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(71) Applicant: **Ávila Chillida, Vicente**
46023 Valencia (ES)

(72) Inventor: **Ávila Chillida, Vicente**
46023 Valencia (ES)

(74) Representative: **Ungria López, Javier**
Avda. Ramón y Cajal, 78
28043 Madrid (ES)

(54) INDUSTRIAL REFRIGERATION SYSTEM

(57) The invention relates to an industrial refrigeration system consisting of various independent refrigerating units (4), where each refrigerating unit (4) is installed in a thermally and acoustically insulated piece of furniture. The refrigeration system comprises a single heat dissipation unit (6) connected by a pipeline by means of a water ring (5) from which branches extend to each of the refrigerating units (4). Each of the refrigerating units (4) and the heat dissipation unit (6) are provided with individual electronic control devices which are connected to each other and to a control centre.

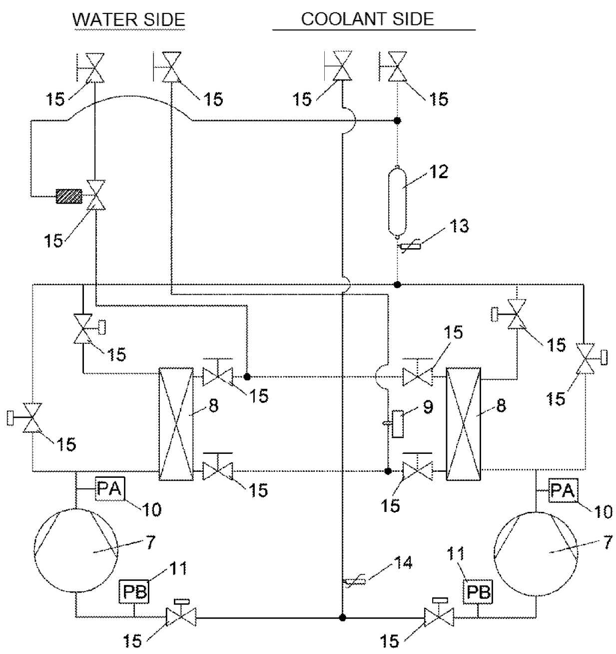

FIG. 1

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Description

OBJECT OF THE INVENTION

[0001] The present invention relates to an industrial refrigeration system comprising a single heat dissipation unit connected by a pipeline in the form of a water ring to a series of refrigerating units. It has particular application in the food, pharmaceutical and medical industries, as well as in morgues.

[0002] It is especially applicable in the industry of installing air-conditioning systems.

TECHNICAL PROBLEM TO BE SOLVED AND BACKGROUND OF THE INVENTION

[0003] A range of refrigeration systems aimed at maintaining a constant temperature in a specific environment are known in the current state of the art.

[0004] However, in most of the existing systems there are two situations that divide the current technology.

[0005] The first is a refrigeration system consisting of a central unit from which the entire refrigeration cycle is carried out. These systems have a series of centralised compressors and condensers that are of the appropriate size to be able to generate the amount of refrigeration needed to reach the working conditions in the specified area.

[0006] The other system consists of having a centralised area and the individual refrigerating units are arranged in the specific area in which a certain temperature is required. The problem with this model is that the cooling liquid flows through the entire circuit, thus causing loses in the system due to joins in the communications.

[0007] In both systems, the problem comes from the heat generated in the condensers, which heat the same area that is to be cooled.

[0008] The present invention aims to resolve these problems via a system formed by individual refrigerating units wherein condensation takes place in a system in which the heat is removed via a pipeline that comes out of the area that is being cooled in order to arrive at a heat dissipater. Heat dissipation is performed through a water exchange unit, by coolant or geothermics.

DESCRIPTION OF THE INVENTION

[0009] The present invention relates to an industrial refrigeration system consisting of various independent refrigerating units aimed at both conservation and freezing, wherein each refrigerating unit is installed in a thermally and acoustically insulated piece of furniture.

[0010] The refrigeration system comprises a single heat dissipation unit connected by a pipeline in the form of a water ring from which branches extend to each of the refrigerating units.

[0011] Each of the refrigerating units and the heat dissipation unit are provided with individual electronic control devices.

[0012] In a first embodiment, the refrigerating units comprise two compressors, which operate alternately and never simultaneously, such that it may continue refrigerating via one of the compressors even if the other compressor breaks down.

[0013] In a second embodiment, each refrigerating unit comprises a single inverter compressor, the frequency of the power supply of the compressor varying depending on the refrigerating power demand and the operation being maintained within the optimum performance curve.

[0014] In the second embodiment, the refrigerating units comprise a liquid/gas heat exchanger that uses the return coolant in gaseous phase when it returns from the evaporator to the refrigerating unit towards the inverter compressor to lower even further the temperature of the coolant that comes out of the heat exchanger of the condenser in liquid phase before arriving at the expansion valve.

[0015] The individual electronic control devices of each of the components are connected to each other and to a control centre that receives information on the state of all the components of the installation and that is capable of detecting notifications and alarms.

[0016] When a notification or alarm is detected, it is sent via SMS or email to an electronic device from which the system, or any of the individual components of the system, may be remotely accessed.

BRIEF DESCRIPTION OF THE FIGURES

[0017] As a complement to the description provided below, and for the purpose of helping to make the characteristics of the invention more readily understandable, in accordance with a preferred practical embodiment thereof, said description is accompanied by a set of figures, which by way of illustration and not limitation represent the following:

- Figure 1 represents a first embodiment of a refrigerator and hydraulic diagram of a refrigerating unit with two compressors.
- Figure 2 represents a refrigerator and hydraulic diagram of the refrigeration system.
- Figure 3 represents a second embodiment of a refrigerator and hydraulic diagram of a refrigerating unit (4) with an inverter compressor.

[0018] A list of numbered references that have been used in the figures shown is provided below:

1. Evaporator.
2. Fan.
3. Expansion valve.
4. Refrigerating unit
5. Water ring.
6. Dissipater.
7. Compressor.

7'. Inverter compressor.
8. Heat exchanger.
9. Flow switch.
10. High-pressure switch
11. Low-pressure switch
12. Filter-drier.
13. High-pressure probe.
14. Low-pressure probe.
15. Pressure valves.
16. Suction pressure probe.
17. Suction temperature probe.
18. Coolant tank.
19. Liquid temperature probe.
20. Gas/liquid heat exchanger.
21. Water temperature probe.
22. Oil exchanger.
23. Discharge pressure probe.
24. Discharge temperature probe.
25. Capillary liquid cooler.
26. Suction container.

DESCRIPTION OF A PREFERRED EMBODIMENT OF THE INVENTION

[0019] The present invention relates to an industrial refrigeration system aimed at conservation and freezing, consisting of individual refrigerating unit (4), a common dissipation system and a management system for regulating and controlling the elements, both individually and jointly, of the entire installation.

[0020] The application of the system is especially recommended for, though not exclusively, the food, pharmaceutical and medical industries, as well as morgues.

[0021] The refrigerating units (4) are compact units, with a horizontal construction below a piece of furniture, that are capable of capturing the heat from food products. One of the main characteristics that define the system of the present invention is that the refrigerating units (4) may be securely integrated in a refrigerator shelf, display case or island freezer.

[0022] The dissipation system comprises an individual dissipater element (6) that is common to the entire system to be assembled inside or outside, which is capable of dissipating the heat captured by the different refrigerating units (4) through the common coolant liquid.

[0023] The regulation and control management system is a system consisting of a software programme and electronic elements for the purpose of remote management that is responsible for food safety, the control of energy efficiency, the management of system alarms, the operation modes and protection of the communication systems. The control system may be provided in on-site form and remote form via the Internet, GPRS or standard telephone line.

[0024] As shown in figure 1, in a first embodiment which has been aimed at the food industry, the refrigerating units (4) have redundant 1+1 systems for capturing heat from food. They are two identical and completely independent compressors (7). This redundant system is carried out such that the compressors (7) operate alternately, one each time, such that the usage time of both is similar. Similarly, if one of the compressors (7) breaks down, the operation of the system is not affected since the second compressor (7) is available.

[0025] Each refrigerating unit (4) also has an individual automated controller to handle, manage and communicate with each of the elements of the refrigerating unit (4), via proprietary management software. The global system individually recognises each refrigerating unit (4) to control the management of the complete system.

[0026] The system has a heat dissipating element (6), common to all the refrigerating units (4), which has a heat exchanger, a water buffer tank, and a redundant recirculation pump for the closed water circuit, which have not been shown in the figures. The management of the operation mode, the management of the alarms and the efficiency of the heat dissipater (6) is performed via proprietary software in a controller installed in the piece of furniture itself of the heat dissipater (6).

[0027] The management system itself carries out the communication of each and every one of the system elements independently via modbus communication networks with open protocol, which is secure and protected against external attacks. The system has a mode, efficiency and alarm management programme that operates individually and globally.

[0028] Implementing the system of the invention provides a series of advantages that shall be described below.

1. Adjust cold production to demand. The refrigerating unit (4) only starts up when an increase in temperature is detected in that particular area. Each refrigerating unit (4) has independent evaporators (1) and is controlled by the temperature of the product.
2. Reduction of electrical costs. The individualised management of the system components, each refrigeration unit (4) having its own compressors (7, 7'), as described above, condensation at low temperatures, the refrigerating units (4) working at low condensing temperatures via a water ring (5), the use of the outside temperatures, the intelligent defrosting management via the introduction of automatic controllers that also manage the electronic expansion valves (3) and the rotation of the compressors (7), the proportional evaporation and remote control of the set points, enable the most efficient cold food system on the market to be offered.
3. Maximum energy efficiency. Condensation at very low temperatures via a water ring (5), the control of reheating through thermostatic expansion valves (3) and the defrosting management by necessity and not routinely, and the use of free-cooling in the ring (5), regardless of the outside temperatures and the use of said temperatures in intermediate seasons and winter guarantees maximum efficiency of the

compressors (7, 7').

4. Elimination of costs due to leaks. The individual design of each refrigerating unit (4) requires minimum coolant charge and mechanical joints have been replaced by welds. The refrigerating units (4) are factory tested via stress testing at 3,000,000 Pa and leak detection, and they are delivered precharged.

5. Reduction of the environmental impact. Due to the elimination of coolant leaks in the individual refrigerating units (4) via the use of multiple fluid-tight circuits with a minimum amount of coolant in each one.

6. Control of technical alarms. The system is equipped with components and open communication protocols for each and every one of the refrigerating units (4), sending information remotely and instantaneously to the alarm centre about any incident in each of the critical elements, via SMS and/or email, of the selected alarms.

7. Reduction of installation, maintenance and renovation costs. Use of affordable elements for the installation, the possibility of being undertaken by unqualified personnel and simplicity of the system and use of refrigerating units (4) that do not require special elements depending on the location thereof.

8. Efficiency management. Remote control of all the system elements, both for acting on them and obtaining operation history that enables the efficiency of the system to be increased and serves for carrying out preventative maintenance.

9. Records. Compliance with the current regulations regarding the traceability of the temperature of the products over time, as well as the necessary records for analysing the energy efficiency and need for planned maintenance.

10. Redundancy. All critical components are equipped with redundancy via duplication for the purpose of guaranteeing the cold food chain in the first embodiment.

11. Noise level. Minimum noise level both inside and outside the sales room via the use of elements with low noise emission and that are equipped with covers and thermal and acoustic insulation.

[0029] The refrigeration system is as described below.

[0030] Each refrigeration area has a motor-compressor producer device that is connected to the evaporator system (1), including a thermostatic expansion valve (3).

[0031] The condensation of the coolant is carried out by water.

[0032] Cooling the condensed water is carried out with outside air in a dry-cooler or via a high-temperature cooler and free cooling.

[0033] The control system of each evaporator-condenser-compressor assembly is included in each producer device, via an independent controller and including the operation programme of each assembly. The control system has modbus communication.

[0034] Each refrigerating unit (4) has the actuation and power protection elements of the evaporator-condenser-compressor assembly.

[0035] All the evaporator-condenser-compressor assemblies, as well as the water cooling system, are connected via modbus to an electronic device, in which all the installation information is received graphically and from which the actuation and state of each element can be accessed and which has the immediate technical alarm and records sending system via SMS or email to a control centre.

[0036] In one of the embodiments, the refrigerating units (4) have refrigeration redundancy and a bypass system of the automated controller to an electromechanical system.

[0037] The hydraulic installation consists of a redundant pump with frequency variation control, expansion tank of the automatic filling system, and redundancy in the fans.

[0038] In one of the embodiments, the refrigerating unit (4) redundantly has the following mechanical components:

- Two rotating horizontal compressors (7) with a HFC/HFCS coolant suppressor.
- Two water-cooling condenser plate exchangers (8).
- One filter-drier (12).
- Independent water service tap for plate exchanger.
- General water service tap.
- High- (10) and low-pressure (11) switch in each refrigerating circuit (pressure probes).
- Solenoid pressure valves (15) in refrigerating circuits.
- Manually actuated coolant taps.
- Flow switch (9).
- Condensation control by regulating the flow of water.

[0039] The refrigerating unit (4) also has the following electrical components:

- Automated controller.
- Electronic expansion valve (3) (in line).
- Suction and discharge temperature probe (suction line).
- Water inlet and outlet temperature probe.
- Humidity sensor.
- Power contactors for contactors.
- Circuit breakers to protect the compressors (7).
- Circuit breaker to protect switching and control.
- Manual over-ride for automatic shutdown.

[0040] The controller incorporated in the refrigerating unit (4) has a display and handling screen in any of the locations in which it is found, whether in refrigerator shelf, display case or island freezer.

- Compressor (7) time routines.
- Compressor (7) rotation management.

- Communication with the management software via modbus.
- Proportional management of the electronic expansion valve (3).
- Intelligent defrosting management.
- If applicable, management of anti-fog systems.
- Alarm and protection routines.
- Fan (2) and evaporator (1) management.

[0041] The refrigeration system further incorporates an integral management and control system for efficiency and alarms.

[0042] Among other functions, this control system carries out the following either remotely or from the touch screen:

- Modification of set points.
- Hourly programming.
- Immediate high-temperature refrigeration alarms.
- Limitation of maximum and minimum adjustments.
- Immediate communication failure alarm.
- Consumption history.
- Technical alarm and incident history.
- Subcooling and reheating history.
- Modification of parameters in the controllers.
- Notifications of necessary predictive maintenance.
- Notification system by SMS and email.

[0043] The hydraulic network of the refrigeration system is arranged from the water cooling unit or dry cooler to the refrigerating units (4), via plastic pipelines without insulation, closing the ring circuit and forming the corresponding branches to each refrigerating unit (4).

[0044] The diameter of the pipeline corresponds to a water speed lower than two meters per second, which corresponds to the maximum instantaneous flow rate.

[0045] A particular feature of the refrigeration system of the present invention is related to the work routine at high water temperatures, thus meaning that the cooling of condensed water may be carried out with ambient air via the use of a dry cooler or, if applicable and, with the purpose of reducing the consumption of the compressors (7) of the end refrigerating units (4), installing an air-condensed water cooler with a free cooling system to work at a lower temperature and reduce electrical consumption.

[0046] The dry cooler or water cooler always has fan redundancy. Depending on the installation, the fans are axial or radial.

[0047] The dry cooler or cooler are also linked to the control centre and the refrigerating units (4) in order to control the state thereof.

[0048] In a first embodiment that is described below, the refrigerating unit (4) has two single stage compressors (7). The capacity of the compressors (7) is redundant. Only one compressor (7) will operate under demand. The two never operate at the same time. A FIFO operating hours rotation between the compressors (7) is established.

[0049] Standard programmable timings are established for start-up, between compressors (7), for minimum operation time and minimum shut-down time.

[0050] Each of the compressors (7) has an operating hours meter with maintenance notification.

[0051] Along with the compressor (7) activation signal, a second signal that is integral thereto is provided to activate the circuit solenoid pressure valves (15). There is a programmable timing delay between the two signals, such that first the solenoid pressure valves (15) are activated, followed by the corresponding compressor (7) thereof.

[0052] With regards to the protections provided in the system, the following may be listed:

Each compressor (7) has a thermal winding. This alarm is not timed. It shuts down the corresponding compressor (7) and activates the twin compressor (7).

[0053] In the general liquid line there is a high-pressure probe. An alarm adjustment is also provided. This alarm is timed in the start-up of the compressor (7) whilst the water switch pressure valve (15) is opened. Once the timing has passed in the alarm moment, it will shut down the corresponding compressor (7).

[0054] When the high-pressure switch (10) is triggered, the compressor (7) signal is deactivated, but the activation signal of the solenoid pressure valves remains active during a programmable time in order to increase the speed in pressure balancing. The twin compressor (7) is then activated.

[0055] In the general aspiration line there is a low-pressure probe. There is a Programmable trigger Adjustment.

[0056] The trigger activation is timed.

[0057] The low-pressure alarm being triggered does not entail the shut-down of the compressors (7). It has the automatic-manual reset routine. If a programmable number of triggers occur within a predetermined time, it will change to manual resetting.

[0058] When the low-pressure switch (11) is triggered, whilst being in automatic reset mode to not enter the twin compressor (7), the same compressor (7) will activate after the reset.

[0059] If the manual reset is triggered, the compressor (7) signal is deactivated, but the activation signal of the solenoid pressure valves (15) remains active during a programmable time in order to increase the speed in pressure balancing. The twin compressor (7) is then activated.

[0060] There are two differentiated digital inputs for the water level alarm: unit input for water and high water level in the tank of the shelf.

[0061] This alarm does not shut down the compressor (7), it is simply informative.

[0062] There is an input for door contact. In the activation moment, the compressors (7), fans (2) and evaporator (1) always shut down.

[0063] The activation of this alarm is programmed. This is a timetable/log in which it is established when the door contact produces an alarm, communicating via modbus.

[0064] If the opening occurs during the hourly programme in which it is uninhibited, but the opening time exceeds one that is previously programmed in minutes, the notification alarm will be generated and start up the corresponding compressor (7).

[0065] The refrigerating unit (4) has the usual different defrosting options in switching the cold food products, but also the switching of defrosting may be inhibited by daily-hourly programming, such that defrosting occurs during a certain time period and with the option of establishing on which days of the week this inhibition occurs.

[0066] During defrosting, high-temperature alarms should not occur.

[0067] There is the option of setting the last temperature before the defrosting starts on the display screen of the shelf.

[0068] The switching of the fan (2) of the evaporator (1) is the standard used in refrigeration islands, shelves and display cases for both conservation and freezing.

[0069] In the fans (2) of the evaporators (1) there is the option of a digital flow switch input. This input is informative and does not shut down the compressors (7) or the fans (2).

[0070] In the set points, the adjustment of the refrigerating unit (4) is by temperature.

[0071] There are three inputs for NTC probes. One of them in coil evaporation for defrosting routines and the other two for temperature readings in the shelf (drive and product or return and product).

[0072] The selection of which of the two temperature probes is the one that acts as an adjustment point is carried out through the programme.

[0073] The adjustment point has the possibility of modifying by time; there will be a minimum of three time periods per day.

[0074] It must be possible to remotely modify the adjustment point and the time programme via the communications bus.

[0075] There is a high-temperature alarm with differential and time delay. Furthermore, a time programme is provided through which the alarm may be deactivated during certain daily time periods.

[0076] The temperature alarm does not work in defrosting or with open door contact (according to the aforementioned routines).

[0077] The high temperature alarm is communicated via modbus.

[0078] In order to understand the system operation, a summary is provided below.

[0079] When the food product temperature probe detects that the temperature has risen above the established set point, the controller sends a start-up command for one of the redundant systems, as specified in the programme switching.

[0080] When the activation is carried out, the compressor (7) increases the pressure and the temperature of the coolant in gaseous phase, sending it to the heat exchanger (8) of the water coolant.

[0081] In the heat exchanger (8), the coolant condenses passing energy to the water, reducing the simple temperature and enthalpy but maintaining the pressure constant (in reality, the pressure is reduced by friction 50,000 Pa)

[0082] Due to the movement of the compressor (7), the coolant comes out of the heat exchanger (8) in liquid phase at a condensing temperature situated between 35°C and 50°C, being sent to the evaporators (1) situated in the shelves, walls or islands.

[0083] Before entering into the evaporator (1), the coolant, in liquid phase, passes through an expanded hole that may be automatically regulated and is situated in the expansion valve (3).

[0084] In the expansion system, the liquid coolant reduces the pressure thereof until it reaches a certain evaporation temperature (variable depending on the type of food product to be cooled).

[0085] In the evaporator (1), the liquid coolant evaporates by capturing the energy of the product to be refrigerated, leaving the evaporator (1) in gaseous phase.

[0086] When the coolant in gaseous phase leaves the evaporator (1), it returns to the suction of the compressor (7) in order to repeat the process.

[0087] This process is repeated until the temperature of the food product lowers to the desired set point.

[0088] When demand occurs again, the controller starts up the twin compressor (7) such that the working hours of the compressors (7) are maintained equal.

[0089] When the refrigerating unit (4) is not under any heat capturing demand, the water inlet to the plate exchangers (18) is blocked by the action of the switch drain valve (15).

[0090] The heat dissipated in the plate exchanger (8), which comes from the food, is released into a volume of water that is maintained in recirculation by means of water recirculating pumps in a closed circuit.

[0091] The system collects all the water from the different refrigerating units (4) that are in operation, sending it by means of a water recirculation pump to the heat dissipater (6).

[0092] The recirculation pumps regulate the flow rate they produce, which is necessary for the operation of the system, via a frequency converter controlled by a water differential pressure probe that maintains the pressure difference between the suction and impulsion of the pump constant.

[0093] The water passes through a water-air heat exchanger (8), via which the heat captured is released in the end food product refrigerating units (4) into the outside air.

[0094] Figure 3 represents a refrigerator diagram of a production unit (4) in a second embodiment wherein the refrigerating units (4) use individual inverter compressors

(7') instead of the aforementioned traditional compressors (7) in redundant mode. In this evaporator unit, also considers the incorporation of a gas/liquid heat exchanger (20) between the inverter condenser (7') and the evaporator (1) which uses the return of the coolant in gaseous phase when it returns from the evaporator (1) to the refrigerating unit (4) towards the inverter compressor (7') in order to further lower the temperature of the coolant that leaves the heat exchanger (20) of the condenser in liquid phase before it arrives at the expansion valve (3) in order to enter the evaporator (1).

[0095] This new embodiment is due to the fact that the inverter compressors (7') do not stop operating as the target temperatures are reached, as takes place with the traditional compressors (7), but rather the speed of the inverter compressor (7') reduces, such that the focus is on maintaining that temperature. As the inverter compressor (7') does not start-up and shut-down, it does not suffer as much and the incorporation of a redundant system to prevent failures is not needed.

[0096] Figure 3 shows how the water from the closed ring (5) comes in and out of the heat exchanger (8) of each of the refrigerating units (4) controlled by both water temperature probes (21).

[0097] Therefore, the coolant, which comes from the evaporator (1) and after passing through a suction pressure probe (16) and through a temperature probe (17), arrives at the gas/liquid heat exchanger (20) in order to be directed to the inverter compressor (7') and continue in order to enter in the heat exchanger (8) of the condenser. Similarly to coming out of the evaporator (1), at the outlet of the inverter compressor (7'), the coolant passes through a discharge pressure probe (23) and through a discharge temperature probe (24).

[0098] At the outlet of the inverter compressor (7'), the coolant passes through an oil exchanger (22) that is responsible for collecting part of the oil included in the coolant and taking it to a capillary liquid cooler (25) in which it condenses.

[0099] Subsequently, the coolant leaves the heat exchanger (8) after having released the heat into the water ring (5) in order to move to a liquid/gas heat exchanger (20), which is incorporated for the purpose of providing greater efficiency to the system.

[0100] There is also a coolant tank (18) in the refrigerating circuit such that the circuit is over-supplied and from which coolant is absorbed according the amounts required.

[0101] From the outlet of the gas/liquid heat exchanger (20), the coolant leaves the refrigerating unit (4) to move towards the expansion valve (3) and the evaporator (1), both elements having already been shown in figure 2, which represents a refrigerator and hydraulic diagram of the refrigeration system.

[0102] As shown in figure 2, the system is mainly made up of a water ring (5) connected to a heat dissipater (6). Branches extend from the water ring (5) to the heat exchanger (8) of the condensers (7, 7') of the different refrigerating units (4) that make up the system. As for the coolant, the refrigerating units (4) are connected to the evaporators (1) through the expansion valves (3). The system represented in figure 2 is valid for the two embodiments, with traditional redundant compressors (7) and with inverter compressors (7'). Similarly, the common heat dissipation system described in the first embodiment with traditional compressors (7) is also valid for the second embodiment with the inverter compressors (7').

[0103] The circuit operation for the second embodiment is the following:

> When the inverter compressor (7') starts up, it increases the pressure and temperature of the coolant in gaseous phase, sending it to the condenser.

[0104] In the heat exchanger (8) of the condenser, the coolant condenses passing energy to the water, reducing the simple temperature and enthalpy but maintaining the pressure constant.

[0105] The coolant leaves the heat exchanger (8) of the condenser in liquid phase at a condensing temperature situated between 35°C and 50°C, and being sent to the evaporator (1).

[0106] Before entering into the evaporator (1), the coolant, in liquid phase, passes through an expanded hole that may be automatically regulated and is situated in the expansion valve (3).

[0107] In the expansion system, the liquid coolant reduces the pressure thereof until it reaches a certain evaporation temperature (variable depending on the type of product to be cooled).

[0108] In the evaporator (1), the liquid coolant evaporates by capturing the energy of the product to be refrigerated, leaving the evaporator (1) in gaseous phase. When the coolant in gaseous phase leaves the evaporator (1), it returns to the suction of the compressor (7') in order to repeat the process.

[0109] This process is repeated until the temperature of the product lowers to the desired set point.

[0110] Since the energy efficiency is improved, energy transfer takes place in a gas/liquid heat exchanger (20) between the coolant in liquid phase at the outlet of the heat exchanger (8) of the condenser and the coolant in gaseous phase when it returns from the evaporator (1) to the refrigerating unit (4) towards the inverter compressor (7').

[0111] The heat dissipated in the heat exchanger (8) of the condenser, which comes from the products, is released into a volume of water that is kept in circulation in a closed ring system (5) by means of water recirculation pumps that are located in the heat dissipater (6), which are not shown in the figures.

[0112] The system collects all the water from the different refrigerating units (4) that are operating, sending it to the water ring (5) by means of the water recirculation pumps to the heat dissipater (6).

[0113] The recirculation pumps regulate the flow rate they produce, which is necessary for the operation of the system, via a frequency converter controlled either by a water differential pressure probe that maintains the pressure difference between the suction and impulsion of the pump constant or by the modulating outlet that the control plate of the unit has in order to manage the flow of water.

[0114] In the heat dissipater (6), the water passes through a water-air heat exchanger, via which the heat captured is released in the end refrigerating units (4) into the outside air.

[0115] The advantages of the refrigeration system of the present invention, in either of the two embodiments thereof are the following:

1. Greater energy efficiency, through the increase of the refrigeration capacity with respect to a decrease in consumption.
Greater energy efficiency takes place in both the end refrigerating units (4) and the cooling unit of the ring (5).
In the end refrigerating units (4), the efficiency takes place through the decrease in condensation temperature by being able to work with low hot water temperatures in the condenser, which can work with 30°C/35°C water and a condenser at 40°C, below the installations of control centres that condense at 50°C. This decrease in condensation positions the end refrigerating units (4) with a COP close to 3, instead of a COP with a value close to 2 that may be achieved with the gas control centre system.
In the cooling unit of the ring (5), in seasons with outside ambient temperature below 25°C, it is not necessary to start up the compressors (7) of the cooling unit due to the fact that they have dry cooler-type free-cooling and the assembly in the coolers of adiabatic cooling of the inlet air in coils.
Furthermore, with temperatures above 25°C, due to the fact that the water cooling is performed with jumps of 30°C/35°C, stead of the typical 7°C/12°C of a cooler, a COP closer to 5 may be achieved, an efficiency that is greater than any other system.
2. Simultaneity. The regulations and good working practices state that production should be adjustable to the demand.
In a hot ring system, cold production is adjusted shelf by shelf, since only the individual compressors (7) that are in cold demand by the shelves.
In the centralised systems, despite having stages in the compressors (7) and some even having control centre systems for frequency variation in the compressors (7), there are many moments in which the minimum production of the gas control centre is greater than the demand of a few shelves, thereby causing an unnecessary waste of energy.
This adaptation of the production to the demand means that energy consumption is considerably reduced.
3. Lower coolant charge in the installation, since the coolant is exclusively concentrated in the compact refrigerating units (4) without the need to move kilograms of coolant through the pipelines of the installation.
The refrigerating units (4) are supplied pre-charged from the factory, both the cooler and the end refrigerating units (4), these being equipped with fast connections for easy installation, therefore meaning that the installer does not need to incorporate any coolant gas charge during the assembly process.
With regard to the classic control centre, the cost of the installation when not using transported coolant gas is lowered and the cost of maintenance and leaks is significantly lowered.
4. Loses in the pipeline, due to temperature transmission. Although an attempt is made to mitigate these loses, it is easy to see that the transmission between the ambient temperature and the pipelines with a very cold environment, at -30°C or -5°C, both in the coolant control centres and in the water control centre, these loses will be even greater if the fluid is between 30° and 35°C, and it is in fact very possible that the pipeline of the hot ring (5) does not need insulating, since the loses in the false ceilings will be minimal and for the rest, if a loss occurs it is good for the operation of the installation.
With the hot ring (5), not only are the loses by transmission eliminated but by not installing the insulating cover, the cost of installation is also eliminated.
5. Freezing. As is logical, the need to use glycol water is eliminated since hot water is used.
6. Maintenance. As the units are compact with compressors (7, 7') and sealed in both the cooler and the end refrigerating units (4), the economic cost of maintenance is significantly reduced.
Furthermore, as these are compact and unitary productions, the problems of the expansion control centres, with regards to liquid hammering in the compressor (7, 7') and control of oil maintenance, disappear completely.
7. Reduction of the installation cost. In the installation of expansion control centres, the pipeline installation must be carried out using copper piping and insulation, using welding and pressurisation and vacuum systems.
In the hot water systems, plastic is used with no insulation and with normal water valves, thereby drastically reducing the cost of the installation compared to any other system.
8. The shelves are the market standard. It is not necessary to perform any special transformation since it is a normal coolant, and not C02.
9. Compact and simple to install refrigerating units (4). The units apply a plug&play philosophy, which entails simply connecting the evaporator (1) to the quick connections, supplying the single-phase current and connecting the hot water ring (5). The unit

is ready to operate.

[0116] Furthermore, the expensive and "complicated" electrical panels in the expansion control centres are removed, since the coolers have their own individual panel and the refrigerating units (4) also have their own. As all the refrigerating units (4) are linked via modbus loop, a complete remote management, handling and control system for each and every one of the production units (4) is provided.

[0117] All that is needed is a power panel with a series of circuit breakers and circuit protection devices to protect the supply lines, since each of the refrigerating units (4) already has its own electrical protection elements.

[0118] Furthermore, these power panels may be equipped with auxiliary trip contacts that are remotely controlled in the alarm and control receiver.

[0119] Being very small end refrigerating units (4) and coolers that may be designed following a modular philosophy, the substitution of classic systems of expansion control centres is carried out very simply.

[0120] Furthermore, the problem of the entire cooling system disappearing when the control centre goes down is removed.

[0121] Lastly, it must be considered that the present invention must not be limited to the embodiment described herein. Other configurations may be made by a person skilled in the art in view of the present description. Consequently, the scope of the invention is defined by the following claims.

Claims

1. An industrial refrigeration system consisting of various independent refrigerating units (4) aimed at both conservation and freezing, **characterised in that**:

   - each refrigerating unit (4) is installed in a thermally and acoustically insulated piece of furniture, and
   - the refrigeration system comprises a single heat dissipation unit (6) connected by a pipeline by means of a water ring (5) from which branches extend to each of the refrigerating units (4), and each of the refrigerating units (4) and the heat dissipation unit (6) being equipped with individual electronic control devices.

2. The industrial refrigeration system according to claim 1, **characterised in that** the refrigerating units (4) comprise two compressors (7), which operate alternately and never simultaneously, in order to continue refrigerating even though a compressor (7) breaks down.

3. The industrial refrigeration system according to claim 1, **characterised in that** each refrigerating unit (4) comprises a single inverter compressor (7'), the frequency of the power supply of the compressor varying depending on the refrigerating power demand and the operation being maintained within the optimum performance curve.

4. The industrial refrigeration system according to claims 1 or 2, **characterised in that** the individual electronic control devices of each of the components are connected to each other and to a control centre that receives information of the state of all the components of the installation and that is capable of detecting notifications and alarms.

5. The industrial refrigeration system according to claim 4, **characterised in that** a detected notification or alarm is sent via SMS or email to an electronic device from which the system, or any of the individual components of the system, may be remotely accessed.

6. The industrial refrigeration system according to claim 3, **characterised in that** the refrigerating units (4) comprise a gas/liquid heat exchanger (20) that uses the return coolant in gaseous phase when it returns from the evaporator (1) to the refrigerating unit (4) towards the inverter compressor (7') to lower even further the temperature of the coolant that comes out of the heat exchanger (8) of the condenser in liquid phase before arriving at the expansion valve (3).

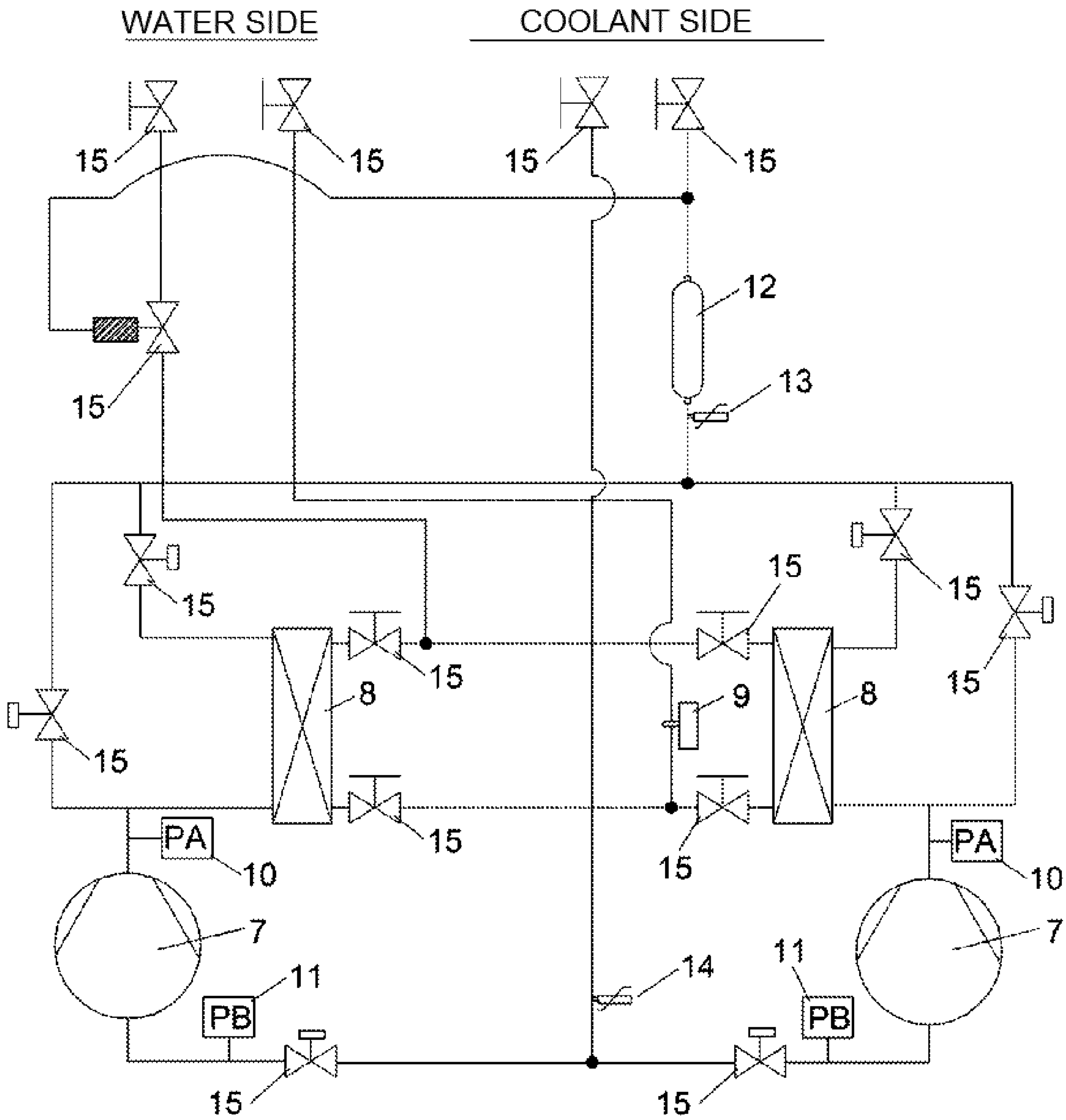
WATER SIDE
COOLANT SIDE
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FIG. 1

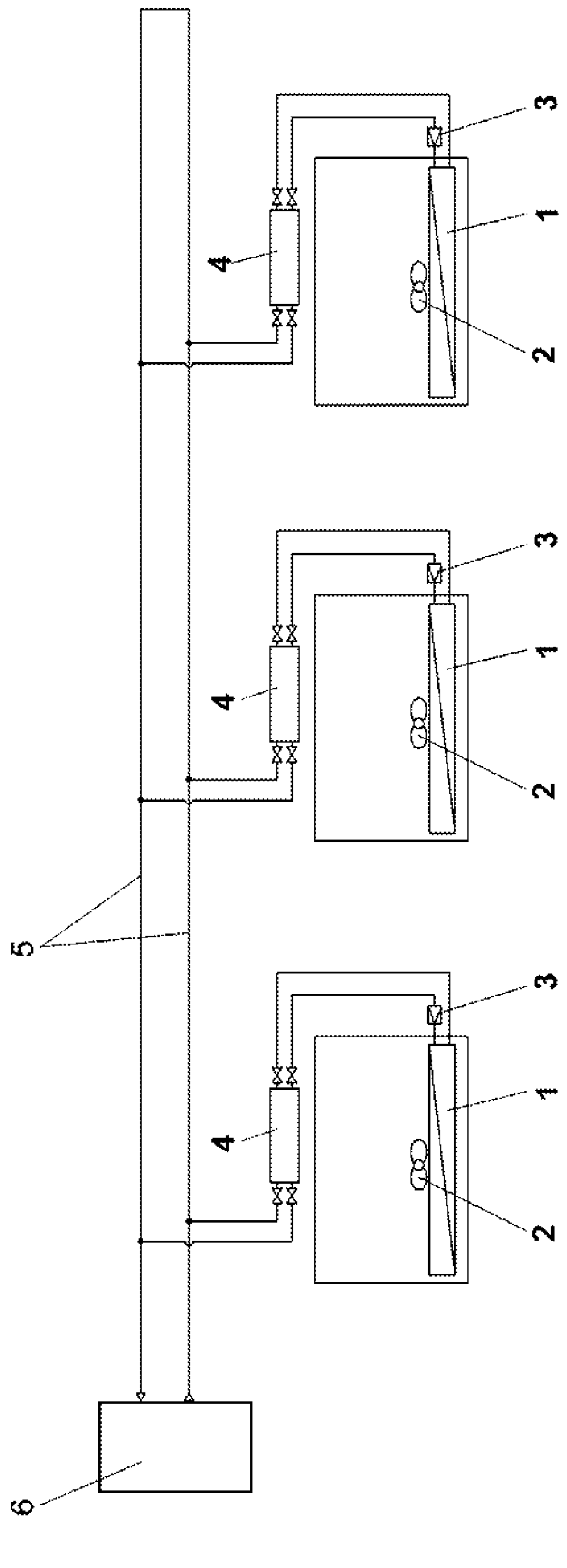
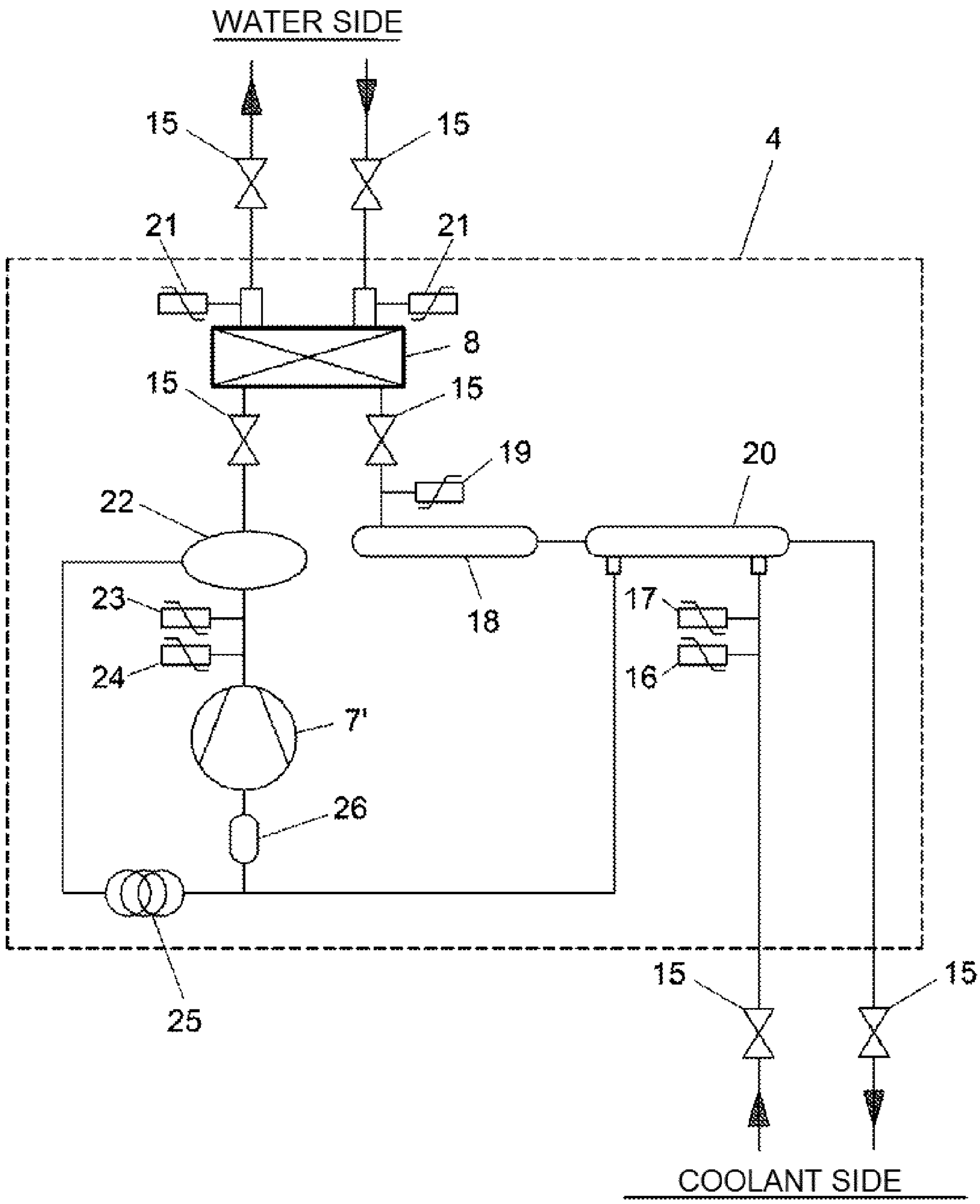


FIG. 2


WATER SIDE
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16
7'
26
25
15
15
COOLANT SIDE

FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/ES2014/070762

A. CLASSIFICATION OF SUBJECT MATTER

See extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F25D, F25B, A47F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC, INVENES

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 9425811 A1 (HUSSMANN CORP) 10/11/1994, abstract; pages 5, 6, 10-17, 23-27; figures.	1-5
X	EP 1262722 A2 (INGENJOERS LENNART ASTEBERG AB) 04/12/2002, abstract; paragraphs 2, 5, 6, 13, 15, 17, 18, 20, 31; figures.	1-5
X	EP 0583152 A1 (CLARES EQUIP LTD) 16/02/1994, abstract; columnas 2-5; figures.	1-3
A	US 3210957 A (RUTISHAUSER DONALD E ET AL.) 12/10/1965, abstract; columnas 1-5; figures.	1
A	WO 9638074 A1 (HMG WORLDWIDE IN STORE MARKETI) 05/12/1996, page 13 lines 12-16, page 14 lines 2-6, page 15 line 28- page 16 line 5; figures.	1

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance.
"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure use, exhibition, or other means.
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other documents , such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
05/12/2014	**(09/12/2014)**
Name and mailing address of the ISA/ OFICINA ESPAÑOLA DE PATENTES Y MARCAS Paseo de la Castellana, 75 - 28071 Madrid (España) Facsimile No.: 91 349 53 04	Authorized officer P. Del Castillo Penabad Telephone No. 91 3495579

Form PCT/ISA/210 (second sheet) (July 2009)

SUPPLEMENTARY INTERNATIONAL SEARCH REPORT

International application No.
PCT/ES2014/070762

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This supplementary international search report has not been established in respect of certain claims under Article 17(2)(a) and Rule 45*bis*.5(c) and (d) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: 6
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful supplementary international search can be carried out, specifically:

Claim 6 lacks clarity because the function of the exchanger (20) is not clear; the fluid that flows to the evaporator (coming from the condenser, where it has released heat) is supposed to be cooled by the fluid from the evaporator (which has been evaporated and maybe heated by absorbing the heat of the products being refrigerated), even though the latter fluid has a temperature that is equal to or higher than the temperature of the former fluid. This is not clear from the description either.

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

4. ☐ Claims Nos.:
because they were not the subject of the international search (Rule 45*bis*.5(d)).

Box No. III Observations concerning unity of invention (Continuation of item 3 of first sheet)

1. ☐ This Authority specified for supplementary search agrees with the conclusions of the International Searching Authority regarding the issue of unity of invention (see Forms PCT/ISA/210 and 237 dated ____________) and refers the applicant to these documents for further details.

2. ☐ At the request of the applicant, this supplementary international search report is limited to the invention specified by the applicant under Rule 45*bis*.1(d) and those parts of the international application which relate to that invention (Rule 45*bis*.5(b)).

3. This Authority specified for supplementary search:

(i) considers that there are ____________ *(number)* inventions claimed in the international application covered by the claims indicated below/on an extra sheet:

(ii) therefore finds that **the international application does not comply with the requirement of unity of invention** (Rules 13.1, 13.2 and 13.3) for the reasons indicated below/on an extra sheet:

(iii) draws the attention of the applicant to the possibility of requesting, within **one month** from the date of mailing of this report, a review of this opinion.

☐ Where the applicant requests the Authority to review this opinion, the applicant is hereby invited, within **one month** from the date of mailing of this report, to pay a review fee (Rule 45*bis*.6(c)) in the amount of ____________ *(currency/amount)*

4. ☐ This supplementary international search report therefore covers only those parts of the international application which relate to the invention first mentioned in the claims ("main invention"). Consequently, this supplementary international search report covers only the following claims: ____________

5. ☐ As all searchable claims could be searched without unreasonable additional effort, this supplementary international search report covers all claimed inventions.

Form PCT/SISA/501 (continuation of first sheet (2)) (January 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/ES2014/070762

C (continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of documents, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2010051198 A2 (CARRIER CORP ET AL.) 06/05/2010, abstract; paragraph 11; figures.	3
A	US 2008289349 A1 (LANDERS DANIEL ET AL.) 27/11/2008, abstract; paragraphs 42-48; figure 1.	1-5
A	US 2002161545 A1 (STARLING NEAL ET AL.) 31/10/2002, abstract; paragraphs 45 and 48; figures.	1-5

Form PCT/ISA/210 (continuation of second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/ES2014/070762

Patent document cited in the search report	Publication date	Patent family member(s)	Publication date
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Form PCT/ISA/210 (patent family annex) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/ES2014/070762

CLASSIFICATION OF SUBJECT MATTER

F25D23/00 (2006.01)
F25B1/04 (2006.01)
F25B49/02 (2006.01)
A47F3/04 (2006.01)

Form PCT/ISA/210 (extra sheet) (July 2009)