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(54) **Combined multitemperature or monotemperature operating cooler and process for controlling the operation of such cooler**

(57) A combined operating cooler (1) is disclosed which independently operates in a monotemperature or multitemperature mode, comprising: at least one refrigerating cell. (3) having an internal volume with a lower area (3a) and an upper area (3b); at least one first temperature detector (11) in the lower area (3a) adapted to detect at least one temperature value (Tb) of the lower area (3a); at least one second temperature detector (13) in the upper area (3b) adapted to detect at least one temperature value (Ta) of the upper area (3b); at least one cold action actuator (15); and at least one hot action actuator (17); means for controlling internal temperatures of the refrigerating cell (3) cooperating with the detectors (11, 13) and the actuators (13, 15) for keeping a monotemperature or multitemperature operation in the refrigerating cell (3) by comparing the temperatures (Tb, Ta) with temperature set point values (SP, SP1, SP2).

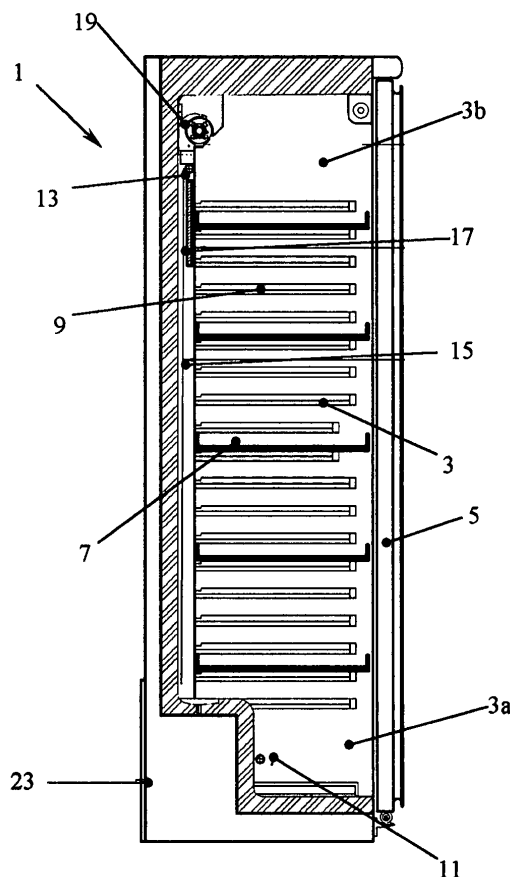


FIG. 2

Description

[0001] The present invention refers to a combined multitemperature or monotemperature operating cooler and to a process for controlling the operation of such cooler.

[0002] The current art provides for coolers, particularly aimed to the wine sector for storing wines at adequate temperatures, substantially of two types:

- multitemperature type;
- monotemperature type.

[0003] As known, the peculiarity of the multitemperature type is obtaining in the same volume of the refrigerating cell a wide distribution of temperatures without having to use separators or partitions adapted to thermally insulate the volumes with different temperatures. This distribution is generally designated by equipment manufacturers as areas with a "defined" temperature, with a variation from 2°C to 5°C from area to area, that can be easily located and used. Normally, the areas are located by means of shelves supplied by the manufacturer. The thermotechnical system is anyway single, since multiple systems are not provided, for example one for each area.

[0004] These temperature areas therefore allow storing the various types of wine at the desired temperatures, which are normally advised for drinking wines.

[0005] In the multitemperature types of coolers, there are, typically, temperatures included between 2°C and 6°C in the lower area of the refrigerating cell, and up to 16°C to 18°C in the upper area. Between the two extremes, there can be a plurality of areas with intermediate temperature levels. This type of cooler is normally used for exposing and/or storing different types of wines, usually by placing white wines in the lower area of the refrigerating cell (colder area) and red wines in the upper area.

[0006] The distribution of temperatures is function of the following factors:

- used temperature checks: the known multitemperature cooler operation is allowed by two controllers which control two different actuators, namely a cold action and an hot action. Such actions respectively activate the internal cold and hot sources. As known in the art, the term cold source means a surface taken to a temperature which is at least lower than the minimum required internal temperature; vice versa, the term hot source means a surface taken to a temperature which is at least greater than the maximum required internal temperature. In practice, due to insulation limits, source spaces limits and thermal interaction among the different areas, among the source temperatures and the values of the corresponding internal areas, there must be a difference on the order of some tenths of degrees centigrades. The logic governing these two controllers is generally the classical thermostatisation one: in fact, a set point (namely a working point, one for the cold area and

one for the hot area) and a temperature hysteresis are set. In this way, the temperatures of two areas are directly controlled. Normally, the controlled areas are, for simplicity, the end areas or those next to the end areas. The set point values can be generally set by the user:

- space distribution and power (temperature) of cold and hot sources: the temperature checks constrain to the thermostatisation two points of the space temperature distribution. For realising the desired temperature distribution, it is therefore necessary to space distribute the thermal sources, obviously taking into account the temperatures at which the sources are;
- temperature layering - specific weight of internal air depending on thermal-hygrometric conditions: this latter aspect exploits the specific weight of air depending on its thermal-hygrometric conditions which, when there is a gravitational field, creates natural convective motions that are realised internally to the apparatus, due to the absence of a forced convection. These motions are anyway extremely slow and therefore originate a temperature layering that allows obtaining a substantially stable temperature distribution.

[0007] In the monotemperature type, instead, the temperature inside the refrigerating cell is single.

[0008] The monotemperature cooler is typically aimed for users who need to expose/store a whole stock of foodstuff, for example wines, at a certain temperature. The temperature check is called "neutral area" and is used for controlling systems that have an element that causes a positive increase (for example heating) and an element that causes a negative increase (for example cooling). A controller will then activate the hot action when the temperature will drop below the set point minus the hysteresis, and vice versa will activate the cold action when the temperature will rise over the set point plus the adjustment hysteresis.

[0009] From the system point of view, it is possible to realise this version in two modes:

- with static refrigeration (without venting): in such case, in order to reach a constant temperature distribution, it is necessary to dose hot and cold sources, though it is possible to use a single temperature checking point;
- with dynamic refrigeration (with internal venting): in this case, the forced convection, if powerful enough, allows homogeneising the internal temperature and therefore the space arrangement of the thermal sources is less important.

[0010] What is however not proposed by the prior art is a single cooler that can be set by the user for having both a multitemperature operation and a monotempera-

ture operation, being anyway able to modify such setting at any time depending on current specific needs. In fact, in the wine sector, it is clear that white and cool wines has a greater request in summer with respect to red wines that are better appreciated in the colder seasons: depending on this seasonality, an operator that in the cold seasons wished to be able to adequately store both red wines and white wines had to purchase a multitemperature cooler; on the contrary, in hot seasons, it would have been more adequate to have a monotemperature cooler available for adequately storing a greater amount of white wines. It is therefore evident that, in order to satisfy the above needs, the operator would have to purchase both a multitemperature cooler, and a monotemperature cooler, with obvious negative results both on purchasing and managing costs, and on encumbrances caused by two distinct coolers.

[0011] Therefore, object of the present invention is providing a combined operation cooler which allows having independently a multitemperature operation or a monotemperature operation in the same refrigerating cell, such operation being able to be set and modified by a user at any time and depending on specific needs.

[0012] Another object of the present invention is providing a combined multitemperature or monotemperature operating cooler equipped with a single thermo-technical system for realising both operations.

[0013] A further object of the present invention is providing an operating process that allows a cooler to operate either with multitemperature or with monotemperature, such operation being able to be set and modified by a user at any time and depending on specific needs.

[0014] The above and other objects and advantages of the invention, as will appear from the following description, are reached with a combined multitemperature or monotemperature operating cooler as claimed in claim 1.

[0015] Moreover, the above and other objects and advantages of the invention are reached with a process for controlling the operation of a multitemperature or monotemperature operating cooler as claimed in claim 11. Preferred embodiments and non-trivial variations of the present invention are the subject matter of the dependent claims.

[0016] The present invention will be better described by some preferred embodiments thereof, provided as a nonlimiting example, with reference to the enclosed drawings, in which:

- FIG. 1 shows a front view of an embodiment of a multitemperature or monotemperature operating cooler according to the present invention;
- FIG. 2 shows a partial side view of the cooler of FIG. 1;
- FIG. 3 shows a block diagram showing a preferred embodiment of an electric diagram of the cooler according to the present invention; and
- FIG. 4 shows a flow diagram representing the steps composing the process according to the present in-

vention.

[0017] For a brief exposure, herein below obviously all descriptions related to common parts and components with other coolers and which are necessary for the basic operation of the cooler, will not be described, since they are deemed as widely known in the art, such as for example electric supply system, systems for insulating, compressing and channelling cooling gases, etc., while instead all aspects and components characterising the cooler 1 according to the present invention will be described in detail.

[0018] With reference therefore to FIG. 1, 2 and 3, it is possible to note an embodiment of the combined multitemperature or monotemperature operating cooler 1 according to the present invention. Such cooler 1 comprises:

- at least one refrigerating cell 3 having inside it independently a monotemperature or multitemperature operation with the modes that follow, such refrigerating cell 3 being obviously closed by at least one insulating door 5 and being equipped inside it with a plurality of shelves 7, preferably adjustable in their height due to positioning brackets 9 or other known adjusting systems; the internal volume of the refrigerating cell can be ideally divided, during its multitemperature operation, into a lower area 3a, that can be found at the lowest temperature of the defined temperature range, and an upper area 3b that can be found at the top temperature of the above range;
- at least one first temperature detector 11 placed in the lower area 3a adapted to detect at least one temperature value of the lower area 3a itself;
- at least one second temperature detector 13 placed in the upper area 3b adapted to detect at least one temperature value of the upper area 3b itself;
- at least one cold action actuator 15;
- at least one hot action actuator 17;
- means for controlling internal temperatures of the refrigerating cell 3; such means, as will be seen below in more detail, depending on the desired operating mode for the cooler 1, control the operation of the cold action actuator 15 and/or the hot action actuator 17 depending on the temperatures detected by the first and second temperature detectors, respectively 11 and 13, and comparing them with a single temperature set point, in case of monotemperature operation, or with at least one lower temperature set point and one upper temperature set point, in case of multitemperature operation, for maintaining the correct monotemperature or multitemperature operation inside the refrigerating cell 3. Moreover, the control means can be equipped with external displaying and driving means 21, such as for example a display equipped with an appropriate device for selecting and entering data, to allow a user to set in particular the desired operating mode for

the cooler 1 and the related parameters mentioned below. The above temperature set point values can be already resident in an hardware memory of the control means; alternatively, in order to allow a greater customisation of the cooler 1, the set point values can be set by the user through the displaying and driving means 21 depending on the desired operating mode. In particular, through the displaying and driving means 21, it is possible to allow a user to modify parameters such as LANGUAGE (this item allows choosing the language with which indications will appear on the display), USE (activates the monotemperature or multitemperature functionality), TEMPERATURE (allows choosing the single temperature set point for the monotemperature operation, and the lower and upper set point values, respectively related to the lower area 3a and the upper area 3b of the refrigerating cell 3, during the multitemperature operation).

[0019] It is also possible to provide that the cooler 1 is equipped with an internal venting system 19 and/or an external venting system in addition to a condensating unit 23.

[0020] The operating modes of the cooler 1 according to the present invention will be described below in case of monotemperature or multitemperature operation.

[0021] As already previously mentioned, in the monotemperature operation, the temperature inside the refrigerating cell 3 must be uniform. In this case, the control means will compare the single set point with the mean of the temperatures detected by the first temperature detector 11 and the second temperature detector 13. Alternatively, it is possible to use also a single detector 11 or 13: however, by using both detectors 11, 13, it is possible to verify the temperature homogeneity inside the refrigerating cell 3. When the mean of the two temperatures detected by the first temperature detector 11 and the second temperature detector 13 is greater than the value of the single set point, possibly taking into account a range of intervention, the control means activate the cold action actuator 15 for cooling the refrigerating cell 3.

[0022] Vice versa, if the mean of the two temperatures detected by the first temperature detector 11 and the second temperature detector 13 is lower than the value of the single set point, the control means activate the hot action actuator 17 for heating the refrigerating cell 3. In particular, by designating with SP the single set point value of the desired temperature in the refrigerating cell 3, Tb the temperature value detected by the first temperature detector 11, Ta the temperature value detected by the second temperature detector 13 and HYS the hysteresis value, it is obtained that the cold action actuator 15 is activated when $(T_b + T_a)/2 > SP + HYS$, while the hot action actuator 17 is activated when $(T_b + T_a)/2 < SP - HYS$.

[0023] The possible internal venting can remain operating independently from the activation of actuators 15

or 17 in order to further homogenise the temperature inside the refrigerating cell 3, but it can be provided to disable it under particular situations, such as for example in case of opening of the door 5.

[0024] Obviously, the possible external venting is activated in conjunction with the turning-on of the compressor (not shown).

[0025] The multitemperature operation of the cooler 1 according to the present invention is instead driven by a completely different logics, though advantageously using the common components to those used for the monotemperature operation.

[0026] Under this operating mode, by interposing the control means, the second temperature detector 13 is adapted to control the intervention of the hot action actuator 17 and the first temperature detector 11 is adapted to control the intervention of the cold action actuator 15.

[0027] In particular, the cold action actuator 15 is activated when the temperature detected by the first temperature detector 11 placed in the lower area 3a of the refrigerating cell 3 is greater than the value of the lower set point plus the hysteresis value. Similarly, the hot action actuator 17 is activated when the temperature detected by the second temperature detector 13 placed in the upper area 3b of the refrigerating cell 3 will be lower than the lower set point value minus the hysteresis value. By designating with SP1 the lower set point value of the desired temperature in the lower area 3a of the refrigerating cell 3 (and with Tb the temperature detected by the first temperature detector 11) and SP2 the upper set point value of the desired temperature in the upper area 3b of the refrigerating cell 3 (with Ta the temperature detected by the second temperature detector 13) and with HYS the hysteresis value, it is obtained that the cold action actuator 15 is activated when $T_b > SP1 + HYS$, while the hot action actuator 17 is activated when $T_a < SP2 - HYS$.

[0028] It can therefore be obtained that, in the multitemperature operating mode, the two actuators 15, 17 are active in the same period of time since the control means are able to independently control the two actuators.

[0029] In this case the control means do not activate the possible internal venting, in order not to create air motions inside the refrigerating cell 3 that obviously would try to make the temperatures uniform. Also the external venting can be not actuated, since it is not always useful to assist the system; it is therefore preferable not to actuate the external venting to reduce the total machine noise and to reduce the energy consumptions.

[0030] Due to what has been stated above, from FIG. 3 it is possible to note a possible embodiment of an electric diagram realising the advantageous characteristics of the cooler 1 according to the present invention, in which, in addition to the already previously described components, the hardware controllers 25a, 25b, 25c, 25d, 25e, 25f are further pointed out, which are respectively related to line connection, first and second temperature detector 11 and 13, hot action actuator 17, internal

venting system 19, external venting system 27 and cold action actuator 15, driven by the control means.

[0031] The present invention further refers to an operating process which allows a cooler 1 according to the present invention to perform a multitemperature operation or a monotemperature operation.

[0032] Then, with reference to FIG. 4, it is possible to note that the process according to the present invention comprises the steps of:

- defining the operating modes of the cooler 1; in particular, such step comprises the step of selecting a monotemperature or multitemperature operating mode (F105);
- if the monotemperature operating mode has been selected, defining (F106) a value of the single set point (SP) of desired temperature in the refrigerating cell 3;
- detecting (F107) a temperature value (Tb) from the first temperature detector 11 and a temperature value (Ta) from the second temperature detector 13;
- if the monotemperature operating mode has been selected, computing (F108) the mean $(Tb + Ta)/2$ of the two temperatures (Tb, Ta) respectively detected by the first temperature detector 11 and the second temperature detector 13;
- if the monotemperature operating mode has been selected, comparing (F109) the value of the single temperature set point (SP) $\pm$ an hysteresis value (HYS) with the mean of the two temperatures (Tb, Ta) detected by the first temperature detector 11 and the second temperature detector 13: if $(Tb + Ta)/2 > SP + HYS$, activating (F111) the cold action actuator 15; if $(Tb + Ta)/2 < SP - HYS$, activating (F113) the hot action actuator 17;
- if the multitemperature operating mode has been selected, defining (F115) at least one lower set point (SP1) of a desired temperature in the lower area 3a of the refrigerating cell 3 and one upper set point (SP2) of a desired temperature in the upper area 3b of the refrigerating cell 3b;
- detecting (F117) a temperature value (Tb) from the first temperature detector 11 and a temperature value (Ta) from the second temperature detector 13;
- if the multitemperature operating mode has been selected, comparing (F119) the temperature (Tb) detected by the first temperature detector 11 placed in the lower area 3a of the refrigerating cell 3 with the value of the lower set point (SP1) plus the hysteresis value (HYS); if $Tb > SP1 + HYS$, activating (F123) the cold action actuator 15;
- if the multitemperature operating mode has been selected, comparing (F121) the temperature (Ta) detected by the second temperature detector 13 placed in the upper area 3b of the refrigerating cell 3 with the value of the upper set point (SP2) minus the hysteresis value (HYS), and, if $Ta < SP2 - HYS$, activating (F125) the hot action actuator 17.

[0033] It is clear that the steps of the above process are cyclically repeated during the whole operation of the cooler 1.

[0034] The step of defining the operating modes of the cooler (1) can further comprise the step of choosing a displaying language (F103) for information on the displaying and driving means 21, for example selecting it from a list of pre-set languages. Obviously, the step of defining the operating modes of the cooler 1 can be realised at any time during operation of the cooler 1.

[0035] Obviously, the invention is also related to at least one computer program comprising computer program code means adapted to run all steps of the above-described process when such program is run on a computer, particularly when it is run by the control means of the cooler 1. Obviously the invention also refers to a computer program as defined and contained on a computer-readable medium.

[0036] The cooler 1 and/or the operating process according to the present invention as previously described have a particular application in the wine sector for the correct storage of wines, but it is wholly evident how they can be advantageously used in any other case in which the same characteristics are required, such as for example in the seasonal storage of different foodstuff that require different storage temperatures in certain periods, and the same temperature in other periods.

Claims

1. Combined operating cooler (1), **characterised in that** it independently operates in a monotemperature or multitemperature mode, comprising:

- at least one refrigerating cell (3) having an internal volume with a lower area (3a) and an upper area (3b);
- at least one first temperature detector (11) in said lower area (3a) adapted to detect at least one temperature value (Tb) of said lower area (3a);
- at least one second temperature detector (13) in said upper area (3b) adapted to detect at least one temperature value (Ta) of said upper area (3b);
- at least one cold action actuator (15);
- at least one hot action actuator (17);
- means for controlling internal temperatures of said refrigerating cell (3) cooperating with said detectors (11, 13) and said actuators (13, 15) for keeping a monotemperature or multitemperature operation in said refrigerating cell (3) by comparing said temperatures (Tb, Ta) with temperature set point values (SP, SP1, SP2).

2. Cooler (1) according to claim 1, **characterised in that** it comprises an internal venting system (19)

and/or an external venting system and/or a condensing unit (23).

3. Cooler (1) according to claim 1, **characterised in that** said control means comprise displaying and driving means (21). 5
4. Cooler (1) according to claim 3, **characterised in that** said displaying and driving means (21) are adapted to allow a setting of a value of said single set point (SP) of desired temperature in said refrigerating cell (3). 10
5. Cooler (1) according to claim 3, **characterised in that** said displaying and driving means (21) are adapted to allow setting a value of said lower set point (SP1) of the desired temperature in said lower area (3a) of said refrigerating cell (3). 15
6. Cooler (1) according to claim 3, **characterised in that** said displaying and driving means (21) are adapted to allow setting a value of said upper set point (SP2) of the desired temperature in said upper area (3b) of said refrigerating cell (3). 20
7. Cooler (1) according to claim 1, **characterised in that** if a mean $(T_b + T_a)/2$ is greater than said value of a single set point (SP) plus an hysteresis value (HYS), said control means activate said cold action actuator (15). 25
8. Cooler (1) according to claim 1, **characterised in that** if a mean $(T_b + T_a)/2$ is lower than said value of a single set point (SP) minus an hysteresis value (HYS), said control means activate said hot action actuator (17). 30
9. Cooler (1) according to claim 1, **characterised in that** if said temperature (T_b) detected by said first temperature detector (11) is greater than a value of said lower set point (SP1) plus said hysteresis value (HYS), said control means activate said cold action actuator (15). 35
10. Cooler (1) according to claim 1, **characterised in that** if said temperature (T_a) detected by said second temperature detector (13) is lower than a value of said upper set point (SP2) minus said hysteresis value (HYS), said control means activate said hot action actuator (17). 40
11. Process for a multitemperature or monotemperature operation of a cooler (1) according to any one of the previous claims, **characterised in that** it comprises the steps of: 45
 - defining operating modes of said cooler (1), said step comprising the step of selecting a

monotemperature or multitemperature operating mode (F105) of said cooler (1);

- if said monotemperature operating mode has been selected, defining (F106) a value of said single set point (SP) of a desired temperature in said refrigerating cell (3);
- detecting (F107) said temperature value (T_b) from said first temperature detector (11) and said temperature value (T_a) from said second temperature detector (13);
- if said monotemperature operating mode has been selected, computing (F108) a mean $(T_b + T_a)/2$ of said two temperatures (T_b , T_a);
- if said monotemperature operating mode has been selected, comparing (F109) said value of said single temperature set point (SP) $\pm$ said hysteresis value (HYS) with said mean of said two temperatures (T_b , T_a), and, if $(T_b + T_a)/2 > SP + HYS$, activating (F111) said cold action actuator (15), and if $(T_b + T_a)/2 < SP - HYS$, activating (F113) said hot action actuator (17);
- if said multitemperature operating mode has been selected, defining (F115) at least one of said lower set points (SP1) of a desired temperature in said lower area (3a) of said refrigerating cell (3) and one of said upper set points (SP2) of a desired temperature in said upper area (3b) of said refrigerating cell (3b);
- detecting (F117) said temperature value (T_b) from said first temperature detector (11) and said temperature value (T_a) from said second temperature detector (13);
- if said multitemperature operating mode has been selected, comparing (F119) said temperature (T_b) with said value of said lower set point (SP1) plus said hysteresis value (HYS), and, if $T_b > SP1 + HYS$, activating (F123) said cold action actuator (15);
- if said multitemperature operating mode has been selected, comparing (F121) said temperature (T_a) with said value of said upper set point (SP2) minus said hysteresis value (HYS), and, if $T_a < SP2 - HYS$, activating (F125) said hot action actuator (17).

12. Process according to claim 11, **characterised in that** said step of defining said operating modes of the cooler (1) comprises the step of choosing a displaying language (F103) for information on said displaying and driving means (21). 50
13. Computer program comprising computer program code means adapted to run all steps of said process according to claims 11 or 12 when such program is run on a computer. 55
14. Computer program according to claim 13 and contained on a computer-readable medium.

15. Program according to claim 13 or 14 adapted to be run by said control means.

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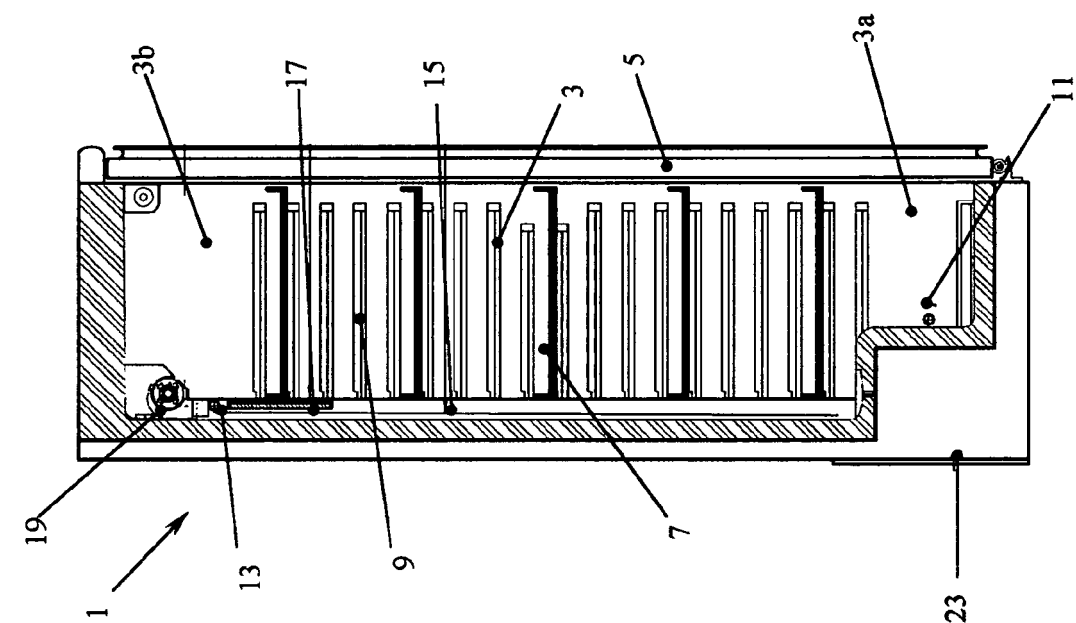


FIG. 1

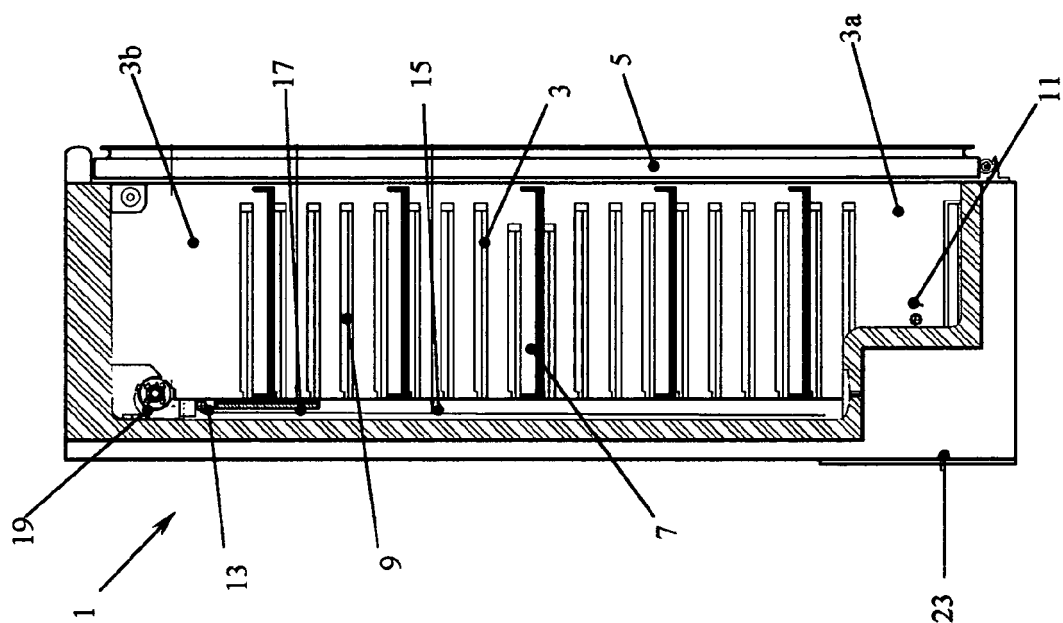


FIG. 2

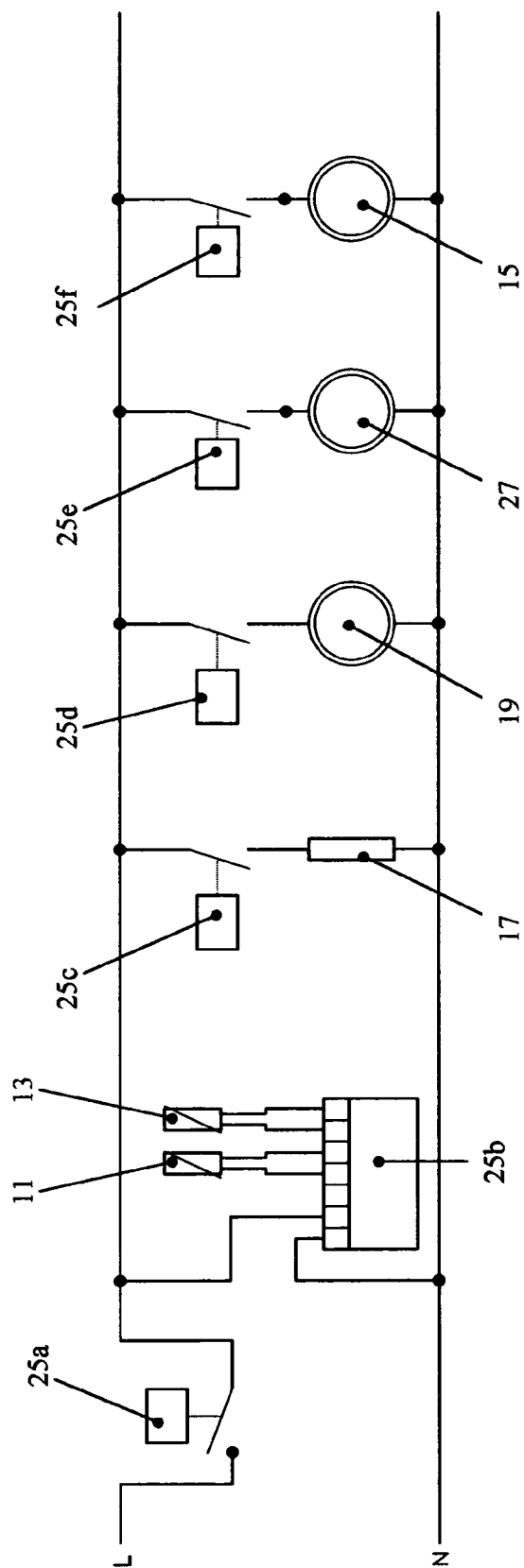


FIG. 3

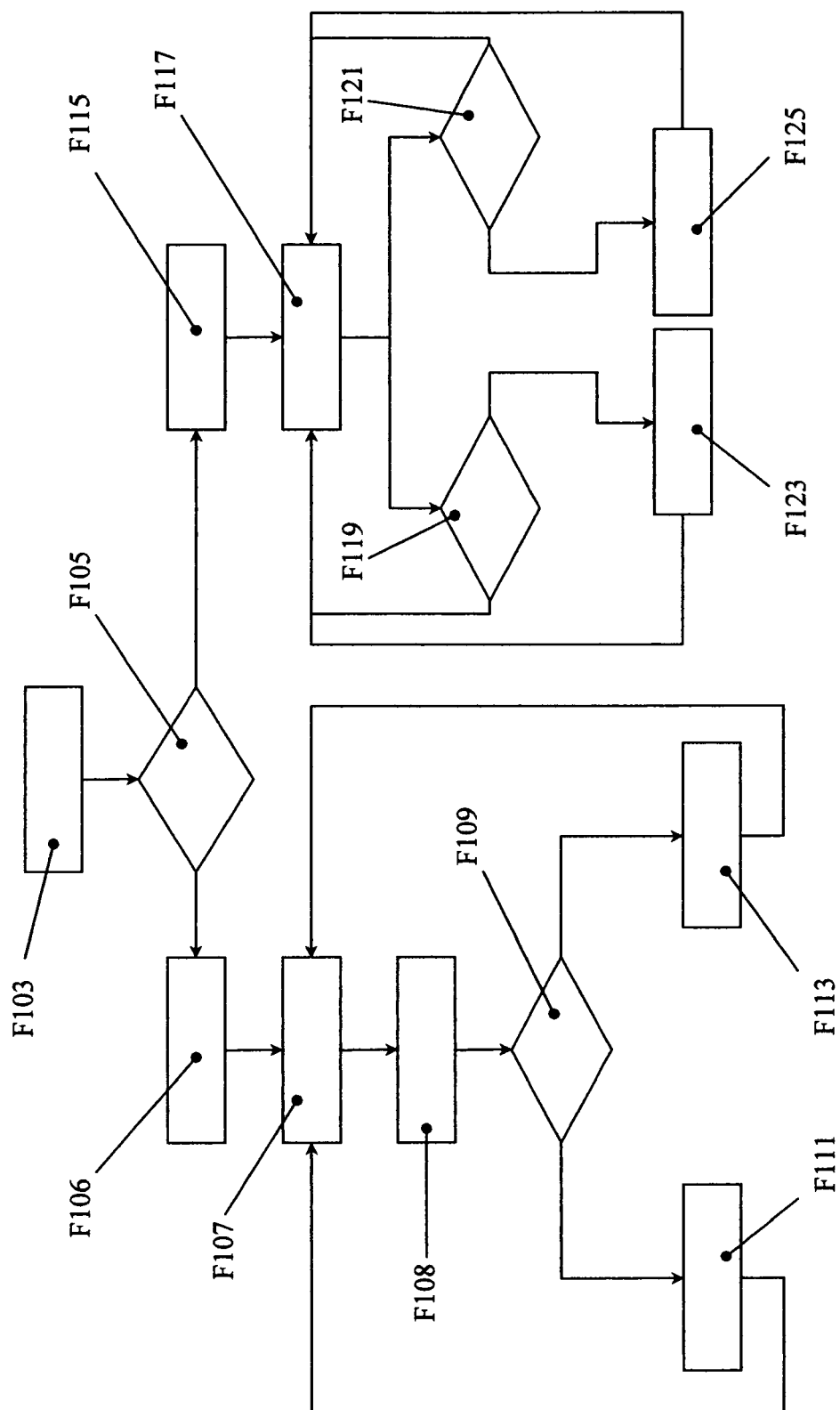


FIG. 4



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 05 42 5555

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A	US 3 135 316 A (FOSTER LAWRENCE H ET AL) 2 June 1964 (1964-06-02) * figure 1 * * column 3, line 48 - column 4, line 5 * * column 6, line 37 - line 48 * -----	1	TECHNICAL FIELDS SEARCHED (IPC) F25D F25B
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Place of search The Hague		Date of completion of the search 14 February 2006	Examiner Yousufi, S
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 05 42 5555

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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