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(54) **Single-compressor refrigeration apparatus with improved control of the temperature of two storage compartments**

(57) Refrigeration apparatus provided with two compartments for storing food at different temperatures, in which the compartment at a higher storage temperature is provided with a switch (1) and a balance heater (2) connected in series, as well as a sensor for detecting the external temperature (6); there are provided an actuation device (4) adapted to actuate said switch (1) into opening and closing, processing and control means (5)

connected to said actuation device (4), an external temperature sensor (6) connected to said means (5) and adapted to send signals relating to the external temperature measurements.

There are also provided separately actuatable adjusting means (8) connected to said processing and control means (5), on which different values of the temperature in the compartment at a lower storage temperature can be set.

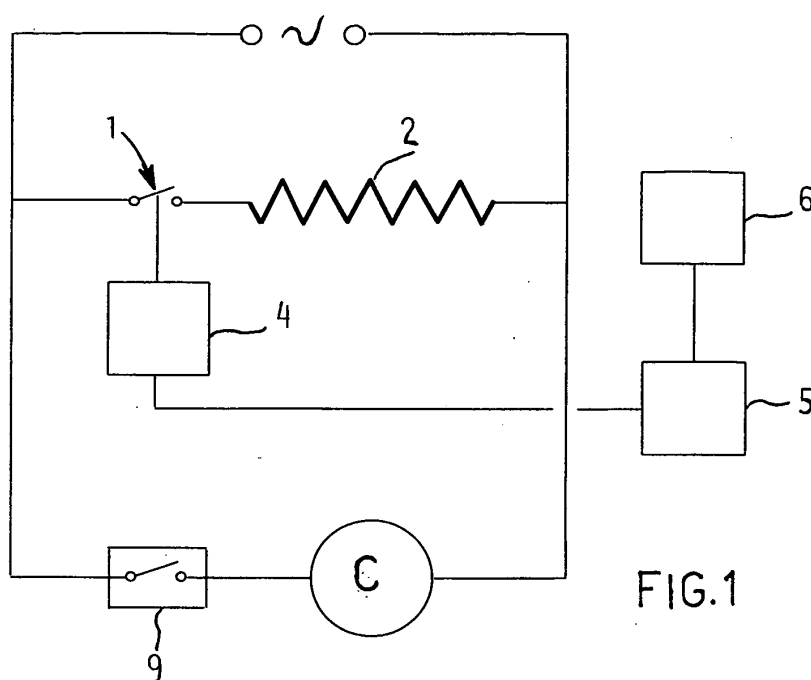


FIG.1

Description

[0001] The present invention refers to an improved type of refrigeration apparatus provided with two separate cold storage compartments cooled by a same refrigerating circuit through distinct evaporators that are anyway cooled by means of a single compressor.

[0002] In particular, it refers to a refrigeration apparatus in which the two storage compartments must be kept at sensibly different temperatures, eg. such as in the case in which a storage compartment is used as a freezer, in which the temperature is held at approximately -18°C, while the other storage compartment is a refrigerated compartment, or cold storage compartment, in which the storage temperature is approximately +5°C.

[0003] It is largely known in the art that, in this case, the cold storage compartment is equipped with a thermostat switch which controls the operation of the compressor, while the refrigerating circuit is made so as to ensure that both compartments are actually capable, under steady-state conditions, of maintaining or sustaining the intended temperature, i.e. the temperature that is intended to prevail in each one of them.

[0004] However, circumstances may arise in which it proves practically impossible for a correct balance of said temperatures to be kept. In particular, this occurs when the temperature outside the refrigeration apparatus decreases to an appreciable extent or when the temperature in the cold or refrigerated storage compartment is adjusted at a value that is higher than the one at which the compartment is intended to operate normally.

[0005] In this case, in fact, a smaller amount of cold, i.e. refrigerating capacity, needs to be contributed in order to enable the compartment for storing food at a higher temperature to be kept at the pre-set temperature value, and the compressor needs therefore to perform a smaller amount of work.

[0006] The practical result of such a condition is that the compartment for storing food at a lower temperature is no longer able to be kept at its pre-set temperature, so that the actual storage temperature prevailing in this compartment tends to rise. This occurrence is on the other hand largely known to all those skilled in the art, so that no need arises here for it to be explained any further.

[0007] In view of doing away with such a kind of drawback, a number of solutions have been disclosed and used: a first such solution consists in providing the refrigerating circuit with an electromagnetic valve and a partially distinct circuitry of the refrigerant medium, and possibly with a second thermostat switch to be arranged in the freezer compartment of the apparatus, so that when the temperature in the freezer compartment is detected to rise, the evaporator in the cold or refrigerated storage compartment is completely or partially shut out, while the compressor is enabled to operate in such a manner as to ensure the desired temperature in the freezer compartment.

[0008] However, such a solution, although quite effective, has a serious drawback in that it proves very expensive as far as both materials and manufacturing are concerned, mainly owing to the complexities involved in practically providing a duplicate of at least a portion of the refrigerating circuit.

[0009] A different solution that has been disclosed in this connection involves providing a suitable heating or balance resistance element in the cold storage compartment, such a resistance element being controlled by a thermostat switch located in the freezer compartment.

[0010] When the temperature in this freezer compartment rises above a pre-determined value, the above cited resistance heater element is energized so that it tends to cause the temperature in the cold storage compartment to increase. As a result, the temperature of this compartment rises and causes the respective thermostat switch to trip, thereby activating the compressor, which is in this way caused to operate in a more intense manner and drive again the temperature in the freezer compartment down to the desired value.

[0011] However, this solution has a major drawback in that the temperature in the cold storage compartment tends to become rather unstable, i.e. a fact that brings about a number of drawbacks, too, as far as the effective preservation of the food stored in the compartment is concerned. In addition, at the beginning of the operation of the apparatus, the temperatures in the compartments needs a longer time to be pulled down and reach steady-state conditions, since the thermostat switch in the freezer compartment, owing to its detecting an ambient and, therefore, relatively high temperature, causes the balance heater to be energized, which of course determines a slower pull-down of the temperature in the cold storage compartment.

[0012] Known from the disclosure in JP 08180353 is a solution in which two heaters are provided in a series arrangement, in which a first heater is located in the immediate proximity of the thermostat switch, and in which a thermostat switch is arranged on the outside of the refrigeration apparatus itself so as to be able to detect the room temperature; when this room or ambient temperature lowers below a certain level, this thermostat switch shorts the second heater, so that said first heater located near said thermostat switch is energized. Anyway, this solution still has much the same drawbacks as the previously discussed one, further aggravated by a cost-intensive complication of the temperature control circuits.

[0013] It should furthermore be noticed that, in the afore described prior-art, setting the temperature of the cold storage compartment at a temperature differing from the nominal or rated one, as this may possibly be required or desired by the user, would lead to a corresponding undesired variation in the temperature in the freezer compartment.

[0014] It therefore would be desirable, and it is actually a main purpose of the present invention to provide

a refrigeration apparatus, preferably for residential use, i.e. of the household type, that is provided with several storage compartments at different storage temperatures, in which the temperatures in the two compartments can be programmed, i.e. set by the user on selectively pre-settable values, in which said temperatures remain constant regardless of the outside temperature, and in which the adjustment of said temperatures can be activated in accordance with and depending on the course or trend of the outside temperature, so as to forestall the thermal oscillations in the two compartments, thereby reducing the overall thermal oscillations themselves.

[0015] According to the present invention, these aims are reached in a particular type of refrigeration apparatus provided with the devices and arrangements as recited in the appended claims and described below by mere way of non-limiting example with reference to the accompanying drawings, in which:

- Figure 1 is a schematical view of a circuit arrangement of a first embodiment of a refrigeration apparatus according to the present invention;
- Figure 2 is a schematical view of a circuit arrangement in an improved embodiment;
- Figure 3 is a schematical view of a circuit arrangement in a further improved embodiment of a refrigeration apparatus according to the present invention;
- Figure 4 is a symbolic view of a kind of database for a refrigeration apparatus according to Figure 2;
- Figure 5 is a view of the temperature trend patterns in the compartments of the refrigeration apparatus in accordance with the outside temperature;
- Figure 6 is a symbolic view of a kind of database for a refrigeration apparatus according to Figure 3;
- Figure 7 is a schematical view of a control board with the means for adjusting the temperature in the two internal compartments of the refrigeration apparatus.

[0016] With reference to Figure 1, a refrigeration apparatus provided with a first embodiment of the present invention comprises:

- a compressor C, a compartment for storing food at a higher temperature and a compartment for storing food at a lower temperature (not shown),
- a switch 1 and a balance heater 2 arranged in series and adapted to be supplied with line voltage,

- an actuation device 4 adapted to actuate said switch 1 into opening and closing,
- processing and control means 5 connected to said actuation device 4, an outside temperature sensor 6 connected to said processing and control means 5 and adapted to send corresponding signals based on the detected values of the outside temperature,
- a thermostat switch 9 located inside the cold storage compartment, i.e. the compartment for storing food at a higher temperature.

[0017] When the outside temperature keeps itself at a baseline or reference value, the refrigeration apparatus operates in a regular manner; it does not require any additional adjustments to be made further to the adjustment set by the thermostat switch 9 provided in series with the compressor C, in a conventional prior-art manner; when the outside temperature on the contrary decreases from said baseline or reference value, the signal delivered by said sensor 6 is received and processed by the means 5 based on algorithms and data provided in such a manner as to cause a signal to be sent to said actuation device 4, which then acts so as to cause the switch 1 to open or to close.

[0018] Said algorithms and data can be easily defined by those skilled in the art and substantially define an activation/deactivation sequence of the actuation device 4 and, therefore, an opening/closing sequence of the switch 1 on the basis of the temperature profile detected by the sensor 6. Such a processing can only consider the outside temperature, as well as the rate of decrease of such a temperature (derived with respect to time).

[0019] It will of course be appreciated that, according to the actual complexity of such a processing, it is possible for an adjustment of the closing sequence of the switch 1 to be obtained, which is as anticipated or early-occurring as possible so as to optimise the compressor activation cycle and, as a result, minimize the transient rise in the temperature of the compartment provided to store food at a lower temperature, as well as minimize the resulting thermal oscillations.

[0020] With reference to Figure 2, where an improved embodiment of the arrangement according to the present invention is illustrated, the balance heater 2 is directly connected to the processing means 5, which are in turn adapted to deliver a variable, selectively controllable voltage to said heater 2 so that a further improvement is obtained in the ability to more readily react, i.e. ensure a quicker response to a decrease in the outside temperature through a prompter adjustment of the power of said balance heater 2.

[0021] With reference to Figure 3, a further improved embodiment consists in additionally providing the apparatus with first independently controllable adjustment means 7, which, further to operatively act as a conven-

tional adjustable thermostat switch, are adapted to also transmit the adjustment that has been set therewith to said processing means 5.

[0022] With particular reference to Figure 3B, a further advantageous possibility derives from the fact of providing also second independently controllable adjustment means 8 for adjusting the temperature in the storage compartment at a lower temperature of the apparatus. In other words, the possibility arises to use these adjustment means 7 and 8, which are connected to said processing and control means 5, to selectively set different temperature values for said storage compartments at a higher and at a lower temperature, respectively.

[0023] This particular embodiment enables a significantly improved refrigeration apparatus to be obtained, since it is provided with the possibility for specific temperatures to be programmed or set both in the warmer and in the colder storage compartment through the use of specific, automatically activated programmes that are selected not only on the basis of said programmed, i.e. set temperature values, but also depending on the value of the outside, i.e. ambient temperature.

[0024] A preferred embodiment of such an apparatus is described below: with reference to Figure 4, a database is defined which is composed of a plurality of records 10 (sets of data that are read on a same line or row), each one of which comprises two fields (sets of data that are read on a same column), according to a terminology and a convention that are well-known to those skilled in the art of information and computer technology.

[0025] In the first field 11 there are entered values that correspond to conventional values of the temperature selected by said first means 7, while in the second field 12 there are entered values that correspond to conventional values of the signal delivered by said outside temperature sensor 6.

[0026] The so defined database is then stored in said processing means 5.

[0027] During the operation of the refrigeration apparatus, these means perform a comparison of the values in the first field of each one of the records of the database to the corresponding value generated by said first means 7, as well as of the values in the second field of each record of the database to the corresponding value generated by said outside temperature sensor. From such a comparison that record is then selected whose values have been verified as being actually existing or present. Finally, in accordance with the record that has been so identified and selected a respective specific programme is activated, which is adapted to energize/de-energize said balance heater according to a pre-determined sequence in such a manner as to ensure that not only the temperature in the colder compartment is kept constant, but also the temperature in the warmer storage compartment of the apparatus is actually kept at the level set by said means 7 in a constant manner.

[0028] In view of better illustrating in just a few words what has been set forth above, reference should be made to Figure 5 in which the course of the temperature in the warmer compartment "A" and the colder compartment "B" without the balance heater, the course of the temperature in the colder compartment "C" under provision of the balance heater according to the present invention, and the various temperature values "A1", "A2", etc. according to the setting of said means 7 are plotted against the outside temperature in the abscissa.

[0029] The above-described apparatus can be further improved through the introduction of the improvement described below. In fact, further to the possibility for the temperature in the warmer compartment to be adjusted as discussed above, it may be desirable, for a number of reasons that shall not be discussed here any further, for also the temperature in the colder compartment to be capable of being adjusted to values that differ from a sole standard value.

[0030] To such a purpose, with reference to Figure 6, a database is defined which is fully similar to the previously described one, except for the fact that, in this case, there are provided three fields, in which a first field 11 includes a value corresponding to a conventional value of the temperature selected by said first means 7, a second field 14 includes a value corresponding to a conventional value of the temperature selected by said second means 8, and the third field, which is of course still indicated with the reference numeral 12, includes a value corresponding to a conventional value of the signal delivered by said outside temperature sensor 6; as it can be readily appreciated, the second field 14 in this case added with respect to the previously described solution.

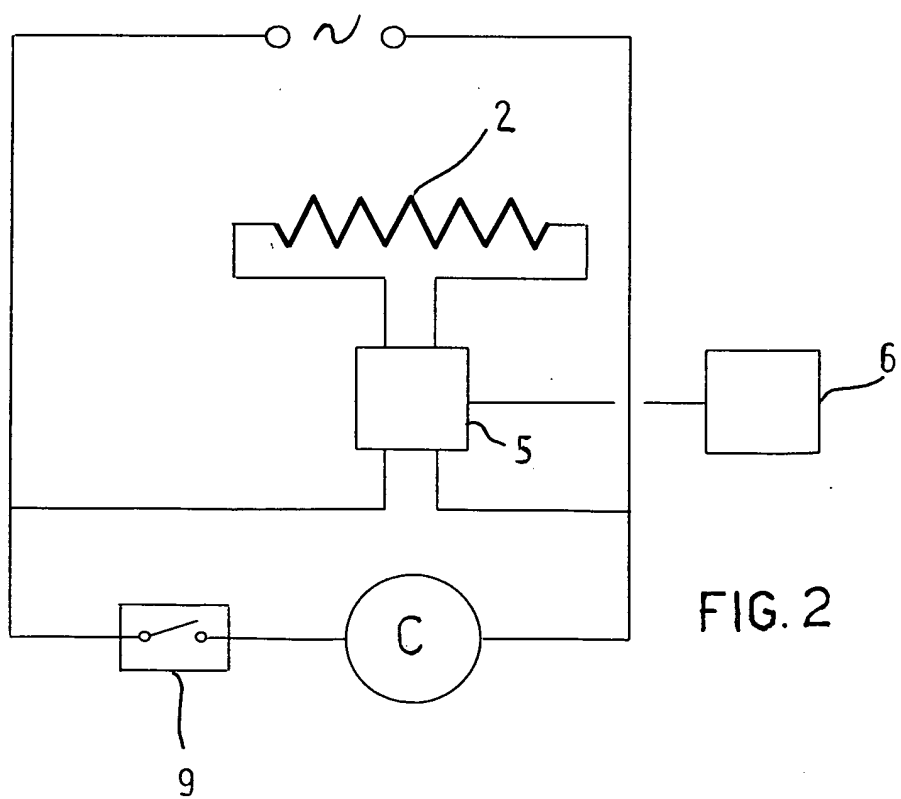
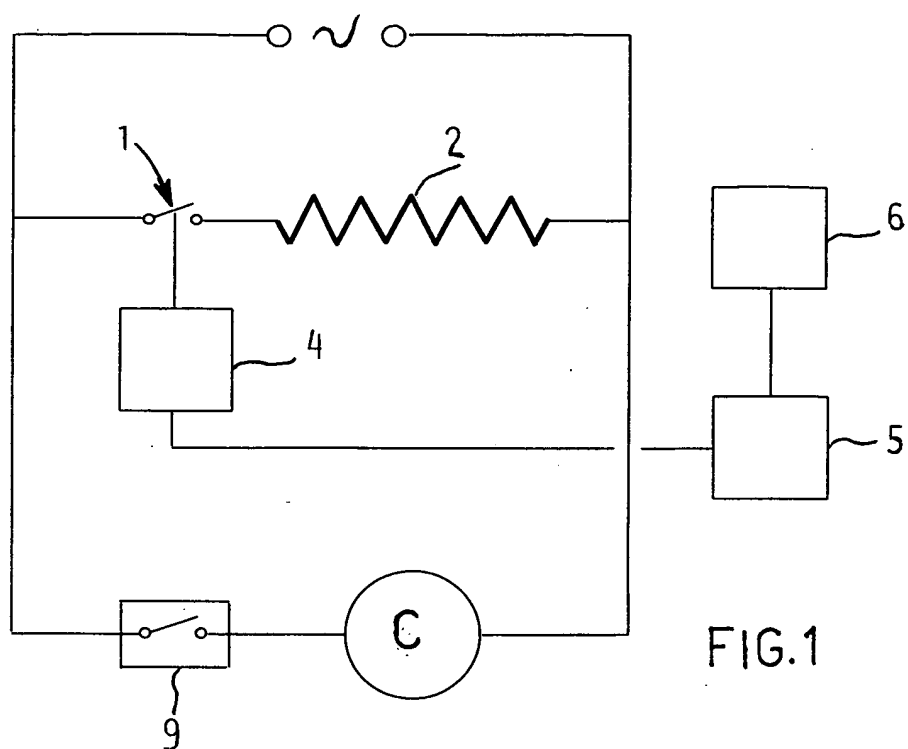
[0031] The operating logics is fully similar to the one discussed in connection with the afore considered case, with the exception that, at each record, the values in all three fields, i.e. the two fields concerning the reference or baseline temperature in the two compartments and the field containing the reference or baseline value of the outside temperature, are in this case compared with the values that are actually set or delivered by said first means 7, said second means 8 and said outside temperature sensor 6.

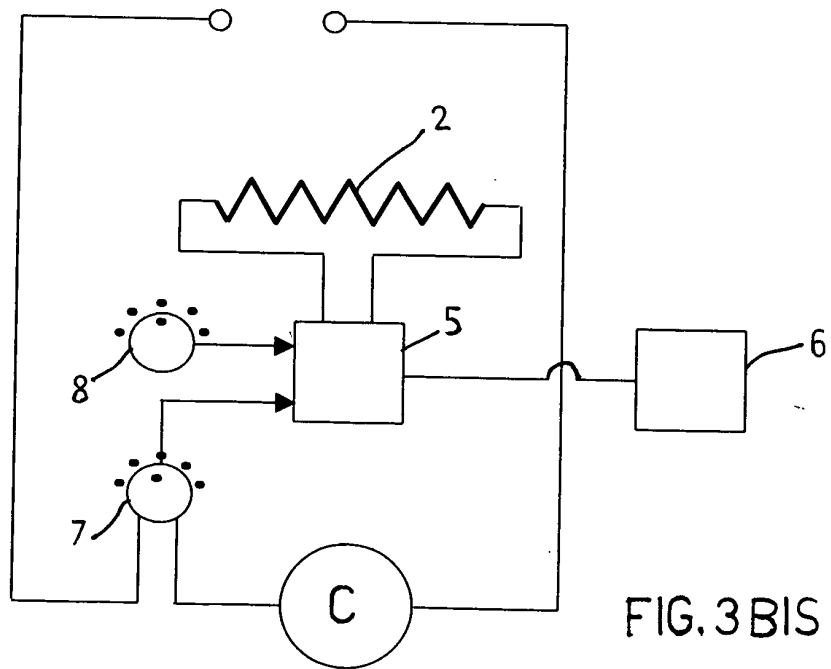
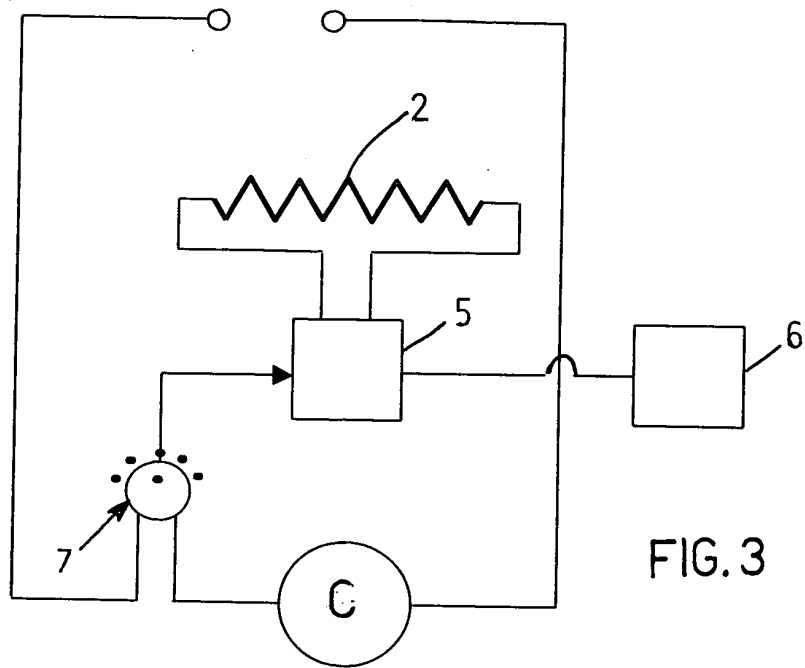
[0032] At this point, no further teaching is needed for those skilled in the art, since they are fully capable of appreciating that, by giving appropriate "instructions" to the processing means 5, these will be able to act on the cycling, i.e. sequence of on-off times of the balance heater in such a manner as to ensure that the respectively set temperature is actually obtained and held in both storage compartments.

[0033] Finally, Figure 7 symbolically illustrates a control panel, for installation on the outside of the apparatus, on which said first means 7 and said second means 8 for setting and adjusting the internal temperature in the respective storage compartments can be appropriately arranged, in a manner that is generally known in the art.

Claims

1. Refrigeration apparatus, in particular for residential use, comprising a compressor, a compartment for storing food at a higher temperature and a compartment for storing food at a lower temperature, in which the compartment at a higher storage temperature is provided with a switch (1) and a balance heater (2) connected in series therewith, as well as a thermostat switch (9), **characterized in that** there are provided an actuation device (4) adapted to actuate said switch (1) into opening and closing, processing and control means (5) connected to said actuation device, an external temperature sensor (6) connected to said means (5) and adapted to send signals corresponding to the detected external temperature. 5 10 15
2. Refrigeration apparatus, in particular for residential use, comprising a compressor, a compartment for storing food at a higher temperature and a compartment for storing food at a lower temperature, in which the compartment at a higher storage temperature is provided with a balance heater (2) and a thermostat switch (9), **characterized in that** there are provided an actuation device (4) adapted to deliver a selectively variable power supply to said balance heater, processing, storage and control means (5) connected to said actuation device, an external temperature sensor (6) connected to said means (5) and adapted to send signals corresponding to the detected external temperature. 20 25 30
3. Refrigeration apparatus according to claim 1 or 2, **characterized in that** it is further provided with first independently controllable adjustment means (7) connected to said processing and control means (5), which are adapted to selectively set different values of the temperature in said compartment at a higher storage temperature. 35 40
4. Refrigeration apparatus according to claim 3, **characterized in that** it is also provided with second independently controllable adjustment means (8) connected to said processing and control means (5), which are adapted to selectively set different values of the temperature in said compartment at a lower storage temperature. 45
5. Refrigeration apparatus according to claim 4, **characterized in that** it is adapted to operate according to specific, automatically activated programmes that are selected on the basis of the value of the external temperature and the temperature values that are set on said first adjustment means (7) and said second adjustment means (8). 50 55
6. Refrigeration apparatus according to any of the preceding claims 2 to 5, **characterized in that** said processing and control means (5):
 - are provided with storage means adapted to store a database organized into a plurality of records (10), in which each record includes two fields, in which a first field (11) contains a value corresponding to a conventional value of the temperature selected by said first adjustment means (7), and the second field (12) contains a value corresponding to a conventional value of the signal delivered by said external temperature sensor (6), and
 - are adapted to energize/de-energize said compressor according to a pre-determined cycling programme based on the single and sole record in which the two fields have values that are similar, within respective pre-determined intervals, to the values corresponding to the value of the temperature selected by said first adjustment means (7), and the measured value of the signal delivered by said external temperature sensor (6), respectively.
7. Refrigeration apparatus according to any of the preceding claims 2 to 5, **characterized in that** said processing and control means (5):
 - are provided with storage means adapted to store a database organized into a plurality of records (10), in which each record includes three fields, in which a first field (11) contains a value corresponding to a conventional value of the temperature selected by said first adjustment means (7), a second field (14) contains a value corresponding to a conventional value of the temperature selected by said first adjustment means (8), and the third field (12) contains a value corresponding to a conventional value of the signal delivered by said external temperature sensor (6), and
 - are adapted to energize/de-energize said compressor according to a pre-determined cycling programme based on the single and sole record in which said three fields have values that are similar, within respective pre-determined intervals, to the values:
 - corresponding to the value of the temperature selected by said first adjustment means (7),
 - corresponding to the value of the temperature selected by said first adjustment means (8), and
 - corresponding to the measured value of the signal delivered by said external temperature sensor (6), respectively.





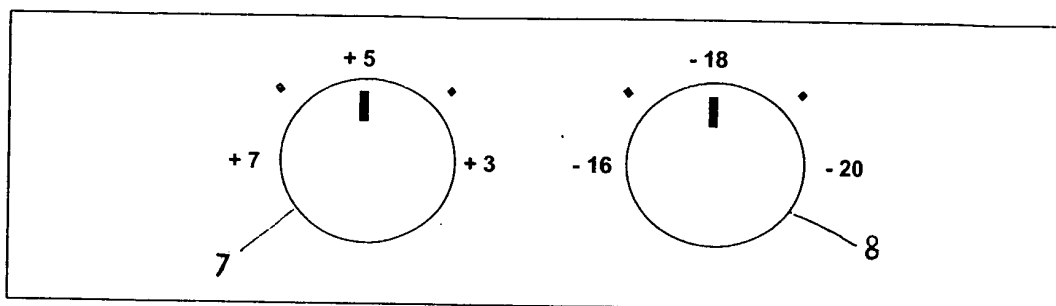


FIG. 7

MEANS	7	SENSOR	6

FIG. 4

MEANS	7	MEANS	8	SENSOR	6

FIG. 6

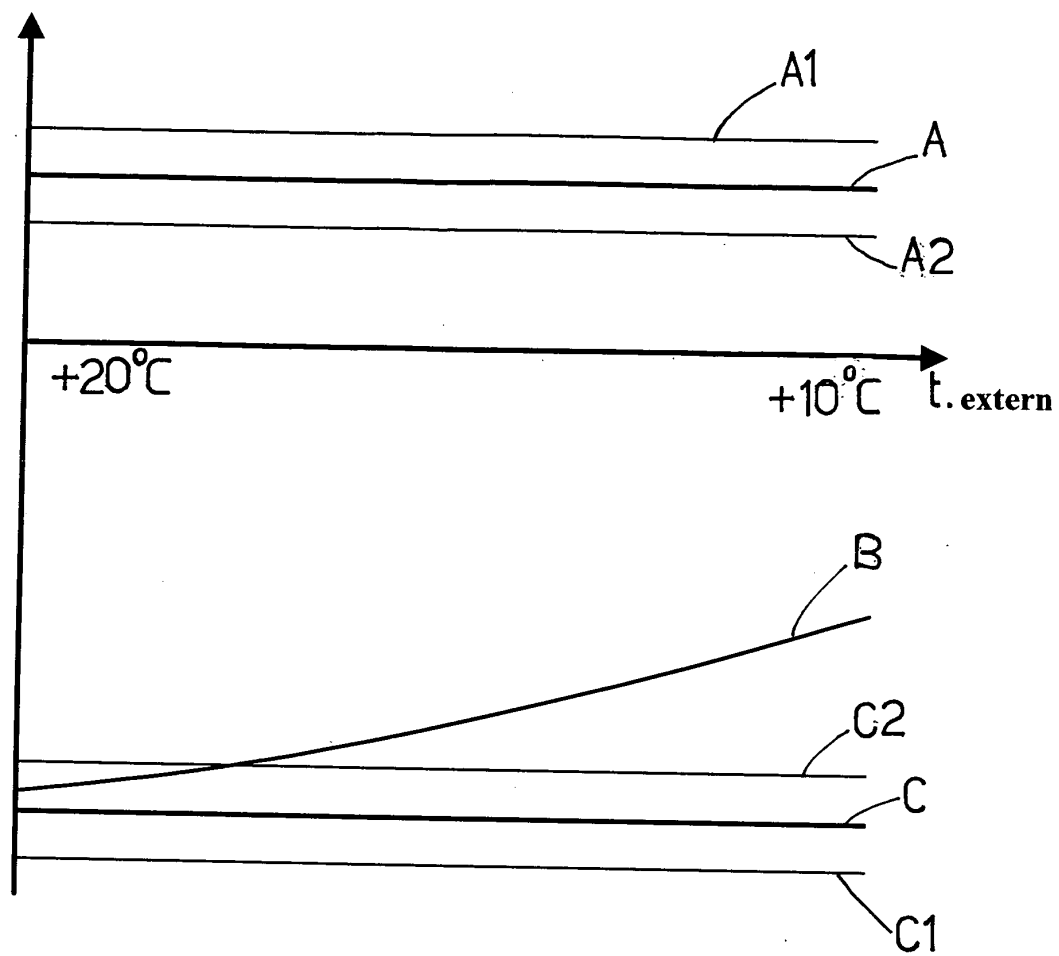


FIG.5



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 03 00 3097

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	EP 0 995 957 A (ELECTROLUX ZANUSSI ELETTRODOME) 26 April 2000 (2000-04-26)	1-3	F25D29/00 F25D11/02
A	* abstract; figures 1,2 * * paragraph '0014! - paragraph '0015! * * paragraph '0018! - paragraph '0020! * * paragraph '0024! - paragraph '0025! * * paragraph '0030! * ----	6,7	
X	WO 00 65289 A (BSH BOSCH SIEMENS HAUSGERAETE) 2 November 2000 (2000-11-02)	1,2	
A	* abstract; figures 1-3 * * page 2, paragraph 3 * * page 4, line 34 - page 5, line 6 * * page 5, line 14 - line 19 * * claim 1 * ----	3	
A	EP 0 345 165 A (SELNOR) 6 December 1989 (1989-12-06) * abstract; figures 2,3 * * column 3, line 54 - column 6, line 10 * -----	4,7	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			F25D
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 27 June 2003	Examiner Yousufi, S
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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 03 00 3097

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27-06-2003

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
EP 0995957	A	26-04-2000	IT	PN980076 A1	24-04-2000
			EP	0995957 A2	26-04-2000
WO 0065289	A	02-11-2000	DE	29907267 U1	15-07-1999
			WO	0065289 A1	02-11-2000
			EP	1175586 A1	30-01-2002
			TR	200103307 T2	22-04-2002
EP 0345165	A	06-12-1989	FR	2632390 A1	08-12-1989
			DE	68900811 D1	19-03-1992
			EP	0345165 A1	06-12-1989
			ES	2028456 T3	01-07-1992

EPO FORM P0459

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