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(54) **Mono-door refrigerator and method for controlling such refrigerator**

(57) A mono-door refrigerator (10) comprises a fresh food compartment (12) with a temperature sensor and a freezer compartment (14), a refrigerating circuit with compressor, evaporator, condenser and a control circuit connected to the temperature sensor and to the compressor. The control unit is adapted to assess the time elapsed from the last activation of the compressor and to compare this value to a threshold value, and to switch on the compressor if the assessed value is higher than the threshold.

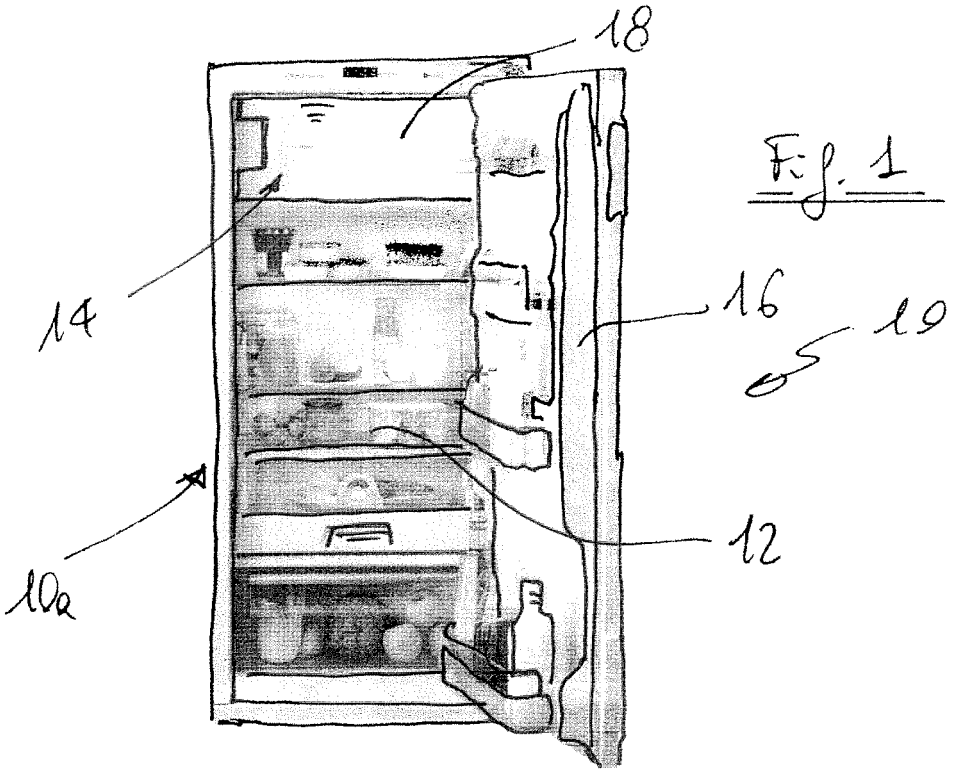


Fig. 1

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## Description

**[0001]** The present invention relates to a refrigerator comprising a fresh food compartment with a temperature sensor device and a freezer compartment, the refrigerator comprising a refrigerating circuit with compressor, evaporator, condenser and a control unit connected to the temperature sensor device and to the compressor.

**[0002]** This kind of refrigerators, known also as "mono-door fridge" or "cabinet mono-door", is well known on the market since it has both the advantages of low cost typical of refrigerators with a single door, and of good performances of more expensive double door refrigerators. One of these refrigerators is shown in appended figure 1.

**[0003]** The major problem of this kind of low cost refrigerators is to guarantee proper performances, particularly of the freezer compartment, at low ambient temperatures, for instance in the range from 8° to 15°C, and according to international standards at 10°C. The appliances currently in production for the European market present a heater in contact with the plastic liner wall and foamed in the insulation. Such heater "foamed in" in the cabinet is activated when ambient temperature is lower than a predetermined value, in order to inject heat in the fresh food compartment of the refrigerator and therefore to force a compressor activation to preserve temperature in the freezer compartment, typically below -18°C.

**[0004]** The technical solution currently in production requires additional cost in term of an additional heater element, additional temperature sensor (thermostat) for ambient temperature and wiring connecting such components and the control unit of the appliance. Also when the heater starts working at low ambient temperature, the energy consumption of household appliance increases.

**[0005]** In figure 2 it is shown an example of this kind of known structure with additional heater. With the reference L it is indicated the liner without the insulation foam, in which a cavity L1 for the freezer compartment and a cavity L2 for the fresh food compartment are shown. An evaporator E is fixed to both the cavities, and on the lower portion of the cavity L2 a heater H is fixed, for instance by means of an adhesive.

**[0006]** It is an object of the present invention to provide a refrigerator of the type mentioned above which does not present the above drawbacks and which has a low overall cost, increasing at the same time the overall efficiency of the appliance.

**[0007]** This object is reached thanks to the features listed in the appended claims. The new concept underlying the present invention is based on the elimination of the heater element and on a compensation of low temperature performances driven by controlling the insertion time of the compressor. According to the invention, the control unit of the appliance (for instance a microprocessor) is continuously measuring the time elapsed from the last insertion of the compressor and comparing it to a predetermined threshold value. The electronic is able through a dedicated algorithm to link such time elapsed from the last insertion to ambient temperature and switch-on the compressor (if needed) to keep the fridge + freezer compartment temperature in the correct range of desired temperature values.

**[0008]** According to another feature of the invention, the control unit of the refrigerator is capable of passing from a first control pattern based to the assessment of the non-insertion time (typical of low ambient temperature) to a second control pattern based on the compressor activation on the basis of the temperature of the fresh food compartment.

**[0009]** Further advantages and features of a refrigerator according to the present invention will be clear from the following description, in which:

- figure 1 is a front view of a typical refrigerator in which the present invention is implemented, with its door in an open configuration;
- figure 2 is a perspective view of the liner of a refrigerator according to prior art; and
- figure 3 is a diagram showing the behaviour of a refrigerator according to the invention.

**[0010]** With reference to the drawings, a refrigerator 10 presents a cavity 10a having a fresh food compartment 12 and a freezer compartment 14. The overall cavity is closed by a door 16, and the freezer "4 stars" compartment is closed by a small auxiliary door 18.

**[0011]** Differently from the known refrigerators (figure 2), the refrigerator according to the invention does not present any heater, which moreover increases the overall efficiency of the refrigerator.

**[0012]** With reference to figure 3, it is indicated how the refrigerator according to the invention can switch from a traditional control pattern, in which the compressor is switched-on and off depending on the temperature inside the cavity, particularly the temperature inside the fresh food compartment 12, to a control pattern in which the activation of the compressor is driven by the time elapsed from the last activation of the compressor. The switch zone between such two patterns can be seen in the zone of the diagram where the ambient temperature Ta passes from 20°C to around 13°C. With the line Tm is shown the temperature of the fresh food compartment 12, with Te the average temperature of the evaporator and with Tz the temperature in the freezer compartment 14. With the line C it is indicated the switching on/off of the compressor.

**[0013]** In the following tables a comparison is made between a refrigerator according to the invention and a prior art refrigerator (with heater), both working with an ambient temperature of 10°C.

**at 10°C ambient temperature without heating element we are in the following conditions :**

| Tm fridge | warmest pack. | % running | cycles/h /On/off |
|---|---|---|---|
| +1.8°C | -18.1°C | 17.2 % | 0.30 / 34' / 165' |
| +5.1°C | -14.9°C | 10.9% | 0.34 / 19' / 176' |
| +6.9°C | -10.3°C | 7.39% | 0.20 / 21' / 279' |
| +4.0°C | **-15.9°C** | **13.0 %** | **0.33/24'/157'** |
| **+1.9°C** | **-18.0°C** | **17.0 %** | **0.30/34'/166'** |

| Tm fridge | warmest pack. | % running | cycles/h /On /off |
|---|---|---|---|
| +2.2°C | -17.2°C | 14.2 % | 0.21 / 41' / 244' |
| +4.5°C | -16.1°C | 12.0 % | 0.33 / 22' / 160' |
| +6.7°C | -12.7°C | 8.52 % | 0.27 / 19' / 203' |
| **+4.0°C** | **-16.3°C** | **12.4%** | **0.30 / 25' / 175'** |
| **+0.5°C** | **-18.0°C** | **15.8%** | **0.123 / 77' / 410'** |

**at 10°C ambient temperature with heating element for comparison:**

| Tm fridge | warmest pack. | % running | cycles/h /On / off |
|---|---|---|---|
| +3.1°C | -20.2°C | 17.0 % | 0.94 / 10' / 53' |
| +3.2°C | -19.0°C | 18.5% | 0.93 / 12'/ 52' |

**[0014]** In the above tables with "warmest pack." is meant the temperature of the warmest test package contained in the freezer compartment.

**[0015]** From the above tables it is clear how the present invention allows to have the same or better performances in term of temperatures of fresh food and freezer compartments with a reduce % of running time of the compressor, which means a higher energy saving compared to prior art.

**[0016]** According to the example shown in the first table, if the compressor remains switched off for more than 110', then the compressor is forced to cycle with 12' ON and 65' OFF time at least 5 times until the compressor will be switched on as requested by fridge temperature probe before 110' from the last switching off. If the temperature probe does not request the compressor activation (which means that the ambient temperature remains low) then the forced cycling should be repeated for 5 times.

**[0017]** The above control can be summed up according to the following cycle:

On 12', Off 65', On 12', Off 65' On 12', Off 65', On 12', Off 65'
On 12', Off 65', On 12', OFF 110' than again On 12', Off 65', On 12', Off 65'
On 12', Off 65', On 12', Off 65' On 12', Off 65', On 12', OFF 110'

**[0018]** Up to fridge probe request.

## Claims

1. Refrigerator comprising a fresh food compartment (12) with a temperature sensor device and a freezer compartment (14), the refrigerator comprising a refrigerating circuit with compressor, evaporator, condenser and a control circuit connected to said temperature sensor device and to said compressor, **characterized in that** the control unit is adapted to assess the time elapsed from the last activation of the compressor and to compare this value to a predetermined threshold value, and to switch on the compressor if the assessed value is higher than said threshold value.

2. Refrigerator according to claim 1, wherein the control unit is adapted to switch automatically from a control pattern based on the time elapsed from the last activation of the compressor to a control pattern based on the temperature sensed by said temperature sensor device, and vice-versa.

3. Refrigerator according to claim 1 or 2, wherein the fresh food compartment (12) and the freezer compartment (14)

are closed by a single main door (16)

4. Refrigerator according to any of the preceding claims, wherein the freezer compartment (14) is provided with an auxiliary door (18).

5. Method for controlling a refrigerator having a fresh food compartment (12) and a freezer compartment (14), wherein a compressor of the refrigerating circuit is switched on when the temperature in the fresh food compartment (12) is higher than a predetermined value, **characterized in that** the time elapsed from the last activation of the compressor is assessed and the compressor is switched on if such assessed value is higher than a predetermined threshold value.

6. Method according to claim 5, wherein after having switched on the compressor on the basis of said elapsed time, the compressor is switched on and off for a predetermined amount of times and for a predetermined switch on and switch off times, and then the control is repeated on the basis of the temperature of the fresh food compartment or of said elapsed time.

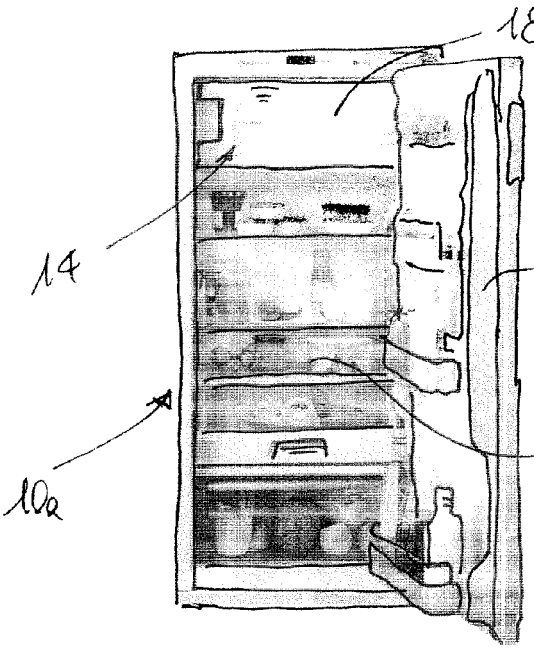


Fig. 1

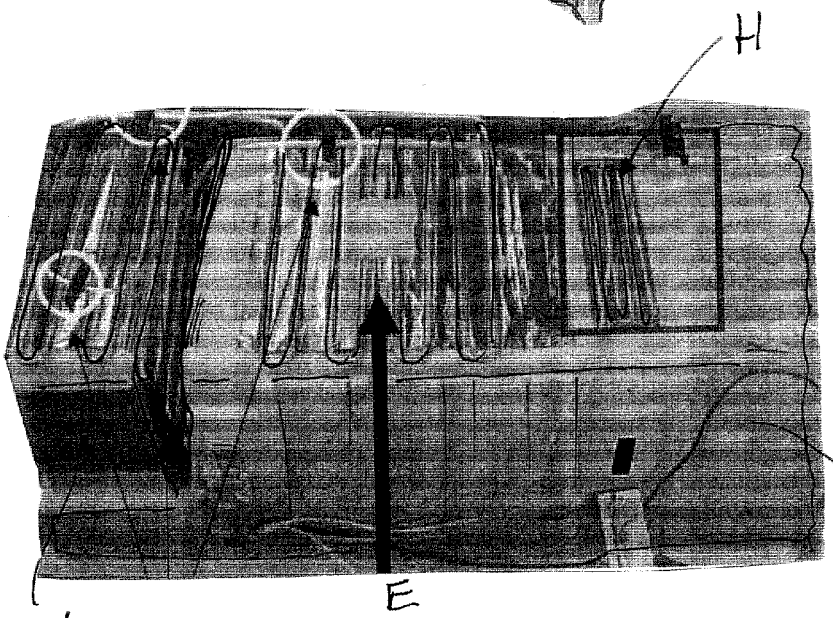


Fig. 2
(PRIOR ART)

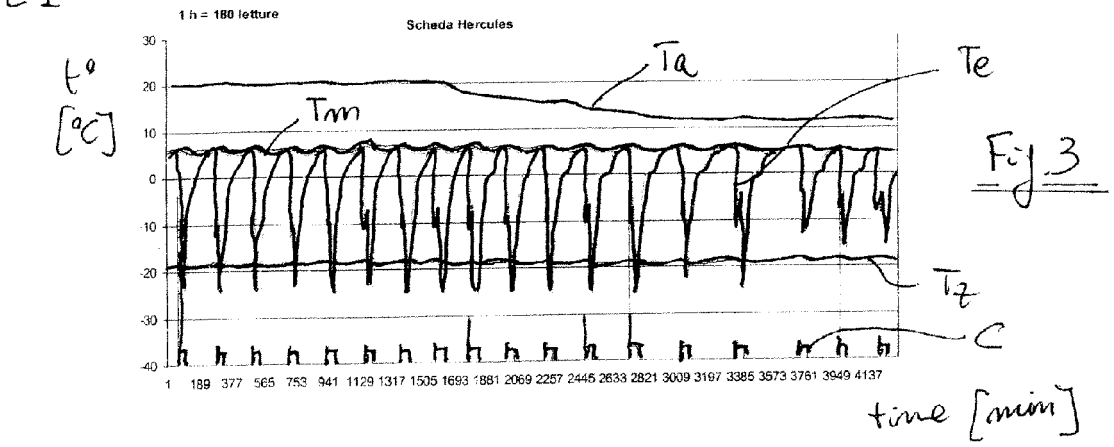


Fig. 3

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# EUROPEAN SEARCH REPORT

Application Number
EP 08 16 6234

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The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| Munich | 10 February 2009 | Amous, Moez |

CATEGORY OF CITED DOCUMENTS

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## ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 08 16 6234

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