



(12)

EUROPEAN PATENT APPLICATION

(43)

Date of publication:
19.07.2000 Bulletin 2000/29

(51)

Int Cl.7: A47F 3/04, F25D 29/00,
F25D 21/06

(21)

Application number: 00100725.1

(22)

Date of filing: 14.01.2000

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(54)

Method to control refrigeration conditions of refrigerated modules and device to achieve said method

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Method and device to control refrigeration conditions in refrigerated showcases, modules (10) or similar, said refrigerated modules comprising at least a front glass (11), a refrigerated compartment, a cooling circuit (17), antimisting devices (32) and a cooling assembly (40), it being provided, during functioning, to measure

at least the values of temperature of the air (21) entering and leaving the evaporator unit (13), to compare them with pre-determined threshold values and to give permission to start a defrosting cycle to defrost the evaporator unit (13) only when the continuously measured values reach the threshold values.

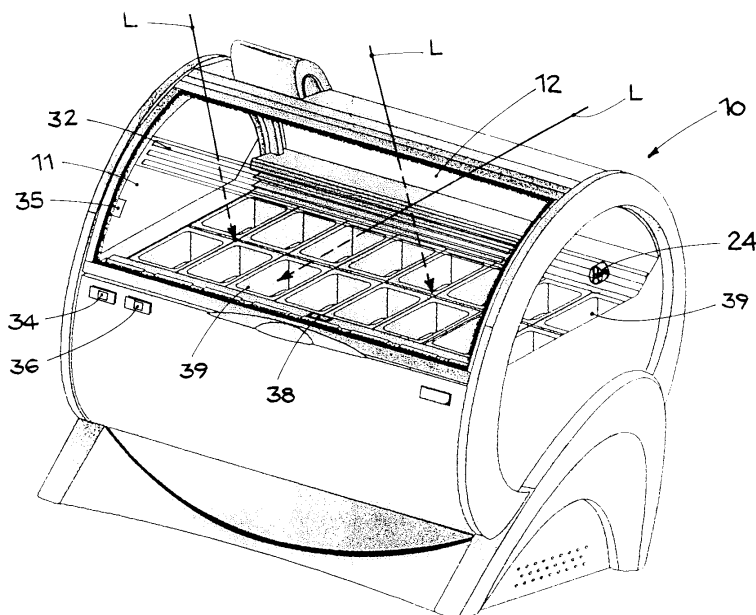


Fig.1

Description

FIELD OF THE INVENTION

[0001] This invention concerns a method to control the refrigeration conditions of refrigerated modules, and the device which achieves said method.

[0002] The invention is suitable to be used in show-cases and refrigerated modules used to display, pre-serve and sell refrigerated food products, in order to re-duce the overall consumption of electric energy and to optimize the preservation conditions of the food prod-ucts.

[0003] The invention allows to reduce to a minimum the influence of the defrosting and anti-misting cycles on the preservation of the food products; it also ensures that the optimum thermostat parameters are maintained for the correct preservation of the refrigerated food stuffs.

BACKGROUND OF THE INVENTION

[0004] There are various problems in the state of the art concerning the refrigeration of foodstuffs in order to ensure optimum hygrothermal conditions for preserva-tion.

[0005] For example, it is well-known that the formation of frost, ice or snow on the surfaces of an evaporator during the functioning of a refrigeration plant can as-sume proportions such as to compromise the correct functioning of the refrigeration system; therefore it is usual practice to follow programmed defrosting cycles to melt the deposits of frost or ice from the surfaces of the evaporator.

[0006] In practice, programmed defrosting cycles are performed automatically, at fixed periods of time, deter-mined according to experience and the functioning pa-rameters of the refrigeration plant.

[0007] However, every defrosting cycle causes an in-crease in temperature and therefore has a negative in-fluence on the preservation of the products themselves, and in any case causes a high energy consumption, at the end of the cycle, in order to restore the correct re-frigeration conditions.

[0008] Alternative solutions have therefore been stud-ied with the purpose of reducing the influence of such cycles on the preservation conditions of the refrigerated products.

[0009] For example, the state of the art includes a method which provides to make a series of short de-frosting cycles, at a limited interval from each other, and then to make a complete defrosting only after the refrig-eration plant has been functioning for a long period of time. This solution does not solve the problem complet-ely, since the defrosting operations do not take into ac-count the real situations which have occurred inside the refrigerated module.

[0010] Another problem connected with maintaining

optimum refrigeration conditions is that when the humid air contained inside the refrigerated compartment comes into contact with a surface which has a lower temperature than dew temperature, condensation forms on said surface and, if the surface is transparent, causes it to mist over.

[0011] Misting over not only reduces visibility for the customer and conceals the products displayed, but also causes drips which can damage the products or the packaging. Moreover, the drips can damage the metal parts of the windows and the refrigerated modules, or can reach the electrical parts, with considerable risks both for the assistants and for the customers.

[0012] To overcome this problem, the state of the art provides to use electric anti-misting devices, including the heating filaments of the type used in the heated rear windows of motor vehicles. In some cases electric fans are also used, suitable to direct a flow of air, heated or not, onto the surfaces most subject to the phenomenon of misting.

[0013] Conventional anti-misting devices are normal-ly kept functioning permanently, which entails a high consumption of electric energy and also a negative ef-fect on the parameters of thermosetting of the refrig-erated showcase.

[0014] The high consumption of electric energy is due not only to the power absorbed directly by the anti-mis-ting devices, but also to the fact that the refrigeration sys-tem of the refrigeration plant must be activated more fre-quently and for longer periods of time to deal with the increase in temperature inside the showcase caused by the anti-misting devices.

[0015] Moreover, the anti-misting devices, which function constantly unless there are correction interven-tions made, can cause a deterioration of the preserva-tion conditions of the food products.

[0016] In conventional refrigerated modules, it is well-known that the thermohygrometric parameters are con-trolled using thermoregulators, or other similar control devices, installed inside the volume of the refrigerated module in a position such that the detector element is suitable to be lapped by the cooling air.

[0017] Such thermoregulators are programmed to de-fine a thermostat setting suitable to ensure the correct conditions for preserving the food products.

[0018] The temperature of the cooling air is constantly measured and, if variations are monitored in the real temperature with respect to the programmed value, an intervention is made on the refrigeration plant to restore correct conditions.

[0019] This method of control, however, ensures that only the thermostat parameters of the cooling air are maintained; it does not allow to control the actual, real temperature of the products contained in the refrigerat-ed module. This is a problem since the action of external agents can alter the relation between the thermostat val-ue (air temperature) and the real temperature of the product.

[0020] It is well-known, in fact, that the external light causes an increase, due to radiance, in the temperature of the products on display, although the temperature of the cooling air remains more or less constant.

[0021] Thus it may happen that, during the course of the day, the real temperature of the products exposed to the light exceeds - even by several degrees - the values set by the thermostat setting and considered optimum for the correct preservation of the foodstuffs.

[0022] The present Applicant has devised, tested and embodied this invention to overcome these shortcomings and to obtain further advantages.

SUMMARY OF THE INVENTION

[0023] The invention is set forth and characterized in the respective main claims, while the dependent claims describe other innovative characteristics of the invention.

[0024] A first purpose of the invention is to determine, in a manner which uses a processor, the activation and duration of the defrosting cycles in an evaporator in a refrigeration plant, in such a way as to reduce the influence of the defrosting operations on the parameters of preservation of the refrigerated products.

[0025] To be more exact, the invention provides to start the defrosting cycles only when necessary, that is, when the conditions inside the refrigeration plant require it because the frost or ice on the outside surfaces of the evaporator begins to influence the thermo-dynamic parameters of the system to a considerable extent.

[0026] Moreover, the invention provides to terminate the defrosting cycle at the actual moment when correct functioning conditions have been restored.

[0027] Another purpose of the invention is to control, in a manner using a processor, the activation and deactivation of the electric anti-misting devices so as to reduce the consumption of electric energy.

[0028] A further purpose of the invention is to regulate the thermostat parameters so as to ensure that the foodstuffs contained therein are perfectly preserved and maintained irrespective of the quantity and type of light striking them.

[0029] To be more exact, the invention provides to regulate the thermostat parameters according to the intensity of the light which strikes the products on display.

[0030] In a first embodiment, the invention provides to control and measure the values of a plurality of parameters of the refrigeration plant, and to begin defrosting of the evaporator only when a significant variation is registered in one or more of said parameters with respect to normal working conditions.

[0031] The significant variation is interpreted by the control system as a symptom of a behavior of the evaporator which is no longer efficient, caused by the presence of an excessive quantity of frost or ice on the walls of the evaporator.

[0032] Similarly, the defrosting cycle is taken to be terminated, and is therefore stopped, when the controlled parameters return within the values corresponding to an efficient functioning of the evaporator.

[0033] The parameters measured include at least the air temperature at inlet to and outlet from the evaporator.

[0034] According to a first variant, the pressure of the gas circulating in the cooling circuit is also measured.

[0035] According to another variant, the speed of circulation of the air inside the refrigerated space is also measured.

[0036] According to a variant, the invention also uses means to physically detect the growth of deposits of frost on the surfaces of the evaporator and uses these values as a threshold value; when this value is exceeded, the defrosting cycle is activated.

[0037] According to a further variant, the invention also uses the parameter relating to the time which has passed since the last defrosting operation was carried out.

[0038] According to another variant, the invention also uses the parameter relating to the time during which the refrigerated showcase has remained open, indirectly deducing the quantity of humidity introduced from outside into the refrigerated compartment containing the products.

[0039] According to the invention, the control system includes means suitable to achieve self-learning operations, in order to use the data acquired in the first defrosting cycles to establish the times and modes to be used in subsequent defrosting cycles.

[0040] In a first embodiment, to establish the end of the defrosting cycle, the invention provides to monitor the actual temperature assumed by the surface of the evaporator. When this temperature reaches a pre-set value, the control system interprets this situation as a signal that all the frost on the surfaces of the evaporator has been completely melted and commands the defrosting cycle to stop.

[0041] According to another variant, optical means are provided suitable to monitor that the frost is completely melted and to give permission for the defrosting cycle to be interrupted.

[0042] According to a further variant, the defrosting cycle is ended a fixed time after starting.

[0043] In another embodiment, the invention provides to continuously measure at least the temperature t_s of the transparent surface of the module on which it is desired to prevent the formation of condensation, and on which the electric anti-misting devices are installed; moreover, it provides to measure the outside temperature t_a and the relative humidity ϕ_a of the location where the refrigerated module is installed.

[0044] According to a variant, the invention provides to measure the humidity ϕ_s inside the refrigerated module.

[0045] According to the invention, the electric anti-misting devices are normally kept inactive, and are only activated when the values detected of the temperatures

t_s and t_a and of the relative humidity φ_a assume, within a defined field of tolerance, pre-set reference values.

[0046] The reference values, pre-determined theoretically or experimentally and memorized in tables in an electronic control unit which manages the functioning of the refrigerated showcase, are those which, under normal working conditions of the refrigeration plant, cause the afore-said surface to mist over.

[0047] The reference values mainly take into account that a high relative humidity φ_a of the premises where the refrigerated showcase or module is installed will systematically cause condensation on a surface every time the temperature t_s of the surface is less than the temperature t_a of the premises and the dew temperature t_d of the air inside said premises.

[0048] In a preferential embodiment, the invention provides to monitor the development in time of these reference values in order to activate the electrical anti-misting devices before the phenomenon of misting-over occurs.

[0049] In one embodiment of the invention, the time that the anti-misting devices are activated may have a fixed and pre-determined value.

[0050] According to a variant, the anti-misting devices are automatically de-activated when the electronic control unit detects that the value of the temperature t_s has risen above a pre-determined threshold, according to the pre-defined conditions of temperature and outside humidity. If these external, environmental conditions change, the threshold value corresponding to the de-activation of the anti-misting devices is also modified in a correlated manner.

[0051] In a further embodiment, the invention provides to use detection means, or light detectors, located inside the refrigerated module and suitable to detect the quantity of light or infra-red entering the cooling volume.

[0052] These detection means are advantageously located very near the products on display, so as to be able to detect, in a credible manner, the actual variation in the temperature of the products caused by the infra-red rays, by means of calculus algorithms.

[0053] The invention provides to condition the functioning of the refrigeration plant according to the quantity of infra-red measured by the detection means, so that the temperature of the products displayed is the optimum temperature for a perfect preservation.

[0054] According to a variant, the invention provides to give an alarm signal to the assistants every time the quantity of infra-red measured by the detection means reaches too high a threshold value which cannot be corrected by a modification to the thermostat setting.

[0055] Another variant provides that, every time the quantity of infra-red measured by the detection means reaches defined threshold values, means are activated to protect the products displayed, such as for example photochromic glass, screens or otherwise, chosen according to the use and location of the refrigerated module.

BRIEF DESCRIPTION OF THE DRAWINGS

[0056] These and other characteristics of the invention will become clear from the following description of some preferential forms of embodiment, given as a non-restrictive example, with reference to the attached drawings wherein:

- Fig. 1 shows a refrigerated showcase adopting the control method according to the invention;
- Fig. 2 shows in simplified form a cooling circuit used in the showcase shown in Fig. 1;
- Fig. 3 is a block diagram of a circuit used in the showcase shown in Fig. 1 to control the defrosting cycles;
- Fig. 4 shows a part of the surface of the evaporator partly covered with frost before the defrosting cycle;
- Fig. 5 shows the same part of Fig. 4 at the end of the defrosting cycle;
- Fig. 6 is a block diagram of a circuit used in the showcase shown in Fig. 1 to control the anti-misting cycles;
- Fig. 7 is a block diagram of a circuit used in the showcase shown in Fig. 1 to control the thermostat parameters.

DETAILED DESCRIPTION OF SOME PREFERENTIAL EMBODIMENTS OF THE INVENTION

[0057] Fig. 1 shows a refrigerated showcase 10, of the type used to display and sell ice cream, comprising at the front part a glass pane 11 and at the rear a hinged top 12 which can be opened and through which the sales assistant can access the refrigerated compartment located inside the showcase.

[0058] The description which follows concerns a showcase for ice cream, but the invention can also be applied substantially to any type of showcase or refrigerated module for the display and sale of refrigerated food products.

[0059] The showcase 10 is equipped with a cooling circuit 17 shown schematically in its essential components in Fig. 2; it comprises an evaporator unit 13, a compressor unit 14, a condenser unit 15 and a stabilizing member 16 to stabilize the cooling fluid, such as an expansion valve, a capillary or other similar element.

[0060] The functioning of the cooling circuit 17 is controlled and managed by an electronic unit, or CPU, 18 which is programmed to maintain inside the showcase 10 the desired hygrothermal conditions according to the organoleptic characteristics of the food product to be refrigerated.

[0061] While the refrigeration plant is functioning, a layer of frost 26 is deposited on the outer surfaces of the fins 19 and the tubes 20 of the evaporator 13, which is transformed into ice if it is not completely eliminated.

[0062] With time, the layer of frost 26 increases in

thickness, and constitutes an obstacle to the flow of air, indicated by the arrows 21 in Fig. 2, through the evaporator 13 and thus lowers the efficiency of the evaporator 13 and the refrigeration plant.

[0063] It is therefore necessary to carry out a defrosting cycle which can be done, for example, by making a hot fluid circulate inside the tubes 20 of the evaporator, or by making a solution with a low freezing point fall into the evaporator, or by switching off the compressor 14 and waiting for the frost 26 to melt naturally.

[0064] The procedure used for defrosting is in any case irrelevant for the purposes of the invention.

[0065] To control the defrosting operations, the invention provides to identify, according to the actual working conditions of the refrigeration plant and to the conditions of the refrigerated environment, the most appropriate moment to begin every defrosting cycle, and the most appropriate moment to end it.

[0066] The circuit suitable to make the control mentioned above comprises temperature monitoring means 22a and 22b located respectively at inlet and outlet of the evaporator 13 and suitable to determine the temperature of the air respectively entering and emerging from the evaporator 13. The circuit also comprises means 23 suitable to detect the pressure of the cooling fluid, arranged along the cooling circuit 17.

[0067] According to a variant, there are also means 24 suitable to detect the speed of the air inside the showcase 10.

[0068] In the variant shown in Fig. 4, there are also optical detection means 25 suitable to measure the thickness of the layer of frost 26 which has formed on the fins 19 and tubes 20 of the evaporator 13, consisting of a light emitter 27 and a mating receiver 28.

[0069] The light emitter 27 advantageously consists of a fiber optic suitable to emit a luminous signal, and the receiver 28 consists of an optical detector which is suitable, according to the luminous signal reflected by the layer of frost 26, to calculate the thickness thereof.

[0070] The control unit 18 comprises a timer 29 suitable to measure and memorize the time which has elapsed since the last defrosting cycle, and to measure the duration of every defrosting cycle.

[0071] According to the invention, the respective parameters measured by the means 22a, 22b, 23, 24 and 25 are sent to the control unit 18, which is suitable to process them according to a pre-established program, possibly interpolating them with each other, and to establish when, inside the showcase 10, the actual conditions have been created which require a defrosting cycle to be started.

[0072] To be more exact, a first embodiment provides to start the defrosting cycle when the difference between the temperature of the air entering the evaporator 13, measured by the probe 22a, and the temperature of the air leaving the evaporator 13, measured by the probe 22b, goes below a pre-determined threshold, when there are defined and pre-determined conditions of the

cooling fluid pressure and possibly of the air speed inside the showcase 10.

[0073] In this case, the control unit 18, according to the signals relating to the measurements made by the sensor 23, and possibly by the sensor 24, which define the working conditions of the refrigeration plant, determines an intervention threshold relative to the difference between the outlet temperature and the inlet temperature of the air to/from the evaporator 13.

[0074] Once this threshold has been exceeded, the control unit 18 supplies a signal to activate the defrosting cycle.

[0075] The defrosting cycle can be actuated by acting on a switch 31.

[0076] In one embodiment, when the switch 31 is commutated, this can cause the cooling fluid to be heated and circulate inside the tubes 20 of the evaporator 13 to melt the frost 26.

[0077] Alternatively the other defrosting methods cited above can be used, or others.

[0078] In the embodiment shown in Fig. 4, among the parameters used to verify whether the defrosting cycle needs to be started, there is also the actual thickness of the layer of frost 26 on the surfaces of the evaporator 13.

[0079] The signal relating to this value of thickness, as detected by the optical sensor 25, is sent to the control unit 18, inside which a threshold value is memorized; when the threshold value is exceeded, the permission for the defrosting cycle to begin is given.

[0080] To start the defrosting cycle, one variant of the invention provides to consider the time which has passed since the last defrosting operation was carried out, calculated by the timer 29.

[0081] In the event that the actual parameters indicated above, as detected by the respective sensors 22a, 22b, 23, 24 and 25, indicate that defrosting is necessary, but that a very short time has elapsed since the last defrosting, then the control unit 18 sends an alarm message, so that the assistants are warned of a possible malfunctioning of the refrigeration plant.

[0082] Similarly, if a long period of time has elapsed since the last defrosting, but the sensors 22a, 22b, 23, 24 and 25 do not indicate that it is necessary to start the defrosting cycle, an alarm signal is given in any case, which warns the assistants of possible malfunction.

[0083] According to a variant, the method provides to define a maximum time threshold; when this is reached, a defrosting cycle is started anyway, even if the actual parameters monitored do not indicate that it is necessary.

[0084] The timer 29 is also used to measure the time during which the glass 11 or the hinged top 12 stay open, that is, the time during which the refrigerated inner environment of the showcase 10 stays in contact with the outside environment, with the relative exchange of air, and therefore humidity is introduced inside the system.

[0085] In the event that the hinged top 12 stays open for a long time, the mean humidity of the inner environ-

ment of the showcase 10 may rise, and therefore this can accelerate the formation of frost 26 on the evaporator 13.

[0086] The control unit 18 can be programmed so as to carry out cross-over comparisons between the parameters detected, and to start the defrosting cycle only when all said parameters, according to the pre-defined thresholds, indicate that defrosting is necessary.

[0087] According to a variant, a preferential threshold is chosen from among those mentioned above, and the other parameters are used only to confirm the indications supplied by the basic parameter.

[0088] After the first defrosting cycles, the control unit 18 can make a self-learning program according to which tables are defined of pre-determined values of all the parameters measured, and permission to start defrosting is given without making interpolations or comparisons but simply when the parameters reach said pre-determined values.

[0089] According to a variant, the first defrosting cycle is always carried out after a pre-set time, in order to define a parameter setting table.

[0090] To bring the defrosting cycle to an end, in order to prevent it continuing for longer than is necessary, a first embodiment of the invention provides to measure, by means of a probe 30, the actual temperature reached by the surface of the evaporator 13.

[0091] This value is measured continuously and compared by the control unit 18 with a pre-defined threshold value, according to which the frost 26 is assumed to have completely melted.

[0092] Once this threshold value has been reached, the defrosting is interrupted and the normal functioning of the cooling circuit 17 restored.

[0093] According to a variant, the control unit 18 uses the data monitored by the optical detection means 25.

[0094] When said means 25 optically detect the complete disappearance of the frost 26 (Fig. 5), the control unit 18 gives permission for the defrosting cycle to be interrupted. According to another variant, the defrosting cycle is interrupted a fixed time after starting, as measured by the timer 29.

[0095] In this case too, the temperature values of the surface of the evaporator 13, the actual thickness of the frost 26 and the defrosting time can be appropriately interpolated and compared with each other by the control unit 18 to establish the most appropriate moment to stop defrosting.

[0096] In this case, the glass 11 is equipped with electrically conductive heating filaments 32 suitable to heat the glass 11 when fed with a specific feed tension V_{alim} (Fig. 6).

[0097] Instead of the heating filaments 32, it is possible to use glass of a pyrolithic type, or glass suitable to cooperate with fans blowing hot air, or other conventional anti-misting systems.

[0098] The invention provides to activate the feed to the heating filaments 32 only when the temperature t_s

of the glass 11, the temperature t_a and the relative humidity ϕ_a of the premises where the showcase 10 is installed assume defined reference values.

[0099] Fig. 6 shows a block diagram of a circuit associated with the control unit 18, suitable to control the anti-misting cycles according to the invention.

[0100] A memorization unit 33, two temperature sensors respectively 34 and 35, a humidity sensor 36 and a switch 37, normally on and serially connected to the heating filament 32, are connected to the electronic control unit 18.

[0101] The temperature sensor 34 detects the temperature t_a of the premises where the showcase 10 is installed, the humidity sensor 36 measures the value of relative humidity ϕ_a of the same premises and the temperature sensor 35 detects the temperature t_s of the surface of the glass 11.

[0102] According to a variant which is not shown here, there is a further sensor connected to the unit 18 suitable to measure the humidity inside the showcase 10.

[0103] The values detected by the sensors 34, 35 and 36 are sent continuously to the control unit 18, which processes them, possibly interpolating them with each other, and compares them with reference values contained in the memorization unit 33. According to this comparison, the control unit 18 defines when conditions to cause the glass 11 to mist over occur and therefore, as a consequence, provides to close the switch 37, for example a relay switch, to feed the heating filament 32 with the feed tension V_{alim} .

[0104] To be more exact, the control unit 18 monitors the variations in time of said temperature values t_a and t_s and of the relative humidity ϕ_a and then can be programmed so as to activate the heating filaments 32 before the conditions occur which cause misting over. The time for which the heating filaments 32 are activated may assume a fixed and pre-ordained value corresponding to a programmed anti-misting time.

[0105] According to a variant, the cessation of feed to the heating filaments 32 is governed by a parameter control made by the unit 18, and in particular by the control of the temperature t_s of the glass 11, established according to the external conditions of outside humidity and temperature.

[0106] A further control of the refrigeration conditions in the showcase 10 is based on the quantity of light "L" which penetrates inside the refrigerated showcase through the glass 11.

[0107] In the course of the day, or in particular display conditions of the showcase 10, the light "L", which may be natural, artificial or mixed, can cause the surface temperature of the products on display to rise, due to radiance.

[0108] This happens even if the temperature of the cooling air, moved by a fan 40a, is kept substantially constant and on the values established by the programmed thermostat setting.

[0109] Inside the showcase 10 there is a light-detector

38 suitable to detect the quantity of infrared "L" striking the products on display, and to transmit the values detected to the control unit 18.

[0110] In this case, the light-detector 38 is installed on the same plane on which the tray 39 lies, so as to detect, in a credible manner, the actual quantity of infrared "L" striking the ice-cream contained therein, so that it is possible to detect the real variation in the temperature of the product with a reasonable degree of reliability.

[0111] The control unit 18 is suitable to pilot the cooling assembly 40 of the showcase 10, a signalling assembly and protection means 42, such as photochromic glass, movable screens or similar, suitable to defend the products on display from the light "L".

[0112] The cooling assembly 40 works with forced air circulation and is normally controlled by a thermoregulator 43, also functionally connected to the control unit 18, suitable to detect the parameters relating to the thermostat setting of the cooling air circulating inside the showcase 10 and to transmit them to the unit 18.

[0113] The values supplied at outlet from the light-detector 38 are acquired continuously by the control unit 18, which conditions the functioning of the cooling assembly 40 according to said values.

[0114] In the event that the light-detector 38 detects a quantity of infrared "L" such as to cause an increase in the temperature of the refrigerated product, the thermostat setting is modified, lowering the temperature of the air by a value correlated to the quantity of infrared detected.

[0115] For example, if according to the thermostat setting the air temperature is fixed at -20°C, this value can be lowered, for example to -22°C, if the light-detector 38 detects a quantity of infrared such as to significantly raise the temperature of the product.

[0116] According to a variant, instead of or in combination with the lowering of the temperature setting, the invention provides to increase the speed of the fan 40a in order to increase the intensity of heat exchange between cooling air and refrigerated products, so that the increase in temperature caused by the light "L" is efficiently combated.

[0117] In a first embodiment, the increase in speed of the fan 40a is timed.

[0118] According to a variant, the speed of the fan 40a is increased until the thermoregulator 43 detects a temperature value equal to that required, but with a defined correction factor added.

[0119] The correction factor is calculated by the control unit 18, using defined algorithms, according to values supplied continuously by the light-detector 38 and is such as to ensure that the products on display have the thermostat parameters required by the legislation in force and necessary for perfect preservation.

[0120] In this case, when the light-detector 38 detects a quantity of infrared which is held to be excessive and cannot be corrected by modifying the thermostat setting, the control unit 18 activates the signalling assembly 41,

which can comprise visual signallers 41a, for example a display, lamps, leds or otherwise, or acoustic signalling means 41b such as a buzzer or similar, or even signalling means of a mixed type. In this case, the control unit 18 can also activate the optional protection means 42 chosen on each occasion according to the use of the showcase 10 or where the showcase 10 is installed.

10 Claims

1. Method to control refrigeration conditions in refrigerated showcases, modules (10) or similar, used in commercial outlets to display, preserve and sell food products, said refrigerated modules comprising at least a front glass (11), an at least partly closed refrigerated compartment, a cooling circuit (17) consisting at least of an evaporator unit (13), a compressor unit (14), a condenser unit (15) and a stabilizing member (16), anti-misting devices (32) associated with said front glass (11) and a cooling assembly (40) controlled by a thermoregulator device (43), the method being characterized in that, during functioning, it provides to continuously measure at least the values of temperature of the air (21) entering and leaving said evaporator unit (13), to compare them with pre-determined threshold values and to give permission to start a defrosting cycle to defrost said evaporator unit (13) only when the continuously measured values reach said threshold values.
2. Method as in Claim 1, characterized in that it also provides to continuously measure the value of the pressure of the cooling fluid circulating inside said cooling circuit (17) and to use said measured value to give permission to start a defrosting cycle.
3. Method as in Claim 1 or 2, characterized in that it also provides to continuously measure the value of the speed of the air circulating inside the refrigerated module (10) and to use said measured value to give permission to start a defrosting cycle.
4. Method as in any claim hereinbefore, characterized in that it provides to optically measure the thickness of the layer of frost (26) which has formed on the surface of the evaporator (13) and to use said measured value to give permission to start a defrosting cycle.
5. Method as in any claim hereinbefore, characterized in that it provides to measure the time which has passed since the last defrosting operation and to use said measured value to give permission to start a defrosting cycle.
6. Method as in Claim 5, characterized in that it pro-

vides to define a maximum threshold time after which a defrosting cycle is in any case started.

7. Method as in any claim hereinbefore, characterized in that it provides to measure the time for which said refrigerated compartment of the refrigerated module (10) has remained in contact with the outside, with consequent exchange of air, and to use said measured value to give permission to start a defrosting cycle.
8. Method as in Claim 1, characterized in that, during the defrosting cycle, it provides to measure the actual temperature reached by a segment of surface of the evaporator (13), and to give permission to interrupt the defrosting cycle when said measured temperature reaches a pre-determined threshold value.
9. Method as in Claim 8, characterized in that, during the defrosting cycle, it provides to optically measure the thickness of the layer of frost (26) which has formed on the surface of the evaporator (13) and to give permission to interrupt the defrosting cycle when said thickness reaches a minimum pre-determined value.
10. Method as in Claim 8 or 9, characterized in that it provides to measure the time which has passed since the start of the defrosting cycle and to give permission to interrupt said cycle after a pre-determined fixed time.
11. Method as in Claim 1, characterized in that it provides to continuously measure at least the values of temperature (t_a) and of relative humidity (φ_a) of the premises where the module (10) is installed and the value of temperature (t_s) of said glass (11), and to activate the feed to said anti-misting devices (32), normally kept inactive, when said values (t_a , φ_a , t_s) assume pre-determined reference values such as to determine conditions where said glass (11) is misted over in normal working conditions of the refrigerated module (10).
12. Method as in Claim 11, characterized in that it provides to monitor the development in time of said temperature values (t_a , t_s) and relative humidity value (φ_a) and to activate said anti-misting devices (32) before misting conditions set in.
13. Method as in Claim 11 or 12, characterized in that it provides to keep the feed to the anti-misting devices (32) active for a pre-determined set time.
14. Method as in Claim 11 or 12, characterized in that it provides to keep the feed to the anti-misting devices (32) active until at least the value

(t_s) of the temperature of the surface (11) assumes a pre-determined value relating to the measured values of temperature (t_a) and outside humidity (φ_a).

15. Method as in Claim 1, characterized in that it provides to use light-detector means (38) suitable to measure the quantity of infrared which passes through said glass (11) and strikes the refrigerated food products, and to condition the thermostat parameters of said cooling assembly (40) according to the quantity of infrared detected by said light-detector means (38).
16. Method as in Claim 15, characterized in that it provides to modify the thermostat setting relating to the temperature of the air circulating inside the refrigerated module (10) according to the quantity of infrared detected by said light-detector means (38).
17. Method as in Claim 15 or 16, characterized in that it provides to modify the parameter relating to the speed of circulation of the air according to the quantity of infrared detected by said light-detector means (38).
18. Method as in Claim 15, characterized in that it provides to signal an alarm condition in the event that the quantity of infrared detected by said light-detector means (38) reaches a value which cannot be corrected by modifying the thermostat parameters.
19. Method as in Claim 15, characterized in that it provides to temporarily activate protection and screening means (42) in the event that the quantity of infrared detected by said light-detector means (38) reaches a value which cannot be corrected by modifying the thermostat parameters.
20. Device to control refrigeration conditions in refrigerated showcases, modules (10) or similar, used in commercial outlets to display, preserve and sell food products, said refrigerated modules (10) comprising at least a front glass (11), an at least partly closed refrigerated compartment, a cooling circuit (17) consisting at least of an evaporator unit (13), a compressor unit (14), a condenser unit (15) and a stabilizing member (16), anti-misting devices (32) associated with said front glass (11) and a cooling assembly (40) controlled by a thermoregulator device (43), the device being characterized in that it comprises means (22a) to measure the temperature of the air (21) entering said evaporator unit (13) and means (22b) to measure the temperature of the air (21) leaving the evaporator unit (13), said means (22a, 22b) being connected to a control unit (18), said control unit (18) being suitable to activate a defrosting cycle to defrost the evaporator (13) when the difference between the temperature of the air

entering and the temperature of the air leaving said evaporator unit (13) reaches a pre-determined threshold value.

21. Device as in Claim 20, characterized in that it comprises means (23) to measure the pressure of the cooling fluid circulating in the evaporator unit (13), said means (23) being connected to the control unit (18), said control unit (18) being suitable to use said pressure value to give permission to start the defrosting cycle. 5
22. Device as in Claim 20 or 21, characterized in that it comprises means (24) suitable to measure the speed of the air circulating inside the refrigeration module (10), said means (24) being connected to the control unit (18), said control unit (18) being suitable to use said air speed value to give permission to start the defrosting cycle. 10
23. Device as in any Claim from 20 to 22 inclusive, characterized in that it comprises optical detection means (25) suitable to measure the value of the thickness of the frost (26) on the surface of the evaporator (13), said means (25) being connected to the control unit (18), said control unit (18) being suitable to use said value of the thickness of the frost (26) to give permission to start the defrosting cycle. 15
24. Device as in Claim 23, characterized in that the optical detection means (25) comprise light-emitting means (27) consisting of a fiber optic suitable to emit a luminous signal, and receiver means (28) suitable to detect the luminous signal reflected by the frost (26) so as to be able to calculate the thickness thereof. 20
25. Device as in any Claim from 20 to 24 inclusive, characterized in that it comprises means (29) suitable to measure the time which has passed since the last defrosting operation, said means (29) being connected to the control unit (18), said control unit (18) being suitable to use said value of the elapsed time to give permission to start the defrosting cycle. 25
26. Device as in Claim 25, characterized in that said means (29) are suitable to measure the time for which the refrigerated compartment of the refrigerated module (10) has remained in contact with the outside, with consequent exchange of air, the control unit (18) being suitable to use said value to give permission to start the defrosting cycle. 30
27. Device as in Claim 20, characterized in that it comprises means (30) suitable to measure the actual temperature of the surface of the evaporator (13) during the defrosting cycle, said means (30) being 35

connected to the control unit (18), said control unit (18) being suitable to give permission to interrupt the defrosting cycle according to the temperature signal supplied by said means (30).

28. Device as in Claim 20, characterized in that it comprises optical detection means (25) suitable to measure the value of the thickness of the frost (26) on the surface of the evaporator (13), said means being connected to the control unit (18), said control unit (18) being suitable to give permission to interrupt the defrosting cycle when the actual value of the thickness of the frost (26) has gone below a minimum threshold value. 40
29. Device as in Claim 20, characterized in that it comprises means (29) suitable to measure the time which has elapsed since the start of the defrosting cycle, said means (29) being connected to the control unit (18), said control unit (18) being suitable to give permission to interrupt the defrosting cycle when the means (29) detect that a pre-determined set time has elapsed since the beginning of the cycle. 45
30. Device as in Claim 20, characterized in that it comprises a memorization unit (33), interruption means (37) to interrupt the electric feed to said anti-misting devices (32) and temperature and humidity sensors (34, 35, 36), said control unit (18) being suitable to compare the values continuously detected by said sensors (34, 35, 36) with reference values contained in said memorization unit (33) and to intervene on said interruption means (37) to activate said anti-misting devices (32) in the event that environment conditions exist such as to cause said glass (11) to mist over. 50
31. Device as in Claim 30, characterized in that a first temperature sensor (34) and a humidity sensor (36) are suitable to detect respectively the temperature (t_a) and the relative humidity (ϕ_a) of the premises where the refrigerated module (10) is installed and a second temperature sensor (35) is suitable to detect the temperature (t_s) of said glass (11). 55
32. Device as in Claim 31, characterized in that said second temperature sensor (35) is attached to the outer face of said glass (11).
33. Device as in Claim 30, characterized in that the control unit (18) is suitable to de-activate the electric feed to the anti-misting devices (32) after a pre-determined set time.
34. Device as in Claim 30, characterized in that the control unit (18) is suitable to de-activate the electric feed to the anti-misting devices (32) according to

the data detected and supplied at least by the second sensor (35) of the temperature (t_s) of the glass (11).

35. Device as in Claim 20, characterized in that it comprises a light-detector (38) connected at inlet to said control unit (18) and suitable to pilot at least said cooling assembly (40) to regulate the thermostat parameters according to the data detected by said light-detector (38). 5
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36. Device as in Claim 35, characterized in that said control unit (18) is suitable to lower the thermostat setting relating to the temperature of the air circulating inside the refrigerated module (10) when the quantity of infrared detected by the light-detector (38) exceeds a defined threshold value. 15

37. Device as in Claim 35 or 36, used in a refrigerated module (10) equipped with a cooling assembly (40) comprising a fan (40a) for the forced circulation of cooling air, characterized in that said control unit (18) is suitable to pilot said fan (40a) to increase the speed of rotation thereof so as to increase the heat exchange between said cooling air and said refrigerated products in such a manner as to combat the variations in temperature of the products caused by the radiance of said light (12). 20
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38. Device as in Claim 37, characterized in that said increase in speed of the fan (40a) occurs in a timed manner. 30

39. Device as in Claim 37, characterized in that said increase in speed of the fan (40a) is maintained until the thermohygrometric parameters detected by the thermoregulator (43) assume a value equal to that normally required, to which a correction factor is added calculated by said control unit (18) according to the values supplied by said light-detector (38). 35
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40. Device as in Claim 35, characterized in that it comprises signalling means (41), of a visual type (41a), acoustic type (41b) or mixed, connected at outlet to said control unit (18), suitable to be activated every time that the value supplied by said light-detector (38) exceeds a pre-determined threshold value. 45

41. Device as in Claim 35, characterized in that it comprises means to temporarily activate protection means (42), such as photochromic glass, screens or similar, suitable to defend said products from said light. 50

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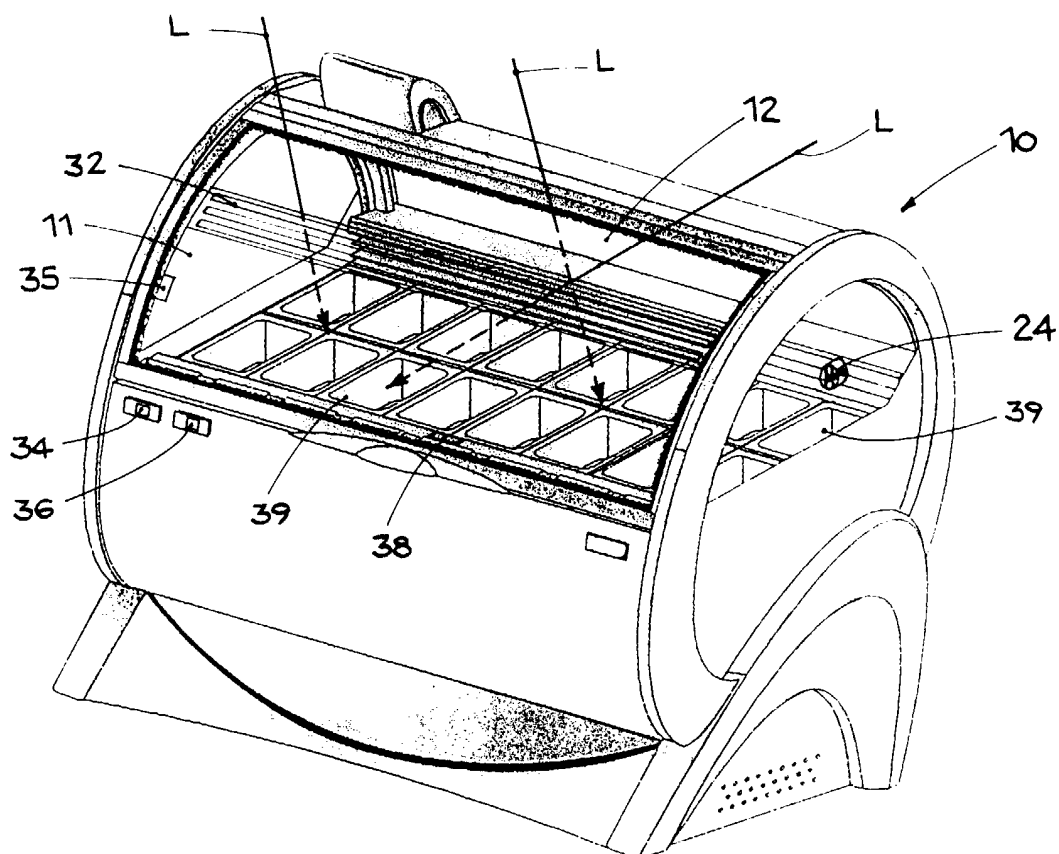


fig.1

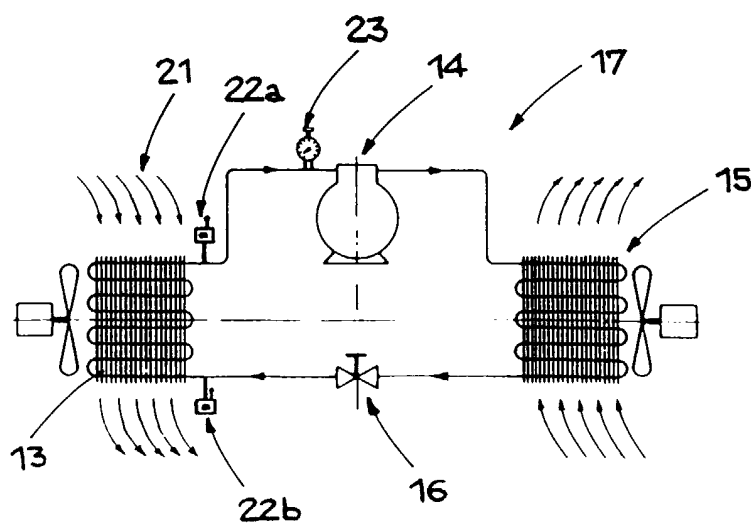


fig.2

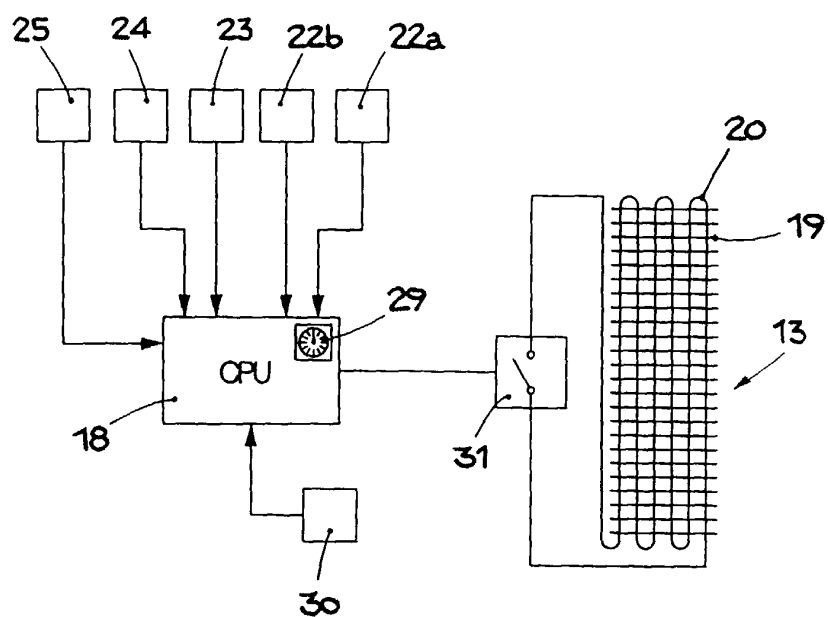


fig.3

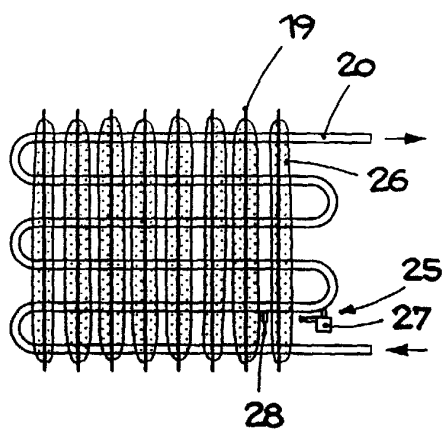


fig.4

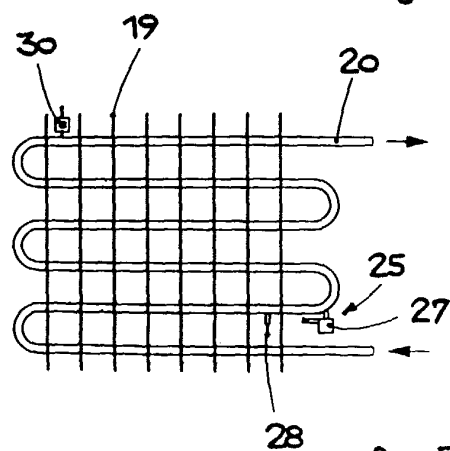


fig.5

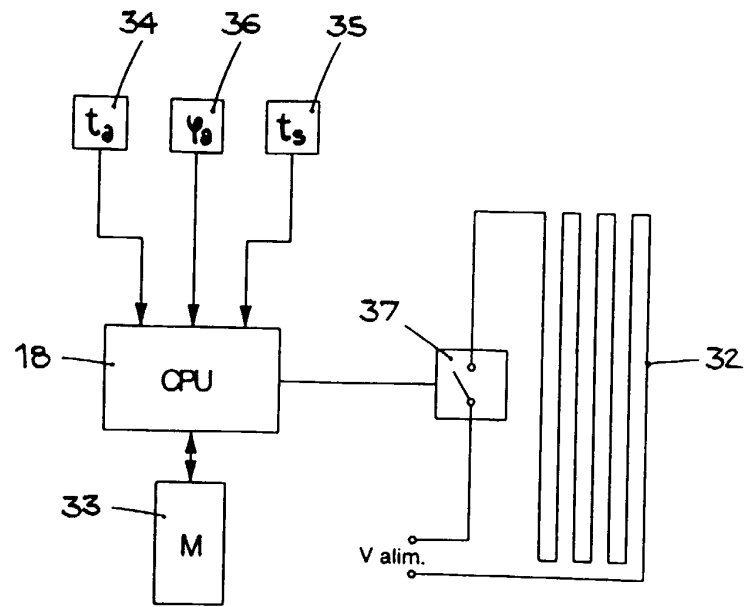


fig.6

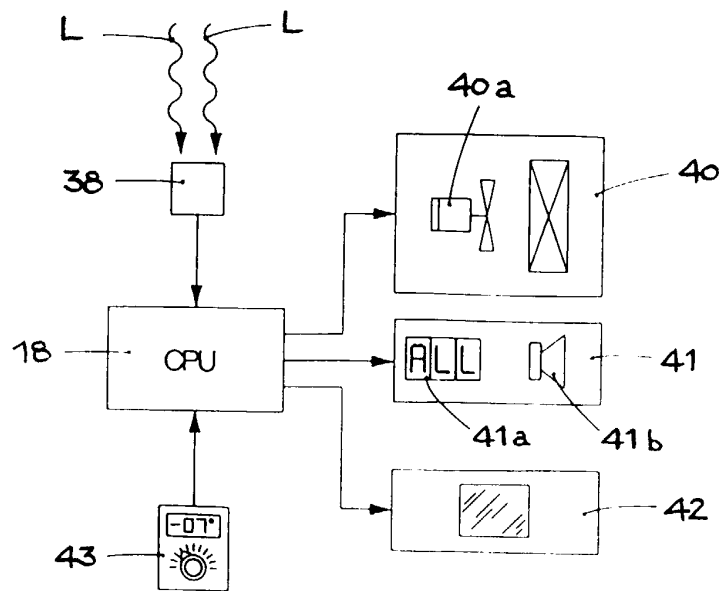


fig.7