



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
20.03.2024 Bulletin 2024/12

(21) Application number: **22197695.4**

(22) Date of filing: **26.09.2022**

(51) International Patent Classification (IPC):
B60H 1/00 (2006.01) **B60H 1/32** (2006.01)
F25D 11/00 (2006.01) **F25B 49/02** (2006.01)
B60P 3/20 (2006.01) **F25B 41/31** (2021.01)
F25B 1/00 (2006.01)

(52) Cooperative Patent Classification (CPC):
F25B 49/02; B60H 1/00; B60H 1/3226; B60P 3/20;
F25B 1/005; F25B 41/31; F25D 11/00;
F25B 2600/0253; F25B 2600/2513; F25B 2700/172;
F25B 2700/2104; F25B 2700/2106;
F25B 2700/21175

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(30) Priority: **19.09.2022 IT 202200019128**

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(54) **IMPROVED MONOBLOCK REFRIGERATION SYSTEM AND RELATED PARAMETER CONTROL METHOD**

(57) The invention is a monoblock refrigeration system comprising an evaporator (1), a compressor (2), a condenser (3), an expansion valve (4) and at least one electronic device or control unit in turn comprising at least one interface for a user which is configured for the selection of one or more from at least two preset programs,

wherein each program is related to a specific food or product in general to be stored and contains the operating parameters, including at least the temperature that must be reached inside said cold room, the ΔT between the temperature inside the cold room and the temperature in the evaporator, the air flow rate in the evaporation unit.

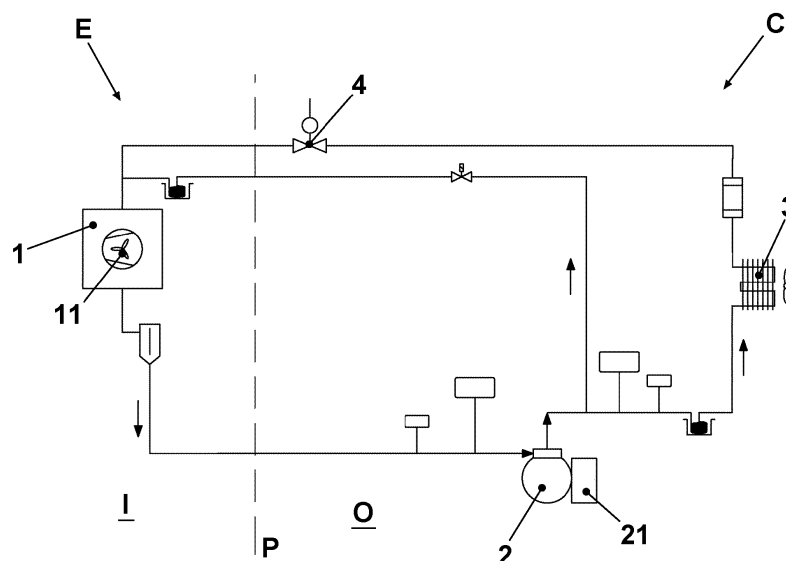


Fig. 1

Description

[0001] The present patent concerns compact refrigeration units, commonly referred to as monoblock refrigeration units, and more specifically it concerns a new improved monoblock refrigeration system and the related method for controlling the parameters of the monoblock system.

[0002] Monoblock refrigeration systems are applied in the cooling processes of cold rooms, which are used to store products at a desired temperature.

[0003] The word "monoblock" derives from the fact that the two main parts that make up the refrigeration cycle, that is, the condensation unit, located outside the environment to be cooled, and the evaporation unit, located inside the environment to be cooled, are directly connected to form a single block.

[0004] The installation of the monoblock refrigeration system in the cold room can be carried out by positioning the monoblock refrigeration system astride the thickness of the cold room side, in the so-called astride or "knapsack" configuration, or it can be carried out by making a hole in the wall of the cold room in such a way as to allow the evaporation unit to be inserted inside the cold room, leaving the condensation unit outside, in the so-called "buffer" configuration.

[0005] The conventional monoblock refrigeration systems currently available on the market are basically of two types, called positive temperature cold rooms and negative temperature cold rooms.

[0006] Positive temperature cold rooms can work at positive temperatures, generally included between -5 and +10 °C, and are suitable for storing food products such as meat, fish, fruit, vegetables and dairy products.

[0007] Negative temperature cold rooms, on the other hand, are set for negative temperatures, generally included between -15 and -25 °C, and are used for storing frozen products. Conventional monoblock refrigeration systems are usually equipped with an electronic instrument that makes it possible to set the temperature value desired for the cold room manually, said value being commonly referred to as the "set point". In the conventional monoblock refrigeration systems, however, it is not possible to adapt the performance according to the type of product to be preserved, and above all it is not possible to switch from the positive temperature to the negative temperature operating configuration.

[0008] It is known that each type of food requires a specific storage temperature in order to maintain its organoleptic properties over time.

[0009] By way of example, the temperature ranges commonly required for the correct preservation of certain food products are specified here below:

- Fruit and vegetables: +4 - +6 °C
- Meat: 0-+2 °C
- Fish: -1 - +1 °C
- Cold meats and cheeses: +4 - +6 °C

- Frozen food: -18 - -25 °C.

[0010] A variation of the set point obviously results in a variation of the thermal load, that is, the difference between the actual temperature in the cold room and the set temperature.

[0011] Said thermal load variation in turn results in a consequent variation of the evaporation temperature of the refrigerant on the evaporator coil.

[0012] The difference between the temperature inside the cold room and the evaporation temperature of the refrigerant is called ΔT and is expressed in Kelvin (K).

[0013] As the ΔT value increases, the air inside the cold room, flowing over the evaporator coil, cools rapidly and deposits most of its humidity by frosting. Therefore, high ΔT values correspond to low relative humidity values in the cold room while, on the contrary, low ΔT values correspond to higher relative humidity values inside the cold room.

[0014] Relative humidity is a factor that can greatly affect the correct preservation of a food product.

[0015] In addition, the frosting of the evaporator reduces its heat exchange capacity, thus further reducing the efficiency of the machine.

[0016] Furthermore, the increase in ΔT reduces the evaporation of the refrigerant, which in turn results in inefficient operation of the compressor, which is forced to work at very low pressures.

[0017] This also prevents the temperature and humidity values inside the cold room from remaining as stable and controllable as possible.

[0018] To optimize the operation of a monoblock refrigeration system, it would be advisable to keep the ΔT at precise values, in such a way as to avoid the above-mentioned drawbacks.

[0019] In the monoblock refrigeration systems of the conventional type it is not possible to control the ΔT value in any way, while it is possible to intervene on the set point value, which can be modified by the user, consequently varying the ΔT value.

[0020] Another fundamental parameter for the correct preservation of a product is the quantity of air with which that product comes into contact. In conventional monoblock refrigeration systems, the air flow moved by the evaporator is always constant, which can cause damage to the more delicate products that instead need to come into contact with a gentler air flow.

[0021] In order to overcome all of the drawbacks mentioned above, a new type of monoblock refrigeration system with improved operation has been designed and manufactured. The main object of the present invention is to provide a refrigeration system in which it is possible to control the ΔT value by means of an innovative combination of components.

[0022] It is another object of the present invention to provide a refrigeration system in which it is possible to automatically control the interaction between the above-mentioned components by means of an electronic con-

troller.

[0023] It is another important object of the present invention to provide a refrigeration system in which it is possible to control the food storage parameters inside the cold room more precisely, with particular reference to temperature and humidity, making the new equipment particularly suitable for installation in cold rooms which must be able to ensure a high food quality level and to guarantee the optimal preservation of the food product over time.

[0024] The present patent concerns also the method for controlling the operating parameters of the monoblock refrigeration system, and in particular of the compressor, the evaporator fan and the expansion valve, in order to modulate the ΔT value as a function of the previously defined set point.

[0025] These and other direct and complementary objects are achieved by the new improved monoblock refrigeration system and by the method for controlling the operating parameters of the same monoblock refrigeration system.

[0026] The new monoblock refrigeration system comprises a casing or containment unit which contains the parts described and claimed below, an evaporation unit and a condensation unit, both of which are enclosed in said casing, and wherein said casing is sized and configured to be installed in a cold room in such a way that said evaporation unit is located inside the cold room while said condensation unit is located outside the cold room.

[0027] Analogously to conventional monoblock refrigeration systems, the new monoblock refrigeration system also includes at least one compressor and at least one expansion valve.

[0028] The monoblock refrigeration system also includes an electronic control unit for controlling the operating parameters of said components.

[0029] The monoblock refrigeration system also includes a display, generically placed on said casing in a position where it can be accessed by a user, with an interface by means of which a user can select the operation program of the monoblock refrigeration system even remotely, according to the type of product to be stored inside the cold room.

[0030] More specifically, according to the invention, said interface can and preferably should allow the user to select from at least five programs: fruit/vegetables, meat, fish, cold meats/cheese, frozen food products.

[0031] It is also preferable that the interface can make it possible to select an additional "free" program, that is, a program that can be modified by the user.

[0032] For example, in a preferred embodiment of the invention, said interface comprises buttons or a touch screen with 6 selectable boxes, one for each of the above-mentioned programs.

[0033] For example, the boxes may be marked with one or more alphanumeric characters or with one or more graphic symbols, for example reproducing the type of product to be stored.

[0034] Each program actually includes operating parameters for the monoblock refrigeration system. Therefore, each program first of all determines the set point value for the corresponding product, that is, the ideal temperature at which the product must be stored and which must be reached inside the cold room.

[0035] Each program determines also the ΔT value for the corresponding product as well as the speed of the evaporator fan, which is directly correlated to the air flow rate.

[0036] The applicant of the present patent has determined the optimal ΔT value for each product and in particular:

- Fruit and vegetables: 7.5 K
- Meat: 8 K
- Fish: 7.5 K
- Cold meats and cheeses: 8 K
- Frozen food products: 6 K.

[0037] The applicant of the present patent has determined the optimal air flow rate value in the evaporator (m^3/h) for each product and in particular:

- Fruit and vegetables: 500 m^3/h
- Meat: 700 m^3/h
- Fish: 500 m^3/h
- Cold meats and cheeses: 500 m^3/h
- Frozen food products: 700 m^3/h .

[0038] The flow rate values specified above refer to a monoblock refrigeration system developed to provide a refrigerating capacity included between 1430W (meat program 0°C) and 610W (frozen products program -25°C).

[0039] In order to be able to control the ΔT value, the new monoblock refrigeration system is equipped with at least one variable speed compressor, controlled by means of an inverter capable of modulating the flow rate of the refrigerant to be compressed as the compressor speed varies, consequently varying the refrigerating capacity according to the thermal load actually required, that is, the difference between the set point temperature set by the program selected by the user and the actual temperature present in the cold room.

[0040] On the contrary, in conventional monoblock refrigeration systems the compressors are usually of the on/off type, meaning with fixed speed, as are the evaporator fans. As a consequence of the above, a conventional monoblock refrigeration system works with a non-optimized ΔT value and above all with a constant air flow rate in the evaporator. An excessive air flow rate can thus produce an excessive dehumidification effect, damaging the most sensitive products (for example, fruit and vegetables). The new monoblock refrigeration system is also equipped with an electronic expansion unit, which is such as to make it possible to set the overheating of the refrigerant, always with the purpose of obtaining and main-

taining the desired ΔT value, differently from what happens in the known monoblock refrigeration systems, where the thermostatic expansion valve is mechanical.

[0041] The new monoblock refrigeration system is also equipped with said condenser with variable speed electronic fan, controlled through the reading of a high-pressure probe that adjusts its speed according to the external temperature, wherein a high external temperature implies a high rotation speed and vice versa.

[0042] The method for controlling the parameters of the monoblock refrigeration system therefore comprises the following steps:

- 1) selection of a program by the user through said interface; this selection involves the determination of a certain set point value, meaning the temperature to be reached inside the cold room, a certain ΔT value and a certain air flow rate in the evaporator;
- 2) automatic setting of the compressor speed, depending on the power to be obtained in the evaporator; said speed is controlled by means of a low-pressure probe, wherein a certain pressure value corresponds to a certain compressor speed;
- 3) automatic setting of the speed of the evaporator, depending on the air flow rate to be obtained in the cold room according to the stored product; said speed is controlled by means of a low-pressure probe, wherein a certain pressure value corresponds to a certain fan speed;
- 4) automatic setting of the expansion valve, depending on the overheating measured at the outlet of the evaporator, that is, the thermal load required in the cold room.

[0043] The characteristics of the new monoblock refrigeration system are explained in greater detail in the following description with reference to the drawings attached hereto by way of non-limiting examples, wherein Figure 1 shows the refrigeration diagram as well as an evaporation unit (E) and a condensation unit (C) positioned astride a side (P) of a cold room in such a way that said evaporation unit (E) is located inside (I) the cold room while the condensation unit (C) is located outside (O) the cold room. Figure 1 shows: an evaporator (1) with an electronic fan (11) with variable speed; a compressor (2) with an inverter (21), a condenser (3), an electronic expansion valve (4).

[0044] Therefore, with reference to the above description and the attached drawings, the following claims are expressed.

Claims

1. Monoblock refrigeration system comprising an evaporation unit (E), a condensation unit (C), a single casing containing said evaporation unit (E) and said condensation unit (C), said casing being dimen-

sioned and configured in such a way that it can be placed in a cold room so that said evaporation unit (E) is inside said cold room while said condensation unit (C) is outside said cold room, and wherein said monoblock refrigeration system comprises at least one evaporator (1), at least one compressor (2), at least one condenser (3), at least one expansion valve (4),

characterized in that it also comprises at least one electronic device or control unit which in turn comprises at least one interface for a user and is configured for the selection of one or more programs from at least two preset programs, wherein each program is related to a specific food or product in general to be stored and contains the operating parameters, including at least the temperature that must be reached inside said cold room, the ΔT between the temperature inside the cold room and the temperature in the evaporator, the air flow rate in the evaporation unit, and wherein said electronic device automatically controls the operation of at least said evaporator (1), said compressor (2) and said expansion valve (4) according to the selected program.

2. Monoblock refrigeration system according to claim 1, **characterized in that** said interface comprises one or more buttons and/or touch screens for selecting one or more programs.
3. Monoblock refrigeration system according to claim 1, **characterized in that** said compressor (2) is a variable speed compressor with inverter (21).
4. Monoblock refrigeration system according to claim 1 or 3, **characterized in that** said evaporator comprises at least one variable speed electronic fan.
5. Monoblock refrigeration system according to claim 1 or 3 or 4, **characterized in that** said condenser comprises an electronic variable speed fan controlled through the reading of a high-pressure probe that regulates its speed according to the external temperature.
6. Monoblock refrigeration system according to claim 1 or 3 or 4 or 5, **characterized in that** said expansion valve is of the electronic type.
7. Method for controlling the parameters of the monoblock refrigeration system according to one or more of the preceding claims, **characterized in that** it comprises the following steps:

- 1) selection of a program by the user via said interface, wherein said selection involves the

determination of a certain set point value, that is, the temperature that must be reached inside the cold room, a certain ΔT value and a certain air flow rate in the evaporator;

2) automatic setting of the speed of the compressor according to the power to be obtained in the evaporator, and wherein said speed is controlled by means of a low-pressure probe, wherein a certain pressure value corresponds to a certain compressor speed; 5 10

3) automatic setting of the speed of the evaporator depending on the air flow rate to be obtained in the cold room according to the stored product, and wherein said speed is controlled by means of a low-pressure probe, wherein a certain pressure value corresponds to a certain fan speed; 15

4) automatic setting of the expansion valve according to the overheating measured at the outlet of the evaporator, that is, according to the thermal load needed in the cold room. 20

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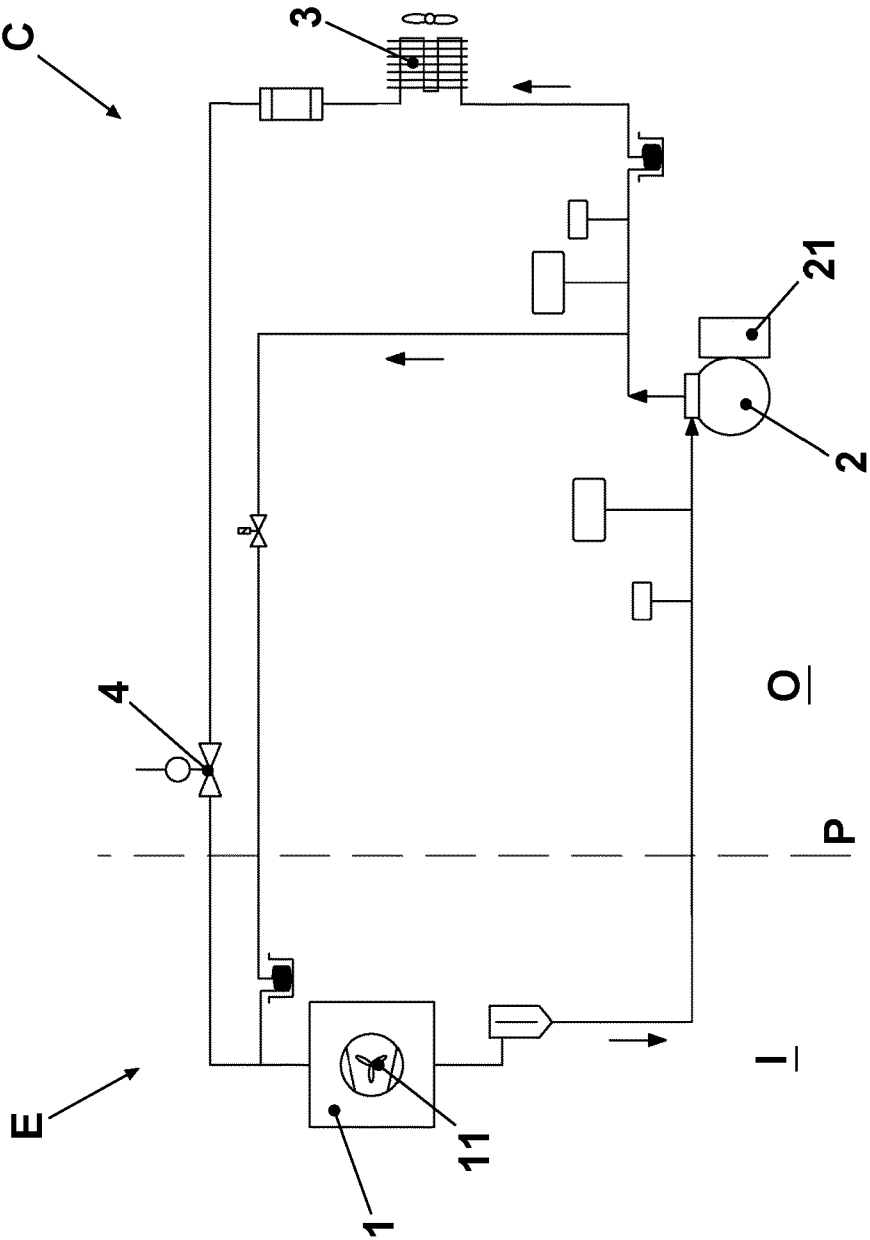


Fig. 1



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Application Number

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