(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 541 944 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
15.06.2005 Bulletin 2005/24

(51) Int Cl.[7]: **F25D 11/02**, F25B 5/04, F25D 25/02

(21) Application number: **04106375.1**

(22) Date of filing: **07.12.2004**

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

(30) Priority: **11.12.2003 IT TO20030991**

(71) Applicant: **Indesit Company s.p.a.**
60044 Fabriano (AN) (IT)

(72) Inventors:
- **Muzzioli, Fabio**
  06037 Foligno (PG) (IT)
- **Grelloni, Alessio**
  62020 Fiuminata (MC) (IT)

(54) Refrigerating apparatus

(57) A two-door type refrigerating appliance (1) is described, which comprises:

- a cooling system,
- a cell for fresh food (2), and
- a cell for frozen food (3),

wherein said cooling system comprises at least two evaporators (5,14,31,32).

The invention consists in the fact that at least one section (5) of the evaporator (31) cooling said cell for frozen food (3) runs within said cell for frozen food (3).

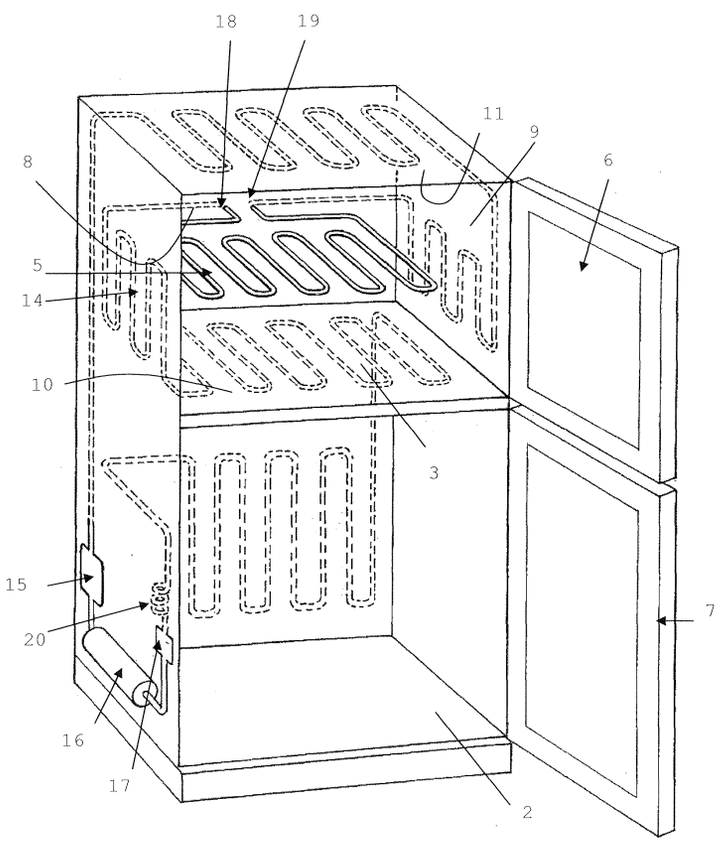

Fig. 2

EP 1 541 944 A1

Description

[0001] The invention relates to a two-door type refrigerating appliance (1) having a cell for fresh food and a cell for frozen food, equipped with energy-saving elements.

[0002] At the state of the art, many solutions are known of refrigerating appliances comprising two separate and independently accessible cells, one for fresh food and the other for frozen food. In particular, on the market of the refrigerating appliances there are two typologies of refrigerating appliances on the market having freezer compartments being accessible through a dedicated closing system, e.g. a door, and therefore not requiring the user to open the cell for fresh food in order to access the compartment containing frozen food. In this sense, therefore, the cell for frozen food is independent from the one for fresh food. Such two typologies of refrigerating appliances are the so-called "two-door" and "combined" refrigerators.

[0003] "Combined" refrigerating appliances usually are characterized in that they have big freezer compartments, generally having a capacity of more than 70/80 lt.

[0004] Due to a number of technical and aesthetical factors, among which big size, the cell for frozen food of these types of refrigerating appliances is located in the lower part of the appliance and is made of plastic material. In combined refrigerating appliances according to the known art, the cell for frozen food therefore consists of a housing made of plastic material inserted within a chair-shaped carrier structure, which supports the cell for fresh food.

[0005] The plastic housing used for the cell for frozen food in combined refrigerating appliances is such to allow the insertion of a series of elements, among which: drawers, shelves and an evaporator arrangement.

[0006] In refrigerating appliances known as "two-door" refrigerators, the cell for frozen food is located in the upper part of the appliance and of reduced size : while in "combined" refrigerating appliances the size of the cell for frozen food may even be 40-50% of the volume of the cell for fresh food, in "two-door" refrigerating appliances the volume of the cell for frozen food is in most cases smaller than 30% of the volume of the cell for fresh food; typically said cell for frozen food having a volume of less than 60 lt. In "two-door" refrigerators, the smaller size of the cell for frozen food allows it to be made of aluminum. Within the cell for frozen food there are some visible shelves, which may be metal grids or solid shelves made of a plastic or glassy material. As it will become apparent later, the aluminum structure offers the advantage of allowing to provide an evaporator running all around said structure, thus remaining within the walls of the cell for frozen food.

[0007] In all known solutions of refrigerating appliances, the food is cooled in a known way through a cooling system comprising a motor operating a compressor, whose task is to compress a gas, generally R134a or R600a, which then reaches high pressure, and to keep it in the gaseous state and to send it to a condenser, where it condenses and it becomes a high-pressure liquid; thanks to a coil located on the rear of the refrigerating appliance, the liquid dissipates its heat and cools down. Subsequently, the high-pressure refrigerant liquid flows through an expansion unit.

[0008] The expansion unit is a component fitted between the condenser and the evaporator system of the refrigerating appliance, having the function of causing a sharp pressure drop.

[0009] The expansion unit therefore acts as a pressure differential. The presence of a pressure differential in a refrigerating cycle is very important, as it causes a variation of the gas boiling point. Without this pressure variation, the refrigerant liquid would not reduce its temperature significantly, reaching some tens of °C below zero, and therefore no refrigeration would take place; the system would just be a simple container of the refrigerant element, e.g. R134a or R600a.

[0010] The refrigerant exiting the expansion unit, generally consisting of a small tube called "capillary", is then sent to a coil, called evaporator, which runs within the walls of the refrigerating appliance in order to absorb heat from within the cell which has to be cooled. Having absorbed heat, the refrigerant liquid evaporates and returns to the gaseous state. This allows to obtain the refrigeration process within the refrigerating appliance.

[0011] The gas is subsequently sent to the compressor and the cycle starts again.

[0012] Depending on the type of refrigerating appliance, the evaporator can be provided in two different and complementary way.

[0013] In "two-door" refrigerating appliances according to the state of the art, the evaporator is made in two parts, one associated with the cell for frozen food and the other associated with the cell for fresh food, and is fitted between the outer part of said refrigerating appliance and the cells; an insulating foam is then injected between the two walls. In particular, the evaporator envelops the cell for frozen food completely.

[0014] In "combined" refrigerating appliances, wherein the cell for frozen food is very big and the structure of said cell is made of a plastic material, the cooling system comprises an evaporator arrangement: the evaporator, which in "two-door" refrigerators is a coil located outside the cell to be cooled, in "combined" refrigerating appliances is provided through a self-standing tubular structure arranged in the form of shelves within the cell. Solutions of evaporator arrangements are known from Patents GB 2133518 and GB 2133519.

[0015] The increasing demand for energy-saving refrigerating appliances has led to the definition of energy consumption classes (indicated by an alphabetic letter from A++ to F, in increasing order of consumption), which are useful as a guarantee for the buyer, and at the same time has led the manufacturers to pay even more attention to the aspect of power consumption.

[0016] In such a context, and being the best solutions for the cooling system already well established (circuit comprising compressor, condenser, expansion unit and evaporator), the attention has shifted to the search for solutions being able to ensure a better insulation and with even more efficient motor-driven compressors. However, such solutions involve high research and development costs, and the improvements attained are often not very appreciable and do not offer an adequate return on investment.

[0017] Aim of the present invention is to solve the above-mentioned problems related to known refrigerating appliances by providing a refrigerating appliance of the type known as "two-door" which allows to save electrical energy and to obtain excellent performance.

[0018] A further aim of the present invention is to provide a solution for the above problems of the known art, being said solution both economical and efficient.

[0019] Said aims are attained by means of a two-door type refrigerating appliance (1) comprising:

- a cooling system,
- a cell for fresh food, and
- a cell for frozen food,

said cooling system comprising at least two evaporators, characterized in that at least one section of the evaporator cooling said cell for frozen food runs within said cell for frozen food.

[0020] Advantageously, said cell for frozen food comprises a dividing shelf, below which said evaporator section runs.

[0021] Further aims and advantages of the present invention will become apparent from the following detailed description and annexed drawings, supplied by way of non-limiting example, wherein:

- figure 1 shows a front view of a refrigerating appliance according to the invention.
- figure 2 shows a transparency view of the cooling system of an embodiment of the refrigerating appliance according to the invention.
- figure 3 shows a cooling system in accordance with a second embodiment of a refrigerating appliance according to the invention.

[0022] Fig.1 illustrates a "two-door" refrigerating appliance, indicated as a whole with reference 1. Said refrigerating appliance comprises two cells (cell for fresh food (2) and cell for frozen food (3)) which may be accessed independently from each other through respective closing systems (6,7).

[0023] In figure 1, said closing systems (6,7), e.g. doors, are shown in the open position, so as to show the inside of said cell for fresh food (2) and of said cell for frozen food (3).

[0024] For simplicity' sake, figure 1 does not show the cooling system of the refrigerating appliance in its entirety. Said system, shown in figures 2 and 3, and further described later, comprises the above-described known elements, i.e.: compressor, condenser, expansion unit (in particular, one or more capillary tubes) and one or more evaporators.

[0025] As already described in detail at the beginning of the present description, the "two-door" refrigerating appliance being the object of the invention comprises a cell for frozen food (3), located in the upper part of said refrigerating appliance and having a reduced size; in particular, said size is such as to allow for the insertion of just one dividing shelf (4). By this it is meant that, in a preferred solution, the spaces (12,13) defined by said shelf (4) within the cell for frozen food (3) are big enough to allow the placing of food. Although they may vary from appliance to appliance depending on technical and aesthetical requirements, usually said spaces are not less than 10 cm high.

[0026] As it can be seen by observing the three figures, the cell for frozen food (3) comprises an additional section (5,14) of the evaporator, i.e. that element of the internal cooling system in which the refrigerant liquid flows (e.g. R134a, R600a, freon).

[0027] According to the invention, said additional evaporator section (5,14) runs outside the cell for frozen food and exits from at least one of said walls, thus running within the cell for frozen food (3).

[0028] According to the invention, said refrigerating appliance (1) therefore has an evaporator section, hereafter referred to as "outer evaporator" (14) and indicated in figures 1 and 2 by a broken line, which, as in the prior art, extends around the cell for frozen food (3) and the cell for fresh food (2), as well as another evaporator section, hereafter referred to as "inner evaporator" (5) and indicated in figures 1 and 2 by a continuous line, which runs within said cell for frozen food (3).

[0029] More in detail, fig. 2 shows a preferred embodiment of the cooling system of a refrigerating appliance according to the invention: a compressor (15) compresses a refrigerant (e.g. freon or R134a or R600a), being in the gaseous state, into a condenser (16) wherein it condenses and cools down.

[0030] Once in liquid state, the refrigerant flows through a filter (17) which traps any impurities being present in the circuit, and subsequently flows in a capillary tube (20) before entering the evaporator.

[0031] The refrigerant flows in an evaporator consisting of a system of pipes, being generally arranged as a coil running mostly within the walls of the refrigerating appliance and then returning to the compressor (15). Along this path from the capillary to the compressor, the refrigerant element in the liquid state absorbs heat and evaporates, thus cooling the inside of the refrigerating appliance.

[0032] Always with reference to fig. 2, besides running within the walls of the refrigerating appliance, the evaporator according to the invention also exits from a point (18) of a wall of the cell for frozen food (3) and runs within

the volume of said cell for frozen food. This exposed section of the evaporator (5), called "inner evaporator", enters again the walls of the refrigerating appliance at a point (19) of said cell for frozen food (3). From that point, the "inner evaporator" (5) becomes "outer evaporator" (14) again and resumes its path, hidden from view, within the walls of the refrigerating appliance (1) as far as the compressor (15).

[0033] Surprisingly, this technical solution allows to produce a refrigerating appliance wherein, for the same volumes, the cooling of the food in the cell for frozen food (3) takes place with a saving of energy: the increase of the refrigerating area, in fact, allows the cooling system to absorb a larger amount of calories from the cell for frozen food, without the need of increasing the operation cycles (i.e. the time periods during which the compressor is on) of the system, and therefore permits to reduce the energy consumption without having to increase the compressor power or to improve the insulating elements. Moreover, the location of the "inner evaporator" (5) is such to improve the cooling of the cell for frozen food (3), in that a cooling evaporating surface is brought within said cell for frozen food.

[0034] In order to make this phenomenon more easily understood, the following will refer to the principles of thermodynamics: the refrigerating appliance (1) is a machine that takes heat from a thermal source (the food within a cell) and yields it to another thermal source (the refrigerant element), and from this to the external environment thanks to the work carried out by the machine itself, which therefore draws energy from the electric network. The amount of heat (Q) exchanged between the two sources is proportional to the evaporating area (S) and to the temperature difference between the two sources ($Q=kS(T_2- T_1)$). In the ideal case, according to the first principle of thermodynamics said amount of heat (Q) should be equal to the energy (E) drawn from the electric network, but actually, due to various dispersions, there is just a proportionality between these two physical quantities.

[0035] From the above it is clear that within a refrigerating appliance the same amount of heat (Q) can be absorbed if we increase the evaporating area (S) and reduce the temperature difference ($T_2- T_1$) between the two thermal sources; in other words, the same calories can be absorbed from within a cell for frozen food if we increase the evaporating area and at the same time reduce the difference between the evaporator temperature T_1 and the food preservation temperature T_2. Being the ideal efficiency of a Carnot machine given by $n= (1-T_1/T_2)$, the more T_1 is close to T_2, the less the energy $E=n*Q$ that the machine must draw from the electric network. It is therefore clear that by increasing the evaporating area we can reduce the consumption of the refrigerating appliance (1).

[0036] According to the invention, said increase of the evaporating area is made possible by the "inner evaporator" (5), i.e. an evaporator section which, besides enveloping entirely the cell for frozen food (3) while remaining between the walls of said refrigerating appliance and the outer walls of the cells for fresh food (2) and/or for frozen food (3), inventively also runs within said cell for frozen food (3).

[0037] Figure 3 shows the cooling circuit, i.e. a circuit diagram of a cooling system, of a second embodiment of a two-door type refrigerating appliance according to the invention. The two-door type refrigerating appliance has two cells, namely a cell for frozen food (3) and a cell for fresh food (2), represented therein through the respective evaporators 31 and 32.

[0038] The cooling system includes a compressor (15), upstream of which there are, in sequence, a condenser (16), a hot pipe (33), a filter (17) and a three-way solenoid valve (34), which is controlled by an electronic thermostat (40); at this point, the cooling circuit is split into two circuits represented by two capillaries, namely a refrigerator capillary (35) and a freezer capillary (36), being connected to said solenoid valve (34), which can perform the hydraulic switching between said two capillaries (35) and (36), so that they may be supplied alternately by the compressor (15) depending on whether it is necessary to cool the cell for frozen food (3) only, or both the cell for fresh food (2) and the cell for frozen food (3).

[0039] Both capillaries (35) and (36) cross a return pipe (39) in a first heat exchanger (37), from which they exit by following separate paths.

[0040] The refrigerator capillary (35) passes through a second heat exchanger (38) and then conveys the refrigerant fluid circulating within to the upper part of an evaporator (32) of the cell for fresh food (2).

[0041] After having run all the evaporator (32) of the cell for fresh food (2), the fluid goes back up and flows through said second heat exchanger (38), thereby absorbing heat from the refrigerator capillary (35), and then enters an evaporator of the cell for frozen food (31). Being a two-door refrigerating appliance, the evaporator coil of the cell for frozen food (31) envelops the whole outside surface (section called "outer evaporator") of the cell for frozen food (3) and, according to the invention, before terminating into said return pipe (39) and going back to the compressor (15), also runs within (section called "inner evaporator" (5)) said cell for frozen food (3), as described with reference to figure 2.

[0042] On the contrary, the freezer capillary (36) runs directly into the upper part of the evaporator of the cell for frozen food (31), therefore without passing through said second heat exchanger (38).

[0043] The electronic control system of the refrigerating appliance, according to the embodiment shown in figure 3, consists of a first temperature sensor (42), located in the cell for fresh food (2), which provides information about the temperature of the air in the cell for fresh food (2) to an electronic thermostat (40); likewise, a second temperature sensor (43) sends information about the temperature of the air in the cell for frozen

food (3) to the same electronic thermostat (40).

[0044] Thus, the control logic of said electronic thermostat (40) can, depending on the values read by said temperature sensors (42, 43), decide moment by moment whether to cool both cells (2,3) in cascade or the cell for frozen food (3) only, by sending a suitable signal to the solenoid valve (34), which in turn will switch the refrigerant fluid either in the refrigerator capillary (35) or in the freezer capillary (36).

[0045] Figure 3 at last also shows a third sensor (41), located on the evaporator (32) of the cell for fresh food (2) and used for controlling the defrosting of said evaporator.

[0046] The two embodiment examples of two-door type refrigerating appliances according to the invention advantageously allow to save energy due to a larger evaporating area, obtained thanks to the evaporator section extending within the cell for frozen food.

[0047] In a preferred embodiment, said evaporator section running and visible within said cell for frozen food ("inner evaporator" (5)) is provided as a coil whose straight sections have a length almost corresponding to the depth of said cell for frozen food (3), being the coil loops close enough to be used as a bearing surface for food. A solution of this type may therefore be used as a shelf within the cell for frozen food. According to a preferred embodiment, shown in figures 1 and 2, the evaporator runs around the side walls (9), the upper wall (11) and the lower wall (10) of the cell for frozen food, whereas it comes out from the rear wall (8) (i.e. facing a user who stands in front of said refrigerating appliance (1) and opens the corresponding door (6) of said cell for frozen food (3)). After running within the cell for frozen food (3), the evaporator enters again said rear wall (8) to run within the other walls of said cell for frozen food and return, as described, to the compressor. For the purposes of the present invention, it is however unimportant whether the "inner evaporator" (5) exits from the rear wall (8) or from any other wall (9,10,11). It is nonetheless advantageous that its shape makes it usable as a shelf.

[0048] It is also clear that many other changes are possible for the man skilled in the art to the present invention; for example, in order to obtain a better aesthetical result, it might be useful to employ a plastic or a glass shelf, arranging the "inner evaporator" (5) on the underside of said shelf. In this way , the surprising advantage of the energy saving offered by a larger evaporating area with respect to the known art would be retained, but the bearing surface would be improved from both an aesthetical and a technical point of view: in fact, the food would not rest directly on the evaporator, but on an easy-to-clean shelf.

Claims

1. Two-door type refrigerating appliance (1), comprising:
   - a cooling system,
   - a cell for fresh food (2), and
   - a cell for frozen food (3),

   said cooling system comprising at least two evaporators (5,14,31,32), **characterized in that** at least one section (5) of the evaporator (14,31) cooling said cell for frozen food (3) runs within said cell for frozen food (3).

2. Refrigerating appliance (1) according to claim 1, **characterized in that** said cell for frozen food (3) has a capacity of less than 60 lt.

3. Refrigerating appliance (1) according to claim 1, **characterized in that** said cell for frozen food (3) has a volume of less than 30% (thirty percent) of the volume of said cell for fresh food (2).

4. Refrigerating appliance (1) according to claim 1, **characterized in that** said cell for frozen food (3) is sized in such a way to allow the insertion of a dividing shelf (4) for supporting the food to be placed.

5. Refrigerating appliance (1) according to claim 1, **characterized in that** said cell for frozen food (3) is sized in such a way to allow the insertion of just one dividing shelf (4).

6. Refrigerating appliance (1) according to claim 5, **characterized in that** the height of the spaces (12,13) defined by said dividing shelf (4) within said cell for frozen food (3) is such to allow the placing of food, and in particular is not less than 10 cm.

7. Refrigerating appliance (1) according to one of claims 4 to 6, **characterized in that** said shelf (4) is provided only by said section (5) of the evaporator (31) running within said cell for frozen food (3).

8. Refrigerating appliance (1) according to one of claims 4 to 6, **characterized in that** said shelf (4) comprises a food bearing surface on the underside of which said section (5) of the evaporator (31) running within said cell for frozen food (3) is arranged.

9. Refrigerating appliance (1) according to claim 8, **characterized in that** said food bearing surface is made of a plastic material.

10. Refrigerating appliance (1) according to claim 8, **characterized in that** said food bearing surface is made of glass.

11. Refrigerating appliance (1) according to one of the previous claims, **characterized in that** said cooling system comprises means for cooling said cell for frozen food (3) independently from said cell for fresh

food (2).

12. Refrigerating appliance (1) according to claim 11, **characterized in that** said means comprise a solenoid valve (34) and two capillaries (35,36) associated with said two cells (2,3) of said refrigerating appliance (1).

13. Refrigerating appliance (1) according to claim 12, **characterized in that** said solenoid valve (34) is controlled by an electronic thermostat (40) and performs the hydraulic switching between said two capillaries (35,36).

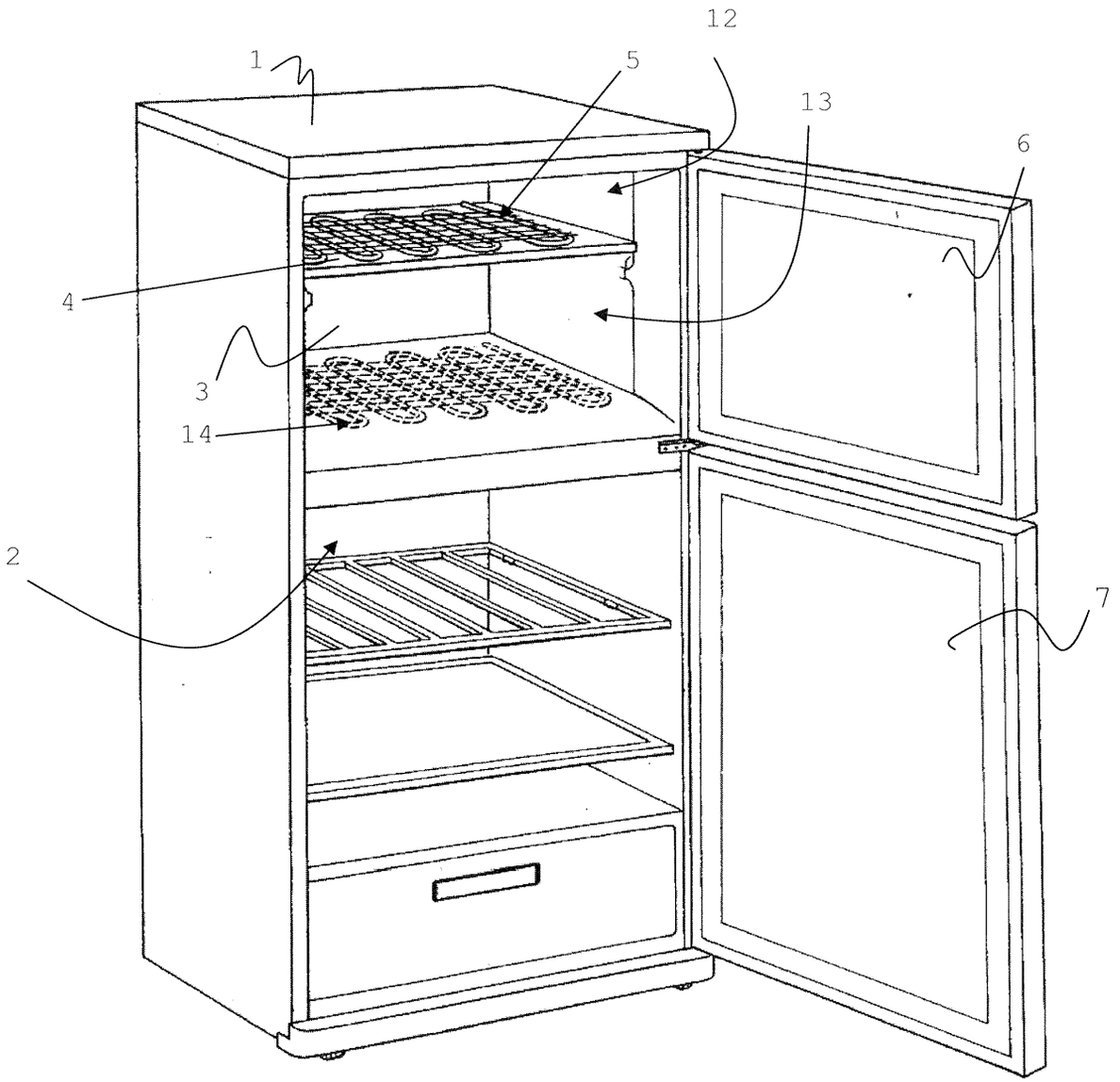

Fig. 1

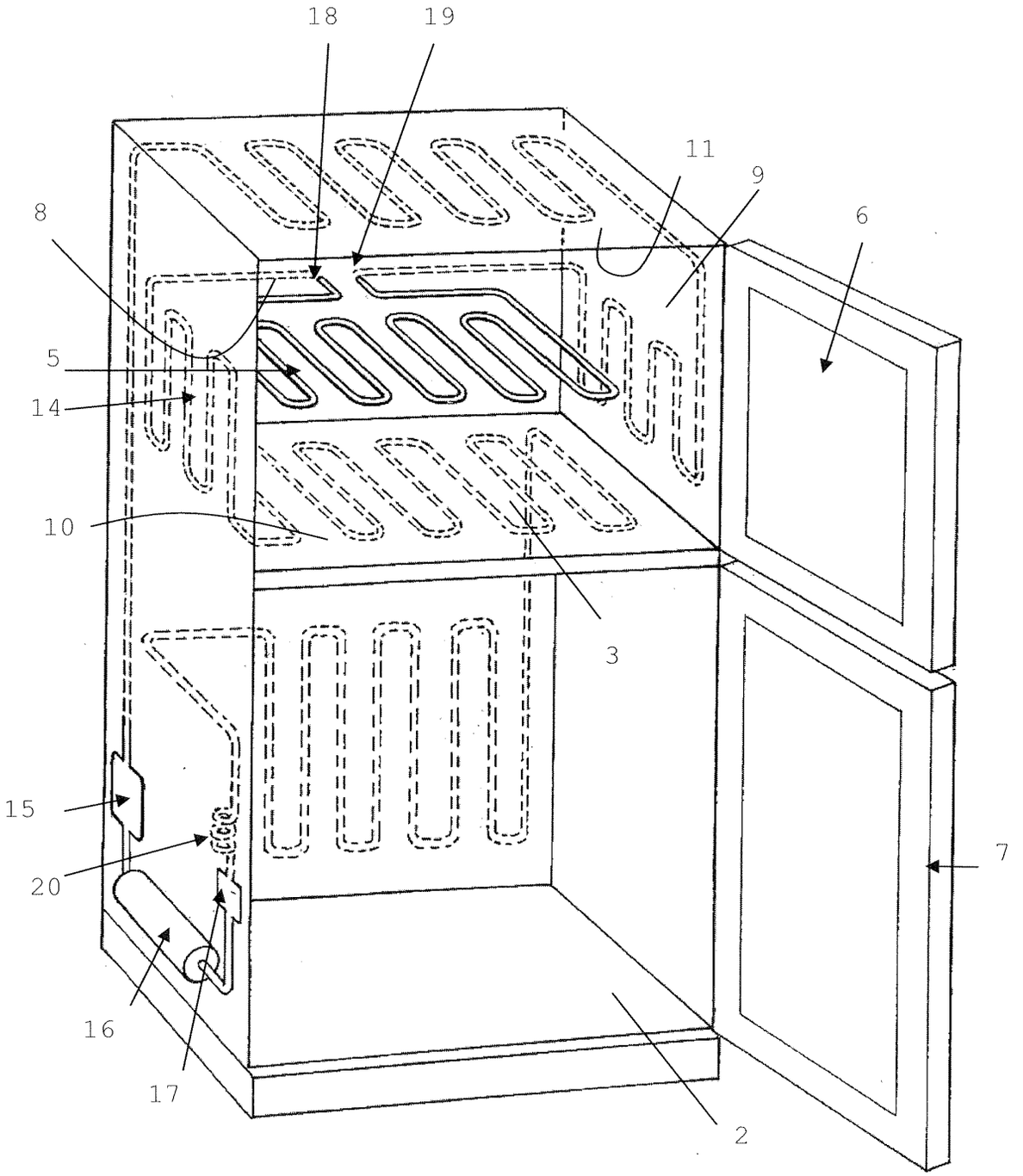

Fig. 2

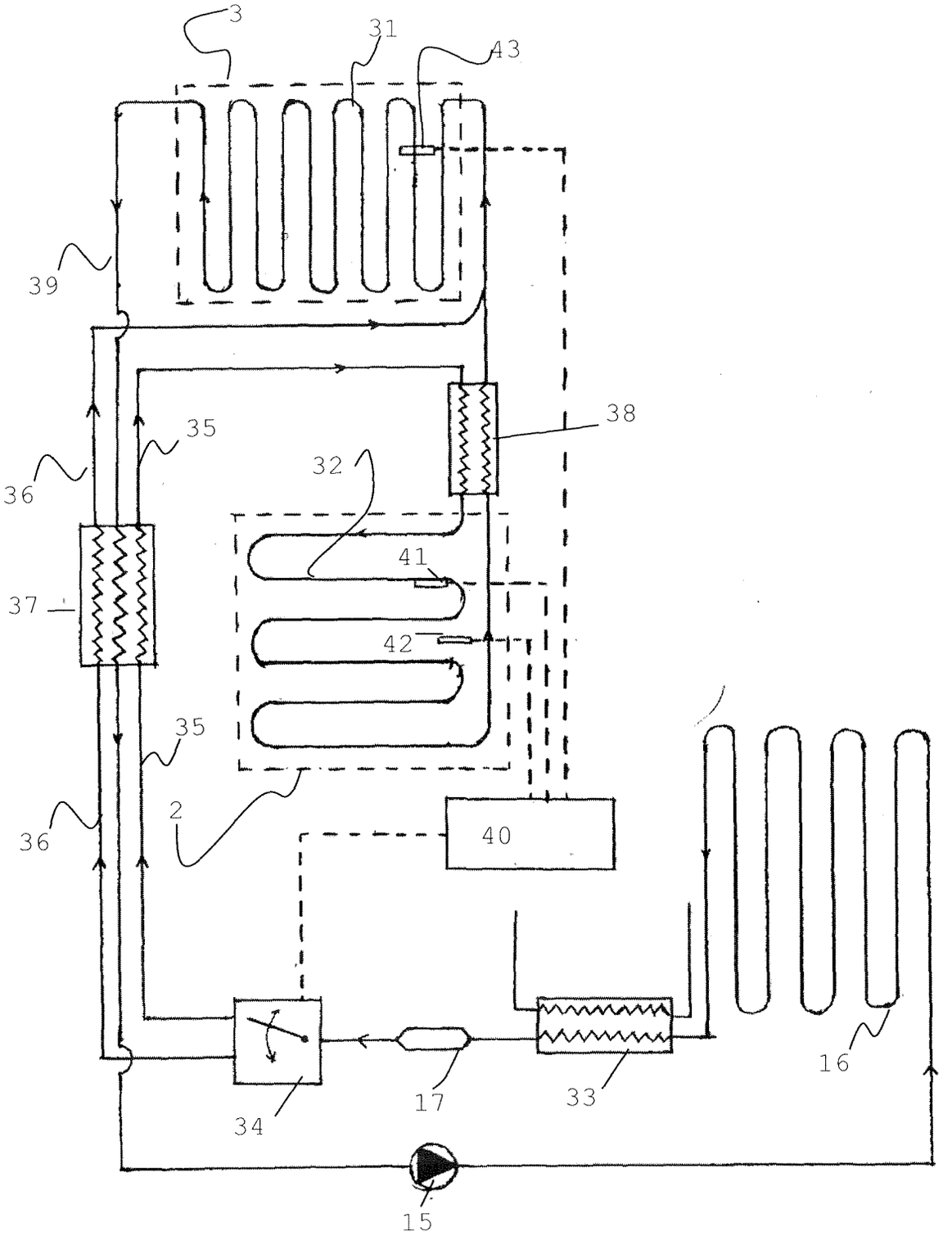

Fig. 3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 04 10 6375

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 Y	US 2003/000241 A1 (HOLZ WALTER ET AL) 2 January 2003 (2003-01-02) * the whole document *	1,4-6, 11,12 7-9	F25D11/02 F25B5/04 F25D25/02
Y	EP 1 124 101 A (CANDY S.P.A) 16 August 2001 (2001-08-16) * column 2, line 13 - line 17 *	7	
Y	GB 2 027 184 A (FULTON LTD) 13 February 1980 (1980-02-13) * page 1, line 65 - line 83 *	8,9	
X Y	US 4 294 081 A (MITANI ET AL) 13 October 1981 (1981-10-13) * column 3, line 2 - line 44; figures 1,2 *	1-3 11-13	
Y	FR 2 831 948 A (MERLONI ELETTRODOMESTICI SPA) 9 May 2003 (2003-05-09) * page 4, line 10 - line 27; figure 1 *	11-13	

TECHNICAL FIELDS SEARCHED (Int.Cl.7)

F25D
F25B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	10 March 2005	Zanotti, L

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

EPO FORM 1503 03.82 (P04C01)

3

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 04 10 6375

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.

10-03-2005

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2003000241 A1	02-01-2003	DE 19957719 A1	31-05-2001
		BR 0015829 A	30-07-2002
		CN 1402825 A	12-03-2003
		WO 0140721 A1	07-06-2001
		EP 1240466 A1	18-09-2002
		TR 200201200 T2	21-08-2002
EP 1124101 A	16-08-2001	IT MI20000231 A1	13-08-2001
		EP 1124101 A2	16-08-2001
GB 2027184 A	13-02-1980	NONE	
US 4294081 A	13-10-1981	JP 1043837 C	30-04-1981
		JP 54145049 A	12-11-1979
		JP 55031388 B	18-08-1980
		DE 2917721 A1	08-11-1979
		GB 2016128 A ,B	19-09-1979
		IT 1116058 B	10-02-1986
		MY 39785 A	31-12-1985
FR 2831948 A	09-05-2003	IT TO20010160 U1	28-02-2003
		DE 20213546 U1	20-02-2003
		ES 1053285 U1	01-04-2003
		FR 2831948 A3	09-05-2003
		PL 355779 A1	10-03-2003

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82