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(54) **METHOD FOR CONTROLLING A REFRIGERATOR SYSTEM**

(57) Method for controlling a refrigerator system comprising a first and a second refrigerated display and a logic control unit, and such method provides for the execution of a first step of cooling the first refrigerated display and a control step.

In the control step, the logic control unit calculates a first virtual time (tv1), in which the first internal temperature (Ti1) of the first refrigerated display reaches a first objective temperature (Tobb1), calculates a second virtual time (tv2), in which the second internal temperature (Ti2) of the second refrigerated display reaches the second maximum threshold temperature (Tmax2), calculates the time interval (Δt) that lies between the first virtual time (tv1) and the second virtual time (tv2) and sets a first real time (tr1), at which the first step of cooling the first refrigerated display terminates, and a second real time (tr2), at which a second step of cooling the second refrigerated display starts.

The first real time (tr1) is subsequent to the second real time (tr2) in order to at least partially overlap the first cooling step and the second cooling step.

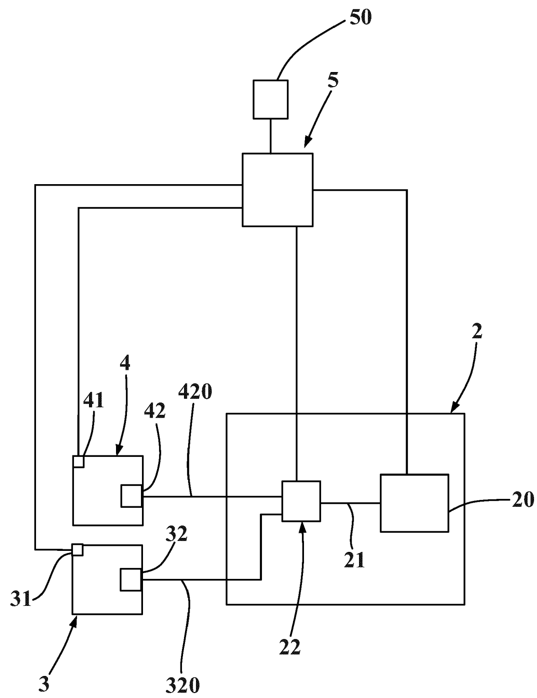

Fig. 1

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Description

Field of application

[0001] The present invention regards a method for controlling a refrigerator system according to the preamble of the independent claim 1.

[0002] The present control method is advantageously intended to be used for controlling the operation of a refrigerator system comprising multiple refrigerated displays, which are situated in stores, supermarkets or other business premises for the display and sale of perishable foods and otherwise. The control method of the present invention is intended to be used for synchronizing the operation of a refrigeration unit arranged for cooling the refrigerated displays placed within the business premises.

[0003] The present method for controlling a refrigeration station is therefore inserted in the industrial field of production of refrigerating systems, logistic warehouses and refrigerating storage cells, e.g. for food products, and in particular in the field of production of cooling systems for the small, medium and large-scale retail channels.

State of the art

[0004] Refrigerator systems are employed in supermarkets, food stores and in general in all those business premises that display foods which require maintenance at a controlled temperature, in addition to logistic deposits where the products are preserved in refrigerator cells that can be considered analogous to refrigerated displays.

[0005] Refrigerator systems, such as for example that described in the patent JP H09217974, comprise multiple refrigerated displays, which allow the display of foods at a controlled temperature, so as to maintain unchanged over time the characteristics of the displayed food product.

[0006] The aforesaid refrigerated displays are provided with at least one internal temperature sensor, in order to control the internal temperature of the corresponding refrigerated display, ensuring the preservation of the foods within the temperature interval specific for that specific food.

[0007] The refrigerator systems also comprise a refrigeration unit, also known as refrigeration station, which is usually placed outside the business premises, in particular in the event in which the business premises are provided with multiple refrigerated displays.

[0008] The refrigeration unit is connected to the refrigerated displays and comprises one or more compressors arranged for cooling a cooling fluid.

[0009] The refrigerator systems also comprise a logic control unit, which is connected to the temperature sensors and to the refrigeration unit and is arranged for enabling and disabling the latter to cool the displays on the basis of the internal temperature detected by the temperature sensors.

[0010] More in detail, the present control method of the refrigerator systems provides for setting an operative temperature interval, within which the display must always be situated, and which depends on the foods preserved in the display, and a maximum threshold temperature, also known as hysteresis temperature, which defines the temperature at which the logic control unit enables the refrigeration unit to cool that display in order to prevent it from being overly heated.

[0011] Presently, each refrigerated display of the cooling system comprises a temperature sensor thereof, which communicates the detected temperatures to the logic control unit which in turn, in an independent manner for each refrigerated display, enables or disables the cooling of the refrigerated displays, for example by closing and opening solenoid valves placed to intercept the cooling circuit between refrigeration unit and refrigerated displays.

[0012] Therefore, each refrigerated display is always cooled upon reaching the maximum threshold temperature (hysteresis) thereof up to a preset objective temperature thereof, therefore defining an operating cycle (for cooling and turning off) that is constant and independent of the other refrigerated displays of the cooling system.

[0013] Such method for controlling a refrigerator system has in practice shown that it does not lack drawbacks.

[0014] The main drawback lies in the fact that such solution involves a high consumption of energy, and consequently high costs for the operation of the refrigerator system.

[0015] More in detail, such control method provides that the logic control unit drives the refrigeration unit on the bases of independent signals arriving from the various internal temperature sensors. This ensures that the compressors are continuously subjected to turning on and off operations, even close to each other, in order to meet the needs of the various refrigerated displays. The turning on (or pickup) of each compressor significantly affects the energy consumptions, and therefore also the cost to be sustained by the owner of the business premises, since a compressor in turning-on step absorbs a quantity of energy that is much greater than that necessary for its normal operation.

[0016] A further drawback lies in the fact that, still due to the repeated operations of turning on and off the compressors, such method negatively affects the wear of the electronic and mechanical components of the compressors themselves.

[0017] A further drawback lies in the fact that, due to the high absorptions from the operations of turning on and off the compressors, the business premises must be equipped with an electrical system suitably for meeting such absorptions, thus it must provide for very heavy components that allow avoiding black-out when multiple compressors are turned on simultaneously.

[0018] Known from the patent US 20150276306 is a control method for optimizing the energy savings in a home refrigerator provided with a refrigeration compartment and with a freezer compartment.

[0019] More in detail, the refrigerator described in such patent comprises a control unit, configured for driving a compressor to start a cooling step within the freezer compartment in order to cool the latter. In addition, the control unit is configured for calculating the speed with which the refrigerator compartment is heated, in order to calculate, on the basis of such speed, the residual time before such refrigerator compartment must also be cooled. The control unit is finally configured for setting a cooling speed of the freezer, on the basis of the aforesaid calculated residual time, so as to make the end of the aforesaid step of cooling the freezer coincide with the start of the step of cooling the refrigerator compartment, and thus reduce the turning on and off cycles of the compressor.

[0020] Nevertheless, even such solution has in practice shown that it does not lack drawbacks. The main drawback lies in the fact that such method is unable to ensure an energy savings, since it provides for setting the cooling speed of the freezer beforehand, on the basis of the residual time of the refrigerator, in some cases having to maintain the compressor turned on for an extremely long time.

[0021] A further drawback lies in the fact that such method of known type does not ensure an optimal management of the cooling of the preserved foods, since such method provides for varying, in a continuous and unpredictable manner, the cooling speed, risking to negatively affect the quality of the preserved foods. A further drawback lies in the fact that such method of known type is usable in a refrigerator system employed in business premises, and in particular comprising more than two refrigerated displays, since it is impossible to synchronize the end of the step of cooling the freezer with the start of the step of cooling all the other refrigerated displays.

Presentation of the invention

[0022] In this situation, the problem underlying the present invention is therefore that of overcoming the drawbacks manifested by the above-described solution of known type, by providing a method for controlling a refrigerator system, which allows optimizing the operation of the refrigeration unit.

[0023] A further object of the present finding is to provide a method for controlling a refrigerator system, which allows reducing the operations of turning on and off the refrigeration unit.

[0024] A further object of the present finding is to provide a method for controlling a refrigerator system, which allows reducing the energy consumption of the business premises in which it is installed.

[0025] A further object of the present finding is to provide a method for controlling a refrigerator system, which allows an energy savings.

[0026] A further object of the present finding is to provide a method for controlling a refrigerator system, which allows reducing the wear of the refrigeration unit.

[0027] A further object of the present finding is to provide a method for controlling a refrigerator system, which allows reducing the maximum power absorbed by the system.

Brief description of the drawings

[0028] The technical characteristics of the invention, according to the aforesaid objects, are clearly seen in the contents of the below-reported claims and the advantages thereof will be more evident in the following detailed description, made with reference to the enclosed drawings, which represent several merely exemplifying and non-limiting embodiments of the invention, in which:

- Figure 1 shows a block diagram of a refrigerator system controllable by means of the control method, object of the present invention;
- Figure 2 shows a flow diagram relative to an exemplifying and non-limiting embodiment of the method for controlling a refrigerator system, object of the present invention.

Detailed description of a preferred embodiment

[0029] The method for controlling a refrigerator system according to the present invention is employed for controlling a refrigerator system which comprises at least one refrigeration unit 2, at least one first refrigerated display 3 provided with at least one first temperature sensor 31 and coolable by means of the aforesaid refrigeration unit 2 during a first cooling step, at least one second refrigerated display 4 provided with at least one second temperature sensor 41 and coolable by means of the same refrigeration unit 2 during a second cooling step and at least one logic control unit 5, connected to the first and second temperature sensors 31, 41.

[0030] Preferably the logic control unit 5 is also connected to the refrigeration unit 2 in order to drive the latter to enable or prevent the cooling of the refrigerated displays.

[0031] More in detail, in a per se known manner and therefore not described in detail hereinbelow, the refrigeration unit 2 comprises a cooling circuit 21, a first evaporator 32, placed within the first refrigerated display 3, a second evaporator 42, placed within the second refrigerated display 4.

[0032] The first and the second evaporator 32, 42 are advantageously hydraulically connected to the aforesaid cooling circuit by means of a corresponding feed duct 320, 420.

[0033] Advantageously, the refrigeration unit 2 also comprises at least one compressor 20, preferably connected to the logic control unit, which is arranged for cooling a cooling fluid, e.g. R744 or R448a, within the cooling circuit 21 in order to feed the aforesaid evaporators 32, 42, cooling the corresponding refrigerated display 3, 4.

[0034] Preferably, the aforesaid refrigerator system 1 also comprises a hydraulic panel 22, and at least two solenoid valves, preferably placed within the hydraulic panel 22 and connected to the logic control unit 5.

[0035] Advantageously, the two solenoid valves are placed to intercept the cooling circuit 21, each at a feed duct 320, 420 of a corresponding evaporator 32, 42, in order to allow or prevent the passage of the cooling fluid towards a corresponding refrigerated display 3, 4, actually enabling or preventing the start of the corresponding cooling step. Hereinbelow, reference will be made, as illustrated in figure 1, to a refrigerator system 1 comprising a compressor 20 and two refrigerated displays 3, 4, nevertheless it being intended that, without departing from the protective scope of the present invention, the control method can be employed for controlling a refrigerator system comprising multiple compressors and a plurality of refrigerated displays.

[0036] In particular, the refrigerator system 1 also comprises more than two refrigerated displays. In this case, advantageously, the present method associates the aforesaid first refrigerated display 3 with each display with the evaporator normally fed, and the aforesaid second refrigerated display 4 with each display with the evaporator normally not fed.

[0037] Preferably, each refrigerated display 3, 4 comprises a containment structure provided with a lower base intended to be abutted against the ground. In particular, the containment structure delimits, at its interior, a refrigerated chamber (in which the products to be cooled are intended to be placed) and a technical compartment (in which the corresponding evaporator 32, 42 is for example housed).

[0038] Advantageously, one or more of the refrigerated displays 3 are placed in a remote position from the refrigeration unit 2 (in which the compressor 20 is present). For example, the refrigerated displays 3 are intended to be positioned at different points of a premises or of a building (e.g. in the different sections of a supermarket), while the refrigeration unit 2 is intended to be placed in a suitable premises set for the climate-control systems.

[0039] In accordance with the invention the control method comprises a first detection step 101 in which the first temperature sensor 31 detects at least one first internal temperature Ti1 of the first refrigerated display 3 and a first comparison step 102 in which the logic control unit 5 compares the aforesaid first internal temperature Ti1 with a first maximum threshold temperature Tmax1 in order to start the first cooling step 201. Advantageously, the first refrigerated display 3 is intended, during use, to be maintained within a first preset temperature interval, which is a function of the foods that the same first refrigerated display 3 is intended to contain.

[0040] For example, in the case of a refrigerated display of class M2, the aforesaid first temperature interval (e.g. in accordance with the UNI EN ISO 23953-2-2016 standard) is comprised between +7°C and -1°C.

[0041] Preferably, the first maximum threshold temperature Tmax1 is the hysteresis temperature, which is lower than the maximum limit of the first temperature interval at which the first refrigerated display 3 must operate and is for example set in an interval comprised between 0.2°C and 1°C lower than the aforesaid maximum limit.

[0042] In this manner, it is possible to ensure that the aforesaid first refrigerated display 3 constantly operates within the preset temperature limit.

[0043] The control method also comprises a second detection step 103 in which the second temperature sensor 41 detects at least one second internal temperature Ti2 of the second refrigerated display 4, and a second comparison step 104 in which the logic control unit 5 compares the second internal temperature Ti2 with a second maximum threshold temperature Tmax2 in order to start the second cooling step.

[0044] Advantageously, the second refrigerated display 4 is intended, during use, to be maintained within a second preset temperature interval, which depends on the foods that the same second refrigerated display 4 is intended to contain.

[0045] Preferably, the second maximum threshold temperature Tmax2 is the hysteresis temperature, which is lower than the maximum limit of the second temperature interval at which the second refrigerated display 3 must operate and is for example set in an interval comprised between 0.2°C and 1°C lower than the aforesaid maximum limit.

[0046] In this manner, it is possible to ensure that the aforesaid second refrigerated display 4 operates constantly within the preset temperature limit.

[0047] In accordance with the idea underlying the present invention, the control method provides for - with the first internal temperature Ti1 greater than or equal to the first maximum threshold temperature Tmax1 and the second internal temperature Ti2 lower than the second maximum threshold temperature Tmax2 - the execution of the first cooling step 201, in which the refrigeration unit 2 cools the first refrigerated display 3. Advantageously therefore the method, object of the present invention, provides that at least one first refrigerated display 3 is in a cooling condition, i.e. at a temperature higher than the first maximum threshold temperature Tmax1 with the refrigeration unit 2 active in order to cool it, and at least one second refrigerated display 4 is in a rest condition, i.e. is at a temperature lower than the second maximum threshold temperature Tmax2 with the refrigeration unit 2 deactivated.

[0048] Advantageously, the present control method comprises a starting step in which the logic control unit 5 drives the refrigeration unit 2 to cool the first refrigerated display 3, in order to bring it from the temperature at which it is situated (higher than the maximum threshold temperature) up to bringing it back within the temperature range at which it must stay in accordance with its climate class. Advantageously, the logic control unit 5 drives the refrigeration unit 2 to cool the aforesaid first refrigerated display 3 with a preset power, preferably constant, which is in particular determined only by the speed with which the refrigerated display 3 must fall within its correct temperature interval. More in detail, the power at which the refrigeration unit 2 is started is (compatibly with the request for possible other displays already in cooling step) the maximum available cooling power, so as to reduce to the minimum the time in which the refrigerated display 3 remains at a temperature higher than the maximum threshold temperature. The method also provides for a control step 202, which is extended at least partly during the first cooling step 201, preferably in proximity to the end of the first cooling step 201, and in which the logic control unit 5 calculates a first virtual time tv1, in which the first internal temperature Ti1 of the first refrigerated display 3, detected during the first detection step 101, reaches a preset first objective temperature Tobb1, lower than the first maximum threshold temperature Tmax1.

[0049] Advantageously, the start of the control step 202 in proximity to the end of the cooling step 201 allows ensuring the maximum priority for the correct operation and cooling of the refrigerated displays 3, 4, ensuring that their cooling is carried out initially quickly in order to fall within the correct temperature interval, in order to be subsequently controlled and adapted only at the end, when the refrigerated display 3, 4 is within a thermal "safe" zone.

[0050] Advantageously, the first virtual time tv2 is therefore definable as the time instant in which the first cooling step 201 of the first refrigerated display 3 is calculated to end.

[0051] Advantageously, the first objective temperature Tobb1 is greater than the minimum limit of the first preset temperature interval, preferably by a value comprised between 1°C and 6°C. In this manner, it is possible to ensure that the first refrigerated display 3 remains in the same first preset temperature interval and is not further cooled due to the end inertia of the refrigeration unit 2.

[0052] Advantageously, the first temperature sensor 31 communicates to the logic control unit 5 when the first internal temperature Ti1 reaches a starting value Tavv of the control step, greater than the first objective temperature Tobb1 and the logic control unit 5 starts the aforesaid control step 202 upon reaching the starting temperature Tavv. Preferably, the starting temperature Tavv is greater than the first objective temperature Tobb1 by a value comprised between 0.1°C and 6°C.

[0053] In the aforesaid control step 202 the logic control unit 5 also calculates a second virtual time tv2, in which the second internal temperature Ti2 of the second refrigerated display 4, detected during the second detection step 103, reaches the second maximum threshold temperature Tmax2.

[0054] Advantageously, the second virtual time tv2 is therefore definable as the time instant in which it is calculated to start the second step of cooling the second refrigerated display 4.

[0055] Of course, as is more evident from the following description, it is not necessary that the second internal temperature Ti2 reach the second maximum threshold temperature Tmax2. With the present method, it is in fact sufficient to calculate how much time the second refrigerated display 4 will take to pass from the aforesaid rest condition to the aforesaid cooling condition.

[0056] In this manner it is possible therefore to calculate the time within which the logic control unit 5 will enable the starting of the refrigeration unit 2 in order to cool the aforesaid second refrigerated display 4.

[0057] In addition, if the second virtual time tv2 is subsequent to the first virtual time tv1, the logic control unit 5 calculates the time interval Δt that lies between the first virtual time tv1 and the second virtual time tv2.

[0058] The method therefore advantageously provides that the control step continues only if the starting of the second cooling step is subsequent to the (virtual) end of the first cooling step.

[0059] In the aforesaid control step 202 the logic control unit 5 also sets, with the time interval Δt lower than a preset threshold time interval Δts, a first real time tr1, at which the first cooling step 201 of the first refrigerated display 3 terminates, and a second real time tr2, at which the second step of cooling the second refrigerated display 4 starts. Advantageously, the first real time tr1 and the second real time tr2 are the time instants at which respectively the first cooling step 201 of the first refrigerated display 3 terminates and the second step of cooling the second refrigerated display 4 starts. Preferably, the preset threshold time interval Δts is comprised between 0.1 and 180 seconds and, still more preferably, is lower than 60 seconds.

[0060] The first real time tr1 is subsequent to the second real time tr2 in order to at least partially overlap the first cooling step 201 and the second cooling step.

[0061] In this manner it is possible to reduce the number of turn on and off cycles of the compressor 20 of the refrigeration unit 2, allowing the reduction of the energy consumptions of the latter, hence simultaneously allowing an energy savings for the business enterprise where the refrigerated displays 3, 4 controlled by means of such method are installed.

[0062] In addition, in this manner it is possible to reduce the wear of the mechanical and electronic components of the same refrigeration unit 2.

[0063] More in detail, with such method it is possible to prevent turning off the compressor or compressors 20 between the first cooling step 201 and the second cooling step, if a reduced time necessary for starting the aforesaid second cooling step was calculated. Hereinbelow, different methods are listed that can be actuated for calculating the first and second virtual times tr1, tr2.

[0064] More in detail, in the first comparison step 102 the logic control unit 5 calculates a first temperature difference $\Delta T1$, which is given by the difference between the first internal temperature Ti1 of the first refrigerated display 3 and the first objective temperature Tobb1.

[0065] In addition, the logic control unit 5 calculates in the second comparison step 104 a second temperature difference $\Delta T2$, given by the difference between the second internal temperature Ti2 of the second refrigerated display 4 and the second maximum threshold temperature Tmax2.

[0066] Advantageously, the method comprises a measuring step, in which at least one between the first and second temperature sensors 31, 41 detects multiple measurements of the corresponding internal temperature Ti1, Ti2 and in which the logic control unit 5 calculates, on the basis of the aforesaid measurements, a thermal variation speed vT of the corresponding refrigerated display 3, 4.

[0067] In particular, the logic control unit 5 calculates at least one between the first virtual time tv1 and the second virtual time tv2, and preferably both, as the ratio between the corresponding temperature difference $\Delta T1$, $\Delta T2$ and the thermal variation speed vT.

[0068] In accordance with a first embodiment, the method comprises multiple consecutive operating cycles, in which each operating cycle comprises at least the first cooling step 201 and the control step 202 and the logic control unit 5 calculates at least one between the first virtual time tv1 and the second virtual time tv2 on the basis of the thermal variation speed vT which was calculated at least during the last of the aforesaid operating cycles.

[0069] In accordance with a second embodiment, the logic control unit 5 calculates at least one between the first virtual time tv1 and the second virtual time tv2, and preferably both, as arithmetic mean of preceding thermal variation speed values vT, calculated during a preset number of preceding operating cycles, in which the aforesaid preset number is preferably comprised between 1 and 10.

[0070] Advantageously, the logic control unit 5 comprises an archiving database 50, arranged for archiving the aforesaid thermal variation speed values vT measured during the preceding operating cycles, and such thermal variation speed values vT are catalogued and divided within the aforesaid archiving database 50 according to at least one historical parameter selected from among: the measurement time range, the day of week of the measurement or the month of the year.

[0071] In accordance with a third embodiment, the logic control unit 5 calculates at least one between the first virtual time tv1 and the second virtual time tv2 as arithmetic mean of a preset number of preceding thermal variation speed values vT archived within the archiving database 50 and which have in common at least the aforesaid historical parameter.

[0072] Preferably the aforesaid preset number is comprised between 1 and 10.

[0073] Hereinbelow, different methods will also be listed and described for setting the first and second real times tr1, tr2 so as to at least partially overlap the first cooling step 201 and the second cooling step.

[0074] The different methods for setting the first and second real times tr1, tr2 are advantageously applicable indiscriminately to the aforesaid embodiments for calculating the first and second virtual times tv1, tv2, independent of which embodiment one wishes to employ for the aforesaid calculation.

[0075] More in detail, during the first cooling step 201, the refrigeration unit 2 advantageously cools the first refrigerated display 3 with a first cooling power P1 and the logic control unit 5 sets, in the control step 202, a second cooling power P2, lower than the first cooling power PI, in order to cool the first refrigerated display 3 with the second cooling power P2 postponing in this manner the first real time tr1 and extending the first cooling step 201.

[0076] Advantageously, the ratio between the second cooling power and the first cooling power is comprised between 0.5 and 0.9.

[0077] In this manner, in addition to allowing the overlapping of the first and second cooling steps, in accordance with the invention, it is also possible to reduce the consumptions of the refrigeration unit 2, reducing the instantaneous power absorbed by the latter.

[0078] In accordance with an embodiment variant of the setting of the first and second real times tr1, tr2, the logic control unit 5 sets, during the control step, a second objective temperature Tobb2 for the first refrigerated display, which is lower than the first objective temperature Tobb1 in order to extend the first cooling step 201. Advantageously, the second objective temperature Tobb2 is lower than the first objective temperature Tobb1 by a value comprised between 0.1°C and 6 °C.

[0079] More in detail, the logic control unit 5 sets the second objective temperature Tobb2 lower than the first objective temperature Tobb1 by a first additional value Tagg1 which is calculated from the product between the thermal variation speed vT (in accordance with any one of the above-described embodiments) and a first additional time tagg1, which is greater than or equal to the time interval Δt.

[0080] Advantageously, the first additional time tagg1 is greater than the time interval Δt by a value comprised between 0.5 and 180 seconds.

[0081] In accordance with a third embodiment variant, the logic control unit 5 sets a third maximum threshold temperature Tmax3 for the second refrigerated display 4, which is lower than the preset second maximum threshold temperature Tmax2 for the same second refrigerated display 4, in order to anticipate the second cooling step.

[0082] Advantageously, the third maximum threshold temperature Tmax3 is lower than the second maximum threshold temperature Tmax2 by a value comprised between 0.1 and 6 °C.

[0083] More in detail, the logic control unit 5 sets the third maximum threshold temperature Tmax3 lower than the second maximum threshold temperature Tmax2, with a second additional value Tagg2, which is calculated from the product between the thermal variation speed vT (in accordance with any one of the above-described embodiments) and a second additional time tagg2, which is greater than or equal to the time interval Δt.

[0084] Advantageously, the second additional time tagg2 is greater than the time interval Δt by a value comprised between 0.5 and 180 seconds.

[0085] The method for controlling a refrigerator system thus conceived therefore reaches the pre-established objects.

Claims

1. Method for controlling a refrigerator system which comprises:

   - at least one refrigeration unit (2);
   - at least one first refrigerated display (3) provided with at least one first temperature sensor (31) and coolable by means of said refrigeration unit (2) during a first cooling step (201);
   - at least one second refrigerated display (4) provided with at least one second temperature sensor (41) coolable by means of said refrigeration unit (2) during a second cooling step;
   - at least one logic control unit (5), connected to said first temperature sensor (31) and said second temperature sensor (41);

   said method comprising:

   - a first detection step (101) in which said first temperature sensor (31) detects at least one first internal temperature (Ti1) of said first refrigerated display (3);
   - a first comparison step (102) in which said logic control unit (5) compares said first internal temperature (Ti1) with a first maximum threshold temperature (Tmax1) in order to start said first cooling step (201);
   - a second detection step (103) in which said second temperature sensor (41) detects at least one second internal temperature (Ti2) of said second refrigerated display (4);
   - a second comparison step (104) in which said logic control unit (5) compares said second internal temperature (Ti2) with a second maximum threshold temperature (Tmax2) in order to start said second cooling step;

   wherein, with the first internal temperature (Ti1) greater than or equal to said first maximum threshold temperature (Tmax1) and the second internal temperature (Ti2) lower than said second maximum threshold temperature (Tmax2):

   - the execution of said first cooling step (201), in which said refrigeration unit (2) cools said first refrigerated display (3);
   - a control step (202), which is extended at least partly during said first cooling step (201) and in which said control unit (5):

     - calculates a first virtual time (tv1), in which the first internal temperature (Ti1) of said first refrigerated display (3), detected during said first detection step (101), reaches a preset first objective temperature (Tobb1), lower than said first maximum threshold temperature (Tmax1);
     - calculates a second virtual time (tv2), in which said second internal temperature (Ti2) of said second refrigerated display (4), detected during said second detection step (103), reaches said second maximum threshold temperature (Tmax2), and if said second virtual time (tv2) is subsequent to said first virtual time (tvl)

   said control method being **characterized in that**, in said control step (202), said control unit (5):

   - calculates the time interval (Δt) that lies between said first virtual time (tvl) and said second virtual time (tv2);
   - sets, with said time interval (Δt) lower than a preset threshold time interval (Δts), a first real time (tr1), at which the first cooling step (201) of said first refrigerated display (3) terminates, and a second real time (tr2), at which the second cooling step of said second refrigerated display (4) starts;

   said first real time (tr1) being subsequent to said second real time (tr2) in order to at least partially overlap said first cooling step (201) and said second cooling step.

2. Method according to claim 1, **characterized in that** in said first comparison step (101) said logic control unit (5) calculates a first temperature difference ($\Delta T1$), as the difference between said first internal temperature (Ti1) and said first objective temperature (Tobb1), and in said second comparison step (103) said logic control unit (5) calculates a second temperature difference ($\Delta T2$), as the difference between said second internal temperature (Ti2) and said second maximum threshold temperature (Tmax2);

   said method comprising a measuring step, in which at least one between said first and second temperature sensors (31, 41) detects multiple measurements of the corresponding said internal temperature (Ti1, Ti2) and in which said logic control unit (5) calculates, on the basis of said multiple measurements, a thermal variation speed (vT) of the corresponding said refrigerat-

ed display (3, 4);
said logic control unit (5) calculating at least one from between said first virtual time (tvl) and said second virtual time (tv2) as the ratio between the corresponding said temperature difference (ΔT1, ΔT2) and said thermal variation speed (vT).

3. Method according to claim 2, **characterized in that** it comprises multiple consecutive operating cycles, which each comprise at least said first cooling step (201) and said control step (202);
said logic control unit (5) calculating at least one between said first virtual time (tvl) and said second virtual time (tv2) on the basis of the thermal variation speed (vT) calculated at least during the last of said operating cycles.

4. Method according to claim 2 and 3, **characterized in that** said logic control unit (5) calculates at least one between said first virtual time (tvl) and said second virtual time (tv2) as arithmetic mean of preceding thermal variation speed values (vT), calculated during a preset number of preceding said operating cycles.

5. Method according to claim 2, **characterized in that** it comprises multiple consecutive operating cycles, which each comprise at least said first cooling step (201) and said control step (202);

said logic control unit (5) comprising an archiving database (50), arranged for archiving the values of said thermal variation speed values (vT) measured during said preceding operating cycles, in which said thermal variation speed values (vT) are catalogued and divided according to at least one historical parameter selected from between: the measurement time range and the day of week of the measurement;
said logic control unit (5) calculating at least one between said first virtual time (tvl) and said second virtual time (tv2) as arithmetic mean of a preset number of preceding thermal variation speed values (vT) in said archiving database (50) and having said historical parameter in common, in which said preset number is an integer comprised between 1 and 10.

6. Method according to any one of the preceding claims, **characterized in that** during said first cooling step (201) said refrigeration unit (2) cools said first refrigerated display (3) with a first cooling power (PI);
said logic control unit (5) setting, in said control step (202), a second cooling power (P2), lower than said first power (P1), in order to cool said first refrigerated display (3) with said second cooling power (P2), postponing said first real time (tr1) and extending said first cooling step (201).

7. Method according to any one of claims 1 to 5, **characterized in that** said logic control unit (5) sets, during said control step (202), a second objective temperature (Tobb2), lower than said first objective temperature (Tobb 1) in order to extend said first cooling step (201).

8. Method according to claims 7, dependent on claim 2, **characterized in that** said logic control unit (5) sets said second objective temperature (Tobb2) lower than said first objective temperature (Tobb1) of a first additional value (Tagg1);
said logic control unit (5) calculating said first added value (Tagg1) from the product between said thermal variation speed (vT) and a first additional time (tagg1), which is greater than or equal to said time interval (Δt).

9. Method according to any one of claims 1 to 5, **characterized in that** in said control step (202), said logic control unit (5) sets a third maximum threshold temperature (Tmax3) for said second refrigerated display (4);
said third maximum threshold temperature (Tmax3) being lower than said second maximum threshold temperature (Tmax2), in order to anticipate said second cooling step.

10. Method according to claim 9, dependent on claim 2, **characterized in that** said logic control unit (5) sets said third maximum threshold temperature (Tmax3) lower than said second maximum threshold temperature (Tmax2) of a second additional value (Tagg2);
said logic control unit (5) calculating said second added value (Tagg2) from the product between said thermal variation speed (vT) and a second additional time (tagg2), which is greater than or equal to said time interval (Δt).

11. Method according to any one of the preceding claims, **characterized in that**, in said first cooling step (201), said first temperature sensor (31) communicates to said logic control unit (5) when said first internal temperature (Ti1) reaches a specific starting value (Tavv) greater than said first objective temperature (Tobb1), and said logic control unit (5) starts said control step (202) upon reaching said starting value (Tavv).

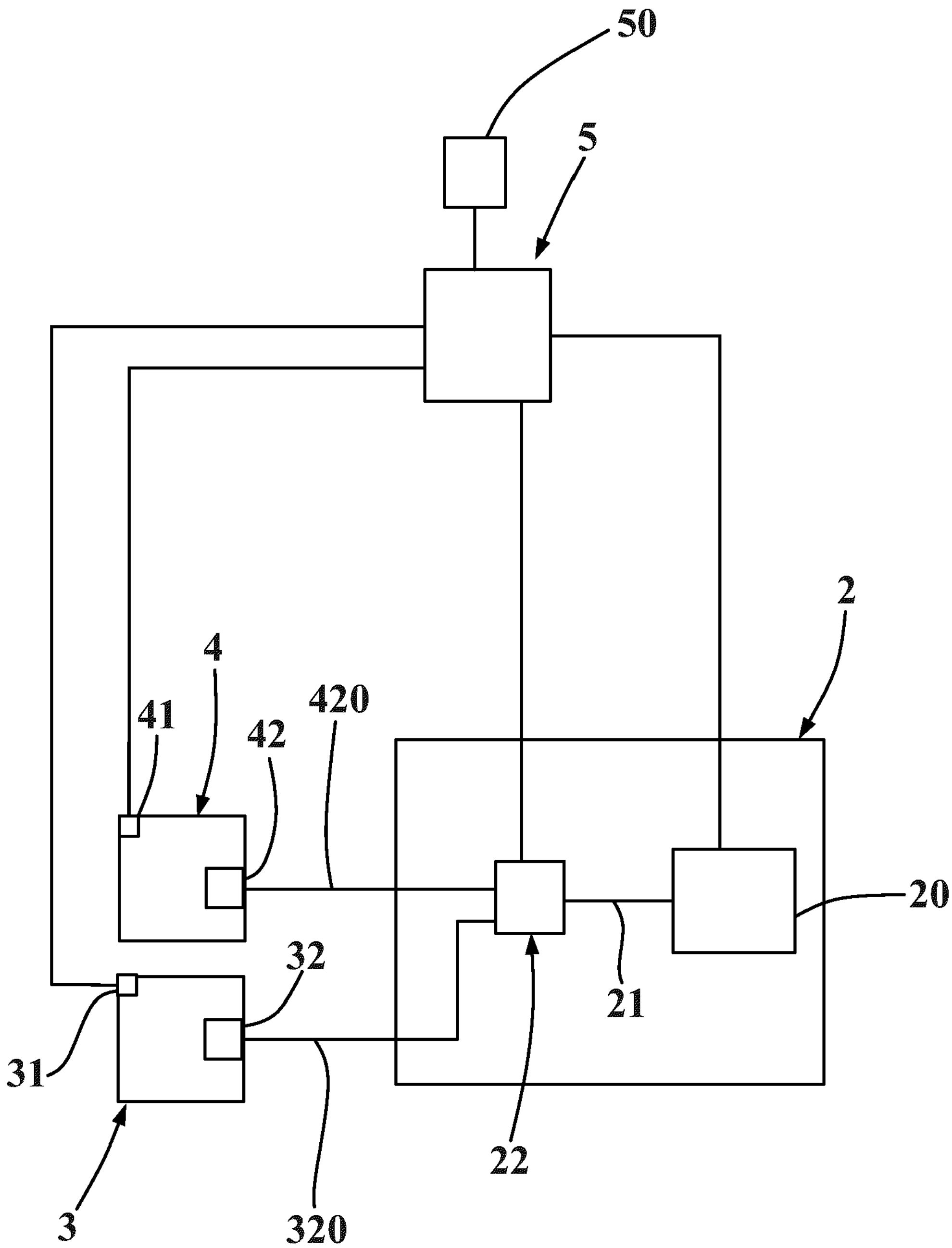

Fig. 1

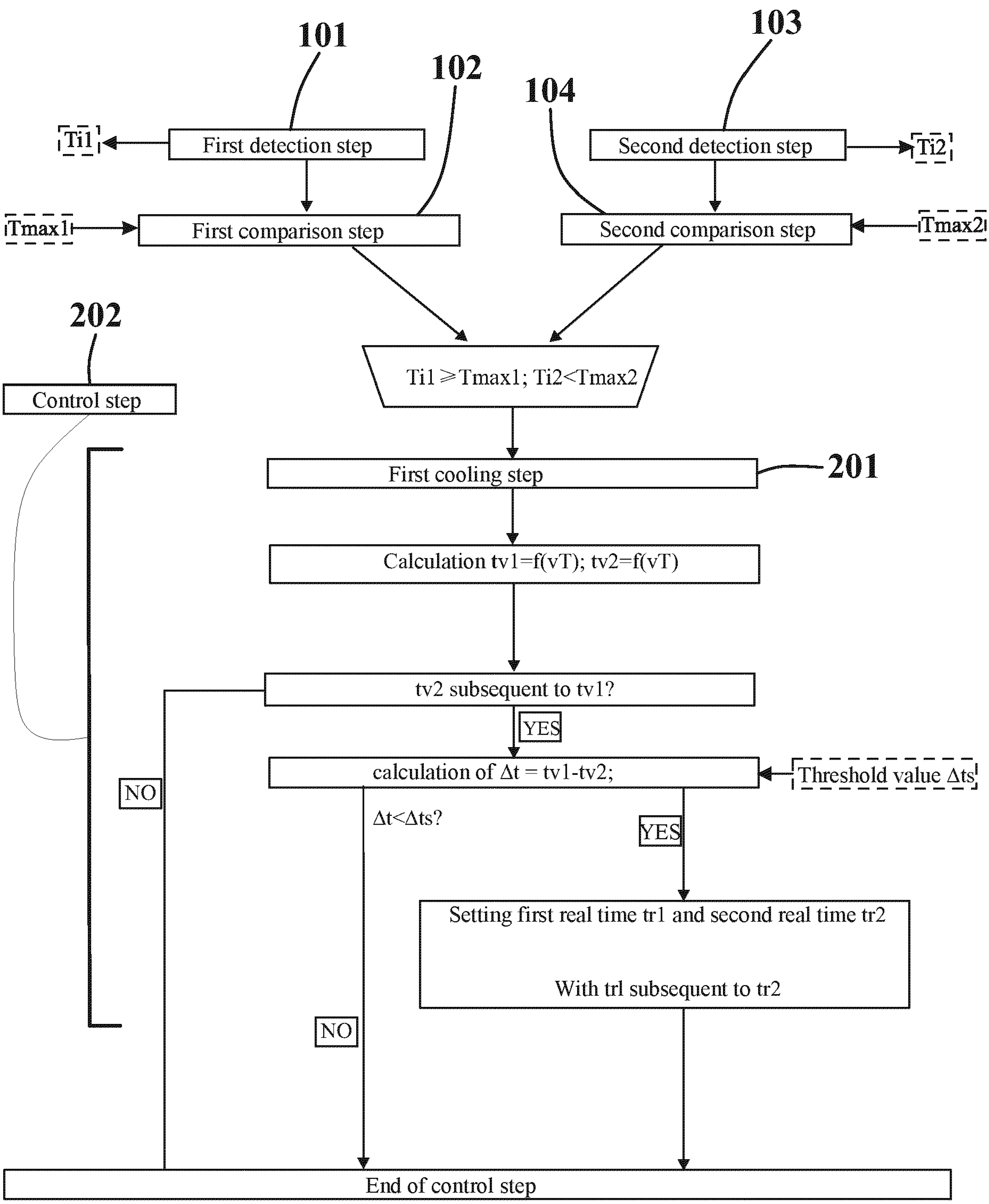
101
102
103
104
Ti1
First detection step
Second detection step
Ti2
Tmax1
First comparison step
Second comparison step
Tmax2
202
Control step
Ti1 ⩾Tmax1; Ti2<Tmax2
First cooling step
201
Calculation tv1=f(vT); tv2=f(vT)
tv2 subsequent to tv1?
YES
NO
calculation of Δt = tv1-tv2;
Threshold value Δts
Δt<Δts?
YES
Setting first real time tr1 and second real time tr2
With trl subsequent to tr2
NO
End of control step

Fig. 2

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EUROPEAN SEARCH REPORT

Application Number
EP 22 18 5780

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 2015/276306 A1 (GOMES ALBERTO REGIO [US] ET AL) 1 October 2015 (2015-10-01) * abstract; figures 1-10 * * paragraphs [0004], [0026], [0042] - [0059], [0069] - [0075] *	1-11	INV. F25D11/02 A47F3/04
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F25D
A47F
F25B

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	23 November 2022	Bejaoui, Amin

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