(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 1 840 488 A2**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
03.10.2007 Bulletin 2007/40

(51) Int Cl.:
F25D 17/04 *(2006.01)* ***F25D 29/00*** *(2006.01)*

(21) Application number: **07103998.6**

(22) Date of filing: **13.03.2007**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC MT NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR MK YU

(30) Priority: **30.03.2006 IT VA20060013 U**

(71) Applicant: **WHIRLPOOL CORPORATION**
Benton Harbor
Michigan 49022 (US)

(72) Inventors:
- **Beati, Sergio,**
  Patent Dept. Whirlpool Europe s.r.l.
  21025, Comerio (IT)
- **Cassani, Massimo,**
  Patent Dept. Whirlpool Europe s.r.l.
  21025, Comerio (IT)
- **Sicher, Paolo,**
  Patent Dept. Whirlpool Europe s.r.l.
  21025, Comerio (IT)

(74) Representative: **Guerci, Alessandro**
Whirlpool Europe S.r.l.
Patent Department
Viale G. Borghi 27
21025 Comerio (VA) (IT)

(54) **Method for recording malfunctions in a device for introducing and/or modulating the passage of air, placed inside a no-frost refrigerator**

(57) Method for recording the malfunctioning of a device for introducing and/or regulating air, as a result of the formation of ice on its moving parts, and an automatic method for resuming its functionality capable of melting ice that has previously formed, without using heating elements.

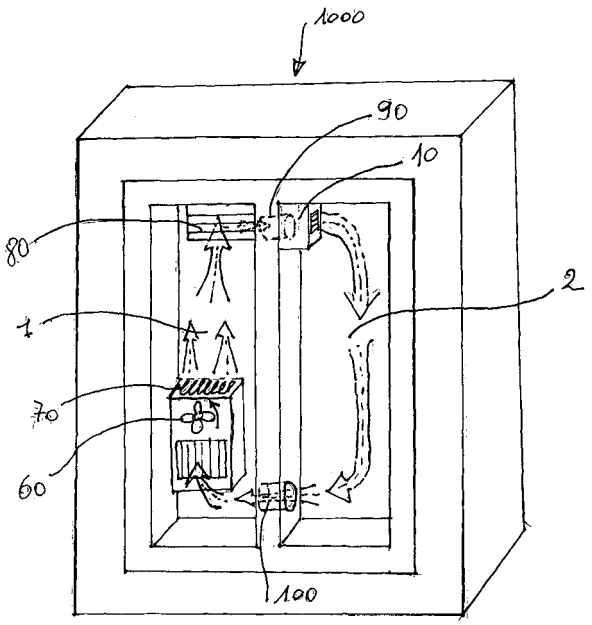

Fig. 2

EP 1 840 488 A2

Description

[0001] The present invention concerns a method for recording malfunctions in a device for introducing and/or modulating the passage of air, placed inside a "no-frost" refrigerator.

[0002] A "no-frost" refrigerator is typically composed of a first refrigerated compartment for preserving frozen foodstuffs, in which a refrigerating unit (typically an evaporator) is located, and of a second refrigerated compartment, cooled with the cold air conveyed from the first compartment by means of a system of conduits (delivery and return), fans and devices for introducing and/or regulating air flow. The second compartment is set to a higher temperature than the first one.

[0003] As an example, while the first compartment is set to a temperature comprised between -12°C and -24°C, the second compartment is set to another temperature comprised within a range, for example, between 0°C and +8°C, in the case of a refrigerator compartment, or between -2°C and +3°C in the case of what is normally called a zone "0-degree".

[0004] One of the operating problems that can normally be found in devices for regulating and/or introducing cold air consists in the formation of ice on the moving parts that open, close and/or regulate the passage of air, preventing any movement of said device. The consequence of this malfunction is that of not subsequently being able to cool the second compartment, if the device jams in the closed position, or of continuously introducing cold air without consequently being able to regulate the temperature of the second compartment, where the device jams in an open position. In both these cases the foodstuffs are not properly preserved in the refrigerator.

[0005] This problem is normally resolved by including in the device suitable heating resistor elements, capable of preventing or eliminating the formation of ice, allowing the device to function normally. Such resistor elements, as well as making the job of the compressor more difficult, reducing the energy efficiency of the household appliance, have a negative effect on the final cost of the product.

[0006] The subject-matter of the present invention is a method for recording the malfunctioning of said device for introducing and/or regulating air, as a result of the formation of ice on its moving parts, and an automatic method for resuming its functionality capable of melting the ice previously formed, without using heating elements.

[0007] The advantages arising from the method according to the present invention can be found in the greater structural simplicity and greater economy of the device. Moreover, the application of the method makes it possible to reduce the energy consumption of the entire refrigerator, keeping its functionality unchanged.

[0008] Further advantages and characteristics of the present invention will become obvious from the following detailed description provided as an example, with reference to the attached drawings in which:

- Figure 1 shows a motorised device for introducing air;
- Figure 2 shows a simplified diagram of the operation of a "no-frost" refrigerator;
- Figure 3 illustrates an outline diagram of the method according to the invention, used in the refrigerator in Figure 2.

[0009] With reference to Figure 1, a known type of device for regulating air flow is indicated with the reference number 10. Said device makes it possible to open/close the passage of air in a "no-frost" refrigerator, by displacing a moving element, or diffuser 20, actuated by an electric motor 30.

[0010] In different embodiments of the device 10, the motor 30 can be replaced by any other movement-generating device. For example, use can be made of generating devices in which the motion is caused by the expansion of gases or liquids (for example, wax), or movement-generating devices that use materials with shape memory.

[0011] The device 10 has end-of travel sensors (not shown) that supply a confirmation signal Sc (Figure 3) to the refrigerator control, said confirmation signal being capable of indicating that the movement of opening/closing the diffuser 20 is completed. The motor 30 is controlled by the refrigerator control (not illustrated). The actuation time Tazm, required by the motor 30 in order to open the diffuser 20 completely or close it completely is, in known devices, approximately 60 seconds. In some devices, said times for opening and closing the diffuser 20 could differ.

[0012] With reference to Figure 2, the "no-frost" refrigerator 1000 is provided with a compressor (not illustrated) connected, in a refrigerating circuit, to an evaporator 70 placed in a first compartment 1, which is set to a temperature T1, comprised between -12°C and -24°C.

[0013] A first temperature-regulation system (not illustrated), records the temperature of the first compartment 1 by means of a first temperature sensor (not illustrated) and sends signals to the refrigerator control for regulating the operation of the compressor, activating/deactivating it or varying its number of revolutions, so as to set the temperature inside the first compartment 1 to the temperature T1.

[0014] A fan 60, placed in the vicinity of the evaporator 70, then sucks in the cooled air conveying it towards the inlet grids 80 of a first air passage 90 so that it can then be introduced inside the second compartment 2. An air introduction device 10, described above, is placed in the first air passage 90 in order to allow or impede the flow of said air to the second compartment 2. A second air return passage 100, always open, connects the second compartment 2 to the first compartment 1. This second

passage 100 it makes it possible to recirculate the air, which is cooled again by passing through the evaporator 70 for a second time.

[0015] The second refrigerated compartment 2 is set to a temperature T2 comprised between +8°C and 0°C, above the temperature T1 of the first compartment 1, by means of a second temperature-regulation system (not illustrated). This second regulation system records the temperature of the second compartment 2 by means of a second sensor (not illustrated) and sends, to the refrigerator control, commands to activate the motor 30 in order to actuate the opening or closing of the diffuser 20 of the air introduction device 10, for the purpose of setting the second compartment 2 to the temperature T2. In a different embodiment the air passage is regulated continuously with the device 10, modulating the opening of the diffuser 20, activating the motor 30 accordingly.

[0016] With reference to Figure 3, which illustrates the method according to the present invention, the motor 30 of the air introduction device 10 is activated for the maximum activation time Taz of 90 sec for the purposes of setting the second compartment 2 to the temperature T2, whenever the second regulation system requests it. This means that if the diffuser 20 is in an open state, it is closed by activating the motor 30, or vice versa. The confirmation signal Sc coming from the end-of travel sensors, is awaited for a waiting time Ta equal to 90 seconds, within which time the movement of opening or closing the diffuser 20 should have been completed. When the confirmation signal Sc is received from the refrigerator control, the activation of the motor 30 ends.

[0017] This waiting time Ta must be at least equal to the greater of the opening and closing times of the diffuser 20 in normal operating conditions.

[0018] In different embodiments, when the opening and closing times of the diffuser 20 differ, the activation times and/or waiting times can differ for each of the movements that the diffuser 20 has to perform.

[0019] If, therefore, following the activation of the motor 30, the confirmation signal Sc is then received within the 90-second waiting time Ta, then the refrigerator continues to function in normal operating mode. In a possible variant of the method, if the confirmation signal Sc is received within the 90-second waiting time Ta, the motor 30 of the air introduction device 10 is activated again causing the diffuser 20 to perform at least one complete opening and closing cycle, for the purpose of removing initial ice formation, finally restoring the diffuser 20 to the requested regulation position (open or closed).

[0020] If no confirmation signal Sc is received within the 90-second waiting time Ta, then the temperature TI1 of first refrigerated compartment 1 at that moment is checked by means of the first temperature-regulation system. If this temperature TI1 is below a threshold temperature TTH equal to -12°C, the refrigerator control jams the compressor and the fans, going into an operating condition Ss of "controlled compressor stall".

[0021] In fact this threshold temperature TTH is the maximum temperature that can be reached by the first compartment 1, in order to be able to ensure that the foodstuffs are preserved properly. This threshold temperature TTH depends on the construction of the refrigerator, and is sometimes dictated by the regulations of the various countries.

[0022] For as long as the "controlled compressor stall" operating condition Ss lasts, the temperature T11 is continuously recorded by the sensor of the first regulation system, being monitored to make sure that its value does not rise above the threshold temperature TTH equal to -12°C.

[0023] Moreover, in the "controlled compressor stall" operating condition Ss, the alarm signal for an unexpected rise in temperature is inhibited.

[0024] In this "controlled compressor stall" operating condition the motor 30 remains activated at all times, in an attempt to move the diffuser 20, while the refrigerator control is still constantly awaiting the confirmation signal Sc.

[0025] It should be noted that, when the motor 30 operates in this "locked rotor" mode, heat develops that can contribute, even significantly, to resolving the situation where the device 10 is jammed due to ice formation.

[0026] If a confirmation signal Sc is received to confirm that the movement is complete, then the motor 30 of the device 10 causes the diffuser 20 to perform a complete opening and closing cycle, for the purpose of removing ice formations definitively, and finally returning the diffuser 20 to the regulation position (open or closed), after which the activation of the motor 30 ends.

[0027] At this point the refrigerator control and the temperature regulation systems go back to functioning in normal operating mode, the malfunction being resolved.

[0028] In an alternative embodiment, in the "controlled compressor stall" operating condition Ss, the motor 30 is activated periodically, rather than constantly and the confirmation signal Sc is awaited, for the waiting time Ta.

[0029] If TI1 rises above the threshold temperature TTH of -12°C, jeopardising the preservation of the frozen foodstuffs, then the refrigerator control and the temperature regulation systems go back to functioning in normal operating mode, starting to cool the first compartment 1 again. An alarm signal can if necessary be generated and be displaced on the user interface of the refrigerator in order to inform the user of the current problem.

[0030] In a subsequent phase, if the temperature T11 of the first compartment 1 again rises above the threshold temperature TTH, the refrigerator control can once more go into the "controlled compressor stall" operating condition Ss, trying again to release the device 10.

[0031] As described in the method according to the invention, it is possible to record the malfunctioning of the device 10 for introducing and/or regulating cold air as a result of the formation of ice on its moving parts, and if necessary to restore its functionality by acting so as to melt the ice previously formed, without using a heating element. The device 10 used in connection with the meth-

od therefore has a simplified construction, since it does not need to include heating elements inside it. This last fact improves the energy consumption of the refrigerator, by reducing it.

Claims

1. Method for recording the malfunctioning of a device (10) for introducing and/or modulating air in a refrigerated zone (1, 2) of a no-frost refrigerator (1000) equipped with compressor and refrigerating circuit, said device (10) being provided with a moving element (20) capable of allowing and/or modulating the passage of air, this moving element (20) being controlled by a motor (30) provided with end-of-travel sensors, which generate a consent signal (Sc), **characterised by** the fact that it comprises;

   - activating the motor (30) for a predetermined activation time (Tazm, Taz),
   - monitoring the consent signal (Sc) for a predetermined waiting time (Ta),
   - where said consent signal (Sc) does not confirm that the moving element (20) has closed/ opened, stopping the compressor for a predetermined period of time.

2. Method according to Claim 1, **characterised by** the fact that at the end of the predetermined period of time when the compressor is stopped, where the consent signal (Sc) confirm that the moving element (20) has opened/ closed, the compressor is restarted.

3. Method according to any one of the preceding claims, **characterised by** the fact that the predetermined activation time (Tazm, Taz) is greater than or equal to the time for opening or closing the moving element (20).

4. Method according to any one of the preceding claims., **characterised by** the fact that the waiting time (Ta) is greater than or equal to the activation time (Taz, Tazm) of the motor (30) of the moving element (20) of the device (10).

5. Method according to any one of the preceding claims, **characterised by** the fact that, where the consent signal (Sc) does not confirm that the moving element (20) has opened/closed, the motor (30) remains activated.

6. Method according to any one of the preceding claims, **characterised by** the fact that the predetermined period of time when the compressor is stopped depends on the refrigerated zone (1, 2) reaching a threshold temperature (TTH).

7. Method according to any one of the preceding claims, **characterised by** the fact that when the compressor is stopped for a predetermined period of time, the alarm signal for an unexpected rise in temperature is inhibited.

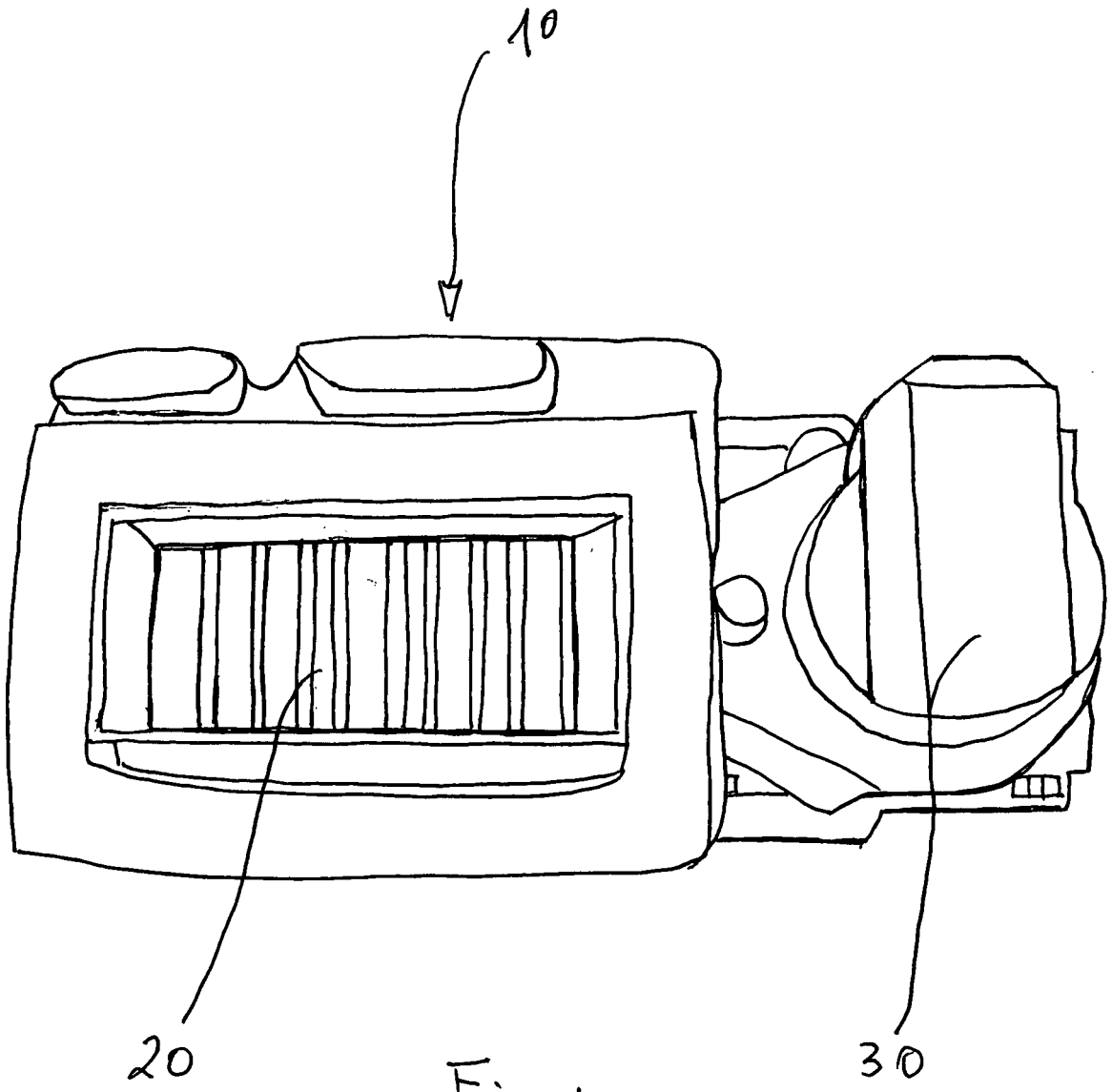

Fig. 1

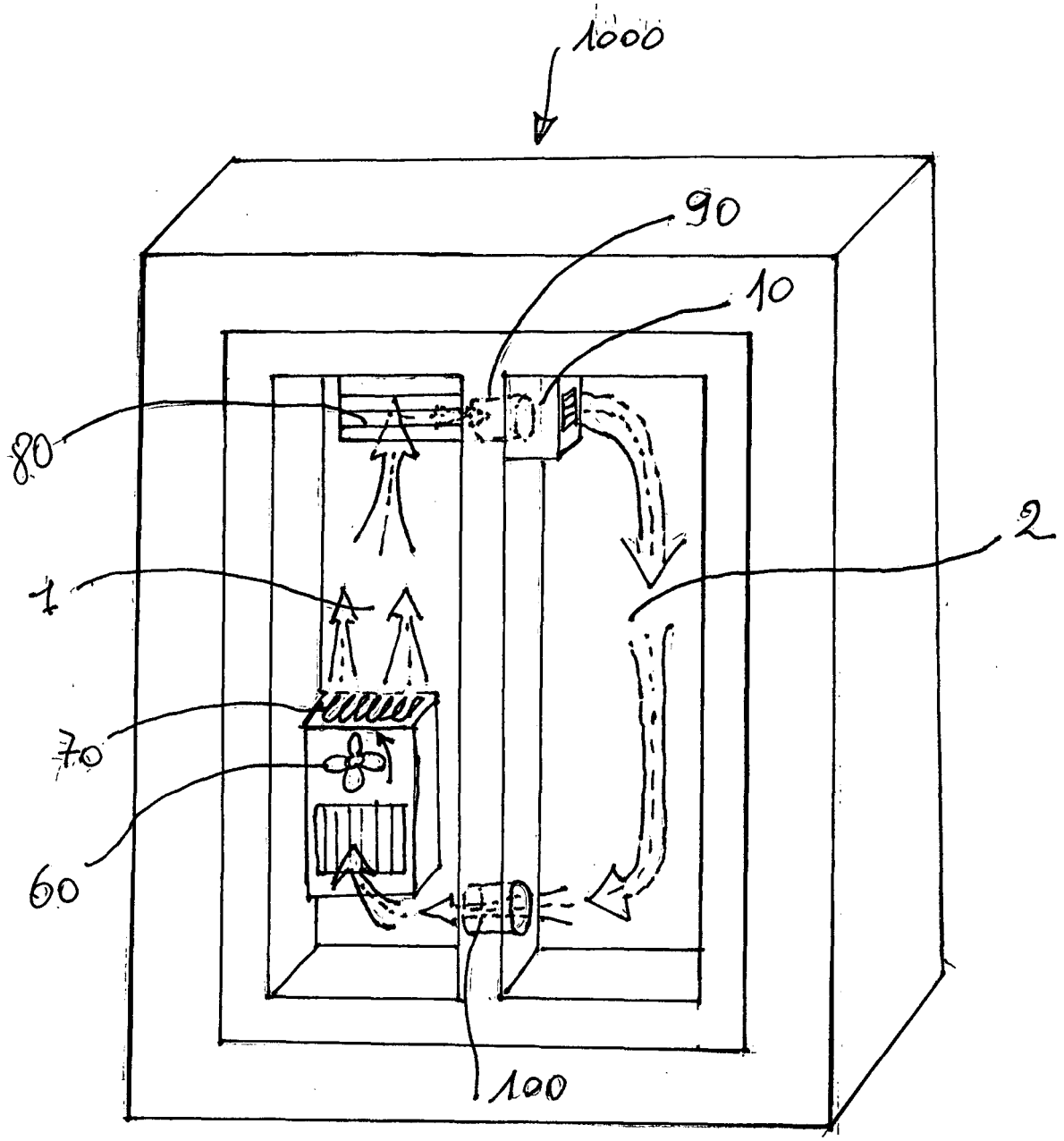

Fig. 2

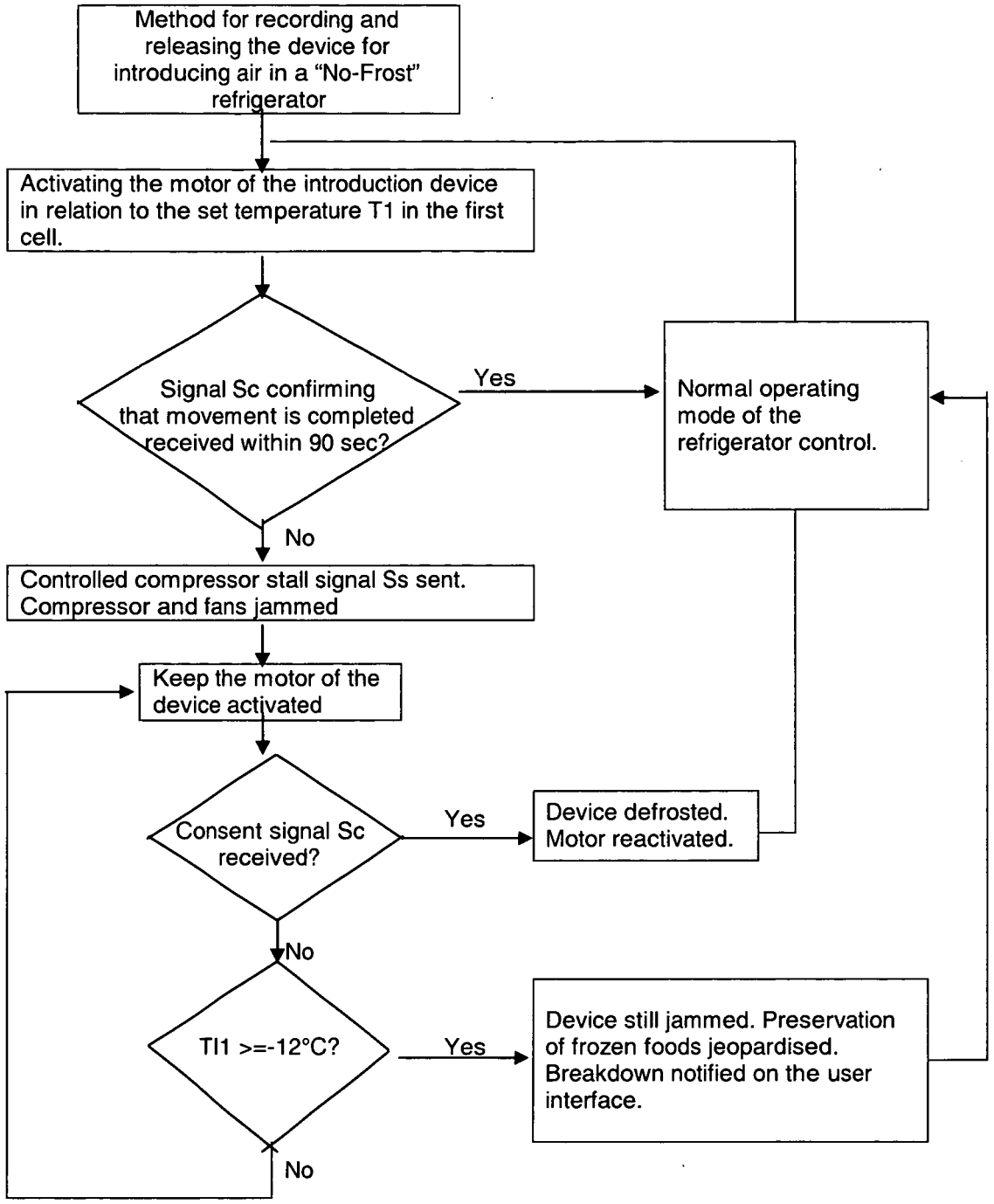
Method for recording and releasing the device for introducing air in a "No-Frost" refrigerator
Activating the motor of the introduction device in relation to the set temperature T1 in the first cell.
Signal Sc confirming that movement is completed received within 90 sec?
Yes
Normal operating mode of the refrigerator control.
No
Controlled compressor stall signal Ss sent. Compressor and fans jammed
Keep the motor of the device activated
Consent signal Sc received?
Yes
Device defrosted. Motor reactivated.
No
TI1 >=-12°C?
Yes
Device still jammed. Preservation of frozen foods jeopardised. Breakdown notified on the user interface.
No

Figure 3