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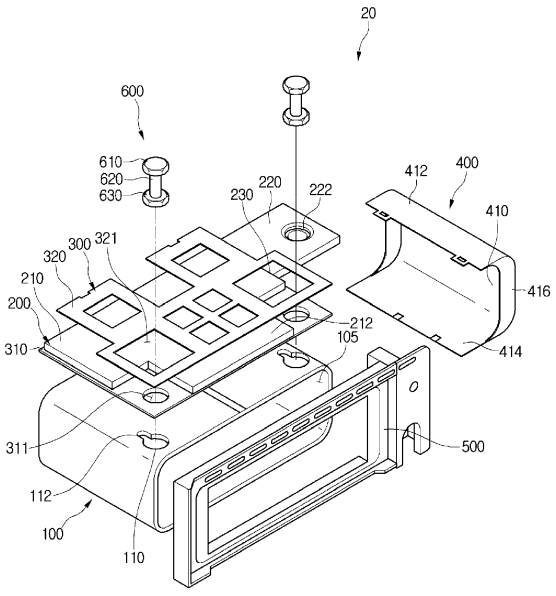
(54) REFRIGERATOR

(57) A refrigerator (1) comprises a cabinet (11) including: an outer case (12); an inner case (13); and an insulator disposed between the outer case (12) and the inner case (13); an evaporator plate (100) disposed in the inner case (13), the evaporator plate (100) including: a tube (103) through which a refrigerant flows; and a first coupling part (110, 112), the first coupling part (110, 112) configured to couple the evaporator plate (100) to the inner case (13); a cold storage pack (200) disposed between the evaporator plate (100) and the inner case (13) and accommodating a phase change material (PCM); a plate (300) closely attached to the cold storage pack (200) so that the PCM is uniformly distributed, the plate (300) including a second coupling part (311) at a position corresponding to a position of the first coupling part (110, 112); a frame (500) disposed on a front side of the evaporator plate (100), and having an opening through which a storage item is introduced into and withdrawn from a storage compartment of the evaporator plate (100); and a fixing member (600) fixed to the inner case (13) to support the evaporator plate (100) by passing through the first and second coupling parts (110, 112; 311).

Fig. 3



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Description

BACKGROUND

[0001] According to a basic principle of an AC powered refrigerator, the AC powered refrigerator is provided with a (mechanical, electronic, or chemical) compressor for transferring heat from a thermal insulation chamber and the inside of the refrigerator to an external environment so that the inside of the refrigerator is cooled at a temperature less than a surrounding temperature of a room. Cooling is a popular food storing technology in the world and is performed to reduce a regeneration rate of bacteria. Since the bacteria is a main reason of food spoilage, the refrigerator helps to reduce a spoilage rate of food.

[0002] Blackout commonly occurs in developing countries, and irregular power supply results in significantly decreasing of cooling efficiency of the refrigerator. This also gives negative effects on quality of food stored in a cabinet of the refrigerator, which is easily rotten, because of low cooling preservation. If blackout continues for a few hours, foods stored in a freezing region may be harmfully affected. In case of high power consumption or a low voltage in a household, the refrigerator may not provide sufficient cooling for goods stored in the refrigerator. Accordingly, it is important to find methods for maintaining a cooling state inside the refrigerator in various situations such as high power consumption, a low voltage, blackout, and the like.

[0003] A phase change material (PCM) may be used in a freezing compartment of the refrigerator as one method for overcoming this limitation. The PCM has been used for several years to store latent heat through solid-solid, solid-gas, and liquid-gas phase changes.

[0004] However, the phase change used for the PCM is only a solid-liquid phase change. Although the liquid-gas phase change causes thermal change greater than that of the solid-liquid phase change, the thermal change is not actually applied due to an involved high pressure. Various types of PCMs may be used as eutectic mixtures, organic PCMs, inorganic PCMs, or the like.

[0005] In case of a refrigerator adopting latent heat storage of the PCMs, cooling of an evaporator freezes the PCMs when power supply is enabled. In case of the blackout, a refrigeration cycle is stopped, and an evaporator plate does not have any cooling source. Thus, an inner temperature of the refrigerator starts to increase. However, a temperature increase rate may be significantly reduced due to the frozen/partially frozen PCMs. Thus, cooling potential of PCMs is used for cooling air inside the refrigerator and maintaining stored goods at a sufficiently low temperature. In general, an allowable temperature is about 0° for a freezing region and about 10° for a refrigerating region. If a temperature increases over the allowable temperature for a long time, the stored goods may become poor.

[0006] However, the existing methods have at least one limitation. For example, if a freezing point of the PCM is too low, the PCM may not be completely frozen. If the freezing point of the PCM is too high, although the PCM is completely frozen, the PCM has quite low cooling potential in terms of latent heat. Thus, it is important to utilize the PCM having a freezing point within an exact temperature range according to a mean temperature of the evaporator plate.

[0007] Another limitation in the existing methods is that the PCM is provided in a plastic case/housing. Thus, heat resistance between the PCM and an evaporator plate is high.

[0008] Also, a contact area between the PCM and the evaporator plate is insufficient to retard the freezing of the PCM and cause high energy consumption while using the power.

[0009] Similarly, the cooling provided to the PCM is very slow during the blackout. Thus, it is important to provide a wide contact area and low heat resistance between the PCM case and the evaporator plate.

[0010] A plurality of cooling storage devices for a chest freezer are disclosed in European Patent No. 152155. Each of the cooling storage devices includes a plastic material containing a eutectic solution, e.g., a case formed of polyethylene. Especially, the storage device may use a method in which the eutectic solution is frozen by a substantially continuous operation of a compressor during a time (night) when a charge of main power is discounted. The heat energy stored by the device is utilized for a time (day) when the cost of main power is maximized to stop an operation of the compressor of the refrigerator for the day time. However, because of contact of an inappropriate area, the compressor has to continuously operate so as to freeze the PCM. Furthermore, since the cooling storage devices match each other through bonding, the case should be thick and hard to lead high heat resistance.

SUMMARY

[0011] Embodiments provide a refrigerator having a PCM maintaining a low temperature during blackout or abnormal operation of the refrigerator.

[0012] In one embodiment, a refrigerator includes: a cabinet including: an outer case; an inner case; and an insulator disposed between the outer case and the inner case; an evaporator plate disposed in the inner case, the evaporator plate including: a tube through which a refrigerant flows; and a first coupling part, the first coupling part configured to couple the evaporator plate to the inner case; a cold storage pack disposed between the evaporator plate and the inner case and accommodating a phase change material (PCM); a plate closely attached to the cold storage pack so that the PCM is uniformly distributed, the plate including a second coupling part at a position corresponding to a position of the first coupling part; a frame disposed on a front side of the evaporator plate, and having an opening through which a storage item is introduced into and withdrawn from a storage com-

partment of the evaporator plate; and a fixing member fixed to the inner case to support the evaporator plate by passing through the first and second coupling parts.

[0013] The cold storage pack may comprise a first cold storage part, and wherein the plate comprises an upper plate disposed between the inner case and the first cold storage part.

[0014] The plate may further comprise a lower plate disposed between the first cold storage part and the evaporator plate.

[0015] The cold storage pack may further comprise a second cold storage part disposed at one side of the evaporator plate.

[0016] The other side of the evaporator may contact with the inner case.

[0017] The refrigerator may further comprise a supporting member surrounding the evaporator plate, the second cold storage part, and the upper plate.

[0018] The supporting member may comprise: a first contact part contacting the second cold storage part; a second contact part bent at one end of the first contact part to contact the upper plate; a third contact part bent at the other end of the first contact part to contact the evaporator plate, wherein the evaporator plate, the upper plate, and the second cold storage part are disposed between the second contact part and the third contact part.

[0019] The supporting member may further comprise a stopper for preventing the second cold storage part from moving in a front-to-rear direction.

[0020] At least one of the first cold storage part and the second cold storage part may further comprise a cold storage material entrance through which the phase change material is introduced and discharged.

[0021] The first coupling part may comprise: a first hole portion through which the fixing member passes; and a second hole portion formed at an edge of the first hole and smaller than the first hole, such that the fixing member passing through the first hole is positioned therein.

[0022] The frame may comprise a cover to shield the second cold storage part and the supporting member.

[0023] The cover may further comprise a manipulation part for setting a temperature of a storage compartment in the evaporator plate.

[0024] The fixing member may comprise: a case fixing part fixed to an upper wall of the inner case; a plate fixing part fixed to the evaporator plate; and a connection part connecting the case to the evaporator plate, wherein the plate has a diameter greater than a diameter of the connection part.

[0025] The details of one or more embodiments are set forth in the accompanying drawings and the description below. Other features will be apparent from the description and drawings, and from the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026]

Fig. 1 is a front view of a single door or direct cooling/freezing system into which a cold storage pack is inserted.

Fig. 2 is a perspective view illustrating a structure of installing a cold storage pack in a refrigerator door according to an embodiment.

Fig. 3 is a perspective view illustrating a coupling process in Fig. 2.

Fig. 4 is a front cross-sectional view illustrating the coupling structure in Fig. 2.

Fig. 5 is a partially enlarged cross-sectional view of an evaporator plate and a phase change material in Fig. 2.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0027] Reference will now be made in detail to the embodiments of the present disclosure, examples of which are illustrated in the accompanying drawings.

[0028] In the following detailed description of the preferred embodiments, reference is made to the accompanying drawings that form a part hereof, and in which is shown by way of illustration specific preferred embodiments in which the invention may be practiced. These embodiments are described in sufficient detail to enable those skilled in the art to practice the invention, and it is understood that other embodiments may be utilized and that logical structural, mechanical, electrical, and chemical changes may be made without departing from the spirit or scope of the invention. To avoid detail not necessary to enable those skilled in the art to practice the invention, the description may omit certain information known to those skilled in the art. The following detailed description is, therefore, not to be taken in a limiting sense.

[0029] Also, in the description of embodiments, terms such as first, second, A, B, (a), (b) or the like may be used herein when describing components of the present invention. Each of these terminologies is not used to define an essence, order or sequence of a corresponding component but used merely to distinguish the corresponding component from other component(s). It should be noted that if it is described in the specification that one component is "connected," "coupled" or "joined" to another component, the former may be directly "connected," "coupled," and "joined" to the latter or "connected", "coupled", and "joined" to the latter via another component.

[0030] Fig. 1 is a front view of a refrigerator with a cooling device installed according to an embodiment. Referring to Fig. 1, a refrigerator 1 according to an embodiment may include a cabinet 11.

[0031] The cabinet 11 may include a cooling device 20 and at least one storage compartment 30. The cabinet 11 may further include an outer case 12, an inner case 13, and an insulator provided between the outer case 12 and the inner case 13.

[0032] Although not shown, a door may be rotatably coupled to the cabinet 11 by a hinge. The door may cover

at least one of the cooling device 20 and the at least one storage compartment 30.

[0033] The cooling device 20 may be disposed inside the inner case 13.

[0034] Fig. 2 is a perspective view of the cooling device according to an embodiment, and Fig. 3 is an exploded perspective view of the cooling device of Fig. 2. Fig. 4 is a cross-sectional view illustrating a state in which the cooling device of Fig. 2 is disposed in a cabinet, and Fig. 5 is a view illustrating an evaporator plate constituting the cooling device of Fig. 2.

[0035] Referring to Figs. 2 to 5, the cooling device 20 may include an evaporator plate 100 and a cold storage pack 200 having a phase change material (PCM).

[0036] The evaporator plate 100 may include a first plate 101 and a second plate 102 coupled to the first plate 101 and defining a tube 103 together with the first plate 101, through which refrigerant flows.

[0037] The evaporator plate 100 may define an accommodation storage compartment 105 into which foods to be cooled by a refrigerant are accommodated.

[0038] The cold storage pack 200 may include a phase change material (PCM). The cold storage pack 200 may be formed of, e.g., a soft material.

[0039] The PCM may have a freezing point less than about 0°C and greater than a mean temperature of the evaporator plate 100.

[0040] In detail, a plurality of PCMs having a freezing point within a range from about -5°C to about 190°C may be used. The PCM that is useful for domestic refrigerators generally has a freezing point equal to or less than about 0°C. Effects of the PCM may be determined on the basis of thermal, dynamical, economical, and chemical characteristics. An important prerequisite is that a melting temperature is within an operation range of the refrigerator.

[0041] The cold storage pack 200 may include a first cold storage part 210 and a second cold storage part 220 connected to the first cold storage part 210 by a connection part 230.

[0042] The first cold storage part 210 may be disposed above the evaporator plate 100, and the second cold storage part 220 may be disposed on one side of the evaporator plate 100. That is, the second cold storage part 220 may be disposed on a left or right side of the evaporator plate 100. For example, Fig. 3 illustrates the second cold storage part 220 disposed on a right side of the evaporator plate 100.

[0043] Thus, the other side of the evaporator plate 100 may contact the inner case 13. On the other hand, one side of the evaporator plate 100 may be spaced apart from the inner case 13 so that the second cold storage part 220 is positioned.

[0044] According to the current embodiment, since the other side of the evaporator plate 100 contacts the inner case 13, the storage compartment 105 defined by the evaporator plate 100 may increase in volume.

[0045] Also, each of the first cold storage part 210 and the second cold storage part 220 may include a space for separately accommodating the PCM. The first and second cold storage parts 210 and 220 may have a space communicating with each other or independent spaces. Although the first cold storage part 210 and the second cold storage part 220 communicate with each other, because the connection part 230 is bent, the communication between the first cold storage part 210 and the second cold storage part 220 may be blocked in a state where the cold storage pack 200 is installed.

[0046] Thus, according to the current embodiment, since the cold storage pack 200 is divided into at least two cold storage parts, a phenomenon in which the PCM is concentrated in one direction within the cold storage pack may be prevented.

[0047] At least one of the first and second cold storage parts 210 and 220 may contact the evaporator plate 100.

[0048] The at least one of the first and second cold storage parts 210 and 220 may further include a cold storage material entrance 222 through which the phase change material is introduced and discharged.

[0049] The cooling device 20 may further include plates 310 and 320 for preventing the PCM from being concentrated to one side in the first cool storage part 210.

[0050] That is, the plate 300 may allow the PCM to be maintained to a predetermined thickness in the first cool storage part 210.

[0051] The plate 300 may include an upper plate 320 seated on the first cool storage part 210. A hole 321 through which a fixing member 600, which will be described later, passes may be defined in the upper plate 320.

[0052] The plate 300 may further include a lower plate 310 seated on the evaporator plate 100. The lower plate 310 is disposed between the evaporator plate 100 and the first cold storage part 210.

[0053] The lower plate 310 may be formed of steel to transfer heat between the evaporator plate 100 and the first cold storage part 210.

[0054] A hole 311 through which the fixing member 600 passes may be defined in the lower plate 310.

[0055] The cooling device 20 may further include a supporting member 400 for fixing relative positions of the evaporator plate 100, the plate 300, and the cold storage pack 200.

[0056] The supporting member 400 may include a first contact part 410 contacting the second cold storage part 220, a second contact part 412 bent from one end of the first contact part 410 and contacting the upper plate 320, and a third contact part 414 bent from the other end of the first contact part 410 and contacting the evaporator plate 100.

[0057] That is, the evaporator plate 100, the plate 300, and the cold storage pack 200 may be disposed between the second contact part 412 and the third contact part 414.

[0058] Here, the first contact part 410 may be disposed between the second cold storage part 220 and the inner

case 13.

[0059] The supporting member 400 may further include a plurality of stoppers 416 for preventing the second cold storage part 220 from moving in a front-to-rear direction. The second cold storage part 220 may be disposed between the plurality of stoppers 416.

[0060] The plurality of stoppers 416 may connect the second contact part 412 to the third contact part 414.

[0061] The cooling device 20 may further include a frame 500 disposed on a front side of the evaporator plate 100.

[0062] The frame 500 may include an opening 510 through which a food is introduced and discharged into/from a storage compartment of the evaporator plate 100.

[0063] The frame 500 may further include a cover 520 for the second cold storage part 220 and the supporting member 400, which are disposed between one side of the evaporator plate 100 and the inner case 13, from being exposed.

[0064] A manipulation part for setting a temperature of the storage compartment in the evaporator plate 100 may be disposed on the cover 520.

[0065] The refrigerator 1 may further include the fixing member for fixing the cooling device 20 to the inner case 13. Although the fixing member 600 is not limited, the fixing member 600 may be fixed to an upper wall 14 of the inner case 13.

[0066] The fixing member 600 may further include a case fixing part 610 fixed to the upper wall 14, a plate fixing part 630 fixed to the evaporator plate 100, and a connection part 620 connecting the case fixing part 610 to the evaporator plate 100.

[0067] Here, the case fixing part 610 may be omitted, and the connection part 620 may be directly fixed to the upper wall 14.

[0068] The plate fixing part 630 may have a diameter greater than that of the connection part 620.

[0069] To fix the fixing member 600 to the evaporator plate 100, the evaporator plate 100 may further include a first coupling part for coupling the fixing member 600.

[0070] The first coupling part may include a first hole 110 through which the plate fixing part 630 passes and a second hole 112 through which the connection part 620 passes. Here, the second hole 112 may have a size less than that of the first hole 110. Also, the first hole 110 may have a diameter equal to or greater than that of the plate fixing part 630.

[0071] Accordingly, when the evaporator plate 100 moves in a state in which the plate fixing part 630 passes through the first hole 110, the connection part 620 may be disposed in the second hole 112, and thus, the evaporator plate 100 may be supported by the supporting member 400.

[0072] Hereinafter, a method for assembling the cooling device 20 will be described.

[0073] As illustrated in Fig. 3, a lower plate 310 formed of steel to transfer heat with a first cold storage part 210 is disposed on an evaporator plate 100.

[0074] Next, a cold storage pack 200 accommodating the PCM therein is disposed on the lower plate 310. Here, the cold storage pack 200 may be coupled to the lower plate 310 and independently separated from the lower plate 310.

[0075] Next, an upper plate 320 in which a hole 321 through which the fixing member 600 passes is formed is seated on the cold storage pack 200.

[0076] After that, a supporting member 400 passes through the holes 311 and 321 and is inserted into and fixedly coupled to the evaporator plate 100 so that the evaporator plate 100, the cold storage pack 200, and the plate 300, which overlap each other, are coupled to each other. The holes 311 and 321 may be called a second coupling part.

[0077] Since the side surfaces of the evaporator plate 100, the cold storage pack 200, and the plate 300, which are fixedly coupled to each other, are assembled by using the fixing member 600 to more firmly fix and couple the evaporator plate 100, the cold storage pack 200, and the plate 300, the evaporator plate 100 as one structure, the evaporator plate 100, the cold storage pack 200, and the plate 300 may be more firmly coupled to each other.

[0078] Therefore, according to the installation structure of the cold storage pack of the refrigerator door, a sufficiently low temperature may be maintained in the refrigerator for a long time during the blackout, the high power consumption, or the low voltage, and the cooling device may also be reduced in required amount of PCM.

[0079] Also, the cooling provided to the refrigerator during the normal operation may be efficiently utilized to reduce the operational costs of the refrigerator.

[0080] Although embodiments have been described with reference to a number of illustrative embodiments thereof, it should be understood that numerous other modifications and embodiments can be devised by those skilled in the art that will fall within the spirit and scope of the principles of this disclosure. More particularly, various variations and modifications are possible in the component parts and/or arrangements of the subject combination arrangement within the scope of the disclosure, the drawings and the appended claims. In addition to variations and modifications in the component parts and/or arrangements, alternative uses will also be apparent to those skilled in the art.

Claims

1. A refrigerator (1), comprising:

a cabinet (11) including:

an outer case (12);
an inner case (13); and
an insulator disposed between the outer case (12)and the inner case (13);

an evaporator plate (100) disposed in the inner case (13), the evaporator plate (100)including:

a tube (103) through which a refrigerant flows; and
a first coupling part (110, 112), the first coupling part configured to couple the evaporator plate to the inner case (13);

a cold storage pack (200) disposed between the evaporator plate (100) and the inner case (13) and accommodating a phase change material (PCM);
a plate (300) closely attached to the cold storage pack (200) so that the PCM is uniformly distributed, the plate (300) including a second coupling part (311) at a position corresponding to a position of the first coupling part (110, 112);
a frame (500) disposed on a front side of the evaporator plate (100), and having an opening through which a storage item is introduced into and withdrawn from a storage compartment of the evaporator plate (100); and
a fixing member (600) fixed to the inner case (13) to support the evaporator plate (100) by passing through the first and second coupling parts (110; 112; 311).

2. The refrigerator according to claim 1, wherein the cold storage pack (200) comprises a first cold storage part (210),
and wherein the plate (300) comprises an upper plate (320) disposed between the inner case (13) and the first cold storage part (210).

3. The refrigerator according to claim 2, wherein the plate (300) further comprises a lower plate (310) disposed between the first cold storage part (210) and the evaporator plate (100).

4. The refrigerator according to any one of the claims 1 to 3, wherein the cold storage pack (200) further comprises a second cold storage part (220) disposed at one side of the evaporator plate (100).

5. The refrigerator according to claim 4,
wherein the other side of the evaporator plate (100) contacts with the inner case (13).

6. The refrigerator according to claim 4 or 5, further comprising a supporting member (400) surrounding the evaporator plate (100), the second cold storage part (220), and the upper plate (320).

7. The refrigerator according to claim 6, wherein the supporting member (400) comprises:

a first contact part (410) contacting the second cold storage part (220);
a second contact part (412) bent at one end of the first contact part (410) to contact the upper plate;
a third contact part (414) bent at the other end of the first contact part (410) to contact the evaporator plate (100),
wherein the evaporator plate (100), the upper plate (320), and the second cold storage part (220) are disposed between the second contact part (412) and the third contact part (414).

8. The refrigerator according to claim 7, wherein the supporting member (400) further comprises a stopper (416) for preventing the second cold storage part (220) from moving in a front-to-rear direction.

9. The refrigerator according to any one of the claims 4 to 8, wherein at least one of the first cold storage part (210) and the second cold storage part (220) further comprises a cold storage material entrance (222) through which the phase change material is introduced and discharged.

10. The refrigerator according to any one of the claims 1 to 9, wherein the first coupling part (110, 112) comprises:

a first hole portion (110) through which the fixing member (600) passes; and
a second hole portion (112) formed at an edge of the first hole portion (110) and smaller than the first hole portion (110), such that the fixing member (600) passing through the first hole (portion 110) is positioned therein.

11. The refrigerator according to any one of the claims 6 to 10, wherein the frame (500) comprises a cover (520) to shield the second cold storage part (220) and the supporting member (400).

12. The refrigerator according to claim 11, wherein the cover (520) further comprises a manipulation part for setting a temperature of a storage compartment in the evaporator plate (100).

13. The refrigerator according to any one of the claims 1 to 12, wherein the fixing member (600) comprises:

a case fixing part (610) fixed to an upper wall(14) of the inner case (13);
a plate fixing part (630) fixed to the evaporator plate (100); and
a connection part (620) connecting the inner case (13) to the evaporator plate (100),
wherein the plate fixing part (630) has a diameter greater than a diameter of the connection part (620).

Fig. 1

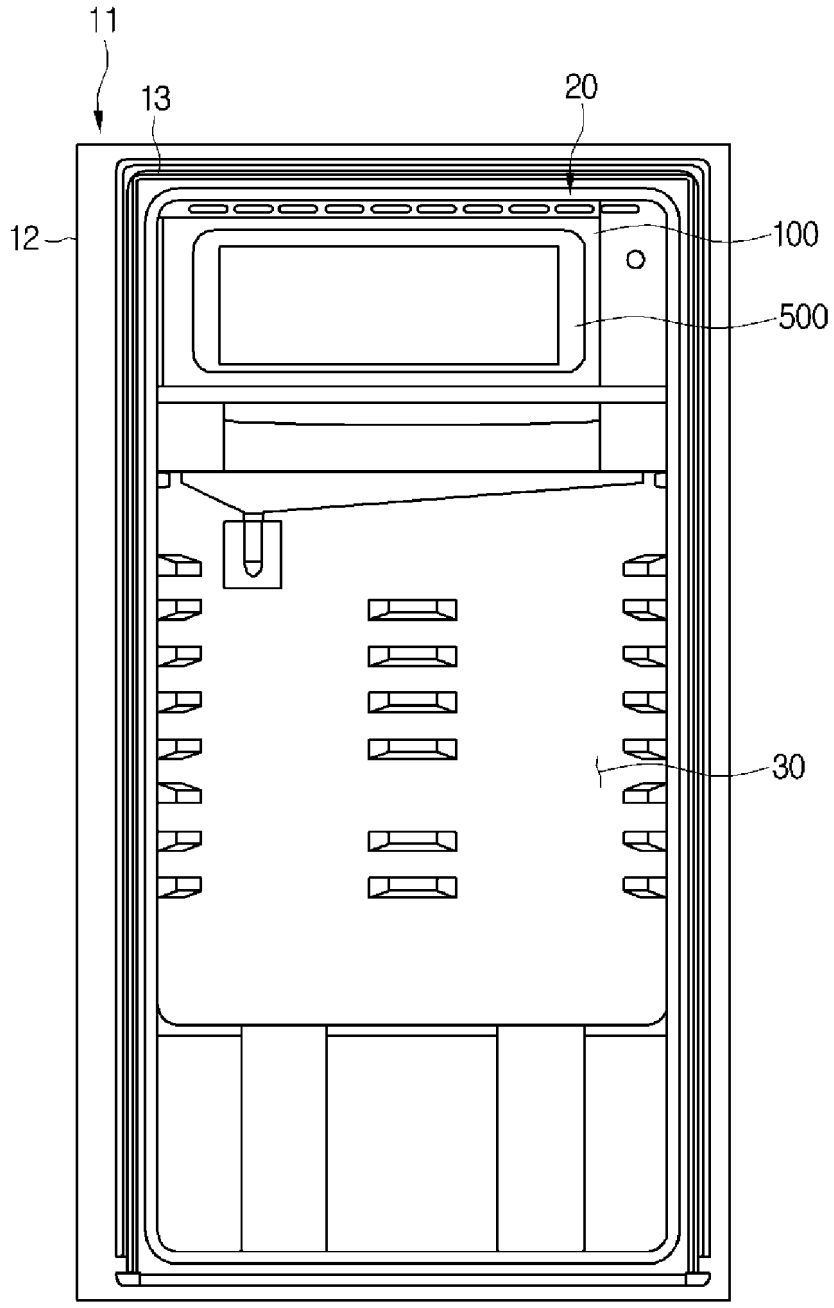

Fig. 2

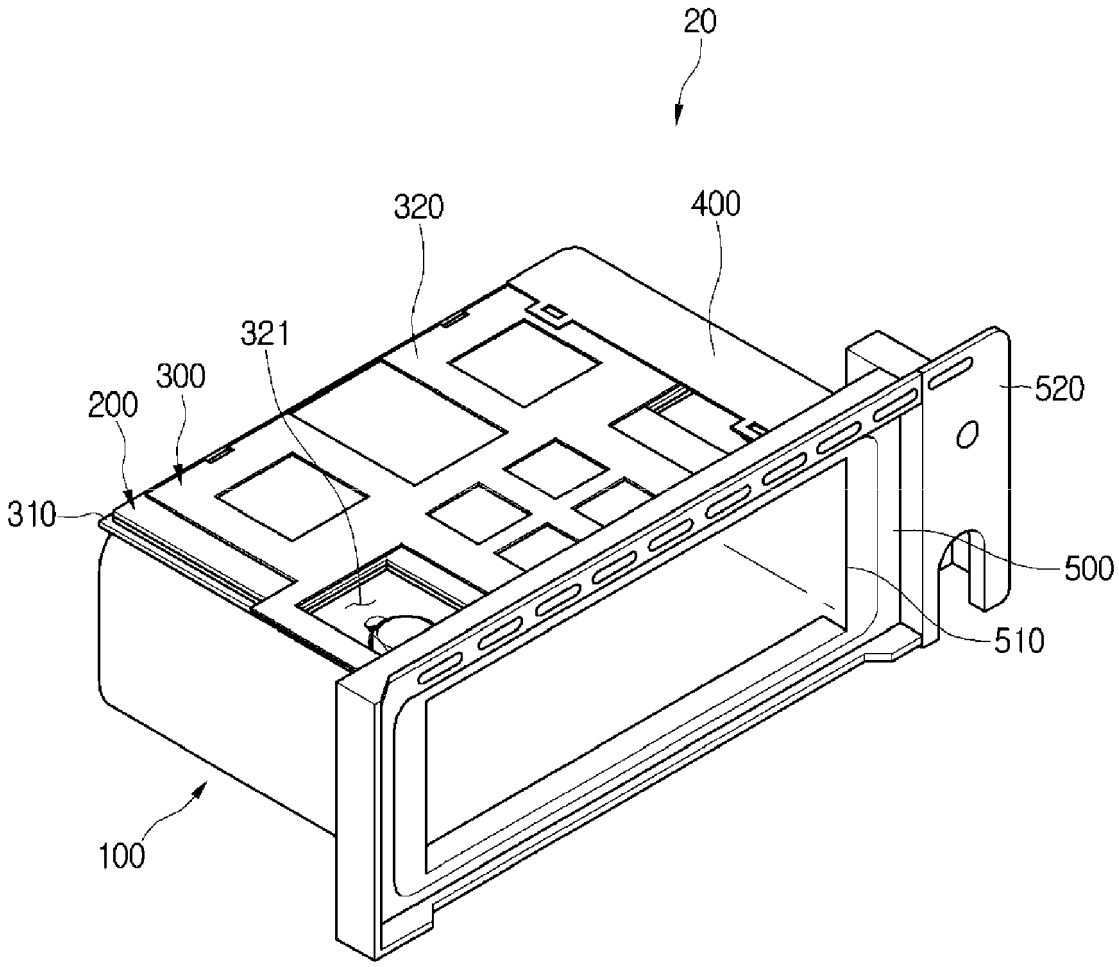

Fig. 3

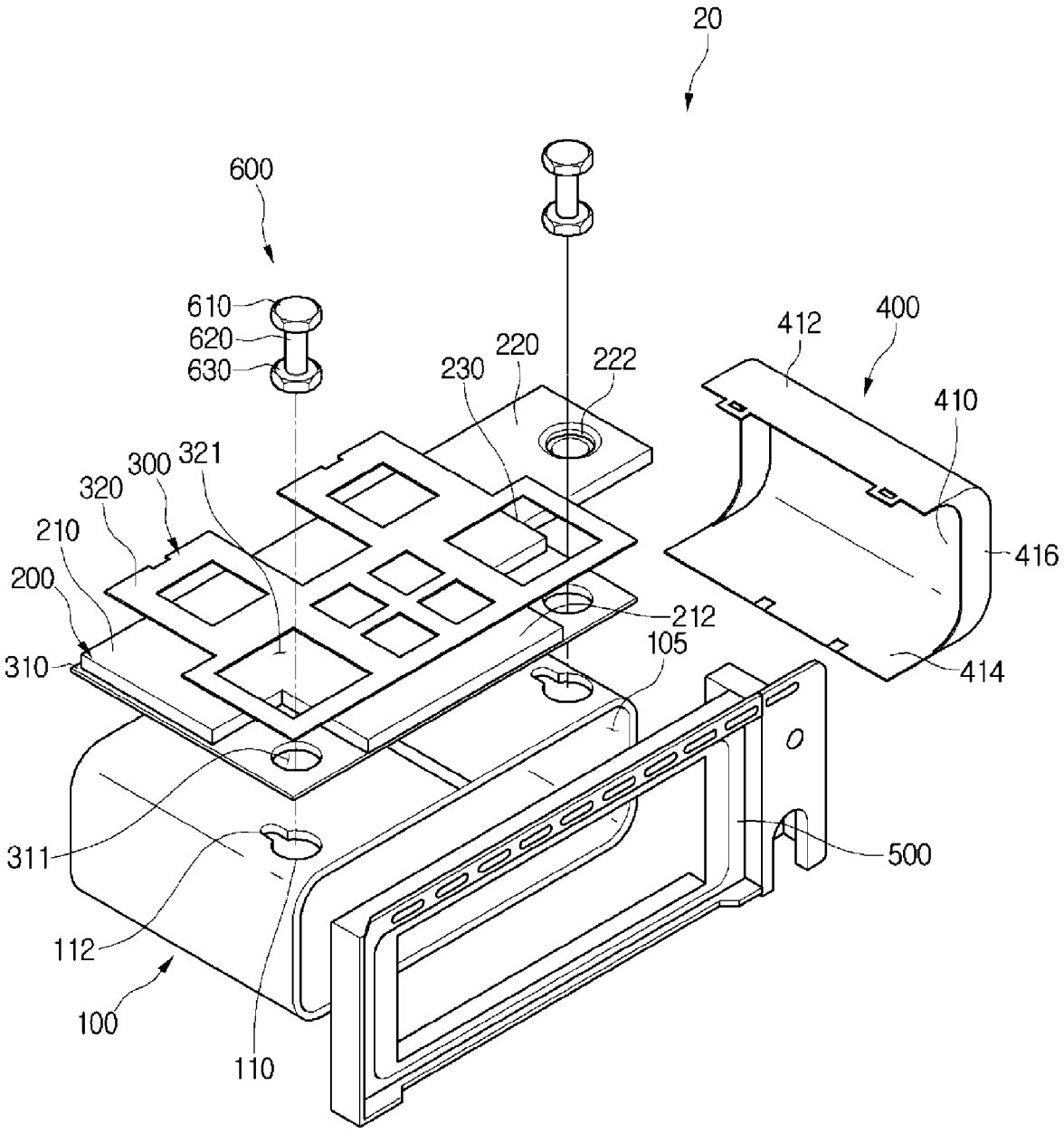
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Fig. 4

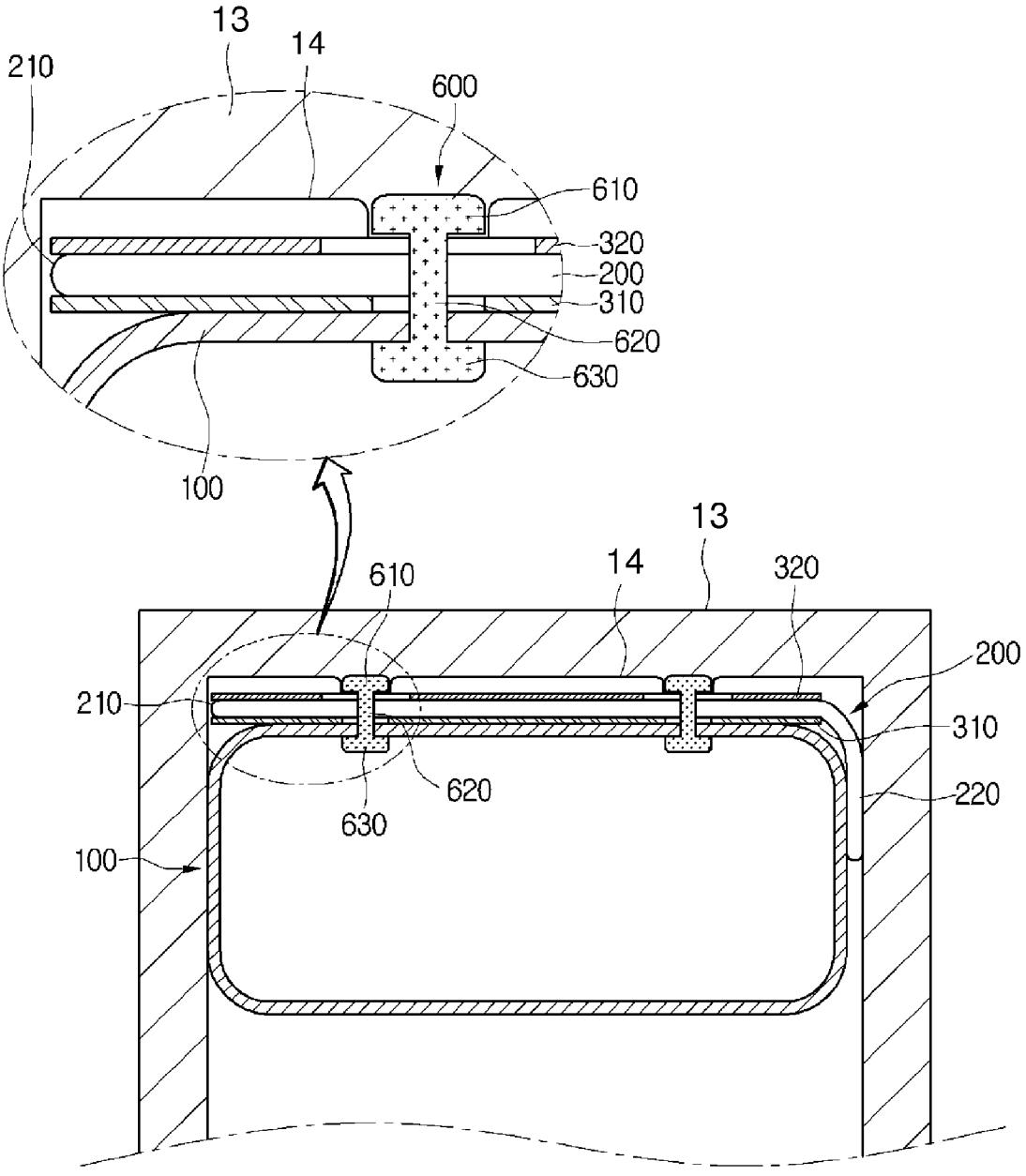
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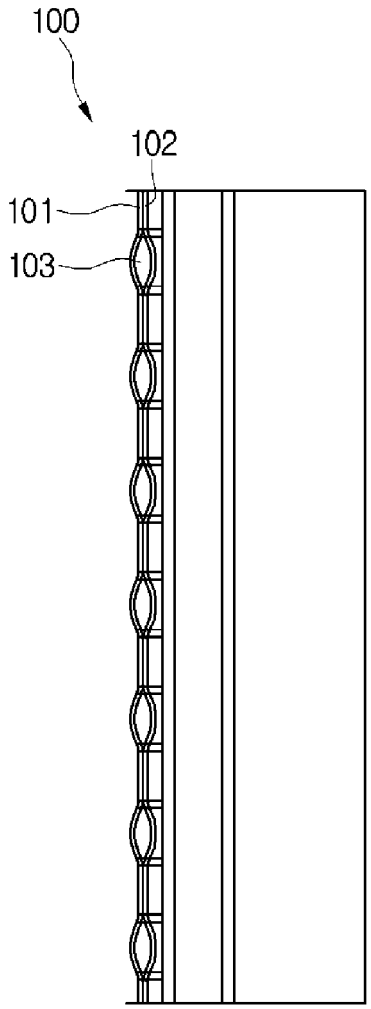
Fig. 5



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EUROPEAN SEARCH REPORT

Application Number
EP 15 17 6010

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 4 459 826 A (HIRANO YOSHIMI [JP] ET AL) 17 July 1984 (1984-07-17) * column 3, lines 13-22; figure 5 *	1-3,7,8, 10-13	INV. F25D11/00
X	WO 2013/156839 A1 (LG ELECTRONICS INC [KR]) 24 October 2013 (2013-10-24) * page 7, lines 15-20; figures 2a, 2b, 2c *	1,4-6,9	

TECHNICAL FIELDS SEARCHED (IPC)

F25D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	12 November 2015	Melo Sousa, Filipe

CATEGORY OF CITED DOCUMENTS

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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 15 17 6010

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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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- EP 152155 A **[0010]**