotational speed to the heat produced by the condenser assembly, thus preventing the refrigeration assembly from decreasing. The condenser assembly can be a single coil condenser or a plurality of condensers. For example, condensers each separately connected to the first and second evaporators corresponding to the refrigeration cycle and the ice making cycle can be used. By means of a common cooling fan, the cooling air can be delivered to the separate condensers constituting the condenser assembly.

[0006] In a preferred embodiment of the present invention, the cooling device comprises a memory module wherein a maximum fan rotational speed value is stored for the cooling fan of which the active rotational speed is adjusted by the control unit when the first evaporator and the second evaporator are activated. The control unit accesses the memory module and receives the suitable rotational speed value for the cooling fan, for example the rotational speed value in case of maximum rotation, thus adjusting the active rotational speed. The rotational speed values stored in the memory module are stored in the memory module in accordance with the experiments that are previously conducted by the producer.

[0007] In a preferred embodiment of the present invention, the memory module is configured to store the condenser normal cooling speed value predetermined in accordance with the heating value corresponding to the case wherein only one of the first evaporator or the second evaporator is activated, so as to transmit the said predetermined value to the control unit. The normal cooling speed values enable the cooling fan to rotate at a preadjusted speed so as to provide the cooling corresponding to the heating value of the condenser assembly when only the refrigeration cycle or the ice making cycle is active. The normal cooling speed is a value lower than the maximum cooling speed.

[0008] A preferred embodiment of the present invention comprises an activation member that can be accessed from the outside and that is connected to

the control unit in signal transmission such that the control unit starts the ice making cycle. The activation member enables the user to obtain ice when required with interaction from the outside. In a preferred embodiment of the present invention, the activation member is in the form of a control panel provided on the cabin. Thus, if ice is needed, the user can activate the ice making cycle via the control panel. Alternatively, the activation member can be operated by transmitting a signal to the control unit from a remote smart device.

[0009] In a preferred embodiment of the present invention, the cooling device comprises an ice making machine that is provided adjacent to the first evaporator in the ice making compartment and that is configured to produce ice when the control unit starts the ice making cycle. The ice making machine provides the production of ice when the first evaporator is activated with the ice making cycle of the cooling device.

[0010] In a preferred embodiment of the present invention, the control unit is configured to reset the active rotational speed when the ice making cycle and the refrigeration cycle are terminated. Thus, energy is saved by stopping the cooling fan.

[0011] A preferred embodiment of the present invention comprises the operational steps of starting the ice making cycle by the control unit; determining whether the refrigeration cycle is active or not, and increasing the active rotational speed if the refrigeration cycle is active. Since the condenser assembly heats up when the second evaporator starts cooling with the refrigeration cycle, the additional temperature increase that occurs with the ice making cycle by means of the increase in the cooling fan speed is prevented from decreasing the ice making efficiency.

[0012] A preferred embodiment of the present invention comprises the operational steps of terminating the ice making cycle by the control unit; determining whether the refrigeration cycle is active or not, and decreasing the active rotational speed if the refrigeration cycle is active. The control unit continues to rotate the cooling fan at a predetermined lower rotational speed suitable for cooling the condenser assembly required by the refrigeration cycle. Decreasing the cooling fan speed enable the cooling

device to consume less energy.

[0013] A preferred embodiment of the present invention comprises the operational steps of terminating the refrigeration cycle by the control unit and resetting the active rotational speed. Since the condenser assembly does not require cooling if both the refrigeration cycle and the ice making cycle are deactivated, the cooling fan is stopped and energy consumption is decreased.

[0014] A cooling device realized in order to attain the aim of the present invention is illustrated in the attached figure, where:

[0015] Figure 1 - is the schematic view of a representative embodiment of a cooling device having the ice making compartment and a separate refrigeration cycle and a separate ice making cycle.

[0016] The elements illustrated in the figures are numbered as follows:

[0017] 1 Cabin

[0018] 2 Refrigeration compartment

[0019] 3 Ice making compartment

[0020] 4 Machine compartment

[0021] 10 Ice making cycle

[0022] 12 First compressor

[0023] 14 First condenser

[0024] 16 Capillary

[0025] 18 First evaporator

[0026] 20 Refrigeration cycle

[0027] 22 Second compressor

[0028] 24 Second condenser

[0029] 28 Second evaporator

[0030] 30 Ice making machine

[0031] 40 Cooling fan

[0032] 50 Control unit

[0033] 52 Memory module

[0034] 54 Activation member

[0035] 55 Control panel

[0036] w_{set} Active rotational speed

[0037] w_{max} Maximum rotational speed

[0038] w_{buz} Ice making rotational speed

[0039] $w_{soğutma}$ Cooling rotational speed

[0040] Figure 1 shows the schematic view of a domestic refrigerator comprising a thermally-insulated cabin (1) that has a machine room (4) disposed at the bottom part thereof and that surrounds a refrigeration compartment (2) and an ice making compartment (3) disposed in the latter. At the upper part of the refrigeration compartment (2), a control unit (50) in the form of an electronic circuit board (PCB) is provided.

[0041] A first compressor (12) and a second compressor (22) that are operated by the control unit (50) are disposed in the machine room (4). From one end the first compressor (12) is connected to a first condenser (14) in fluid communication. The first condenser (14) is a coil condenser of wire-on-tube (WOT) type. From one end, the first condenser (14) delivers the refrigerant cooled by the latter and leaving the first compressor (12) to a first evaporator (18) provided in the ice making compartment (3) through a capillary (16). From a first surface, the first evaporator (18) bears against an ice making machine (30). The first compressor (12), the first condenser (14) and the first evaporator (18) together constitute an ice making cycle (10).

[0042] A second compressor (22) disposed in the machine room (4) is connected to a second condenser (24) in the form of a coil condenser in refrigerant transmission. The second condenser (24) in turn is connected to a second evaporator (28). The second evaporator (28) is fixed on the cabin (1) so as to open into the refrigeration compartment (2). The second compressor (22), the second condenser (24) and the second evaporator (28) together constitute a refrigeration cycle (20).

[0043] A cooling fan (40) is positioned in the machine room (4) opposite to both the first condenser (14) and the second condenser (24). The cooling device (40) is connected to the control unit (50) so as to transmit electricity.

[0044] In order to refrigerate the foodstuffs in the refrigeration compartment (2) of the refrigerator, an operational temperature of approximately +4°C is

maintained by provided control by means of sensors (not shown in the figures). This temperature can be changed by the user via a control panel (55) connected to the control unit (50) so as to transmit electric signals. The refrigeration cycle (20) can be activated/deactivated by the control unit (50) in order to maintain the operational temperature. When the refrigeration cycle (20) is activated, the second compressor (22) is operated by the control unit (50) and the refrigerant is compressed and sent to the second condenser (24). While being passed through the second condenser (24), the refrigerant heated by the second compressor (22) while being compressed is cooled by the ambient heat since the machine room (4) is open to the outer environment. The cooling fan (40) is operated by the control unit (50) to provide forced convection. The heating amount of the second condenser (24) during the refrigeration cycle (20) and the temperature to which the cooling fan (40) must decrease the second condenser (24), and the predetermined cooling rotational speed ($w_{soğutma}$) that determines the cooling amount of the cooling fan (40) when the refrigeration cycle (20) is active are stored in an internal memory module (52) of the control unit (50). When the refrigeration cycle (20) is activated, the control unit (50) quickly accesses the memory module (52) and reads the cooling rotational speed ($w_{soğutma}$), and defines an active rotational speed (w_{set}) as the cooling rotational speed ($w_{soğutma}$) for the cooling fan (40).

[0045] When the user desires to obtain ice by means of the refrigerator, he/she gives the ice production command via the corresponding button (not shown in the figures) on the control panel (55) and enables the control unit (50) to active the ice making cycle (10). With the ice making cycle (10), the control unit (50) activates the first compressor (12). The refrigerant is compressed in the first compressor (12) and sent to the first condenser (14). The refrigerant heated in the first condenser (14) is cooled by providing heat transfer with the ambient air. The control unit (50) checks whether the refrigeration cycle (20) is still active or not through the signal showing the operational status of the cooling fan (40). If the cooling fan (40) is not active, the cooling fan (40) is operated to deliver air to the first

condenser (14) by forced convection. The temperature to occur on the first condenser (14) and the output temperature desired to be obtained by means of the ice making cycle (10) are known. Accordingly, the ice making rotational speed (w_{buz}) for the cooling fan (40) stored in the memory module (52) and determining the cooling amount when the ice making cycle (10) is active is determined as the active rotational speed (w_{set}) by the control unit (50). If the control unit (50) determines that the refrigeration cycle (20) is active, the active rotational speed (w_{set}) is determined as equal to the total of the cooling rotational speed ($w_{soğutma}$) and the ice making rotational speed (w_{buz}). In an alternative embodiment, the active rotational speed (w_{set}) can be determined by only increasing the cooling rotational speed for example by 10%. This resulting increased cooling fan rotational speed defines the maximum fan rotational speed (w_{max}).

[0046] The ice making cycle (10) is completed with the termination signal transmitted from the ice making machine (30) to the control unit (50). In this case, the first compressor (12) is deactivated by the control unit (50). Subsequently, the control unit (50) checks whether the refrigeration cycle (20) is active or not when the ice making cycle (10) is completed. If the refrigeration cycle (20) is not active, the active rotational speed (w_{set}) is reset and the cooling fan (40) is turned off. The turning off process can be realized in a delayed manner by means of a time limit relay. If the control unit (50) detects that the refrigeration cycle (20) is still active, the active rotational speed (w_{set}) of the cooling fan (40) is decreased as much as the ice making rotational speed (w_{buz}). Thus, the cooling fan (40) is slowed so as to consume less energy.

Claims

1. A cooling device **comprising** a refrigeration compartment (2) and an ice making compartment (3) provided in a thermally-insulated cabin (1); a first evaporator (12) that is provided in the ice making compartment (3) and that is configured to be activated when an ice making cycle (10) is started; a second evaporator (22) that is provided in the refrigeration compartment (2) so as to provide cooling air and that is configured to be activated when a refrigeration cycle (20) is started, and a condenser assembly (14, 24) that is connected to the first evaporator (12) and the second evaporator (22) so as to provide refrigerant transmission, **characterized by** a cooling fan (40) that delivers the cooling air to the condenser assembly (14, 24) and a control unit (50) that controls the state of the ice making cycle (10) and the refrigeration cycle (20) and adjusts the rotational speed of the cooling fan (40) to a predetermined active rotational speed value (w_{set}) in accordance with the heating amount of the condenser assembly (14, 24).
2. A cooling device as in Claim 1, comprising a memory module (52) wherein a maximum fan rotational speed (w_{max}) value is stored for the cooling fan (40) of which the active rotational speed (w_{set}) is adjusted by the control unit (50) when the first evaporator (12) and the second evaporator (14) are activated.
3. A cooling device as in Claim 2, wherein the memory module (52) is configured to store the condenser normal cooling speed (w_{normal}) value predetermined in accordance with the heating value corresponding to the case wherein only one of the first evaporator (14) or the second evaporator (24) is activated, so as to transmit the said predetermined value to the control unit (50).
4. A cooling device as in any one of the above claims, comprising an activation member (54) that can be accessed from the outside and that is connected to the control unit (50) in signal transmission such that the control unit (50) starts the ice making cycle (10).
5. A cooling device as in any one of the above claims, wherein the activation member (54) is in the form of a control panel (55) provided on the cabin (1).
6. A cooling device as in any one of the above claims, comprising an ice making machine (30) that is provided adjacent to the first evaporator (12) in the ice making compartment (3) and that is configured to produce ice when the control

unit (50) starts the ice making cycle (10).

7. A cooling device as in any one of the above claims, wherein the control unit (50) is configured to reset the active rotational speed (w_{set}) when the ice making cycle (10) and the refrigeration cycle (20) are completed.
8. A control method for a cooling device as in any one of the above claims, comprising the operational steps of starting the ice making cycle (10) by the control unit (50); determining whether the refrigeration cycle (20) is active or not, and increasing the active rotational speed (w_{set}) if the refrigeration cycle (20) is active.
9. A control method as in Claim 8, comprising the operational steps of terminating the ice making cycle (10) by the control unit (50); determining whether the refrigeration cycle (20) is active or not, and decreasing the active rotational speed (w_{set}) if the refrigeration cycle (20) is active.
10. A control method as in Claim 9, comprising the operational steps of terminating the refrigeration cycle (20) by the control unit (50) and resetting the active rotational speed (w_{set}).

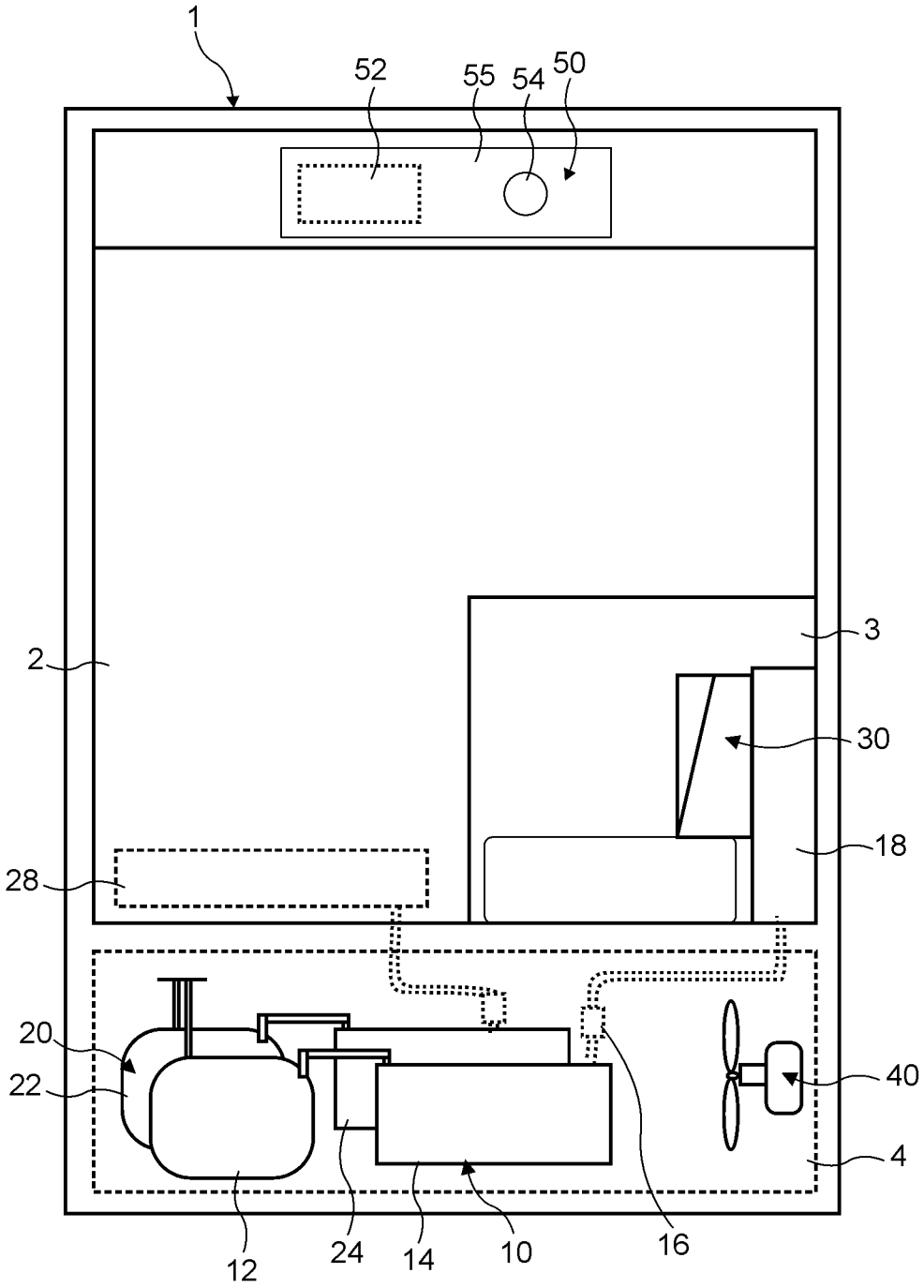


Figure 1

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/069692

A. CLASSIFICATION OF SUBJECT MATTER
INV. F25D11/02 F25C1/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F25D F25B F25C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 2002/134095 A1 (TEMMYO MINORU [JP] ET AL) 26 September 2002 (2002-09-26) paragraphs [0062], [0063]; figures 2, 5-10 -----	1-3,8-10 4,5
X	US 6 397 608 B1 (SAKUMA TSUTOMU [JP] ET AL) 4 June 2002 (2002-06-04) figures 2,5 -----	1,6,7
Y	US 2006/065008 A1 (PARK YONG P [KR]) 30 March 2006 (2006-03-30) paragraphs [0035], [0036]; figure 1 -----	4,5

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 October 2017	26/10/2017

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

Information on patent family members

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