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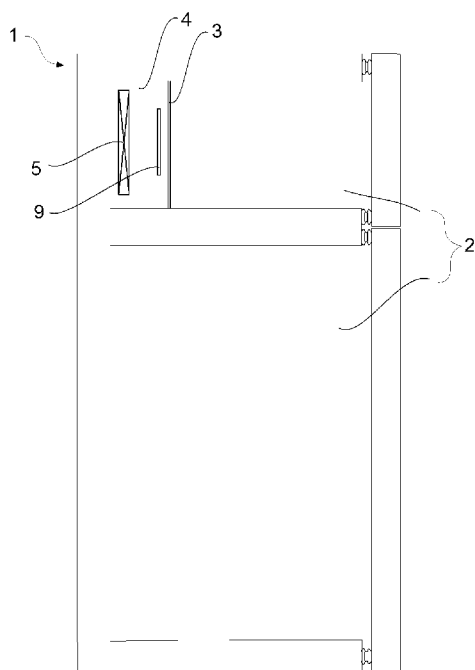
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(54) Title: A COOLING DEVICE

Figure 1



(57) Abstract: A cooling device (1) comprising a compartment (2) wherein food-
stuffs desired to be cooled are placed, a receptacle (4) that is disposed in the com-
partment (2) and that is separated from the compartment (2) by means of a panel (3),
an evaporator (5) that is disposed in the receptacle (4) and that provides the cooling
of the compartment (2); at least one light source (6) that is configured to emit light
at the wavelength of the color of the evaporator (5) and at wavelengths different
from the color of the evaporator (5); at least one color sensor (7), that is disposed
in the compartment (2) and that detects the light reflected from the evaporator (5)
surface, and an electronic card (9) having a control unit (8) that compares the values
detected by the color sensor (7) with the values predetermined by the producer so
as to decide whether there is frost on the evaporator (5).



Description**A COOLING DEVICE**

- [0001] The present invention relates to a cooling device with increased cooling efficiency.
- [0002] In cooling devices, frost on the evaporator adversely affects the cooling performance and decreases the energy efficiency of the cooling device. Heaters are used to remove or prevent said frost on the evaporator. Said heaters consume energy to remove the frost and adversely affect the energy efficiency of the cooling device by increasing the ambient temperature. Said heaters do not operate depending on the frost formation or the thickness of the frost, but operate according to time or temperature values. Therefore, the heaters may operate early or late or more or less than needed. In order to maintain the energy efficiency of the cooling device, the frost on the evaporator and the thickness thereof must be detected before operating the heater. Various methods are used to detect the frost on the constantly-cooled evaporator and the thickness thereof.
- [0003] In the method of detection of frost with light, one of the methods used for detecting the frost on the evaporator, light is sent onto the evaporator surface and if there is no frost, said light is reflected from the evaporator surface. The reflection is detected by light sensors and the light intensity is measured. In case of frost, the intensity of the light received by the light sensor decreases due to the light being absorbed by the ice and being reflected from the ice so as to scatter. Said value compared with the light intensity measured in case of the absence of frost is used to determine the amount of frost on the evaporator. The main problem with this method is that the ice being white increases its reflectance and the use of white light in the determination of the frost thickness causes disadvantages. Therefore, the frost cannot be linearly detected. In the first case caused as a result of this, frost may form on the evaporator, thus decreasing the energy efficiency of the cooling device. In the second case, the heater may be operated more than required, similarly, decreasing the energy efficiency of the cooling device.
- [0004] In the state of the art United States Patent Document No. US9328953, a

system is disclosed, providing the detection of the frost on the evaporator.

[0005] The aim of the present invention is to detect the frost on evaporators used in cooling devices.

[0006] In the cooling device realized in order to attain the aim of the present invention, explicated in the first claim and the respective claims thereof, at least one compartment wherein the foodstuffs to be cooled are placed is provided. A receptacle separated by means of a plate-shaped panel from the compartment is provided in said compartment. An evaporator is disposed in the receptacle, and by means of said evaporator the receptacle and the compartment are cooled, thus enabling the foodstuffs placed into the compartment to preserve their freshness for a long time. A part of the outer surface of the evaporator is colored with a color determined by the producer and suitable for reflecting the light at a certain wavelength. A light source is disposed so as to be aligned with the colored area. Said light source is configured to emit light at the wavelength of the colored area and at a wavelength different from said wavelength. The light source is disposed on a color sensor detecting the light reflected from the evaporator surface. The light emitted by the light source first reaches the evaporator surface and is reflected from there depending on the wavelength of the color of the colored area or partially absorbed. The reflected light reaches the color sensor and thus the reflectance of the light can be calculated. The intensities of the light emitted and of the light received are compared by means of a control unit. The ratio of the intensities of the light emitted and of the light received are compared with values predetermined by the producer. Said process is repeated with lights at different wavelengths, and the lights at different wavelengths produce different absorption rates on the colored area of the evaporator. As a result of the comparison, the control unit decides whether there is frost on the evaporator surface. The control unit is disposed on the electronic card. Thus, the frost on the evaporator and the thickness of the frost are detected, the defrosting operation is carried out only in case of the presence of the frost and the energy efficiency of the cooling device is increased.

- [0007] In an embodiment of the present invention, the evaporator extends almost parallel to the panel. Thus, the light source, the color sensor, the control unit and the electronic card are disposed on the panel, providing ease of production.
- [0008] In an embodiment of the present invention, the light source is configured to emit light at the wavelengths of blue, green and red. By using light in different colors, the intensity of the light reflected from the colored area on the evaporator differs. The ratio therebetween is compared with the values predetermined by the producer and thus the amount of frost on the evaporator can be detected. Consequently, the defrosting operation is carried out in case of the presence of frost and according to the amount of frost, decreasing the energy consumption of the cooling device.
- [0009] In an embodiment of the present invention, the light source has at least one photodiode. By means of the narrow peak wavelength range of the photodiodes and depending on the wavelength of the light produced by the same, said light is substantially reflected from or absorbed by the colored area of the evaporator. Thus, in case of the absence of frost on the colored area, only the light at the wavelength of the color of the colored area is reflected and the lights at other wavelengths are substantially absorbed and an accurate measurement can be made. In case of frost, all the wavelengths are reflected from the surface with frost at similar rates and thus the presence of frost can be detected.
- [0010] In an embodiment of the present invention, the color sensor is disposed on the electronic card. Thus, ease of assembly is provided and labor costs are decreased.
- [0011] In an embodiment of the present invention, the light source is disposed on the electronic card. Thus, ease of assembly is provided and labor costs are decreased.
- [0012] In an embodiment of the present invention, the peak light absorption wavelength of the color sensor is between 655-665nm. The range of 655-665nm among the lights at different wavelengths reflected from the evaporator to reach the color sensor is detected at the most. Thus, selectivity against certain wavelengths is provided. The peak light

absorption wavelength of the color sensor which is 655-665nm matches with the wavelength of the color of the part of the evaporator colored by the producer, thus the frost can be precisely measured.

[0013] In another embodiment of the present invention, the peak light absorption wavelength of the color sensor is between 560-570nm. The range of 560-570nm among the lights at different wavelengths reflected from the evaporator to reach the color sensor is detected at the most. Thus, selectivity against certain wavelengths is provided. The peak light absorption wavelength of the color sensor which is 560-570nm matches with the wavelength of the color of the part of the evaporator colored by the producer, thus the frost can be precisely measured.

[0014] In an embodiment of the present invention, the peak light absorption wavelength of the color sensor is between 425-435nm. The range of 425-435nm among the lights at different wavelengths reflected from the evaporator to reach the color sensor is detected at the most. Thus, selectivity against certain wavelengths is provided. The peak light absorption wavelength of the color sensor which is 425-435nm matches with the wavelength of the color of the part of the evaporator colored by the producer, thus the frost can be precisely measured.

[0015] By means of the present invention, the frost on the evaporator that adversely affects the operational efficiency of the cooling device can be detected.

[0016] A cooling device realized in order to attain the aim the object of the present invention is illustrated in the attached figures, where:

[0017] Figure 1 - is the sideways cross-sectional view of the cooling device.

[0018] Figure 2 - is the sideways view of the evaporator and the control card.

[0019] Figure 3 - is the rear view of the control card in front of the evaporator.

[0020] Figure 4 - is the front view of the control card.

1. Cooling device
2. Compartment
3. Panel
4. Receptacle
5. Evaporator

6. Light source
7. Color sensor
8. Control unit
9. Electronic card

[0021] The cooling device (1) of the present invention comprises

- at least one compartment (2) wherein foodstuffs desired to be cooled are placed,
- a receptacle (4) that is disposed in the compartment (2) and that is separated from the compartment (2) by means of a panel (3), and
- an evaporator (5) that is disposed in the receptacle (4) and that provides the cooling of the compartment (2).

[0022] The cooling device (1) of the present invention comprises the evaporator (5) of which at least a part of the outer surface is colored with a color determined by the producer and suitable for reflecting the light at a certain wavelength; at least one light source (6) that is disposed so as to be aligned with the evaporator (5) and that is configured to emit light at the wavelength of the color of the evaporator (5) and at wavelengths different from the color of the evaporator (5); at least one color sensor (7) whereon the light source (6) is disposed, that is disposed in the compartment (2) and that detects the light reflected from the evaporator (5) surface, and an electronic card (9) having a control unit (8) that compares the values detected by the color sensor (7) with the values predetermined by the producer so as to decide whether there is frost on the evaporator (5).

[0023] The cooling device (1) of the present invention comprises the compartment (2) wherein the foodstuffs to be cooled are placed. The receptacle (4) is produced so as to be adjacent to said compartment (2) in the cooling device (1) and is separated from the compartment (2) by means of the panel (3). The evaporator (5) providing the cooling of the compartment (2) and hence the foodstuffs placed into the compartment (2) is disposed in the receptacle (4). During the operation of the evaporator (5), the temperature of the evaporator (5) drops below zero and thus, free water vapor thereon, in particular on the center thereof condenses so as to form frost. A part of the evaporator (5) is colored with a color

predetermined by the producer. The light source (6) is disposed so as to be aligned with said colored area and is configured to emit light at the wavelength of the color of the colored area and at wavelengths different therefrom. The light emitted by the light source (6) onto the evaporator (5) is reflected to return to the color sensor (7) disposed on the light source (6). The color sensor (7) transmits the detected light intensity to the control unit (8) so as to be compared with the values predetermined by the producer. The control unit (8) compares the received value with the predetermined values and decides whether there is frost on the evaporator (5). The control unit (8) is disposed on the electronic card (9). Thus, in case of absence of frost on the evaporator (5), the defrosting process causing high energy consumption is not started, thereby the energy consumption of the cooling device (1) is decreased and the operational efficiency thereof is improved.

[0024] The cooling device (1) of the present invention comprises the evaporator (5) that extends almost parallel to the panel (3). By positioning the evaporator (5) parallel to the panel (3), the panel (3) provides an area for positioning the light source (6) and the color sensor (7) to be aligned with the colored area of the evaporator (5), thus providing ease of assembly.

[0025] The cooling device (1) of the present invention comprises the light source (6) that emits light at the wavelengths of blue (450-495nm), green (495-570nm) and red (620-750nm). By emitting light at different wavelengths, the amount of frost can be measured. In case of absence of frost, the lights emitted by the light source (6) at the wavelengths of blue, green and red are reflected from the evaporator (5), and the intensity (I1) of the light with the wavelength closest to the wavelength of the color of the colored area is more than the other two light intensities (I2 and I3). Thus, the control unit (8) detects the color of the colored area. At the beginning of frosting, similarly, the lights emitted by the light source (6) at the wavelengths of blue, green and red are reflected from the evaporator (5), and in this case, while the intensity (I4) of the light with the wavelength closest to the wavelength of the color of the colored area decreases, but is still more than the other two light intensities (I5 and I6) ($I4 > I5$ and $I4 > I6$).

The control unit (8) compares the values (I_1 and I_4) and if $I_1 > I_4$, decides that the frosting has started on the evaporator (5). In case the evaporator (5) is completely covered with frost, the lights emitted by the light source (6) at the wavelengths of blue, green and red are reflected from the evaporator (5) and the color sensor (7) measures the intensity of the reflected lights. In this case where the light intensities of three colors are respectively I_7 , I_8 and I_9 , due to the frost and according to the amount of the frost, each of the three values converges to zero ($I_7 = I_8 = I_9 = 0$). The intensities of lights at the wavelengths of blue, green and red reflected in different cases (I_1 , I_4 , I_7 and I_2 , I_5 , I_8 and I_3 , I_6 , I_9) are respectively compared with the values predetermined by the producer by means of the control unit (8) and thus information corresponding to the presence of frost and if any the thickness of the frost and the area covered by the frost is obtained. Thus, the operational efficiency of the cooling device (1) is improved and the energy consumption is decreased.

[0026] The cooling device (1) of the present invention comprises the light source (6) having at least one photodiode. By means of the narrow peak wavelength range of the photodiodes, with the photodiodes emitting light at a wavelength similar to the wavelength of the color of the colored area of the evaporator (5), almost the entire light falling on the colored area is reflected and with the photodiodes emitting light at a different wavelength, almost the entire light falling on the colored area is absorbed. Thus, the frost can be precisely measured and the operational efficiency of the cooling device (1) is improved and the energy consumption is decreased.

[0027] The cooling device (1) of the present invention comprises the electronic card (9) at the center of which the color sensor (7) is disposed. By disposing the color sensor (7) on the electronic card (9), ease of production and assembly is provided.

[0028] The cooling device (1) of the present invention comprises the electronic card (9) whereon the light source (6) is disposed. By disposing the light source (6) on the electronic card (9), ease of production and assembly is provided.

[0029] The cooling device (1) of the present invention comprises the electronic

card (9) having the color sensor (7) of which the peak light absorption wavelength is within the range of 655-665nm. By means of the narrow light sensitivity range of the color sensor (7), the sensitivity thereof against lights at other wavelengths and thus, the lights at other wavelengths are prevented from causing interference in the control unit (8) during the measurement of the thickness of the frost and a precise measurement is provided.

[0030] The cooling device (1) of the present invention comprises the electronic card (9) having the color sensor (7) of which the peak light absorption wavelength is within the range of 560-570nm. By means of the narrow light sensitivity range of the color sensor (7), the sensitivity thereof against lights at other wavelengths and thus, the lights at other wavelengths are prevented from causing interference in the control unit (8) during the measurement of the thickness of the frost and a precise measurement is provided.

[0031] The cooling device (1) of the present invention comprises the electronic card (9) having the color sensor (7) of which the peak light absorption wavelength is within the range of 425-435nm. By means of the narrow light sensitivity range of the color sensor (7), the sensitivity thereof against lights at other wavelengths and thus, the lights at other wavelengths are prevented from causing interference in the control unit (8) during the measurement of the thickness of the frost and a precise measurement is provided.

[0032] In an embodiment of the present invention, the light source (6) in the cooling device (1) is configured to emit light at the wavelengths of 425-435nm, 560-570nm and 655-665nm. Thus, the need for using more than one light source (6) is eliminated and the product costs are decreased.

[0033] In an embodiment of the present invention, the color sensor (7) in the cooling device (1) is configured to detect light at the wavelengths of 425-435nm, 560-570nm and 655-665nm. Thus, the need for using more than one color sensor (7) is eliminated and the product costs are decreased.

[0034] By means of the present invention, in the cooling devices (1), it is detected whether there is frost on the evaporator (5) during and after the cooling process, and if any, what the thickness of the frost is and how large the area covered by the frost is.

Claims

1. A cooling device (1) **comprising**
 - at least one compartment (2) wherein foodstuffs desired to be cooled are placed,
 - a receptacle (4) that is disposed in the compartment (2) and that is separated from the compartment (2) by means of a panel (3),
 - an evaporator (5) that is disposed in the receptacle (4) and that provides the cooling of the compartment (2),**characterized by**
 - the evaporator (5) of which at least a part of the outer surface is colored with a color determined by the producer and suitable for reflecting the light at a certain wavelength;
 - at least one light source (6) that is disposed so as to be aligned with the evaporator (5) and that is configured to emit light at the wavelength of the color of the evaporator (5) and at wavelengths different from the color of the evaporator (5);
 - at least one color sensor (7) whereon the light source (6) is disposed, that is disposed in the compartment (2) and that detects the light reflected from the evaporator (5) surface, and
 - an electronic card (9) having a control unit (8) that compares the values detected by the color sensor (7) with the values predetermined by the producer so as to decide whether there is frost on the evaporator (5).
2. A cooling device (1) as in Claim 1, **characterized by** the evaporator (5) that extends almost parallel to the panel (3).
3. A cooling device (1) as in any one of the above claims, **characterized by** the light source (6) that emits light at the wavelengths of blue (450-495nm), green (495-570nm) and red (620-750nm).
4. A cooling device (1) as in any one of the above claims, **characterized by** the light source (6) that has at least one photodiode.
5. A cooling device (1) as in any one of the above claims, **characterized by** the electronic card (9) at the center of which the color sensor (7) is disposed.
6. A cooling device (1) as in any one of the above claims, **characterized by** the electronic card (9) whereon the light source (6) is disposed.

7. A cooling device (1) as in any one of the above claims, **characterized by** the electronic card (9) having the color sensor (7) of which the peak light absorption wavelength is within the range of 655-665nm.
8. A cooling device (1) as in any one of Claims 1 to 6, **characterized by** the electronic card (9) having the color sensor (7) of which the peak light absorption wavelength is within the range of 560-570nm.
9. A cooling device (1) as in any one of Claims 1 to 6, **characterized by** the electronic card (9) having the color sensor (7) of which the peak light absorption wavelength is within the range of 425-435nm.

Figure 1

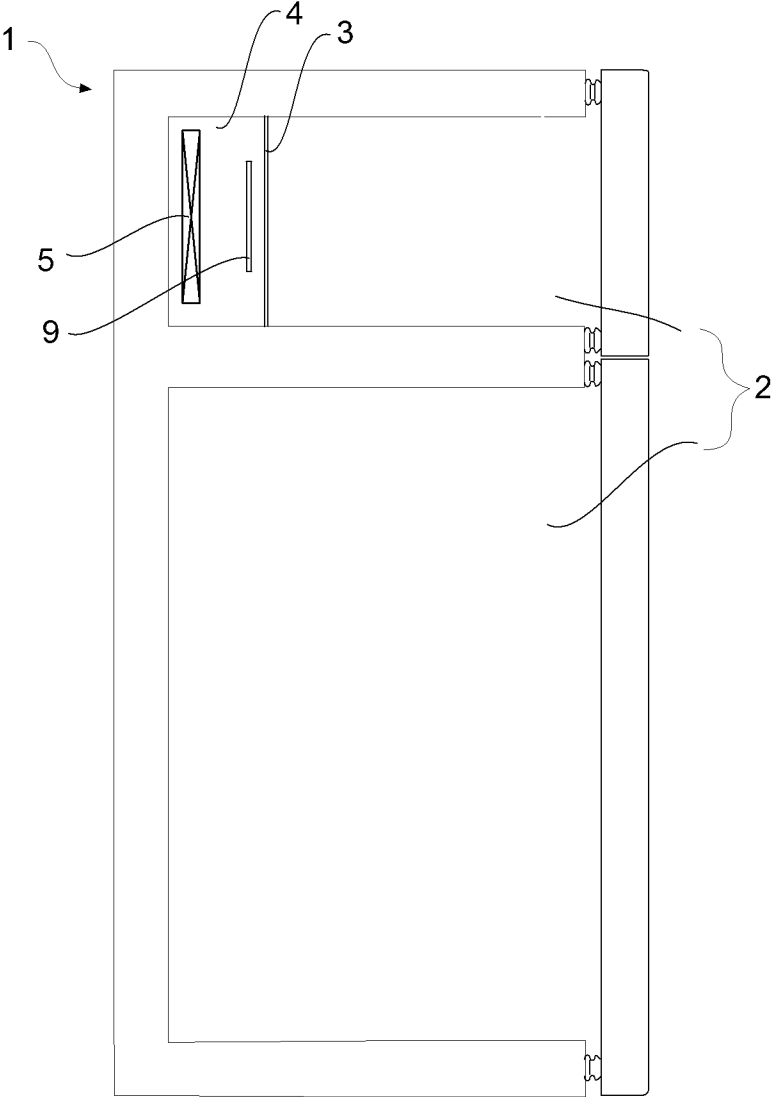


Figure 2

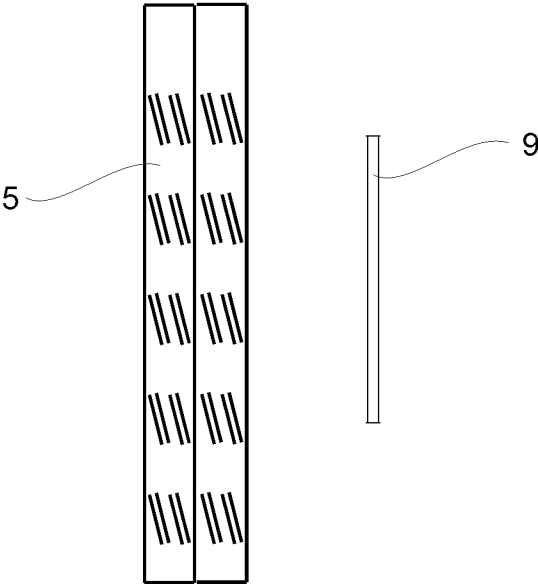


Figure 3

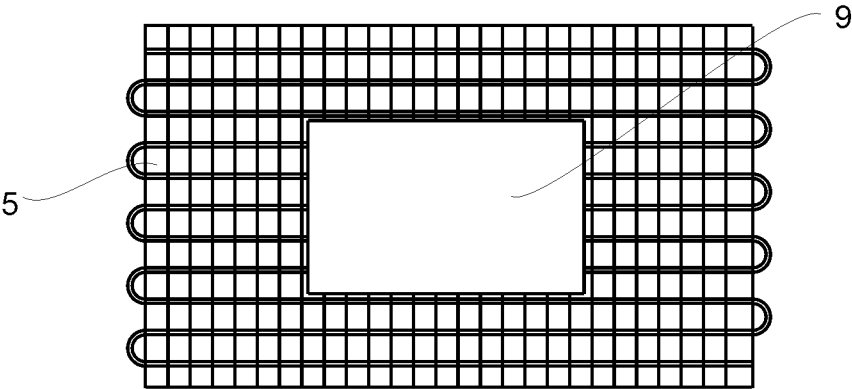
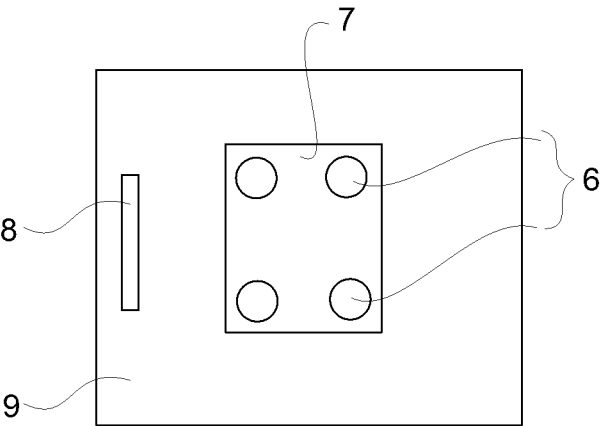


Figure 4



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2018/054735

A. CLASSIFICATION OF SUBJECT MATTER

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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 G01N

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	JP 2007 271168 A (MITSUBISHI ELECTRIC CORP) 18 October 2007 (2007-10-18) paragraphs [0013], [0019], [0033], [0034]; figures 1, 4 -----	1-9
X	EP 1 620 686 A1 (DANTHERM AIR HANDLING AS [DK]) 1 February 2006 (2006-02-01) paragraph [0021]; figure 1 -----	1,2,4,6
X	US 9 459 038 B1 (READ ROBERT MICHAEL [US]) 4 October 2016 (2016-10-04) figure 2 -----	1-4
A	JP S58 28966 A (MITSUBISHI ELECTRIC CORP) 21 February 1983 (1983-02-21) paragraph [0001]; figure 3 -----	7-9



Further documents are listed in the continuation of Box C.



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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2007271168	A	18-10-2007	NONE

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