



Europäisches Patentamt
European Patent Office
Office européen des brevets



(11) **EP 1 586 837 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
19.10.2005 Bulletin 2005/42

(51) Int Cl.7: **F25D 17/06, F25D 21/12**

(21) Application number: **04101589.2**

(22) Date of filing: **16.04.2004**

(84) Designated Contracting States:
**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR
HU IE IT LI LU MC NL PL PT RO SE SI SK TR**
Designated Extension States:
AL LT LV MK

(72) Inventor: **Nilsson, Per Olof**
I-31058, Susegana (TV) (IT)

(74) Representative: **Giugni, Valter et al**
PROPRIA S.r.l.,
Via Mazzini 13
33170 Pordenone (IT)

(71) Applicant: **Electrolux Home Products**
Corporation N.V.
1930 Zaventem (BE)

(54) **Refrigerator apparatus with freezer compartment and simplified defrosting device**

(57) Refrigerator apparatus comprising: - a refrigeration compartment (2), - a freezing compartment (3) placed inside said refrigeration compartment (2), - a refrigerating assembly with a compressor (6) and a condenser (7), - air conveying means (8) able to allow air communication between said refrigeration compartment (2) and said freezer compartment (3), and placed into said refrigeration compartment (2), - two evaporators (4,5), lodged inside said conveying means (8), - two fans (12,13), each of them being able to blow respective

air-flows from the inside of said refrigeration compartment (2) towards the inside of said freezing compartment (3), passing through or over a respective said evaporator, - a three-ways valve (14) able to selectively deviate the refrigeration liquid coming from said condenser (7) to either said evaporators; it is able to operate in a first mode wherein only a specific fan and said valve being activated to make to work the corresponding evaporator, in the second mode being operated the other fan only and said valve being activated to make to work only the corresponding other evaporator.

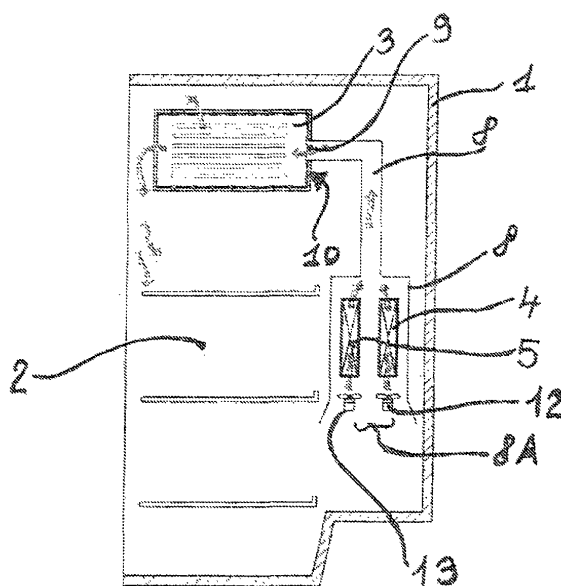


Fig 2

EP 1 586 837 A1

Description

[0001] This invention refers to an household refrigerator apparatus provided with a food refrigeration compartment, normally held at a temperature around + 5°C, lodging in it a freezer compartment, or a compartment held at a colder temperature, for instance of *, **, *** and that is kept insulated with respect to the refrigerator compartment.

[0002] These types of apparatuses are universally known, as they combine a remarkable manufacturing and operating simplicity, to the possibility of arranging a small compartment whose temperature is maintained well under 0°C, and therefore being used as a long term food storage compartment.-

[0003] Normally these types of apparatuses do use as a refrigerating source a single evaporator, made from a serpentine tube or from a roll-bond, covering the walls of said freezer compartment or that directly forms the same walls; through a suitable sizing of the various used elements it can be easily obtained that the freezer compartment be kept at a low temperature as desired, while the refrigerator temperature compartment is kept at a properly higher temperature.-

[0004] However these apparatuses do show a well known drawback based on the fact that the evaporator is periodically covered with ice or frost, and its thickness may became so high that it covers the food stored in the freezer compartment.-

[0005] Such a phenomenon brings to a progressive reduction of the refrigerator efficiency (caused by the well know fact that the ice covering the evaporator constitutes an insulating partition, worsening the thermal exchange); moreover the food itself often are as "welded" and blocked against the bottom of the freezer compartment, inhibiting an easy removal.

[0006] These facts implicate the need of periodically carrying out the freezer defrost; such an operation however requires a manual operation that is frequently uncomfortable in order to move away the water resulting from the ice fusion; moreover during the whole time needed for the defrosting, the refrigerator apparatus obviously cannot work, and the stored food have to be taken away from the freezer compartment and so they are kept for a certain time at a room temperature.-

[0007] Then the unpleasant consequences on their preservation quality are apparent, and moreover it is normally not possible to freeze them again.-

[0008] The need of a periodic defrost or de-icing operation on the evaporator is as much experienced as more the apparatus is kept in an hot and humid environment, as in the tropical countries; in the fact the high humidity entering the compartment each time the door is opened generates a quick ice increasing on the evaporator, and this fact is further aggravated by the high room temperature that makes the refrigerating group to work for prolonged periods.-

[0009] In order to avoid such problems, different types

of refrigerator apparatuses have been proposed which are provided with features assuring either to avoid the ice growth on the food, or to prevent that the ice made on the evaporator will cover also the food, and that it be defrosted by known means.-

[0010] The adopted solutions therefore have taken into account both the automatic defrosting of the refrigerator compartment, and alternatively have developed various solutions aimed to ventilate one or both compartments using a forced air-flow.-

[0011] Said solutions, represented only for sake of exemplary clarity in the further cited patents, are proved to be efficient from the operating point of view; however they are also proved to be scarcely usable, as they can be realised in the cases where the two compartments are actually separated, even if they can show a common refrigerating circuit, or part thereof, or the means apt to circulate the forced air-flow.-

[0012] When, on the contrary, refrigerator apparatuses are used that must be especially cheap and simple, as those provided with a food refrigeration compartment, normally held at a temperature around 0°C, simply lodging, (but not insulated) a freezer compartment, for example a *, or **, or *** type, then no one of the divulged solutions can be helpful exploited.-

[0013] As a matter of fact in these apparatuses it is enough that the cooled air-flow be so low to cool both compartments, but this limited air-flow is often not able to prevent, as in the described situations of high room temperature and humidity, that the evaporator will be covered with ice/frost.-

[0014] From US 5,867,994 a solution is known on a refrigerator comprising a freezer and a refrigerator compartment, provided with a single evaporator; in this case it is stated that the evaporator defrosting is carried out through the blown air coming from the refrigerator and, being at a higher temperature, it melts the ice/frost.-

[0015] However said solution has often turned to be not effective as if the apparatus has to work in a heavy duty mode, then there is actually no possibility of defrosting the evaporator as it is almost all the time operating.-

[0016] From US 5,732,561 a solution is known basically similar to the previous one, wherein the two compartments at different temperatures are cooled down by only one evaporator that is ventilated by a single fan; even in this case some circumstances could happen wherein it is not possible to fully defrost the evaporator; furthermore said apparatus requires using sophisticated control means that are always quite expensive.-

[0017] The two patents US 4,122,687 and US 5,375,428 do show some substantially similar solutions but exploiting control means of different complexity; then in the case of an heavy duty mode of operation the same previously explained drawbacks are shown.-

[0018] The patent US 5,487,277 shows a refrigerator apparatus wherein the freezer compartment is insulated and separated from the refrigerator compartment; in this

case the proposed solutions are aimed to improve the switching/operating mode of the thermostats, and are not applicable to the case, that is here interesting, relevant to a very cheap apparatus with two compartments held at different temperatures but basically non insulated between each other, as in the cases of a compartment with * or ** or ***.-

[0019] From US 5,406,805 a refrigerator apparatus is known provided with two compartments at different temperatures, and two respective evaporators and two respective fans; in this case the defrost of the two evaporators is achieved by a controlled-valve arrangement between the two refrigerating circuits, allowing the refrigerating fluid to pass from a circuit to the other; even in this case the showed solution is not helpful as it refers to an apparatus having two separate compartments, and moreover the arrangement of the conduits between the two evaporators is positively quite burdensome.-

[0020] From US 6,286,326 a refrigerator apparatus is known using some solutions that either embody a variable-capacity compressor, and then are complicate and expensive, or they use some of the solutions already above described, and therefore useless to the present problem.-

[0021] From JP 11148759 a refrigerator apparatus is known wherein the two compartments at different temperatures are not inter-connected and the two temperatures are controlled in a fully independent way; the features there offered are then not helpful when the requested and described cost and simplicity constraints are clear and present.-

[0022] In US 6,427,463 a refrigerator apparatus is shown wherein the two compartments at different temperatures are thermally insulated, and the defrosting is achieved by a sort of "thermal siphon" that in certain cases may be not efficient; the shown solutions, even if they can well work in certain cases, are then not applicable to the present case.-

[0023] From US 5,722,248 a kind of refrigerator apparatus is known where the two compartments at different temperatures are thermally insulated each other and are cooled in specific and independent mode; furthermore to make them properly operate a type of computing and control device is needed, which is always complicate and expensive.-

[0024] The teaching there given cannot then be used in the present situation.

[0025] It would be therefore desirable, and is actually a main purpose of the present invention, to provide a refrigerator apparatus provided with two distinct compartments at respective different temperatures, each of them being ventilated, wherein the compartment at the lower temperature is simply lodged in the other compartment and not thermally insulated from it, said apparatus being able to void the need of periodically and manually defrosting both evaporators.-

[0026] According to another purpose of the present invention said apparatus should be able to operate and

automatically defrost without any need of complicate and expensive devices, and specifically without the need of electronic control devices.-

[0027] According to a further purpose of the invention, this apparatus should be able to be easily manufactured using existing ready available materials and techniques, and be competitive in its construction without suffering any alteration or reduction in the performance and reliability thereof.-

[0028] These aims are achieved in a two-compartments refrigerator apparatus embodying the features as recited in the appended claims and including such operating means as described below by mere way of non-limiting example with reference to the accompanying drawings, in which:

- Fig. 1 shows a perspective simplified view of an refrigerator apparatus generally according to the invention,
- Fig. 2 shows a schematic vertical side section of a refrigerator apparatus according to the invention, with two evaporators placed one ahead the other on the user's view,
- Fig. 3 shows a schematic vertical front view of a refrigerator apparatus according to the invention, with two evaporators placed side by side,
- Fig. 4 shows a symbolic representation and connections among the functional devices in a refrigerator apparatus according to a first embodiment of the invention,
- Fig. 5 shows a schematic vertical front view of a second embodiment of an apparatus according to the invention, and having two evaporators placed side by side,
- fig. 6 shows a schematic vertical side section of a refrigerator apparatus according to the second embodiment of the invention, with the two evaporators placed one ahead the other on the user's view,
- fig. 7 shows a symbolic representation and connections among the functional devices in a refrigerator apparatus according said second embodiment,
- fig. 8 represents the graph of the working modes, on the same time-base, of some devices showed in fig. 4.-

[0029] The instant invention is mainly based on the well known fact that in an refrigerator apparatus, provided with two compartments at different temperatures, and with only one evaporator, the defrosting of said evaporator is given by the relatively high air temperature in the refrigerator compartment, and that such air is blown on the evaporator when it is not operating.-

[0030] Such technique however shows not effective when the evaporator defrosting phase is not strong or long enough to fully defrost it.-

[0031] The solution here found, that is remarkable for its effectiveness and simplicity, together with its cheapness, consists:

- in the duplication of that part only of the refrigerating circuit that creates the problem, obtaining then two operating sub-assemblies quite identical,
- and in making them work in an alternate mode.-

[0032] To sum up, two sub-assemblies are created that are connected in parallel each other with respect to single refrigerator line comprising one compressor/condenser, each of these sub-assembly being activated when the other sub-assembly is kept inactive.-

[0033] With ref. to the figures, an apparatus according to the invention comprises an external cabinet 1, into which a refrigeration compartment 2 is placed; a freezer compartment 3, that preferably is a *, or ** or ***, is lodged inside said refrigeration compartment 2.-

[0034] Still two distinct evaporators 4, 5 are both placed inside said refrigerator compartment 2, and said evaporators are connected to the only refrigerator group comprising a compressor 6 and a relate condenser 7 (see Fig. 4).-

[0035] Said two evaporators 4, 5 are lodged in an air duct 8 having the inlet port 8A open in said refrigerator compartment 2 and the output port in the freezer compartment 3, passing through suitable apertures 9 made in a wall 10 of said compartment 3.-

[0036] Just down-stream of said inlet port 8A, and inside said duct 8, two distinct fans 12, 13 are placed, each of said fans being apt to blow a respective air-flow, sucked from the inside of said refrigerator compartment, against a respective of said evaporators 4, 5.-

[0037] These are connected each other and to the refrigerating group by a three-way valve 14, one way of it being permanently connected to the branch 15 coming from the condenser 7, while the other two ways are selectively and alternatively connected to either of said two evaporators 4, 5.-

[0038] Said compressor, the two fans and the valve 14 are electrically connected to a control means 16, whose operation will be better described in the following, and to which arrive also the signals coming from the thermostat 17, lodged in the refrigerator compartment 2.-

[0039] The operation of this apparatus is as follows: during the beginning working time the refrigerating gas coming from the condenser 7 goes to the valve 14, which, having received a suitable signal from the control means 16, directs said fluid towards the evaporator 4; in the same time the same control means 16 sends an operating signal to the fan 12; as a consequence said fan blows a flow of very cooled air from said evaporator 4 into said conduit 8, and from here to the freezer compartment 3.-

[0040] At a later time, and at a certain predefined moment, the control means sends respective suitable signals both to the valve 14 and to the two fans, so that the refrigerating fluid is now directed to said evaporator 5 only, the fan 12 is de-activated and the fan 13 is activated.-

[0041] From that moment on, the evaporator 4, no more working and neither cooled, is progressively heated by the relatively warmer air of the surrounding room, and the ice/frost generated in the previous cycle is then melted and eliminated through known means.

[0042] In order to offer a more precise explanation of the present refrigerator apparatus, Fig.8 illustrates the specific graphs representing the operating modes of the various functional devices, shown on the same time-base, are represented, in the case two different fans 12, 13 are used.-

[0043] The main reference is of course the temperature level set by the user on the thermostat, and indicated as To, i. e. an horizontal and absolutely constant line; as a consequence the refrigerator apparatus does work in an intermittent way, and its inner temperature is represented by the line "B", well known to the man skilled in the art; it is apparent that, in correspondence of the temperature limit value Ba or Bb the thermostat 17 will send ON/OFF signals to the compressor, that begins to work or it stops, according to a working mode as shown by the line "C".-

[0044] On the control means 16 a definite change of compressor working mode is selected and pre-defined; during its operation it is continuously monitored whether and when said definite change of compressor working mode is detected.-

[0045] When said change of the compressor working mode is detected, a suitable signal is sent to the valve 14, which changes over its operation; in the figure 8 it is supposed that the selected change of the compressor working mode happens each time the compressor passes from the mode ON to the mode OFF, i. e. in the times P1, P2, P3 etc.-

[0046] Therefore the valve 14 deviates changes from a state over the other, deviating the refrigerating flow alternatively from an evaporator to the other, and the signal on said valves 14 is represented by the line "E".-

[0047] The fans 12, 13 instead have to work only during the periods when the compressor is in ON condition, but apparently each fan must work only when the respective fan is working, and must not work when the compressor either is not working, or the compressor is working but it is connected to the other evaporator.

[0048] Under these circumstances, if the fan 12 is associated to the position A of the valve 14, and the fan 13 is associated to the position B of the fan 13, then the working mode of the two fans 12 and 13 is respectively represented by the lines "H" and "K" of the same fig. 8.- Still later on the control means 16 sends suitable signals to the valve 14 and to the two fans so that the initial situation is reinstated; from that moment on, is the evaporator 4, now defrosted, to operate together with the respective fan 12, while the evaporator 5 begins its phase of spontaneous defrosting.-

[0049] The succession of the defrosting phases, just described, is the continued with the same procedure.-

[0050] Preferably between said two evaporators 4, 5

a separator element 11 is firmly placed; its purpose is to favour the channelling of the different air-flows into said conduit 8 only, and to prevent that an air-flow, cooled from a certain evaporator, be able to reach the other evaporator, so compromising its defrosting.

[0051] As far said control means 16 is concerned, this is obviously connected to the compressor 6 too, and is so designed that it can send a group of signals to the valve 14, to the compressor 6 and to the two fans 12, 13 so that it can make to operate in the same time, but alternatively, either of the two fans, and of course the compressor.-

[0052] Such control means 16 is easily apt to be produced by any man skilled in the art, and therefore the detailed description is here omitted.-

[0053] It can work according to a pre-defined time sequence, or its sequence may be determined by the signal coming from the thermostat 17 measuring the refrigerator compartment temperature, or even according to a combined sequence; for instance, a predefined time sequence can be modified or synchronised by suitable signals coming from said thermostat.

[0054] Said control means 16 may also be realised in a more complex way and to operate in a more sophisticated way, but this would go against the ratio of this invention, which tends to obtain a very cheap and simple working apparatus, but provided with an automatic defrost.-

[0055] With ref. to the **figures 5 to 7**, a useful different embodiment can be obtained with a configuration having a separator 11 such to form two distinct channel 22, 23 in which said two evaporators are respectively disposed; these two distinct channels are supplied with a single common inlet mouth 24, and between said channels 22, 23 and said mouth, a single fan 25 and a damper 26 are placed; said damper is conventionally activated by a suitable actuator that is apt to be selectively positioned so that it allows the air-flow into either of said channels, and so selectively towards said respective evaporators.-

[0056] With reference to the defrosting, the operation is similar to what previously described; from the electric point of view however it is here observed that the control means 16 controls not two but the only fan 25, and that the operation of controlling said damper 26 simultaneously with the operation of said valve 14 must be added.-

[0057] In the facts when the valve 14 is activated so that the evaporator 4 is operated, then the damper 26 must be so oriented that the air flow is directed towards said evaporator 4 only; on the contrary when the valve 14 activates the evaporator 5, then it is needed to send a proper control signal to the damper in order to change-over its orientation accordingly-

[0058] Of course in this case too the operation of the control means 16 can be easily guessed from the previous description; only the output connections have to be rearranged as in this case one of said fans has been substituted with the damper 26.-

[0059] An advantageous constructional embodiment is showed in **fig. 5**; it illustrates that the two evaporators 4 and 5 and the related conduit/channels 8, 22, 23 and the fans are positioned along the vertical back wall 27 of the refrigeration compartment; that will allow to save some useful room as well as to simplify its construction, and doesn't prejudice in any kind the apparatus operation.-

[0060] Preferably, and both in the case the two fans or in the case of one fan only, these fans are of the radial (tangential) type; indeed such kind of fans can show very limited dimensions in the axial direction, and so they can be mounted in such a way such as to minimise the room requests inside the apparatus.-

Claims

1. Refrigerator apparatus comprising:

- a refrigeration compartment (2),
- a compartment held at a lower temperature, as a freezing compartment (3), placed inside said refrigeration compartment,
- a unique refrigerating assembly with a compressor (6) and a condenser (7),

characterised in that it also comprises:

- air conveying means (8) able to allow air communication between said refrigeration compartment (2) and said freezer compartment (3), and basically placed into said refrigeration compartment (2),
- two distinct evaporators (4, 5), lodged inside said conveying means (8),
- two fans (12, 13), each of them being able to blow respective air-flows from the inside of said refrigeration compartment (2) towards the inside of said freezing compartment (3), passing through or over a respective said evaporator (4, 5),
- a three-ways valve (14) able to selectively deviate the refrigeration liquid coming from said condenser (7) to one or the other of said evaporators.-

2. Refrigerator apparatus according to claim 1, **characterised in that** said compressor, said valve (14) and said two fans (12, 13) are electrically connected to a common control means (16).-

3. Refrigerator apparatus according to claim 2, **characterised in that** to said control means (16) is connected also a thermostat (20).-

4. Refrigerator apparatus according to any of the previous claims, **characterised in that** it is able to op-

erate with two different and alternative modes, in a first mode being operated only a specific fan (12) and said valve being activated to make to work the corresponding evaporator (4), in the second mode being operated the other fan only (13) and said valve (14) being activated to make to work only the corresponding other evaporator (5).-

5. Refrigerator apparatus according the preamble of claim 1, **characterised in that** it also comprises:

- air conveying means (8) able to allow air communication between said refrigeration compartment (2) and said freezer compartment (3), and basically placed into said refrigeration compartment (2),
- two distinct evaporators (4, 5), lodged inside said conveying means (8),
- one fan (25) able to blow an air-flow from the inside of said refrigeration compartment (2) towards the inside of said freezing compartment (3), upstream of said evaporators,
- a three-ways valve (14) able to selectively deviate the refrigeration liquid coming from said condenser (7) to one or the other of said evaporators,
- a damper (26) placed downstream of said fan (25) and upstream of said evaporators, and able to selectively deviate the air-flow coming from said fan (25) towards one or the other of said evaporators.-

6. Refrigerator apparatus according to claim 5, **characterised in that** said compressor, said valve (14) and said fan (25) and said damper (26) are electrically connected to a common control means (16).-

7. Refrigerator apparatus according to claim 6, **characterised in that** to said control means (16) is connected also a thermostat (20).-

8. Refrigerator apparatus according to any of the previous claims, **characterised in that** it is able to operate with two different and alternative modes,

- in a first mode being operated only said fan (25) and said valve (14) being activated to make to work the corresponding evaporator (4), and said damper being operated to a position allowing the air-flow towards said corresponding evaporator (4),
- in the second mode being operated the same fan (25), said valve (14) being activated to make to work only the corresponding other evaporator (5), and said damper being operated to a position allowing the air-flow towards said corresponding other evaporator (5).-

9. Refrigerator apparatus according to any previous claim, **characterised in that** a separator (11) is placed inside said conveying means (8) between said two evaporators.-

10. Refrigerator apparatus according to any previous claim, **characterised in that** said evaporators, said conveying means (8, 22, 23) and said fans are placed on the vertical back side of said refrigerator compartment (2).-

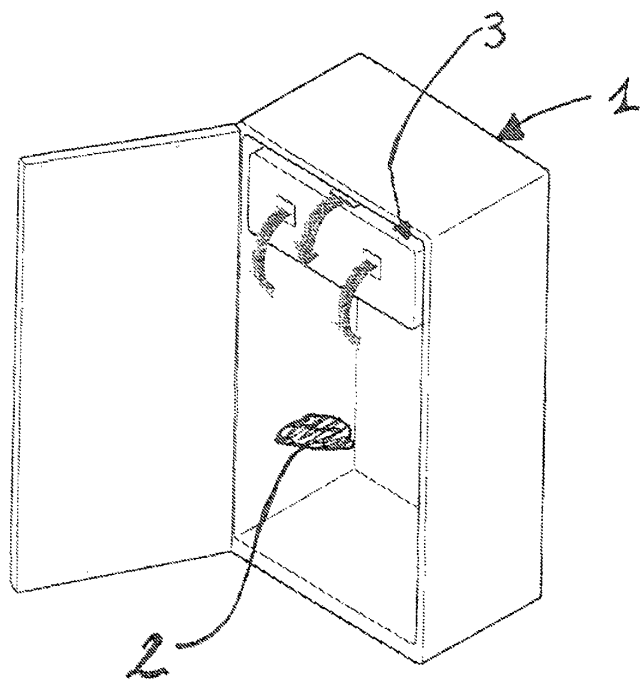


FIG. 1

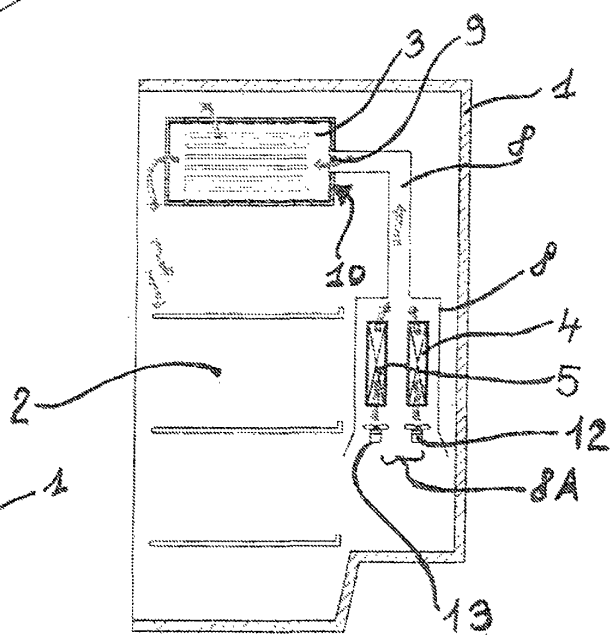


FIG. 2

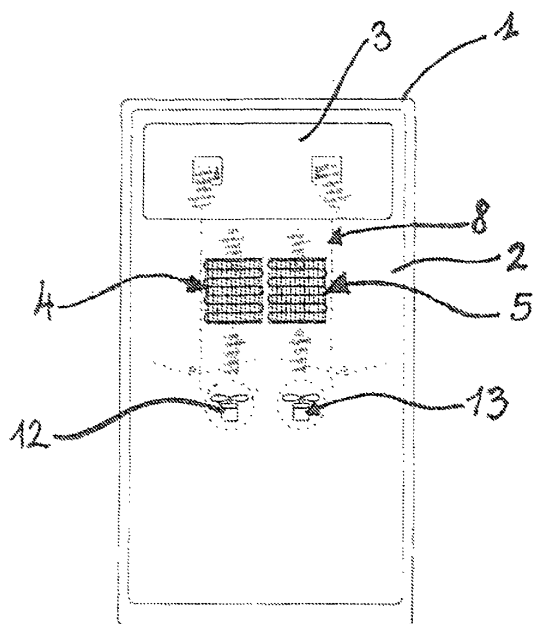


FIG. 3

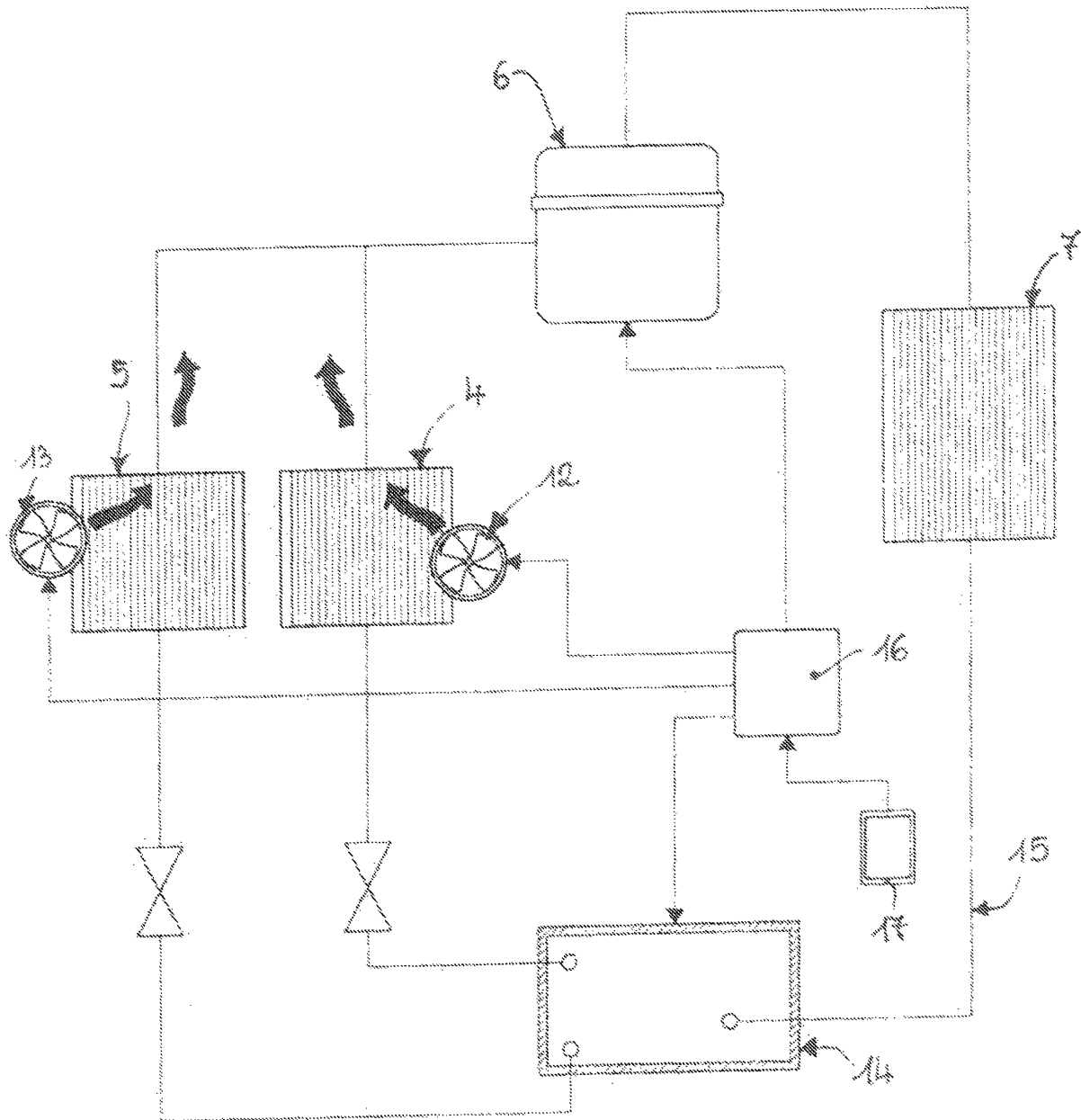
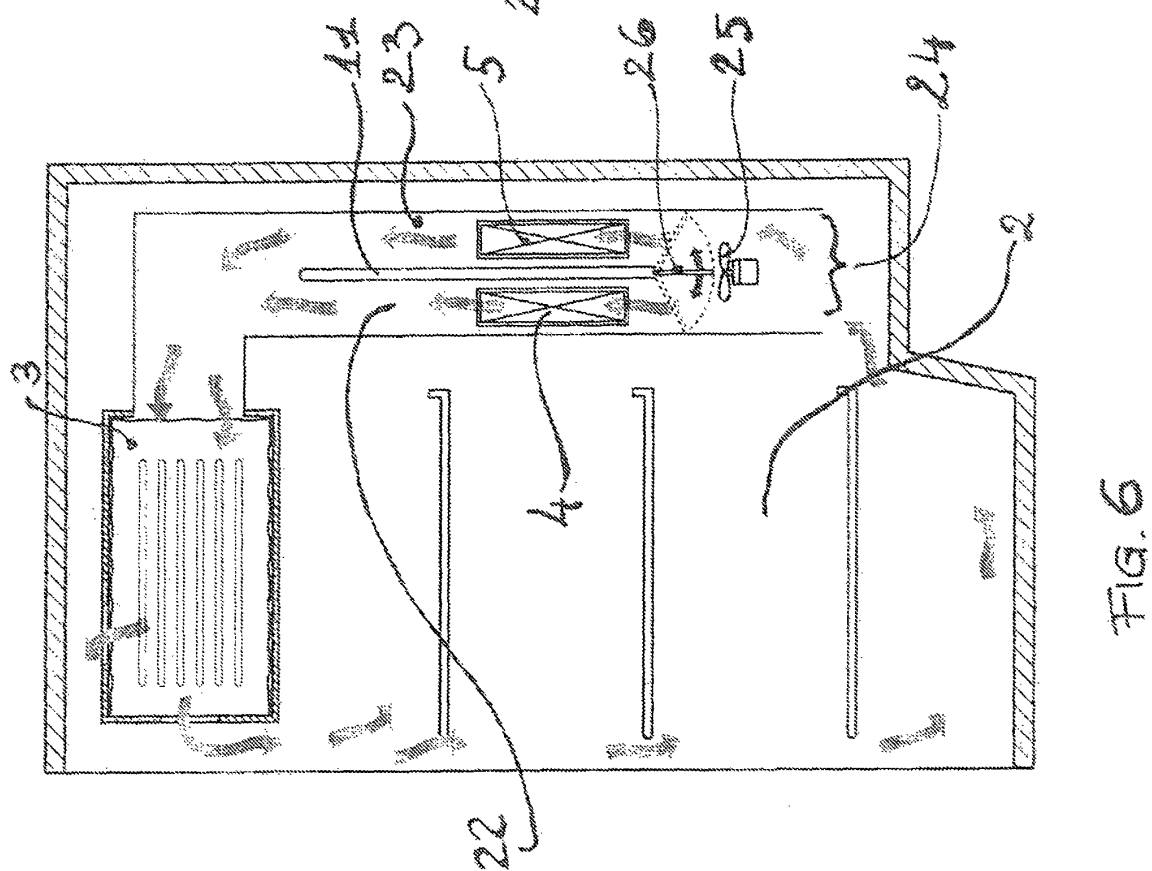
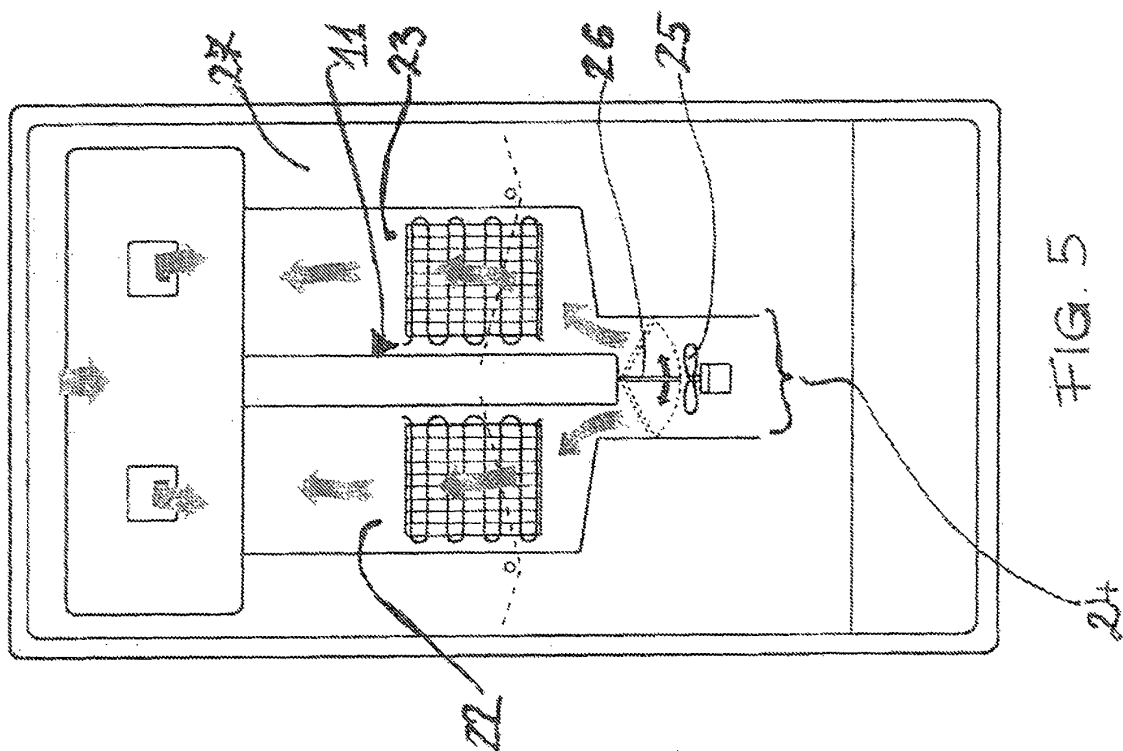
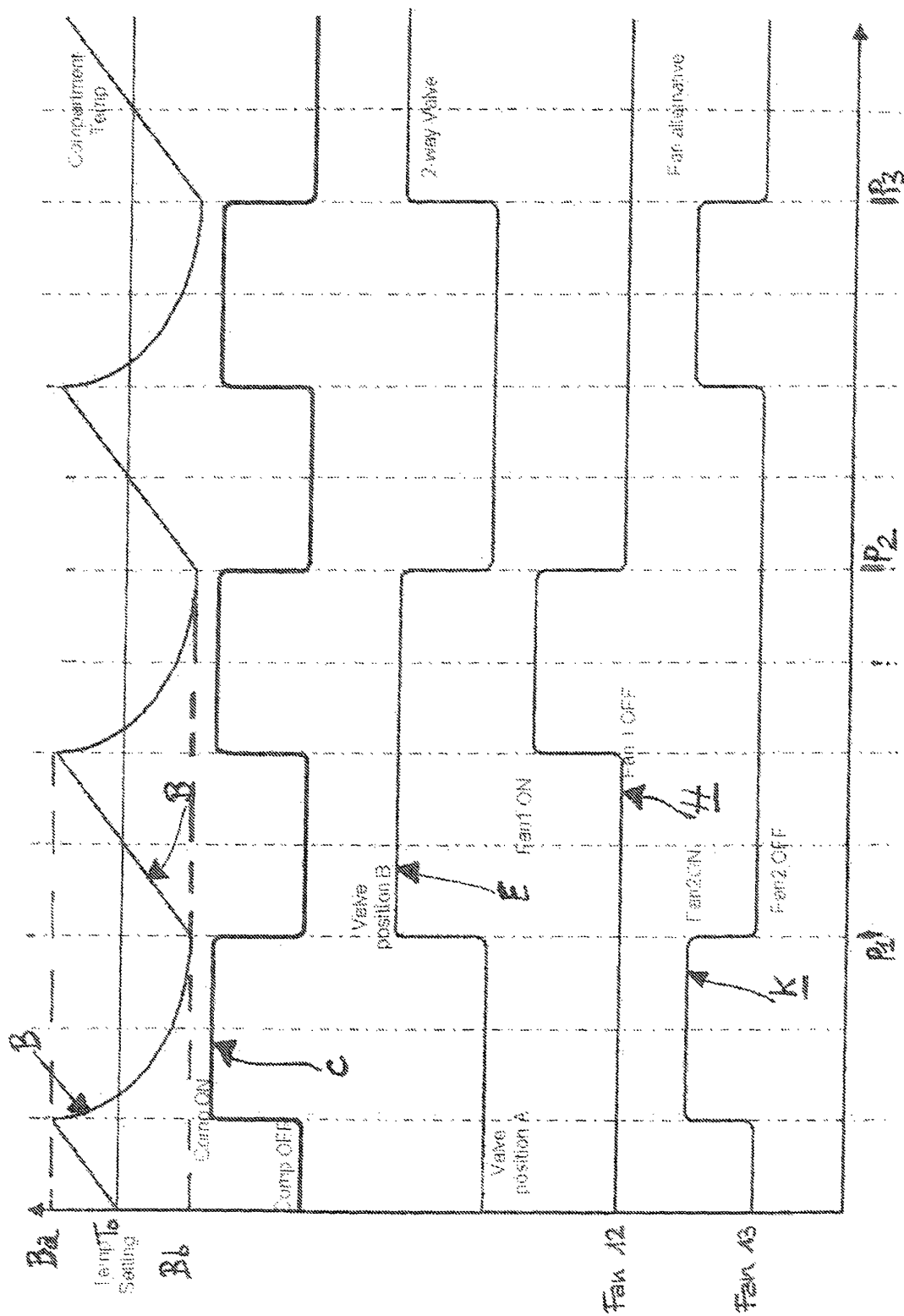


FIG. 4





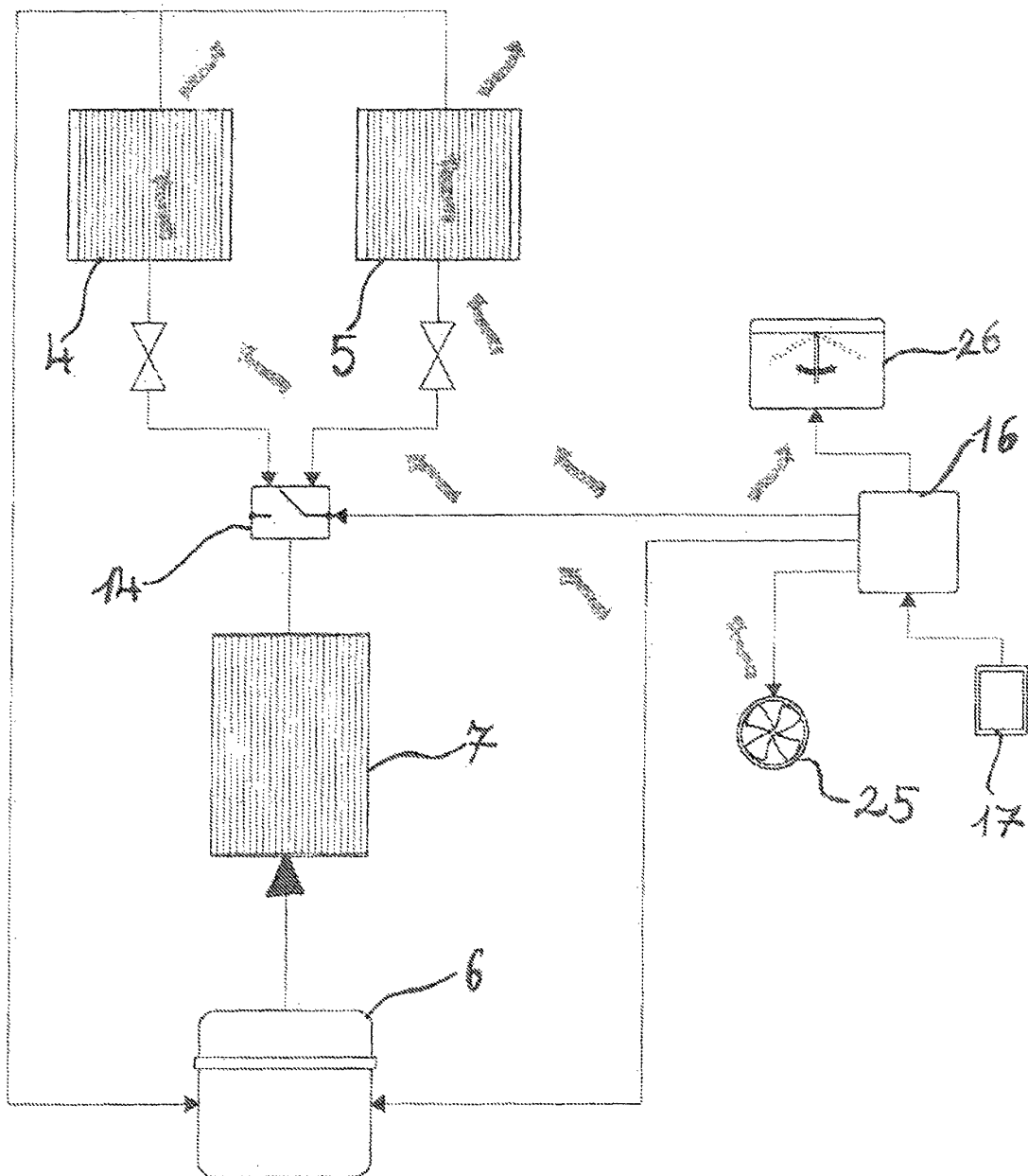


FIG. 7



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 04 10 1589

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	US 5 901 570 A (SIN JUN-CHUL) 11 May 1999 (1999-05-11)	1-4,9,10	F25D17/06 F25D21/12
Y	* abstract; figures 3,7 * * column 7, line 10 - line 21 * -----	5-8	
Y	US 3 572 052 A (TOTH STEVEN J) 23 March 1971 (1971-03-23) * abstract; figure * * column 3, line 10 - line 13 * -----	5-8	
A	WO 02/37038 A (ARCELIK AS ; INAN CEMIL (TR)) 10 May 2002 (2002-05-10) * abstract; figure 1 * -----	1,4	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			F25D F25B
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 17 September 2004	Examiner Yousufi, S
<p>CATEGORY OF CITED DOCUMENTS</p> <p>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</p> <p>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</p>			

1
EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 04 10 1589

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
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

17-09-2004

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 5901570	A	11-05-1999	CN 1204037 A ,B JP 11023131 A	06-01-1999 26-01-1999
US 3572052	A	23-03-1971	DE 2022797 A1 FR 2042663 A7 GB 1244579 A	19-11-1970 12-02-1971 02-09-1971
WO 0237038	A	10-05-2002	WO 0237038 A1 AU 1568001 A EP 1334321 A1	10-05-2002 15-05-2002 13-08-2003