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(71) Applicant: **Vestel Beyaz Eşya Sanayi ve Ticaret A.Ş.**
45030 Manisa (TR)

(72) Inventor: **ASIK, Rüstem**
45030 Manisa (TR)

(74) Representative: **Cayli, Hülya**
Paragon Consultancy Inc.
Koza Sokak No: 63/2
GOP
06540 Ankara (TR)

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(54) **A REFRIGERATION DEVICE**

(57) The refrigeration device (S) according to the present invention comprises a body (G); a freezing compartment (S1) disposed in the body (G); a first refrigeration system for cooling the freezing compartment (S1) and comprising a compressor (K), a condenser and a first evaporator (E1); a refrigerant circulated through the system; an ice-making compartment (1); and a second refrigeration system including a first heat exchanger (2a); a second heat exchanger (2b); a coolant which is passed through the first heat exchanger (2a) and second heat exchanger (2b) and which does not freeze within the operation temperature range of the freezing compartment (S1) and does not undergo a phase change throughout the refrigeration process; a first line (3a), one end of which is connected to the first heat exchanger (2a) and another end of which is connected to the second heat exchanger (2b), and through which the coolant which has left the second heat exchanger (2b) is conveyed to the first heat exchanger (2a); a second line (3b) one end of which is connected to the first heat exchanger (2a) and another end of which is connected to the second heat exchanger (2b), and through which the coolant which has left the first heat exchanger (2a) is conveyed to the second heat exchanger (2b); a circulation pump (4) for circulating the coolant.

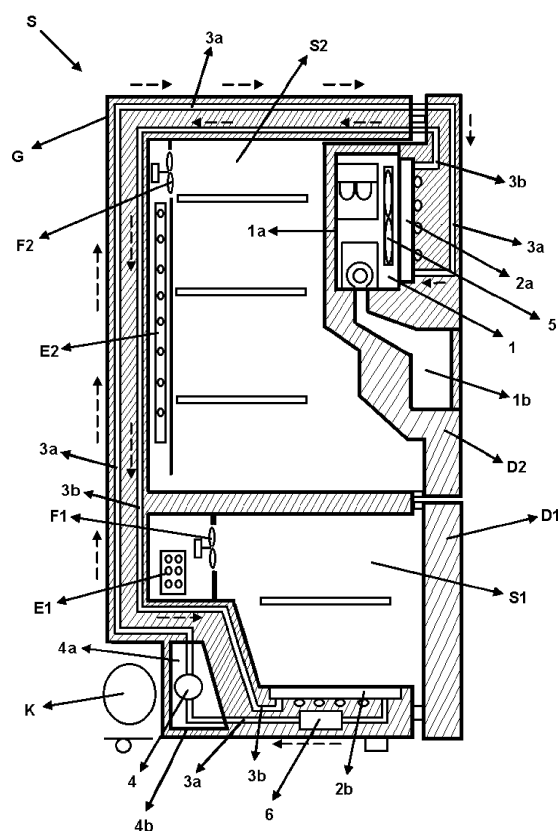


Figure 1

Description**Field of the Invention**

5 **[0001]** The present invention relates to refrigeration devices with an ice-making compartment.

Background Art

10 **[0002]** In order to store a product, particularly food products, below a certain temperature, refrigeration devices are used comprising at least one compartment suitable for receiving the products to be stored. Said compartment is mainly cooled by a refrigeration cycle performed by at least one compressor, at least one condenser, at least one capillary pipe, at least one evaporator included in the refrigeration device and at least one refrigerant circulated in between said equipments. In the said refrigeration cycle, the heat of the refrigerant leaving the compressor in a hot state is transferred to the outer environment, while it is being passed through the condenser, whereby it is condensed and cooled to a certain extent. Thereafter, the refrigerant, which is passed through the capillary pipe such that its pressure is reduced, reaches to the evaporator. Here, the refrigerant is easily evaporated and converted into a gas thanks to its low pressure and the heat taken from the compartment, and it cools down the compartment with the heat taken therefrom. Then, the refrigerant is returned back to the compressor and the refrigeration cycle is completed.

20 **[0003]** Said refrigeration devices may also perform an ice-making process. One of the embodiments for ice-making in the prior art is to dispose an ice container filled with water into a freezing compartment of the refrigeration device, whereby water in the ice chamber is frozen so as to give ice. However, in this case, ice-making process is quite long and cannot sufficiently meet the needs of the user. In another embodiment, a separate ice-making compartment is formed in the refrigeration device, wherein a separate refrigeration cycle is performed in order to obtain ice. An example of said embodiment is disclosed in US2011185760A1. In the embodiment disclosed in the said document, the refrigeration device comprises an ice-making compartment disposed in the refrigeration compartment. Said refrigeration device comprises a compressor for cooling the refrigeration compartment, a condenser, a capillary pipe and a cooling evaporator. Said refrigeration device also comprises an ice-making evaporator connected to the outlet of the condenser and to the inlet of the compressor in order cool the ice-making compartment, a valve disposed at the outlet of the compressor, and a bypass pipe extending between the outlet of the compressor and the inlet of the ice-making evaporator. In the embodiment disclosed in the said document, in the ice-making process, the heated refrigerant leaving the compressor is passed through the condenser and distributed into the capillary pipe and ice-making evaporator. The refrigerant passed through the capillary pipe reaches to the cooling evaporator, and cools down the refrigeration compartment while being passed therethrough and returns to the compressor. The refrigerant that has reached to the ice-making evaporator cools down the ice-making compartment so that ice is obtained. The refrigerant leaving the ice-making evaporator is returned to the compressor and the cycle is thus completed. If the user is desirous to use the ice obtained in the ice-making compartment, instead of circulating the heated refrigerant in the refrigeration cycle by means of a valve disposed at the outlet of the compressor, it is passed through the ice-making evaporator via a bypass pipe so that ice generated in the ice-making compartment is easily cracked and separated from each other. In the embodiment disclosed in the said document, since the refrigerant is circulated through different pipes to cool the ice-making compartment of the refrigeration compartment, the refrigeration process of the refrigeration compartment does not need to be stopped in order to cool the ice-making compartment, and these compartments may be cooled simultaneously. However, use of the compressor and condenser to cool down the ice-making compartment results in a phase change in the refrigerant for the cooling process, which reduces the amount of energy to be obtained from the refrigerant. Besides, since both of the refrigeration cycles are supplied by a single compressor, the compressor should be operated intensely in order to cool down the two compartments as required, which increases energy consumption of the refrigeration device. Due to said drawbacks, operational efficiency of the refrigeration device is reduced.

Brief Description of the Invention

50 **[0004]** The refrigeration device according to the present invention and comprising at least one body; at least one freezing compartment disposed in the said body and having a temperature below 0°C; at least a first refrigeration system for cooling said freezing compartment and comprising at least one compressor, at least one condenser and at least a first evaporator; a refrigerant circulated through this system; and at least one ice-making compartment for making ice, also comprises at least a second refrigeration system for cooling the ice-making compartment comprising at least a first heat exchanger positioned in such a way to make heat exchange with the ice-making compartment; at least a second heat exchanger positioned in such a way to make heat exchange with the said freezing compartment; a coolant which is passed through the first heat exchanger and second heat exchanger so as to conduct said heat exchange operations and which does not freeze within the operation temperature range of the freezing compartment of the refrigeration device

and does not undergo a phase change throughout the refrigeration process; at least a first line at least one end of which is connected to the first heat exchanger and at least another end of which is connected to the second heat exchanger, and through which the coolant which has left the second heat exchanger and has been cooled down due to the heat transferred to the freezing compartment is conveyed to the first heat exchanger; at least a second line at least one end of which is connected to the first heat exchanger and at least another end of which is connected to the second heat exchanger, and through which the coolant which has left the first heat exchanger and has been heated due to the heat taken from the ice-making compartment is conveyed to the second heat exchanger; and at least one circulation pump for circulating the coolant between the first heat exchanger and the second heat exchanger.

[0005] With the refrigeration device according to the present invention, ice is able to be generated in the refrigeration device without negatively affecting the cooling efficiency of a freezing compartment or a refrigeration compartment of the refrigeration device. Furthermore, since a coolant, which does not undergo a phase change (which constantly remains liquid within the operation temperature of the refrigeration device, which does not freeze or evaporate), is used in the inventive refrigeration device to cool down the ice-making compartment, no compressor is needed in the second refrigeration system, and cycling of the coolant may be performed with the use of a simpler structure (circulation pump) that consumes far less energy than the compressor. Moreover, external elements such as valves are not needed to separate the second refrigeration system that cools the ice-making compartment from the first refrigeration system. Thus, a refrigeration device may be obtained which is inexpensive to produce, easy to use, practical and reliable.

Object of the Invention

[0006] An object of the present invention is to provide a refrigeration device comprising an ice-making compartment.

[0007] Another object of the present invention is to provide a refrigeration device that cools the ice-making compartment by means of an external refrigeration system.

[0008] A further object of the present invention is to provide a refrigeration device wherein the ice-making compartment may be cooled independently and in accordance with the user's needs.

[0009] Another object of the present invention is to provide a refrigeration device that cools the ice-making compartment without reducing cooling efficiency of the main compartment thereof.

[0010] Another object of the present invention is to provide a refrigeration device wherein the ice-making compartment is cooled down without a phase change is experienced in the refrigerant used for cooling said compartment.

[0011] Still another object of the present invention is to provide a refrigeration device which is easy to use, cost-effective and reliable.

Description of the Drawings

[0012] An embodiment of the refrigeration device according to the present invention is illustrated in the annexed drawing, wherein;

Figure 1 is a side sectional view of the inventive refrigeration device.

[0013] All the parts illustrated in the figures are individually assigned a reference numeral and the corresponding terms of these numbers are listed as follows:

Refrigeration device	(S)
Body	(G)
Freezing compartment	(S1)
Refrigeration compartment	(S2)
First evaporator	(E1)
Second evaporator	(E2)
First fan	(F1)
Second fan	(F2)
Compressor	(K)
First door	(D1)
Second door	(D2)
Ice-making compartment	(1)
First isolation member	(1a)
Ice-removing compartment	(1b)
First heat exchanger	(2a)
Second heat exchanger	(2b)
First line	(3a)
Second line	(3b)

Circulation pump	(4)
Chamber	(4a)
Second isolation member	(4b)
Third fan	(5)
Liquid container	(6)

Description of the Invention

[0014] The refrigeration devices, wherein products are stored that are desired to be cooled, generally have an ice-making compartment, through which ice requirement of the user is fulfilled. In order to cool said compartment, in addition to elements provided in the system that performs normal refrigeration cycle of the refrigeration device, said system is modified by incorporating additional elements into the system. This, however, results in loss of energy and reduces operational efficiency of the refrigeration device. Therefore, with the present invention, there is provided a refrigeration device wherein the ice-making compartment is cooled down without reducing operational efficiency of the refrigeration device.

[0015] The refrigeration device (S) according to the present invention, as illustrated in figure 1, comprises at least one body (G); at least one freezing compartment (S1) disposed in the said body (G) and having a temperature below 0°C; at least a first refrigeration system for cooling said freezing compartment (S1) and comprising at least one compressor (K), at least one condenser (not shown) and at least a first evaporator (E1); a refrigerant circulated through this system; and at least one ice-making compartment (1) for making ice. The inventive refrigeration device (S) also comprises at least a second refrigeration system for cooling the ice-making compartment (1), which the second system comprises at least a first heat exchanger (2a) positioned in such a way to make heat exchange with the ice-making compartment (1) (preferably, inside the body (G) so as to contact with at least one side of the ice-making compartment (1)) and preferably closer to the outer environment where the refrigeration device (S) is situated; at least a second heat exchanger (2b) positioned in such a way to make heat exchange with the said freezing compartment (S1) (preferably, inside the body (G) so as to contact with at least one side of the freezing compartment (S1) or inside the freezing compartment (S1), particularly at an area close to the first evaporator (E1) (i.e. above, below, next to the first evaporator (E1))); a coolant which is passed through the first heat exchanger (2a) and second heat exchanger (2b) so as to conduct said heat exchange operations and which does not freeze within the operation temperature range of the freezing compartment (S1) of the refrigeration device (S) (i.e. not freezing till -30°C) and does not undergo a phase change throughout the refrigeration process (said coolant preferably contains a low freezing point substance such as ethylene glycol, methanol which is preferably different from the said refrigerant); at least a first line (3a) at least one end of which is connected to the first heat exchanger (2a) and at least another end of which is connected to the second heat exchanger (2b), and through which the coolant which has left the second heat exchanger (2b) and has been cooled down due to the heat transferred to the freezing compartment (S1) is conveyed to the first heat exchanger (2a); at least a second line (3b) at least one end of which is connected to the first heat exchanger (2a) and at least another end of which is connected to the second heat exchanger (2b), and through which the coolant which has left the first heat exchanger (2a) and has been heated due to the heat taken from the ice-making compartment (S1) is conveyed to the second heat exchanger (2b); and at least one circulation pump (4) for circulating the coolant between the first heat exchanger (2a) and the second heat exchanger (2b), which pump is preferably disposed in the first line (3a). The refrigeration system (S) preferably comprises at least one fan (F1) that increases air circulation inside the freezing compartment (S1) in order to cool it in a more efficient manner. Moreover, said first line (3a) and second line (3b) may either be positioned in the body (G), or it may be positioned outside the body (G) by enclosing it with an insulation material.

[0016] In an illustrative embodiment of the invention, the coolant which has left the second heat exchanger (2b) in a cooled state, due to the heat exchange between the second heat exchanger (2b) and the freezing compartment (S1), is passed through the first line via the circulation pump (4) and reaches to the first heat exchanger (2a). Here, the coolant takes heat from the ice-making compartment (1) and by doing so becomes heated to some extent, and accordingly the ice-making compartment (1) is cooled. The coolant leaving the first heat exchanger (2a) is passed through the second line (3b) and returned to the second heat exchanger (2b), so the cycle is completed. With a constant repetition of this cycle, the ice-making compartment (1) is allowed to reach to the sufficient coldness level and ice is generated. In the refrigeration device (S), since the ice-making compartment (1) is cooled by a second refrigeration system independent from the first refrigeration system that cools the freezing compartment (S1), cooling efficiency of the refrigeration device (S) is not reduced during the ice-making process.

[0017] In a preferred embodiment of the invention, the second heat exchanger (2b) is positioned at a lower portion of the freezing compartment (S1). In this embodiment, the first heat exchanger (2a) is preferably positioned at an upper portion of the freezing compartment (S1), whereby the amount of energy required for circulation of the coolant between the first heat exchanger (2a) and second heat exchanger (2b) is reduced and operational efficiency of the refrigeration device (S) may be increased. Furthermore, the first evaporator (E1) that cools the freezing compartment (S1) is preferably

positioned at an upper portion of the freezing compartment (S1) as well, so that the coolant is cooled in an efficient and fast manner during the heat exchange of the second heat exchanger (2b) with the freezing compartment (S1), based on the principle of expansion and rising of heated air, while at the same time the temperature of the freezing compartment (S1) may be maintained at the desired value and a reduction in the cooling efficiency of the freezing compartment may be prevented.

[0018] In another alternative embodiment of the invention, the refrigeration device (S) comprises at least one chamber (4a), wherein the circulation pump (4) is positioned. Thus, in case the temperature of the coolant is lower than that of the outer environment, any loss of heat that may occur in the refrigeration device (S) during its passage through the circulation pump (4) may be prevented. In this embodiment, at least a first isolation member (4b) is preferably positioned around the chamber (4a). In this way, any frost deposit that may occur in the circulation pump (4), due to said low temperature, may be avoided.

[0019] In another illustrative embodiment of the invention, the refrigeration device (S) comprises at least one activation member (not shown) that controls operation of the circulation pump (4), in order to operate circulation pump (4) depending on the user's need and switch off the circulation pump (4), if not needed, so as to prevent further energy consumption. Thanks to the said member, if it is desired to make ice in the ice-making compartment (1), the circulation pump (4) is operated and the coolant is allowed to circulate between the first heat exchanger (2a) and the second heat exchanger. If it is not required to make ice, then operation of the circulation pump (4) is stopped by the said member, whereby unnecessary operation of the circulation pump (4) is prevented and operational efficiency of the refrigeration device (S) is increased.

[0020] In another preferred embodiment, the refrigeration device (S) preferably comprises at least a first door (D1) through which access to the freezing compartment (S1) is controlled and the ice-making compartment (1) is positioned on the first door (D1) (preferably the first heat exchanger (2a) is also positioned on the first door (D1)). In this embodiment, the refrigeration device (S) also comprises at least one ice-removing compartment (1b) which is positioned on the first door (D1), connected with the ice-making compartment (1) and suitable to be reached from the outside environment where the refrigeration device (S) is situated, without opening the first door (D1). Ice generated in the ice-making compartment (1) is collected in the said ice-removing compartment (1b), so the need to open and close the door is reduced and the operational efficiency of the refrigeration device (S) is increased.

[0021] In another embodiment of the invention, the refrigeration device (S) comprises at least one refrigeration compartment (S2) which is positioned in the said body (G) such that it is preferably located at the upper portion of the freezing compartment (S1), and which is cooled by the said first refrigeration system in order to ensure that its temperature is from 0°C to 5°C, and at least a second door (D2) for controlling access to the said refrigeration compartment (S2). In this embodiment, the ice-making compartment (1) is preferably positioned in the second door (D2) so that the user may easily reach to the ice-making compartment (1) (preferably, the first heat exchanger (2a) is also positioned on the second door (D2)). Cooling of the said refrigeration compartment (S2) may be performed by the first refrigeration system of the refrigeration device (S) (i.e. by conveying the cold air in the freezing compartment (S1) to the refrigeration compartment (S2) via an air channel), or else in order to cool the refrigeration chamber (S2), the refrigeration device (S) may also comprise at least a second evaporator (E2) and preferably at least a second fan (F2) to increase air circulation in the refrigeration compartment (S2). In addition, the refrigeration device (S) preferably comprises at least one ice-removing compartment (1b) which is positioned on the second door (D2), connected with the ice-making compartment (1) and suitable to be reached from the outside environment where the refrigeration device (S) is situated, without opening the second door (D2). Ice generated in the ice-making compartment (1) is collected in the said ice-removing compartment (1b), so the need to open and close the door is reduced and the operational efficiency of the refrigeration device (S) is increased. When the ice-making compartment (1) is positioned on the second door (D2), since it may occur bleeding on the door due to the fact that the temperature of the ice-making compartment (1) is below 0°C, the refrigeration device (S) preferably comprises at least a second isolation member (1a) positioned around the ice-making compartment (1).

[0022] In another alternative embodiment, the refrigeration device (S) preferably comprises at least a third fan (5) that increase air circulation in the ice-making compartment (1) in order to cool the said ice-making compartment (1) in a faster and more effective manner.

[0023] In another preferred illustrative embodiment of the invention, the refrigeration device (S) preferably comprises at least one liquid container (6) for preventing cavitation that may be seen on the circulation pump (4) due to insufficient amount of the coolant, which container is positioned on the first line (3a) or second line (3b) and contains a certain amount of the said coolant. Thus, the refrigeration device (S) is operated in a reliable manner. In this embodiment, said liquid container (6) is preferably positioned in such a way that it is located at that part of the circulation pump (4) that is connected to the second heat exchanger (2b).

[0024] With the refrigeration device (S) according to the present invention, ice is generated in the refrigeration device (S) without negatively affecting the cooling efficiency of a freezing compartment (S1) or a refrigeration compartment (S2) of the refrigeration device (S). Furthermore, since a coolant is used in the inventive refrigeration device (S) to cool down the ice-making compartment (1) which does not undergo a phase change (which constantly remains liquid within

the operation temperature of the refrigeration device (S), which does not freeze or evaporate), no compressor is need in the second refrigeration system, and cycling of the coolant may be performed with the use of a simpler structure (circulation pump (4)) consuming far less energy than the compressor. Moreover, external elements such as valves are not needed to separate the second refrigeration system that cools the ice-making compartment (1) from the first refrigeration system. Thus, a refrigeration device (S) may be obtained which is inexpensive to produce, easy to use, practical and reliable.

Claims

1. A refrigeration device (S) comprising at least one body (G); at least one freezing compartment (S1) disposed in the said body (G) and having a temperature below 0°C; at least a first refrigeration system for cooling said freezing compartment (S1) and comprising at least one compressor (K), at least one condenser and at least a first evaporator (E1); a refrigerant circulated through this system; and at least one ice-making compartment (1) for making ice, **characterized by** comprising at least a second refrigeration system for cooling the ice-making compartment (1) including:
 - at least a first heat exchanger (2a) positioned in such a way to make heat exchange with the ice-making compartment (1);
 - at least a second heat exchanger (2b) positioned in such a way to make heat exchange with the said freezing compartment (S1);
 - a coolant which is passed through the first heat exchanger (2a) and second heat exchanger (2b) so as to conduct said heat exchange operations and which does not freeze within the operation temperature range of the freezing compartment (S1) of the refrigeration device (S) and does not undergo a phase change throughout the refrigeration process;
 - at least a first line (3a), at least one end of which is connected to the first heat exchanger (2a) and at least another end of which is connected to the second heat exchanger (2b), and through which the coolant which has left the second heat exchanger (2b) and has been cooled down due to the heat transferred to the freezing compartment (S1) is conveyed to the first heat exchanger (2a);
 - at least a second line (3b), at least one end of which is connected to the first heat exchanger (2a) and at least another end of which is connected to the second heat exchanger (2b), and through which the coolant which has left the first heat exchanger (2a) and has been heated due to the heat taken from the ice-making compartment (S1) is conveyed to the second heat exchanger (2b); and
 - at least one circulation pump (4) for circulating the coolant between the first heat exchanger (2a) and the second heat exchanger (2b).
2. A refrigeration system (S) according to claim 1, **characterized in that** the circulation pump (4) is disposed in the first line (3a).
3. A refrigeration system (S) according to claim 1, **characterized in that** said first line (3a) and the second line (3b) is disposed outside the body (G) by being enclosed by an isolation material.
4. A refrigeration device (S) according to claim 1, **characterized in that** the second heat exchanger (2b) is positioned at a lower portion of the freezing compartment (S1).
5. A refrigeration device (S) according to claim 4, **characterized in that** the first heat exchanger (2a) is positioned at an upper portion of the freezing compartment (S1).
6. A refrigeration system (S) according to claim 1, **characterized by** comprising at least one activation member that control operation of the circulation pump (4).
7. A refrigeration system (S) according to claim 1, **characterized by** comprising at least a first door (D1) through which access to the freezing compartment (S1) is controlled and on which the ice-making compartment (1) is positioned.
8. A refrigeration system (S) according to claim 1, **characterized by** comprising at least one refrigeration compartment (S2) which is positioned in the said body (G) and which is cooled by the said first refrigeration system in order to ensure that its temperature is from 0°C to 5°C, and at least a second door (D2) for controlling access to the said refrigeration compartment (S2).

9. A refrigeration device (S) according to claim 8, **characterized in that** the refrigeration compartment (S2) is positioned so as to be at an upper portion of the freezing compartment (S1).
10. A refrigeration device (S) according to claim 8 or 9, **characterized in that** the ice-making compartment (1) is positioned on the second door (D2).
11. A refrigeration device (S) according to claim 8, **characterized by** comprising at least a second evaporator (E2) for cooling the said refrigeration compartment (S2).
12. A refrigeration device (S) according to claim 10, **characterized by** comprising at least one ice-removing compartment (1b) which is positioned on the second door (D2), connected with the ice-making compartment (1) and suitable to be reached from the outside environment where the refrigeration device (S) is situated, without opening the second door (D2).
13. A refrigeration device (S) according to claim 10, **characterized by** comprising at least a second isolation member (1a) positioned around the ice-making compartment (1).
14. A refrigeration device (S) according to claim 10, **characterized in that** the first heat exchanger (2a) is positioned on the second door (D2).
15. A refrigeration device (S) according to claim 1, **characterized by** comprising at least one liquid container (6) for preventing cavitation that may be seen on the circulation pump (4) due to insufficient amount of the coolant, which is positioned on the first line (3a) or second line (3b) and contains a certain amount of the said coolant.

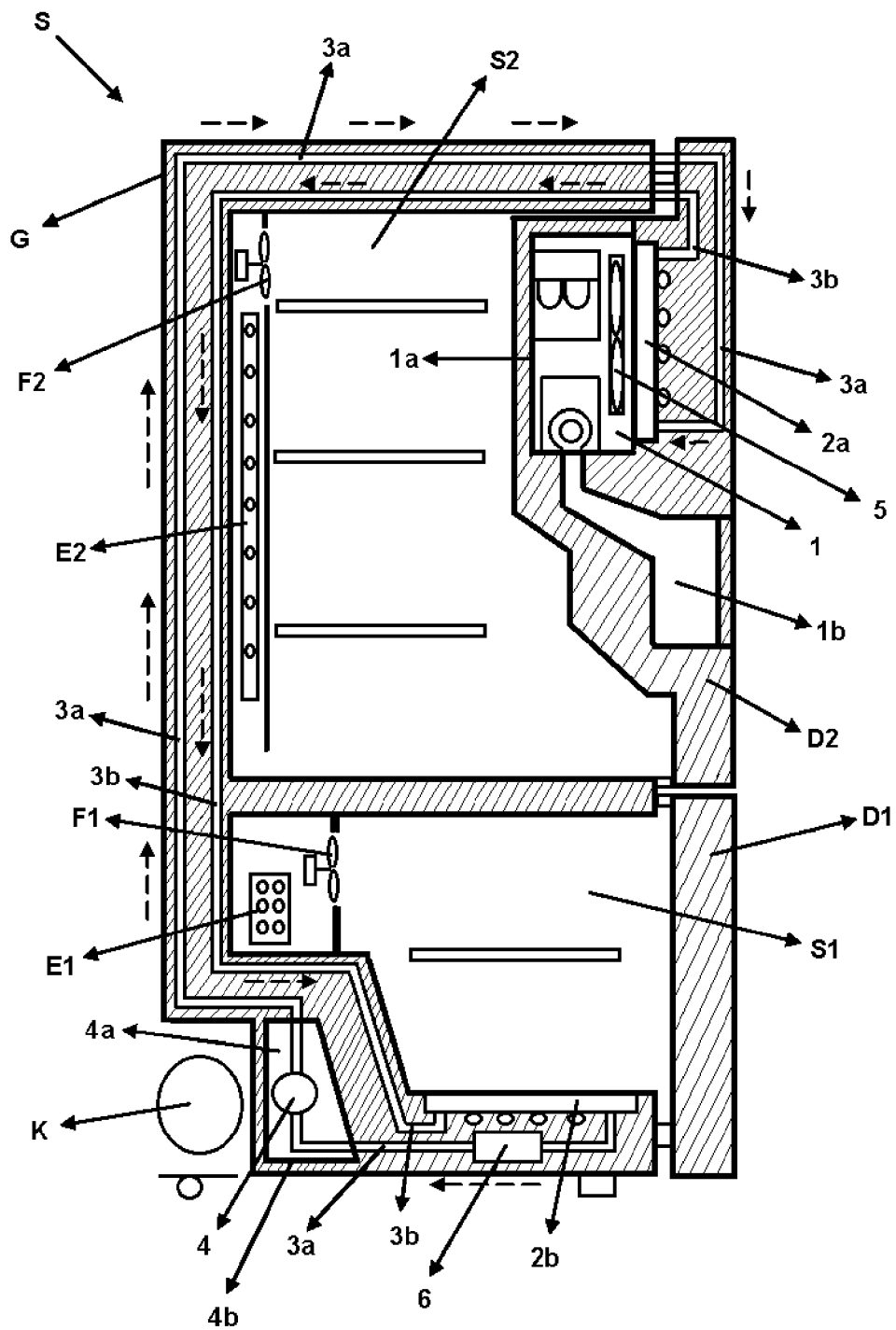


Figure 1



EUROPEAN SEARCH REPORT

Application Number
EP 15 19 7921

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EPO FORM 1503 03.82 (P04C01)

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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 23 June 2016	Examiner Bejaoui, Amin
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	

**ANNEX TO THE EUROPEAN SEARCH REPORT
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5 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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