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(54) Method of operation for a household refrigerating apparatus

Betriebsverfahren für ein Haushaltskühlgerät

Procédé de fonctionnement pour une réfrigérateur ménager

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Description

[0001] The present invention relates to a method of operation of a household refrigerating apparatus and to a household refrigerating apparatus implementing said method.

[0002] It is worth stating beforehand that the term household refrigerating apparatus as used in the present description and in the appended claims refers to those refrigerating apparatuses which comprise a first cooled compartment which is typically kept at a temperature between 0 °C and 12°C (commonly called refrigerator compartment) and a second cooled compartment which is typically kept at a lower temperature between -12 °C and -35 °C (commonly called freezer compartment).

[0003] More in particular, the present invention addresses all those refrigerating apparatuses which are commonly referred to as no-frost, wherein the cooling of the foodstuffs stored in both cells is ensured by cold air conveyed therein by a forced ventilation system; the circulating air is cooled by an evaporation-type exchanger, or evaporator, by thermal exchange with a colder refrigerating fluid circulating within a refrigerating circuit that comprises at least one compressor, one condenser and one expansion valve.

[0004] A household refrigerating apparatus of the no-frost type as described above typically produces some operating noise mainly caused by two components: the compressor and the fan of the forced ventilation system; of these two components, the compressor is certainly the one which is more noisy (in terms of noise perceived within the apparatus installation environment), since the fan is arranged inside the apparatus, near the channels that circulate the cold air into both compartments.

[0005] As a matter of fact, when the apparatus is operating normally, the compressor starts whenever cold air must be produced in order to maintain the preset temperature inside the cells: tests carried out have shown that the frequency of compressor intervention in a refrigerating apparatus placed in an environment at 25°C with the cell access doors closed is approximately thirty minutes of continuous operation per hour.

[0006] It can therefore be easily understood that the frequent activation of the compressor represents a source of disturbance, in particular in all those situations where the need of reducing noise is particularly felt, e.g. during the night.

[0007] Some solutions have been conceived in the art, such as the one described in patent KR2001-0081331 to SAMSUNG ELECTRONICS CO LTD, wherein, in order to reduce the noise produced by the apparatus in predetermined time periods, the compressor operating parameters are changed by using a timer or a brightness sensor.

[0008] However, this solution is not optimal, in that the compressor must still be activated, although at lighter operating conditions, in order to keep the compartments at a preset operating temperature, and this prevents total

or almost total silence from being obtained (as required, for example, when a refrigerating apparatus is to be installed near a bed in a one-room or two-room apartment).

[0009] Another solution is disclosed in document US5,355,686, which discloses a method of operation of a household refrigeration apparatus according to the preamble of claim 1 and relates to a dual compartment single evaporator refrigerator and temperature control apparatus that controls two compartment temperatures by making the evaporator fan control independent of the control cycle. However, the solution disclosed in document US5,355,686 is aimed at reaching an advantage that is totally opposite to the teachings of the present invention, since said solution is aimed at reducing the risk of overcooling the freezer compartment.

[0010] The present invention aims at overcoming these and other drawbacks of the systems known in the art through a method of operation for a household refrigerating apparatus according to claim 1.

[0011] The present invention also relates to a household refrigerating apparatus implementing said method.

[0012] The present invention is based on the idea of using the freezer compartment (i.e. the one kept at a lower temperature than the refrigerator compartment) as a tank from which cold air can be taken and conveyed into the refrigerator compartment (operating at a higher temperature) in order to keep the latter at a preset and possibly constant temperature while keeping the compressor off, after the freezer compartment has been brought to a temperature below its normal operating temperature, which condition does not affect the quality of preservation of the foodstuffs stored in such compartment.

[0013] This advantageously allows the compressor to stay off for a long time, approximately three to eight consecutive hours, thereby eliminating any noise related to compressor operation. Further advantageous features will be set out in the appended claims, which are intended as an integral part of the present text.

[0014] These features as well as further advantages of the present invention will become apparent from the following description of an embodiment thereof as shown in the annexed drawings, which are supplied by way of non-limiting example, wherein:

Fig. 1 shows a household refrigerating apparatus; Fig. 2 is a flow chart of the method according to the present invention;

Fig. 3 shows the time trend of the temperatures in the refrigerator compartment and freezer compartment during an operating cycle according to the present invention.

[0015] Fig. 1 shows a no-frost refrigerating apparatus 1 as described above; it comprises a refrigerator compartment 2 and a freezer compartment 3, in fluidic communication with the evaporator 4 of the refrigerating circuit and a fan 5; the air circulated by the fan 5 laps the

evaporator 4, thereby being cooled, and is then admitted into the freezer compartment 3 to refrigerate it, wherefrom it subsequently enters the refrigerator compartment 2 through a channel 6 in order to cool and dehumidify this compartment as well; circulation may be ensured in this case by a second fan 12 arranged at the end of the channel 6; it must however be specified that the second fan 12 is optional, in the sense that it may be omitted.

[0016] The air flow coming from the freezer compartment 3 and directed to the refrigerator compartment 2 is regulated by means of an on-off valve 8 installed in the channel 6 (commonly called "damper" by those skilled in the art), which is shown herein in its simplest form, i.e. a gate that shuts off the cross-section of the channel 6.

[0017] The position of the on-off valve 8 may vary depending on specific implementation requirements; in general, it may be located anywhere along the channel 6 that carries the air from the freezer compartment 3 to the refrigerator compartment 2: for example, if the second fan 12 is not provided, the on-off valve may be installed in its place, i.e. in that part of the channel 6 which is closest to the refrigerator compartment 2.

[0018] The forced air circulation is conceived in a manner such that the air exiting the refrigerator compartment 2 flows back into the freezer compartment 3 through an additional return duct (not shown for clarity), which puts the refrigerator compartment 2 in fluidic communication with the freezer compartment 3, so that the air is cooled down again by the evaporator 4 and a new cycle is started.

[0019] Of course, an on-off valve may be installed on the air return duct as well; however, the characteristics of said return duct and of its on-off valve are not important for understanding the present invention and may vary depending on specific construction requirements.

[0020] The evaporator 4 belongs to a refrigerating circuit of a per se known type, which also includes a compressor 9, a throttling valve 10 and a condenser 11, with all the respective connection pipes (indicated by means of a dashed-dotted line in the drawing).

[0021] Fig. 1 also shows the shelves 13 typically provided in the compartments 2 and 3, the doors 14 and 15 for closing the latter, and two temperature sensors 17 and 18 respectively arranged in the refrigerator compartment 2 and in the freezer compartment 3 and adapted to detect the air temperature, respectively T_f and T_c , within said compartments.

[0022] The fans 5 and 12 and the on-off valve 8 are driven each by a respective electric motor (not shown) controlled by a control unit (not shown) which receives the temperature data read by the sensors 17 and 18 and controls the refrigerating cycle accordingly, e.g. by controlling the operation of the compressor 9.

[0023] In general, of course, the presence of an additional compartment will not affect the method of operation of the refrigerating apparatus 1.

[0024] During the normal operating cycle, the control unit is inputted the temperatures T_f and T_c respectively

detected by the sensors 17 and 18 and then controls the compressor 9, the fans 5 and 12 (if present) and the on-off valve 8 accordingly so as to keep the temperatures in both compartments 2 and 3 within preset values: the average temperature in the refrigerator compartment 2 can typically be set between 2°C and 12°C, whereas the average temperature in the freezer compartment 3 can be set between -18°C and -26°C, in both cases with an oscillation of about 4°C around the set average value.

[0025] More in detail, if during a normal operating cycle the sensors 17 and 18 detect a temperature rise in the refrigerator compartment 2 or in the freezer compartment 3, the compressor 9 will be started, the fans 5 and 12 will be turned on, and the on-off valve 8 will be opened (completely or partially), so as to cool down the freezer compartment 3 and partialize the cold air flow directed therefrom towards the refrigerator compartment 2, thereby adjusting the temperature thereof.

[0026] In this regard, it should be pointed out that during the normal operating cycle the fans 5 and 12 are turned on and the on-off valve 8 is made to open the channel 6 only when the compressor 9 is operating; as soon as the latter is switched off, the fans 5 and 12 will be deactivated and the on-off valve 8 will close the channel 6.

[0027] The method of operation according to the present invention is based on the execution of at least the following steps:

- b) turning off the compressor 9;
- c) taking a cold air flow from the freezer compartment 3 and conveying it into the refrigerator compartment 2, so as to keep the temperature of the latter within predefined minimum and maximum threshold values T_{fmin} and T_{fMAX} .

and wherein the time interval during which the compressor 9 is off is such that the temperature in the freezer compartment 3 does not exceed a predefined threshold value T_{sup} . It is thus possible to adjust the temperature of the refrigerator compartment 2 by taking cold air from the freezer compartment 3 without having to use the compressor 9, thereby making the refrigerating apparatus 1 extremely quiet.

[0028] Taking a cold air flow from the freezer compartment 3 necessarily implies that the temperature of the latter will rise; for this reason, a maximum threshold temperature may be set above which the compressor 9 will be turned on, thus ending the quiet operation mode. Aiming at extending the period of quiet operation (i.e. with the compressor 9 switched off) of the refrigerating apparatus 1, the method provides for carrying out, prior to step b) as previously described, a step a) consisting of bringing the temperature of the freezer compartment 3 down to a value T_{inf} which is lower than the normal operating temperature T_{cn} ; this is made possible by the fact that a decrease in the temperature inside the freezer compartment 3 below the normal operating temperature T_{cn} will

cause no damage to the foodstuffs stored therein, while at the same time allowing the freezer compartment 3 to cool the air directed to the refrigerator compartment 2 for quite a long time before the temperature rising inside the freezer compartment requires that the compressor 9 be turned on again.

[0029] More specifically, step a) is effected by keeping the compressor 9 on for a longer time than normal: for example, if in normal operation the compressor stays on for approximately thirty minutes, in this case it may be kept on continuously for a period which may vary preferably between sixty and one hundred and eighty minutes, and anyway in a manner such that the temperature in the freezer compartment 3 drops below the normal operating temperature T_{cn} (typically $T_{cn} = -18^{\circ}\text{C}$), e.g. until a value T_{inf} in the range of -23°C to -26°C is reached, i.e. five to eight Celsius degrees less than temperature T_{cn} .

[0030] In this respect, it must be pointed out that step a) may be effected by using as a control quantity either the operating time of the compressor 9 or the temperature reached in the freezer compartment 3: such quantities are related in a proportional manner to each other, i.e. the longer the continuous operation of the compressor 9, the lower the temperature reached in the freezer compartment 3. For the purposes of the present invention, either solution may be adopted for executing step a), i.e. it is possible to choose whether the compressor 9 should operate for a preset period of time or, alternatively, until it is detected that a temperature threshold has been reached in the freezer compartment 3.

[0031] After step a) has been carried out, independently of the control quantity employed (operating time or temperature in the freezer compartment 3), the compressor 9 is turned off, thereby starting the quiet operation of the refrigerating apparatus 1: in this situation, the sensors 17 and 18 detect the temperatures T_f and T_c in both compartments 2 and 3 at predefined time intervals (or continuously) and send the data obtained to the control unit. Assuming that the doors 14 and 15 stay closed, the two compartments 2 and 3 will remain at optimal temperatures for a certain period of time, thanks to the gaskets and insulation provided.

[0032] Due to the thermal exchange with the environment surrounding the refrigerating apparatus 1, however, the temperatures in both compartments 2 and 3 will tend to rise again.

[0033] In particular, after a certain time has elapsed, the temperature T_f in the refrigerator compartment 2 will rise above a set threshold value T_{fMAX} (e.g. $T_{fMAX} = 5^{\circ}\text{C}$); on the other hand, the temperature T_c in the freezer compartment 3, which during step a) was brought much below the normal operating temperature (to value T_{inf}), will still remain for a long time at a value below a predefined threshold value T_{sup} , which may be chosen to be equal to the normal operating temperature T_{cn} (e.g. $T_{sup} = T_{cn} = -18^{\circ}\text{C}$).

[0034] When the control unit detects that the preset threshold temperature T_{fMAX} in the refrigerator compart-

ment 2 has been exceeded, it opens the on-off valve 8 and turns on the fan 5 and (if present) also the second fan 12 in order to carry out step c), wherein a cold air flow is taken from the freezer compartment 3 and is conveyed into the compartment at the higher temperature, i.e. the refrigerator compartment 2, until the latter reaches again a preset temperature, e.g. equal to the lower threshold value T_{fmin} , without the help of the compressor 9, which is left off.

[0035] Step c) may be carried out multiple times, at least as long as the temperature inside the freezer compartment 3 remains below the predefined maximum threshold value T_{sup} .

[0036] In this regard, it should be noted that step c) may be effected either continuously or through a certain number of repetitions; in the former case, the on-off valve 8 will always stay at least partially open, and the fans 5 and 12 (if present) will be turned on (possibly at a variable revolution speed) based on the temperature values detected in the refrigerator compartment 2: if the temperature rises, the fan 5 and/or 12 will be turned on and possibly the on-off valve 8 will open a larger section of the channel 6 (in order to let more cold air flow therethrough) for the purpose of lowering the temperature in the refrigerator compartment 2; when the temperature in the latter becomes optimal, the fan 5 and/or 12 will be turned off (or, likewise, the revolution speed thereof will be reduced to the minimum), but the on-off valve 8 will stay open.

[0037] As a preferable alternative, step c) is effected by repeating the steps of opening the on-off valve 8 and activating the fan 5 and/or 12 until the threshold temperature T_{fmin} is reached in the refrigerator compartment 2, which condition will be followed by the fan being turned off and the on-off valve 8 being closed as soon as the temperature in the refrigerator compartment 2 reaches a predefined value.

[0038] In any case, when the sensor 18 detects that the temperature inside the freezer compartment 3 has reached or exceeded a maximum threshold value ($T_c \geq T_{sup}$), the quiet operation cycle will end and the compressor 9 will be turned on again.

[0039] It must be pointed out that in optimal conditions, i.e. when the refrigerating apparatus 1 is placed in an environment at approximately 10°C and the doors 14 and 15 are not open, by setting the threshold values as follows:

$$\begin{aligned} T_{inf} &= -24^{\circ}\text{C} \\ T_{sup} &= -18^{\circ}\text{C} \\ T_{fmin} &= 0^{\circ}\text{C} \\ T_{fMAX} &= 4^{\circ}\text{C} \end{aligned}$$

it will be possible to leave the compressor 9 off for periods of time as long as about eight consecutive hours, thus attaining a substantial improvement over prior-art solutions, wherein the compressor 9 had to be turned on more often, although at lighter operating conditions.

[0040] Even in less favourable conditions, e.g. when

ambient temperature is 35°C, it has been discovered that this solution allows to leave the compressor 9 off for a time longer than three consecutive hours, thus leading to a definite improvement over prior-art systems.

[0041] Of course, repeated openings of the door 15 of the freezer compartment 3 may heavily affect the time of operation with the compressor 9 off. However, it is often desirable that the apparatus be quiet at nighttime, when the compartments of the refrigerating apparatus 1 are accessed relatively seldom (or never at all), so that the behaviour of a refrigerator implementing such a method is deemed to be satisfactory.

[0042] The flow chart of the method of operation according to the present invention is shown in Fig. 2: the operating cycle starts with a first step of turning on the compressor 9, which is kept on for a predefined time (condition TIMER END) or until the temperature in the freezer compartment T_c drops and becomes substantially equal to the threshold temperature T_{inf} (condition $T_c = T_{inf}$), after which the compressor 9 is turned off and the on-off valve 8 is closed.

[0043] The temperature T_f in the refrigerator compartment 2 is then detected: as long as it remains below the maximum threshold T_{fMAX} , no action will be taken.

[0044] When the temperature T_f rises above the maximum threshold value T_{fMAX} , the temperature T_c in the freezer compartment 3 will be verified: if this is lower than the upper threshold value T_{sup} , the on-off valve 8 will be opened and the fan 5 or the second fan 12 (if present) will be turned on in order to direct a cold air flow from the freezer compartment 3 to the refrigerator compartment 2, until the temperature T_f in the refrigerator compartment 2 becomes equal to the lower threshold value T_{fmin} , at which the on-off valve 8 will be closed and the fan(s) 5 and 12 will be turned off.

[0045] If, on the contrary, after the temperature T_f has risen above the maximum threshold value T_{fMAX} , it is verified that the temperature T_c in the freezer compartment 3 is higher than the upper threshold value T_{sup} , then the cycle will be considered to be finished and the compressor 9 will be turned on, the on-off valve 8 will be opened, and the fans 5 and 12 will be turned on in order to restore the temperatures of the normal operating cycle.

[0046] According to an advantageous variant, the threshold temperatures set for the refrigerator compartment 2 are equal to each other, i.e. T_{fmin} is equal to T_{fMAX} .

[0047] In such a case, the system will still operate as described above, except that the temperature in the refrigerator compartment 2 will always be kept substantially around a single predefined value, i.e. $T_{fmin}=T_{fMAX}$.

[0048] In this regard, it must be pointed out that this variant also provides for changing the temperature thresholds of the refrigerator compartment 2 as the compressor 9 is operating continuously during step a): in normal operation, as aforementioned, the cooling of the refrigerator compartment 2 is controlled in a manner such that the temperature of the latter oscillates by about 4°C around a set average value; in this variant of the method,

instead, during step a) the temperature of the refrigerator compartment 2 is already set to the value $T_{fmin}=T_{fMAX}$, i.e. the temperature threshold value to be maintained in the course of the subsequent step c), so that when the latter starts the temperature in the refrigerator compartment 2 will have already reached the value to be maintained when operating with the compressor 9 off.

[0049] Said temperature value $T_{fmin}=T_{fMAX}$ is reached and maintained in the refrigerator compartment 2 by turning on the fans 5 and/or 12 and by opening and closing the on-off valve 8, so as to deliver a variable cold air flow into the refrigerator compartment 2 in order to bring it to the desired temperature $T_{fmin}=T_{fMAX}$ and keep it at that temperature.

[0050] It is important to underline that the solution provided by this variant allows to extend the time during which the compressor 9 stays off and cold air is taken from the freezer compartment 3; in fact, the more the instantaneous temperature inside the refrigerator compartment 2 is kept constant, the less thermal energy must be used for keeping the average temperature constant, and hence the longer the time that the compressor 9 will stay off.

[0051] This solution is shown in Fig. 3, where time (expressed in hours) is indicated on the abscissas and temperature is indicated on the ordinates; the upper bundle of curves C1 shows the temperature trend in various points inside the refrigerator compartment 2, while the lower bundle of curves C2 shows the temperature trend in various points inside the freezer compartment 3.

[0052] As can be seen, in normal operation an operating cycle is activated which comprises the steps of the method according to the present invention: during the above-described step a), the compressor 9 is turned on for a period of time of approx. 80 minutes, during which the temperature in the freezer compartment 3 drops from an initial value (in the steady state of normal operation) of approx. -18°C to a value T_{inf} of approx. -25°C, as shown by the trend of the bundle of curves C2. Within this period of time, the value of the temperature in the refrigerator compartment 2 also drops from a higher initial value to settle around a value T_{fMAX} of approx. 4°C, as shown by the trend of the bundle of curves C1, in accordance with the above discussion.

[0053] When such values are reached, step b) of the above-described method is carried out, wherein the compressor 9 is turned off and the on-off valve is closed.

[0054] Subsequently, for a period of about four hours, the temperature in the refrigerator compartment 2 is kept substantially constant, being ($T_{fmin}=T_{fMAX}$) approximately equal to 5°C, by implementing step c) of the method, i.e. by taking cold air flows from the freezer compartment 3, the temperature of which, as shown by the trend of the bundle of curves C2, rises up to the threshold value T_{sup} , at which step c) will end and the normal operation of the refrigerating apparatus 1 will be resumed.

[0055] It should be noted that the temperature T_{inf} may be, in general, any temperature lower than T_{cn} , although

the best results are attained by setting it to a value lower than the temperature T_{cn} by three to ten Celsius degrees, in particular six Celsius degrees.

[0056] More specifically, the threshold value T_{fmin} varies between 0°C and 2°C , the threshold value T_{fMAX} varies between 4°C and 6°C , the threshold value T_{sup} varies between -20°C and -16°C , and the threshold value T_{inf} varies between -24°C and -30°C , the normal operating temperature of the freezer compartment 3 being approx. -18°C .

[0057] As concerns the command issued by the user in order to start the method of operation described so far, three different conditions may take place, respectively coinciding with manual, semi-automatic and automatic operation.

[0058] In the first case (manual control), the user sets the method starting instant (coinciding with the beginning of step a)) by simply pressing a button specifically intended for that purpose.

[0059] In the second case (semi-automatic operation), the user sets a time interval after which the refrigerating apparatus 1 will have to start operating in quiet mode; for example, the user may want the refrigerating apparatus 1 to start operating in quiet mode after four hours, which coincides, as described above, with the fact that the compressor 9 will have to stay off after the selected time interval; in this case, the control unit of the refrigerating apparatus 1 includes a timer and controls the execution of step a) at a time preceding the time chosen by the user, so that said step will be completed at the end of the selected time interval. It must be pointed out that this mode of operation is particularly feasible when the control quantity in use for step a) is the continuous operating time of the compressor 9, as opposed to the temperature reached in the freezer compartment 3.

[0060] In the third case (automatic operation), the user sets a time at which the quiet operation mode will have to start (i.e. steps b) and c)): in this case, the control unit includes a suitable clock or timer, and controls the execution of step a) in a manner such that it will end at the time set by the user. In this case as well, it will be preferable to use the operating time of the compressor 9 instead of the temperature reached in the freezer compartment 3 as a control quantity for step a).

[0061] The present invention also relates to a refrigerating apparatus 1 of the type shown in and described with reference to Fig. 1, which implements the method according to the present invention.

[0062] As a variation, it should be pointed out that, in the refrigerating apparatus 1, the shelves 13 may be equivalently replaced with drawers or compartments; likewise, the on-off valve 8 may be of any kind (e.g. butterfly, sector or the like), provided that it is suitable for intercepting the channel 6 in order to allow the air flow carried therethrough to be adjusted. In turn, the channel 6 may be arranged differently than illustrated herein, for example by connecting different points of the compartments 2 and 3, without however departing from the scope

and objects of the present invention.

[0063] The on-off valve 8 may then be placed anywhere along the channel 6, e.g. even in a position adjacent to the refrigerator compartment 2.

[0064] Finally, the fans 5 and 12 may be arranged differently than illustrated herein and, as aforementioned, the second fan 12 may be omitted.

10 Claims

1. Method of operation of a household refrigeration apparatus (1), of the type comprising at least a first (2) and a second (3) compartments for foodstuff storage, and a refrigerating circuit for cooling said compartments (2,3), wherein the refrigerating circuit comprises at least one compressor (9) and the compartments are kept at different temperatures, the first compartment (2) being a refrigerator compartment (2) kept at a higher temperature, and the second compartment (3) being a freezer compartment (3) kept at a lower temperature, said method comprising at least the following steps:

b) turning off the compressor (9) for a time interval;

c) taking a cold air flow from the freezer compartment (3) and conveying it into the refrigerator compartment (2), so as to keep the temperature of the latter within a temperature range defined by a first and a second threshold values (T_{fmin} , T_{fMAX}),

and wherein said time interval during which the compressor (9) is off is such that the temperature in the freezer compartment (3) does not exceed a third predefined threshold value (T_{sup}),

characterized in that

said step b) follows a step a) wherein the temperature of the freezer compartment (3) is brought to a fourth threshold value (T_{inf}) which is lower than the normal operating temperature value (T_{cn}).

2. Method according to claim 1, wherein the normal operating temperature value (T_{cn}) of the freezer compartment (3) essentially matches said third threshold value (T_{sup}).

3. Method according to any of the preceding claims, wherein said first and second threshold values (T_{fmin} , T_{fMAX}) of the temperature in the refrigerator compartment (2) are substantially equal.

4. Method according to any of the preceding claims, wherein the step c) of taking a cold air flow from the freezer compartment (3) and conveying it into the refrigerator compartment (2) so as to keep the temperature of the latter within a temperature range de-

finied by a first and a second threshold values (T_{fmin} , T_{fMAX}) is repeated several times.

5. Method according to any of the preceding claims, comprising the steps of:

- turning on the compressor (9) and keeping it on until the temperature (T_c) in the freezer compartment (3) reaches said fourth threshold value (T_{inf}) or for a predefined time interval;
- turning off the compressor (9);
- preventing air from passing between the refrigerator compartment (2) and the freezer compartment (3);
- detecting the temperature (T_f) in the refrigerator compartment (2);
- comparing said temperature value (T_f) detected in the refrigerator compartment (2) with said second threshold value (T_{fMAX});
- if the temperature value (T_f) exceeds the maximum threshold value (T_{fMAX}), the temperature (T_c) in the freezer compartment (3) is detected and compared with said third threshold value (T_{sup}) and, if the temperature value (T_c) in the freezer compartment (3) is lower than said third threshold value (T_{sup}): the refrigerator compartment (2) is put in fluidic communication with the freezer compartment (3), so as to transfer a cold air flow from the latter to the former, thereby cooling the refrigerator compartment until the measured temperature reaches said first threshold value (T_{fmin}) or until the temperature (T_c) in the freezer compartment exceeds the threshold value (T_{sup});
- if the temperature value (T_f) exceeds the maximum threshold value (T_{fMAX}), the temperature (T_c) in the freezer compartment (3) is detected and compared with said third threshold value (T_{sup}) and, if the temperature value (T_c) in the freezer compartment (3) is higher than said third threshold value (T_{sup}): the compressor (9) is turned on.

6. Method according to any of the preceding claims, wherein said fourth threshold value (T_{inf}) is lower than the normal operating temperature (T_{cn}) by a value between three and ten Celsius degrees, in particular six Celsius degrees.

7. Method according to any of the preceding claims, wherein the first threshold value (T_{fmin}) varies between 0°C and 2°C, the second threshold value (T_{fMAX}) varies between 4°C and 6°C, the third threshold value (T_{sup}) varies between -20°C and -16°C, the fourth threshold value (T_{inf}) varies between -24°C and -30°C, and the normal operating temperature of the freezer compartment (3) is approximately -18°C.

8. Method according to any of the preceding claims, wherein the duration of step a) is established as a function of a control quantity, such as the temperature in the freezer compartment (3) or a time interval.

9. Method according to any of the preceding claims, wherein the first threshold value (T_{fmin}) is equal to the second threshold value (T_{fMAX}).

10. Method according to any of the preceding claims, wherein during step a) the refrigerator compartment (2) temperature is brought to a value which is substantially equal to the first threshold value (T_{fmin}).

11. Method according to any of the preceding claims, wherein the activation of step a) of the method is controlled by the user.

12. Method according to any of claims 1 to 10, wherein the activation of step a) of the method is controlled by a control unit of the refrigeration apparatus (1) depending on an instant of activation of step b) chosen by a user, in a manner such that step a) ends when step b) is activated.

13. Refrigeration apparatus (1) of the type comprising a first refrigerator compartment (2) and a second freezer compartment (3), wherein at least the freezer compartment (3) is in fluidic communication with an evaporator (4) of a refrigerating circuit comprising at least one compressor (9), one throttling valve (10) and one condenser (11), and wherein a forced circulation of air cooled by the evaporator is generated in the freezer compartment (3) by at least one fan (5), said refrigerator compartment (2) and said freezer compartment (3) being in fluidic communication with each other by means of a channel (6) intercepted by an on-off valve (8), so that the refrigerator compartment (2) is cooled by an air flow taken from the freezer compartment (3),
characterized in that
it includes a control unit configured to perform steps a), b) and c) of the method according to any of claims 1 to 12.

Patentansprüche

1. Betriebsverfahren für ein Haushaltkühlgerät (1) des Typs, der mindestens ein erstes (2) und ein zweites (3) Fach zur Lebensmittellagerung, und einen Kühlkreislauf zum Kühlen der Fächer (2,3) aufweist, wobei der Kühlkreislauf mindestens einen Kompressor (9) aufweist und die Fächer bei verschiedenen Temperaturen gehalten wird, wobei das erste Fach (2) ein Kühlfach (2) aufweist und das zweite Fach (3) ein bei einer niedrigeren Temperatur gehaltenes Gefrierfach (3) ist, wobei das Verfahren mindestens die

folgenden Schritte aufweist:

- b) Abschalten des Kompressors (9) für ein Zeitintervall;
 - c) Abziehen eines Kaltluftstroms aus dem Gefrierfach (3) und Leiten in das Kühlfach (2), so dass die Temperatur von letzterem innerhalb eines Temperaturbereichs gehalten wird, der durch einen ersten und einen zweiten Schwellenwert (T_{fmin} , T_{fMAX}) definiert ist, und wobei das Zeitintervall, während dessen der Kompressor (9) abgeschaltet ist, so ist, dass die Temperatur in dem Gefrierfach (3) einen dritten vordefinierten Schwellenwert (T_{sup}) nicht überschreitet,
- dadurch gekennzeichnet, dass**
der Schritt b) auf einen Schritt a) folgt, wobei die Temperatur des Gefrierfachs (3) auf einen vierten Schwellenwert (T_{inf}) gebracht wird, der niedriger ist als der normale Betriebstemperaturwert (T_{cn}).
2. Verfahren nach Anspruch 1, wobei der normale Betriebstemperaturwert (T_{cn}) des Gefrierfachs (3) im Wesentlichen mit dem dritten Schwellenwert (T_{sup}) übereinstimmt.
 3. Verfahren nach einem der vorangehenden Ansprüche, wobei der erste Schwellenwert und der zweite Schwellenwerte (T_{fmin} , T_{fMAX}) der Temperatur im Kühlfach (2) im Wesentlichen gleich sind.
 4. Verfahren nach einem der vorangehenden Ansprüche, wobei der Schritt c) des Abziehens eines Kaltluftstroms aus dem Gefrierfach (3) und sein Überführen in das Kühlfach (2), so dass die Temperatur von Letzterem innerhalb eines Temperaturbereichs gehalten wird, der durch einen ersten Schwellenwert und einen zweiten Schwellenwert (T_{fmin} , T_{fMAX}) definiert ist, mehrere Male wiederholt wird.
 5. Verfahren nach einem der vorangehenden Ansprüche, das die folgenden Schritte aufweist:
 - Einschalten des Kompressors (9) und eingeschaltet halten, bis die Temperatur (T_c) in dem Gefrierfach (3) den vierten Schwellenwert (T_{inf}) erreicht, oder für ein vordefiniertes Zeitintervall;
 - Abschalten des Kompressors (9);
 - Verhindern, dass Luft zwischen Kühlfach (2) und Gefrierfach (3) strömt;
 - Nachweisen der Temperatur (T_f) in dem Kühlfach (2);
 - Vergleichen des in Kühlfach (2) nachgewiesenen Temperaturwerts (T_f) mit dem zweiten Schwellenwert (T_{fMAX});
 - wenn der Temperaturwert (T_f) den maximalen Schwellenwert (T_{fMAX}) übersteigt, Nachweisen der Temperatur (T_c) in dem Gefrierfach (3) und

Vergleichen mit dem dritten Schwellenwert (T_{sup}), und wenn der Temperaturwert (T_c) im Gefrierfach (3) niedriger ist als der dritten Schwellenwert (T_{sup}): das Kühlfach (2) in fluidleitende Verbindung mit dem Gefrierfach (3) bringen, so dass ein Kaltluftstrom aus letzterem in ersteres übergeführt und dadurch das Kühlfach gekühlt wird, bis die gemessene Temperatur den ersten Schwellenwert (T_{fmin}) erreicht, oder bis die Temperatur (T_c) in dem Gefrierfach den Schwellenwert (T_{sup}) übersteigt;
- wenn der Temperaturwert (T_f) den maximalen Schwellenwert (T_{fMAX}) übersteigt, erfassen der Temperatur (T_c) in dem Gefrierfach (3) und Vergleichen mit dem dritten Schwellenwert (T_{sup}), und wenn die Temperaturwert (T_c) in dem Gefrierfach (3) höher ist als der dritten Schwellenwert (T_{sup}): einschalten des Kompressors (9).

6. Verfahren nach einem der Ansprüche, wobei der vierte Schwellenwert (T_{inf}) um einen Wert zwischen drei und zehn Grad Celsius, insbesondere sechs Grad Celsius, niedriger liegt als die normale Betriebstemperatur (T_{cn}).
7. Verfahren nach einem der Ansprüche, wobei der erste Schwellenwert (T_{fmin}) zwischen 0 °C und 2 °C variiert, der zweite Schwellenwert (T_{fMAX}) zwischen 4 °C und 6 °C variiert, der dritte Schwellenwert (T_{sup}) zwischen -20 °C und -16 °C variiert, der vierte Schwellenwert (T_{inf}) zwischen -24 °C und -30 °C variiert, und die normale Betriebstemperatur des Gefrierfachs (3) ungefähr -18 °C beträgt.
8. Verfahren nach einem der Ansprüche, wobei die Dauer von Schritt a) als Funktion einer Kontrollgröße entwickelt wird, wie die Temperatur in dem Gefrierfach (3) oder ein Zeitintervall.
9. Verfahren nach einem der Ansprüche, wobei der erste Schwellenwert (T_{fmin}) gleich dem zweiten Schwellenwert (T_{fMAX}) ist.
10. Verfahren nach einem der Ansprüche, wobei während Schritt a) die Kühlfach (2)-Temperatur auf einen Wert gebracht wird, der im Wesentlichen gleich dem ersten Schwellenwert (T_{fmin}) ist.
11. Verfahren nach einem der Ansprüche, wobei die Aktivierung von Schritt a) des Verfahrens durch den Benutzer gesteuert wird.
12. Verfahren nach einem der Ansprüche 1 bis 10, wobei die Aktivierung von Schritt a) des Verfahrens durch eine Steuereinheit des Kühlgeräts (1) in Abhängigkeit von einem durch einen Benutzer gewählten Umstand der Aktivierung von Schritt b) derart gesteuert wird, dass Schritt a) endet, wenn Schritt b) aktiviert

wird.

13. Kühlgerät (1) des Typs, aufweisend ein erstes Kühlfach (2) und ein zweites Gefrierfach (3), wobei mindestens das Gefrierfach (3) in fluidleitender Verbindung mit einem Verdunster (4) eines Kühlkreislaufts steht, aufweisend mindestens einen Kompressor (9), ein Drosselventil (10) und einen Kühler (11), und wobei eine Luftumwälzung von durch den Verdunster gekühlter Luft in dem Gefrierfach (3) durch mindestens einen Ventilator (5) erzeugt wird, wobei das Kühlfach (2) und das Gefrierfach (3) miteinander mittels eines Kanals (6) in fluidleitender Verbindung stehen, der von einem Ein-Ausschaltventil (8) unterbrochen wird, so dass das Kühlfach (2) durch einen Luftstrom gekühlt wird, der aus dem Gefrierfach (3) entnommen wird, **dadurch gekennzeichnet, dass** es eine Steuereinheit aufweist, die zur Durchführung der Schritte a), b) und c) des Verfahrens nach einem der Ansprüche 1 bis 12 konfiguriert ist.

Revendications

1. Procédé de fonctionnement d'un appareil électromécanique de réfrigération (1), du type comprenant au moins un premier (2) et un second (3) compartiment pour le stockage d'aliments, et un circuit de réfrigération pour refroidir lesdits compartiments (2, 3), dans lequel le circuit de réfrigération comprend au moins un compresseur (9) et les compartiments sont maintenus à des températures différentes, le premier compartiment (2) étant un compartiment réfrigérateur (2) maintenu à une température plus élevée, et le second compartiment (3) étant un compartiment congélateur (3) maintenu à une température plus basse, ledit procédé comprenant au moins les étapes suivantes :

b) arrêt du compresseur (9) pendant un intervalle de temps ;

c) prélèvement d'un flux d'air froid dans le compartiment congélateur (3) et son acheminement dans le compartiment réfrigérateur (2), de façon à maintenir la température de ce dernier dans une plage de températures définie par une première et une deuxième valeur seuil (T_{fmin} , T_{fMAX}),

et dans lequel ledit intervalle de temps pendant lequel le compresseur (9) est arrêté est tel que la température dans le compartiment congélateur (3) ne dépasse pas une troisième valeur seuil prédéfinie (T_{sup}),

caractérisé en ce que

ladite étape b) suit une étape a) dans laquelle la température du compartiment congélateur (3) est amenée à une quatrième valeur seuil (T_{inf}) qui est plus

basse que la valeur de température de fonctionnement normale (T_{cn}).

2. Procédé selon la revendication 1, dans lequel la valeur de température de fonctionnement normale (T_{cn}) du compartiment congélateur (3) concorde essentiellement avec ladite troisième valeur seuil (T_{sup}).
3. Procédé selon l'une quelconque des revendications précédentes, dans lequel lesdites première et deuxième valeurs seuils (T_{fmin} , T_{fMAX}) de la température dans le compartiment réfrigérateur (2) sont sensiblement égales.
4. Procédé selon l'une quelconque des revendications précédentes, dans lequel l'étape c) de prélèvement d'un flux d'air froid dans le compartiment congélateur (3) et son acheminement dans le compartiment réfrigérateur (2) de façon à maintenir la température de ce dernier dans une plage de températures définie par une première et une deuxième valeur seuil (T_{fmin} , T_{fMAX}) est répétée plusieurs fois.
5. Procédé selon l'une quelconque des revendications précédentes, comprenant les étapes de :
- allumage du compresseur (9) et son maintien jusqu'à ce que la température (T_c) dans le compartiment congélateur (3) atteigne ladite quatrième valeur seuil (T_{inf}) ou pendant un intervalle de temps prédéfini ;
 - arrêt du compresseur (9) ;
 - prévention de passage d'air entre le compartiment réfrigérateur (2) et le compartiment congélateur (3) ;
 - détection de la température (T_f) dans le compartiment réfrigérateur (2) ;
 - comparaison de ladite valeur de température (T_f) détectée dans le compartiment réfrigérateur (2) avec ladite deuxième valeur seuil (T_{fMAX}) ;
 - si la valeur de température (T_f) dépasse la valeur seuil maximale (T_{fMAX}), la température (T_c) dans le compartiment congélateur (3) est détectée et comparée à ladite troisième valeur seuil (T_{sup}) et, si la valeur de température (T_c) dans le compartiment congélateur (3) est plus basse que ladite troisième valeur seuil (T_{sup}) : le compartiment réfrigérateur (2) est mis en communication fluide avec le compartiment congélateur (3), de façon à transférer un flux d'air froid du dernier au premier, refroidissant ainsi le compartiment réfrigérateur jusqu'à ce que la température mesurée atteigne ladite première valeur seuil (T_{fmin}) ou jusqu'à ce que la température (T_c) dans le compartiment congélateur dépasse la valeur seuil (T_{sup}) ;
 - si la valeur de température (T_f) dépasse la va-

- leur seuil maximale (T_{fMAX}), la température (T_c) dans le compartiment congélateur (3) est détectée et comparée à ladite troisième valeur seuil (T_{sup}) et, si la valeur de température (T_c) dans le compartiment congélateur (3) est plus élevée que ladite troisième valeur seuil (T_{sup}) : le compresseur (9) est allumé.
6. Procédé selon l'une quelconque des revendications précédentes, dans lequel ladite quatrième valeur seuil (T_{inf}) est plus basse que la température de fonctionnement normale (T_{cn}) d'une valeur entre trois et dix degrés Celsius, en particulier de six degrés Celsius.
7. Procédé selon l'une quelconque des revendications précédentes, dans lequel la première valeur seuil (T_{fmin}) varie entre 0 °C et 2 °C, la deuxième valeur seuil (T_{fMAX}) varie entre 4 °C et 6 °C, la troisième valeur seuil (T_{sup}) varie entre - 20 °C et -16 °C, la quatrième valeur seuil (T_{inf}) varie entre - 24 °C et -30 °C, et la température de fonctionnement normale du compartiment congélateur (3) est d'approximativement -18 °C.
8. Procédé selon l'une quelconque des revendications précédentes, dans lequel la durée de l'étape a) est établie en fonction d'une quantité de commande, telle que la température dans le compartiment congélateur (3) ou un intervalle de temps.
9. Procédé selon l'une quelconque des revendications précédentes, dans lequel la première valeur seuil (T_{fmin}) est égale à la deuxième valeur seuil (T_{fMAX}).
10. Procédé selon l'une quelconque des revendications précédentes, dans lequel, pendant l'étape a), la température du compartiment réfrigérateur (2) est amenée à une valeur qui est sensiblement égale à la première valeur seuil (T_{fmin}).
11. Procédé selon l'une quelconque des revendications précédentes, dans lequel l'activation de l'étape a) du procédé est commandée par l'utilisateur.
12. Procédé selon l'une quelconque des revendications 1 à 10, dans lequel l'activation de l'étape a) du procédé est commandée par une unité de commande de l'appareil de réfrigération (1) selon un instant d'activation de l'étape b) choisi par un utilisateur, de manière à ce que l'étape a) se termine lorsque l'étape b) est activée.
13. Appareil de réfrigération (1) du type comprenant un premier compartiment réfrigérateur (2) et un second compartiment congélateur (3), dans lequel au moins le compartiment congélateur (3) est en communication fluide avec un évaporateur (4) d'un circuit de

réfrigération comprenant au moins un compresseur (9), une vanne d'étranglement (10) et un condenseur (11), et dans lequel une circulation forcée d'air refroidi par l'évaporateur est générée dans le compartiment congélateur (3) par au moins un ventilateur (5), ledit compartiment réfrigérateur (2) et ledit compartiment congélateur (3) étant en communication fluide l'un avec l'autre au moyen d'un canal (6) intercepté par une vanne marche-arrêt (8), de sorte que le compartiment réfrigérateur (2) soit refroidi par un flux d'air prélevé dans le compartiment congélateur (3),

caractérisé en ce que

il comporte une unité de commande configurée pour réaliser les étapes a), b) et c) du procédé selon l'une quelconque des revendications 1 à 12.

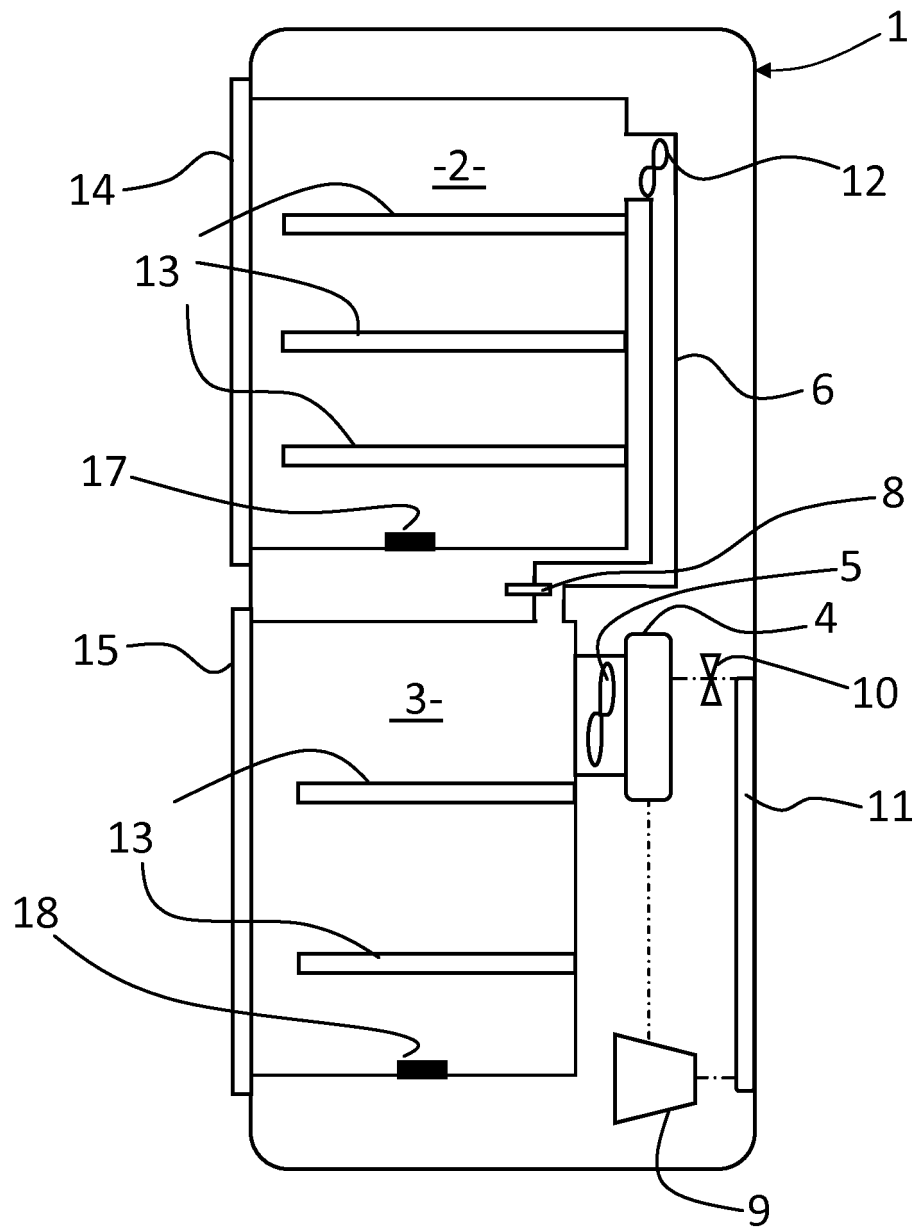


Fig. 1

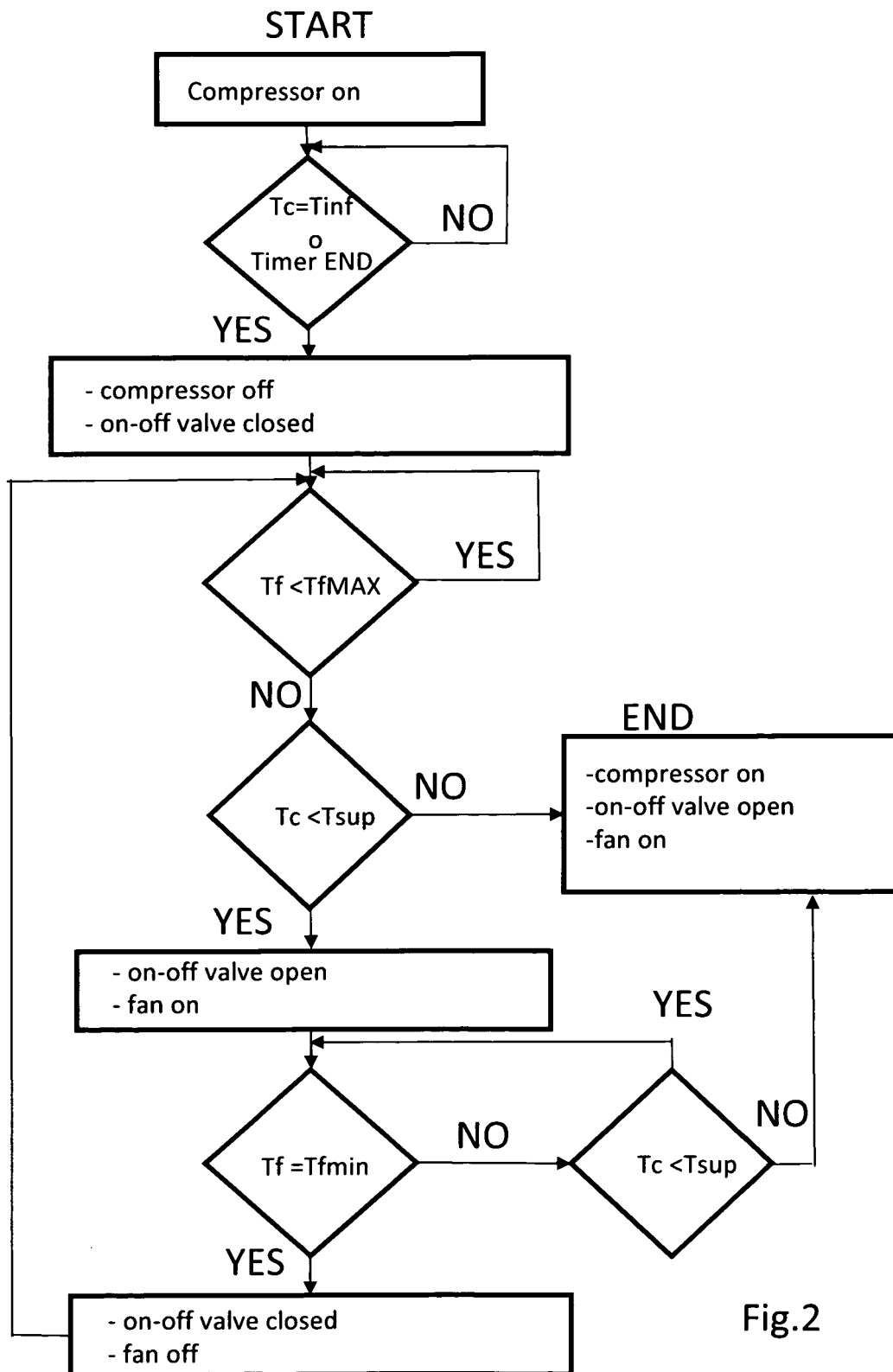


Fig.2

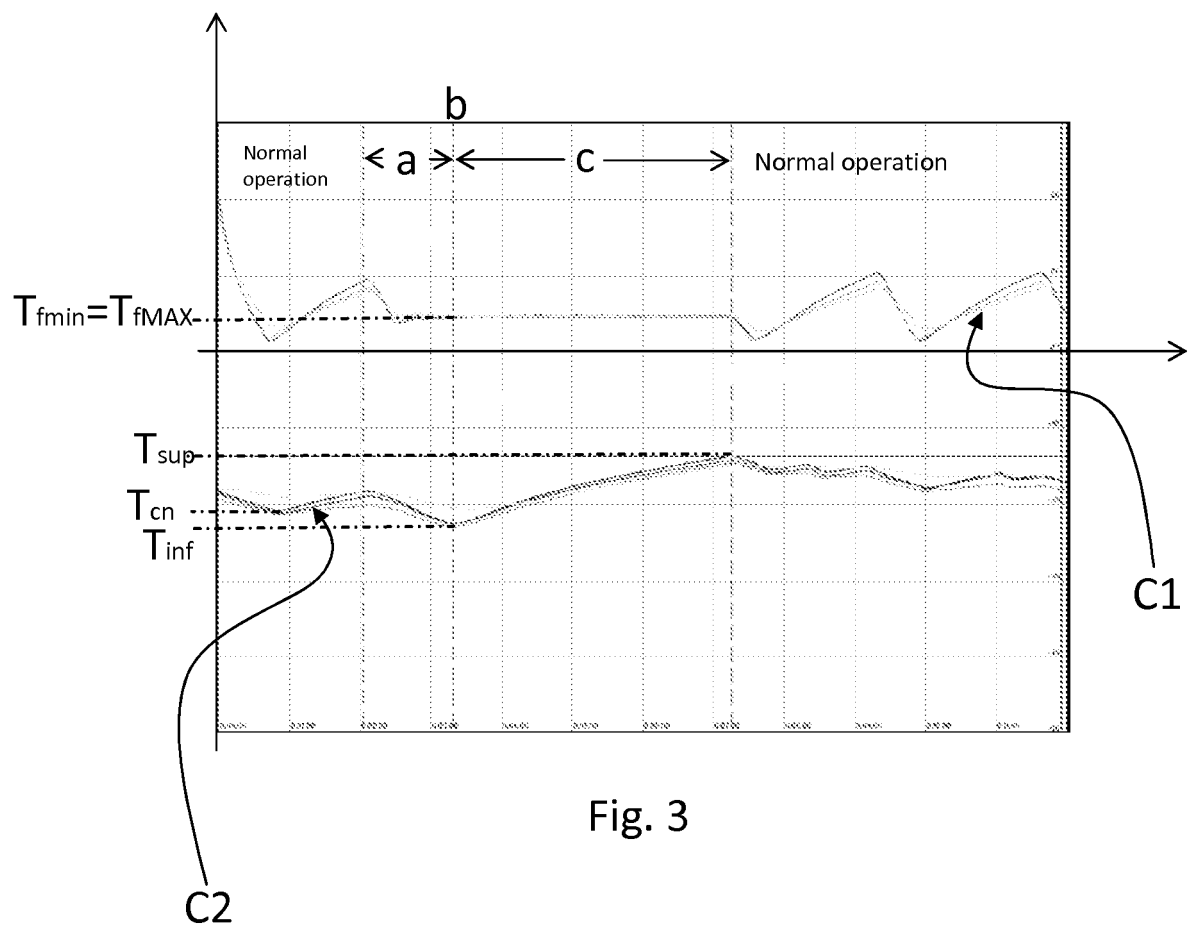


Fig. 3

REFERENCES CITED IN THE DESCRIPTION

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