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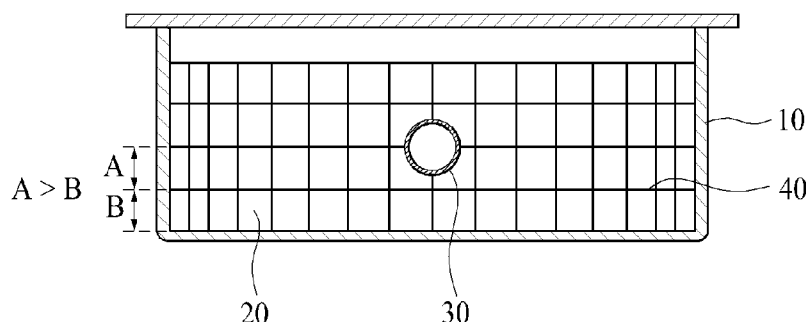
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(54) Title: COLD STORAGE MODULE HAVING MESH METAL STRUCTURE OF UNEQUAL GAP, REFRIGERATOR CONTAINER HAVING COLD STORAGE MODULES MOUNTED THEREIN, AND REFRIGERATOR VEHICLE



(57) Abstract: There are disclosed a cold storage module comprising a mesh metal of an unequal gap structure including a housing comprising a phase change material (PCM) provided therein; a heat exchange pipe arranged through the housing, in which a low temperature refrigerant flows to cool the phase change material; and a mesh metal configured to transfer a cold heat energy generated from the heat exchange pipe to the phase change material in the housing, wherein the mesh metal comprises a plurality of wires alternatively coupled to each other in unequal gaps, a refrigerator container comprising the plurality of the cold storage modules mounted in an upper portion thereof, and a refrigerator container vehicle comprising the refrigerator container mounted therein.



Description

Title of Invention: COLD STORAGE MODULE HAVING MESH METAL STRUCTURE OF UNEQUAL GAP, REFRIGERATOR CONTAINER HAVING COLD STORAGE MODULES MOUNTED THEREIN, AND REFRIGERATOR VEHICLE

Technical Field

- [1] The present invention relates to a cold storage module having a mesh metal structure of an unequal gap in a cold storage system using a phase change cold storage material, which may enhance heat conductivity and application extension, a refrigerator container having a plurality of such cold storage modules mounted therein and a refrigerator vehicle

Background Art

- [2] A refrigerator includes an evaporator, a compressor and a condenser. The evaporator evaporates the low temperature/pressure refrigerant expanded while passing through the expansion valve absorbs heat from a space or an object which will be chilled. The evaporator is a type of heat exchangers.
- [3] The compressor changes the low pressure refrigerant into a high pressure refrigerant and transmits the high pressure refrigerant into the condenser. The condenser chills the high temperature/pressure refrigerant compressed by the compressor and condenses by cold into a liquid to re-transmit the condensed liquid to the evaporator.
- [4] Typically, such the refrigerator having the structure mentioned above is mounted in a refrigerator container vehicle for transporting loads kept fresh or public transportation for transporting passengers.
- [5] As the refrigerator is mounted in the refrigerator container vehicle, an overall weight of the vehicle has to increase and the engine force generated while driving has to be partially used as a driving source of the refrigerator. Accordingly, the vehicle driving efficiency of the vehicle might deteriorate.
- [6] Considering only the driving efficiency of the vehicle, an auxiliary driving source only for the driving the refrigerator provided in the vehicle can solve the disadvantage. However, the vehicle price has to increase and the vehicle weight has to increase more such that fuel loss while the driving of the vehicle may increase to be even a cause of excessive noxious gas emission.
- [7] In the structural characteristic of the refrigerator, the refrigerator consists of several parts and it has causes of failures accordingly. Such failures of the refrigerator frequently generate damage on the loads which has to be kept fresh and gives incon-

venience to the passengers desiring pleasant trip.

- [8] Accordingly, there might be disadvantages of loss in transit, rise of logistical cost and service deterioration of public transportation.
- [9] To solve such the disadvantages generated by driving the refrigerator directly mounted in the vehicle and to efficiently use secondary power (e.g., midnight electric power), methods for efficient dispersion storage of electric power are under development.
- [10] For example, there are under development of a phase change cold storage material using endothermic reaction accompanied by phase change (e.g., dissolution and solidification) of a material as a heating medium and development of a cold storage module or cold storage system using the phase change cold storage material.
- [11] The cold storage system may have two usage objects. One of the objects is to drive a heat source device (e.g., a refrigerator) for generating cold and heat in a cold storage system in a time having a low power consumption, using midnight electric power as one of energy usage rationalization methods, so as to store coldness and to maintain cooling, refrigerating and freezing, using the cold and heat source stored in a cold state in a time range with high electric power demand, so as to stabilize supply and demand of national electric power.
- [12] The other object is to maintain a high quality in processes of processing, storing and transporting products by providing an uniform temperature cold and heat source to a system requiring cooling, refrigerating and freezing, in comparison with a conventional system, or to improve a performance or economic feasibility of an entire system by uniformly cooling a heat generation unit provided in each of various systems.
- [13] Moreover, cold storage technology may be widely applied to aerospace engineering, high tech weapon control, electronic engineering, communication, biology, medical industry, clothes for special needs and so on.
- [14] The core of the cold storage technology is a phase change material (PCM) that changes a phase in specific ranges of temperatures and the latent heat may be stored as much as the phase change enthalpy accompanying with the phase change. At this time, the phase change material is referred to as a phase change cold storage material.
- [15] The phase change cold storage material accumulating coldness emits coldness, when necessary. Such the phase change cold storage material is fabricated, using inorganic-based materials (e.g., inorganic salt and inorganic water-molecule containing salt) or organic-based materials (e.g., paraffin and polyethylene and alcohol).
- [16] An inorganic-based material advantageously has a high heat conductivity and a much quantity of latent heat than, with a small volume change rate, compared with an organic-based material.
- [17] The cold storage module is typically fabricated of a metallic container filled with a

phase change cold storage material, considering fabrication cost or heat transfer efficiency.

[18] In case of using the metallic container, the container might be disadvantageously corroded with reaction with the phase change cold storage material by activation of metallic ions.

[19] Especially, if such corrosion is rapidly processing, the container might be deformed severely or even damaged.

[20] To solve such deformation or damage of the container, an anti-corrosion material is coated on the metallic container and a fabrication process of the metallic container cannot help being complicated and raising the fabrication cost.

[21] Technology of fabricating the container formed of a high polymer is developed accordingly.

[22] In other words, the container is fabricated in methods of gas assisted injection molding or injection molding, using a polyethylene-based material having a good low temperature characteristic (e.g., low density polyethylene, linear low density polyethylene and high density polyethylene).

Disclosure of Invention

Technical Problem

[23] The container formed of such a high polymer may be fabricated in various shapes easily, compared with the metallic container. However, such the high polymer container has a poor heat characteristic of thermal energy storage or emission and a weaker mechanical property, compared with the metallic material.

[24] Accordingly, the most urgent priority for the cold storage module having the container filled with the phase change cold storage material is to develop an optimized container in consideration of fabrication cost and thermal energy emission.

[25] Moreover, there are increasing demands for technology of transmitting the cold heat to the phase change cold storage material rapidly while accumulating the cold heat, using the phase change cold storage material filled in the container of the cold storage module or technology of transmitting the phase change cold storage material uniformly and simultaneously.

[26] Exemplary embodiments of the present disclosure provide a cold storage module having a mesh metal structure of a unequal gap in a cold storage system using a phase change cold storage material, which may optimize a thermal energy transfer characteristic by transferring cold heat to a phase change cold storage material filled therein rapidly and uniformly, a refrigerator container having a plurality of such cold storage modules mounted therein and a refrigerator vehicle.

[27] Exemplary embodiments of the present disclosure also provide a cold storage module

having a mesh metal structure of a unequal gap in a cold storage system using a phase change cold storage material, which may minimize structural transformation of a container while providing optimized efficiency in cold storage and cold emission, a refrigerator container having a plurality of such cold storage modules mounted therein and a refrigerator vehicle.

Solution to Problem

- [28] To achieve these objects and other advantages and in accordance with the purpose of the invention, as embodied and broadly described herein, a cold storage module comprising a mesh metal of an unequal gap structure includes a housing comprising a phase change material (PCM) provided therein; a heat exchange pipe arranged through the housing, in which a low temperature refrigerant flows to cool the phase change material; and a mesh metal configured to transfer a cold heat energy generated from the heat exchange pipe to the phase change material in the housing, wherein the mesh metal comprises a plurality of wires alternatively coupled to each other in unequal gaps.
- [29] The plurality of the wires may include horizontal wires arranged in a horizontal direction and vertical wires arranged in a vertical direction.
- [30] One or more of the horizontal wires may contact with an outer circumferential surface of the heat exchange pipe.
- [31] One or more of the vertical wires may contact with an outer circumferential surface of the heat exchange pipe.
- [32] Gaps between each two neighboring ones of the horizontal wires and gaps between each two neighboring ones of the vertical wires may be getting narrower outwardly from an outer circumferential surface of the heat exchange pipe.
- [33] When the outermost one of the horizontal wires from the outer circumferential surface is defined as N wire and the outermost one of the vertical wires from the outer circumferential surface is defined as M wire, a gap between an inner lateral surface of the housing and the N wire may be corresponding to a gap between the K wire and the (K-1) wire of the horizontal wires and a gap between a bottom or top surface of the housing and the M wire is corresponding to a gap between the k wire and the (k-1) wire of the vertical wires. The K may be $1 \leq K \leq N$ and the k may be $1 \leq k \leq M$.
- [34] The plurality of the wires may be formed of a metallic material comprising copper and stainless steel.
- [35] The housing may be fabricated of a carbon fiber-based material, a graphite fiber-based material or a glass fiber-based material.
- [36] The housing may be formed of a compound combined with one of the carbon fiber-based material and the graphite fiber-based material and Cyclic Butylenes

Terephthalate (CBT).

- [37] The heat exchange pipe may be formed of a metallic material comprising copper and aluminum.
- [38] A longitudinal length of the housing corresponding to a direction in which the heat exchange pipe penetrates may be relatively larger than a traverse length.
- [39] Air or inert gas may be injected into a spare space inside the housing except the space filled with the phase change material.
- [40] An internal pressure of the housing may be a minus pressure.
- [41] In another aspect, a refrigerator container comprising a plurality of cold storage modules mounted therein comprises the plurality of the cold storage modules mounted in an upper portion thereof.
- [42] The plurality of the arranged cold storage modules may include first to P cold storage modules, and the heat exchange pipe may be connectedly arranged between two neighboring ones of the first to P cold storage modules and a heat exchange pipeline in which the refrigerant flows from the first cold storage module to the P cold storage module is formed.
- [43] A refrigerant outlet hole for exhausting a refrigerant and a refrigerant inlet hole for drawing the refrigerant may be provided in a lateral portion of the refrigerator container, and an inlet hole of a heat exchange pipe provided in the first cold storage module may be connected to the refrigerant inlet hole and an outlet hole of a heat exchange pipe provided in the P cold storage module is connected to the refrigerant outlet hole.
- [44] The refrigerant inlet hole and the refrigerant outlet hole may be provided to connect the refrigerator container to a refrigerator provided outside the refrigerator container.
- [45] The heat exchange pipeline may include heat exchange pipes provided in the first to P cold storage modules, respectively; and a U-pipe configured to connect predetermined ones of the first to P cold storage modules to each other.
- [46] In a further aspect, a refrigerator container vehicle includes the refrigerator container mounted therein.

Advantageous Effects of Invention

- [47] According to the present disclosure, the thermal energy transfer characteristic may be maximized, using the mesh metal of the unequal gap structure. Accordingly, the cold heat may be transmitted to the phase change material rapidly and uniformly.
- [48] Furthermore, the time taken to accumulate the cold heat may be reduced by the uniform transfer of the cold heat to the phase change material. In other words, the mesh metal of the unequal gap structure is provided and the time taken for the temperature of the phase change material to reach a freezing temperature point is getting

shorter. Accordingly, the refrigerating cycle or the freezing cycle may be reduced and it is advantageous to keep loads fresh.

[49] Still further, the housing filled with the phase change material is fabricated of the compound having a predetermined strength and ductility (the compound of the fiber-based material and CBT) to make an internal pressure be a minus pressure (-P). Accordingly, a structural deformation of the housing may be minimized and the housing is subject to deformation or damage of the cold storage module. Also, the housing formed of the metallic material is secure from corrosion.

[50] Still further, the refrigerator driven by a surplus electric power such as midnight electric power is provided and it is advantageous to use the energy efficiently.

[51] Additional advantages, objects, and features of the invention will be set forth in part in the description which follows and in part will become apparent to those having ordinary skill in the art upon examination of the following or may be learned from practice of the invention. The objectives and other advantages of the invention may be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

Brief Description of Drawings

[52] Arrangements and embodiments may be described in detail with reference to the following drawings in which like reference numerals refer to like elements and wherein:

[53] FIG. 1 is a perspective diagram illustrating a unit structure of a cold storage module according to exemplary embodiments of the present disclosure;

[54] FIG. 2 is a front view of the cold storage module according to the exemplary embodiment of the present disclosure;

[55] FIG. 3 is a longitudinal sectional diagram of a cold storage module having an unequal gap mesh metal structure according to one embodiment of the present disclosure;

[56] FIG. 4 is a longitudinal sectional diagram of a cold storage module having an unequal gap mesh metal structure according to another embodiment of the present disclosure;

[57] FIG. 5 is a perspective diagram of the cold storage module having the unequal gap mesh metal structure according to one embodiment of the present disclosure;

[58] FIG. 6 is a diagram illustrating phase change of a phase change material in the cold storage module according to the exemplary embodiments of the present disclosure;

[59] FIG. 7 is a horizontal sectional diagram of a refrigerator container having a plurality of cold storage modules according to one embodiment of the present disclosure;

[60] FIG. 8 is a horizontal sectional diagram of a refrigerator container having a plurality

of cold storage modules according to another embodiment of the present disclosure;
and

- [61] FIG. 9 is a diagram illustrating the structure in which the plurality of the cold storage modules is mounted in the refrigerator container according to the embodiment.

Best Mode for Carrying out the Invention

- [62] Exemplary embodiments of the disclosed subject matter are described more fully hereinafter with reference to the accompanying drawings. The disclosed subject matter may, however, be embodied in many different forms and should not be construed as limited to the exemplary embodiments set forth herein. Rather, the exemplary embodiments are provided so that this disclosure is thorough and complete, and will convey the scope of the disclosed subject matter to those skilled in the art. In the drawings, the size and relative sizes of layers and regions may be exaggerated for clarity. Like reference numerals in the drawings denote like elements.
- [63] Exemplary embodiments of the disclosed subject matter are described herein with reference to cross-section illustrations that are schematic illustrations of idealized embodiments (and intermediate structures) of the disclosed subject matter. As such, variations from the shapes of the illustrations as a result, for example, of manufacturing techniques and/or tolerances, are to be expected. Thus, exemplary embodiments of the disclosed subject matter should not be construed as limited to the particular shapes of regions illustrated herein but are to include deviations in shapes that result, for example, from manufacturing. It will be further understood that terms, such as those defined in commonly used dictionaries, should be interpreted as having a meaning that is consistent with their meaning in the context of the relevant art and will not be interpreted in an idealized or overly formal sense unless expressly so defined herein.
- [64] Hereinafter, exemplary embodiments of a cold storage module having an unequal gap mesh metal structure, a refrigerator container having a plurality of cold storage modules mounted therein and a refrigerator container vehicle are described in detail.
- [65] The present disclosure describes a cold storage module mounted in a refrigerator container and a vehicle having the refrigerator container mounted therein. However, the present disclosure may be broadly applied to a cold storage type freezer, a refrigerator, a refrigerator vehicle, a refrigerator container and a movable refrigerator container.
- [66] FIG. 1 is a perspective diagram illustrating a unit structure of a cold storage module according to exemplary embodiments of the present disclosure and FIG. 2 is a front view of the cold storage module according to the exemplary embodiment of the present disclosure.

- [67] Referring to FIGS. 1 and 2, the cold storage module 100 includes a housing 10 having a phase change material (PCM) 20 and a heat exchange pipe 30 arranged through the housing 10.
- [68] The housing 10 is corresponding an airtight container filled with the phase change material 20 and it may be formed of a thermal carbon fiber-based material or a graphite fiber-based material.
- [69] Especially, the housing 10 may be formed of a compound mixed with a carbon fiber based material, a graphite fiber-based material and glass fiber-based material and Cyclic Butylenes Terephthalate (CBT). Or, the housing 10 may be formed of a compound of combining one of the carbon fiber-based or graphite fiber-based material with nylon material.
- [70] Preferably, the housing 10 may be fabricated of a compound synthesizing the glass fiber-based material with CBT.
- [71] The material combined with the fiber-based material and BT to have a matrix structure with a predetermined rigidity and ductility may be used in fabricating the housing 10. As the housing 10 is fabricated of such the compound, an outer wall of the housing 10 may be thin. For example, the thickness of the housing 10 may be 0.5 ~ 1.0mm.
- [72] In the embodiment, the housing 10 has a quadrilateral shape, especially, a rectangular shape. The shape of the housing is not limited thereto and various shapes may be possible.
- [73] The housing includes a mounding portion 11 having an upper surface extended outwardly and a lower surface.
- [74] The mounding portion 11 includes one or more coupling holes 12 enabling a cold storage module 100 coupled in a predetermined coupling portion. At this time, the coupling portion shown in FIGS. 7, 8 and 9 may be an inner top surface of a refrigerator container and the cold storage module 100 may be coupled by a screw via the one or more coupling holes.
- [75] As the housing 10 is formed in the rectangular shape, the heat exchange pipe 30 penetrates two lateral surfaces of the housing 10 facing each other.
- [76] It is preferred that the heat change pipe 30 penetrate central portions of the two lateral surfaces facing each other in the housing 10 to disperse the cold transferred to the housing 10 uniformly.
- [77] Especially, the heat exchange pipe 30 penetrates in a longitudinal direction having a relatively large length. In other words, the heat exchange pipe 30 penetrates the two lateral surfaces which compose the width of the housing 10.
- [78] In another embodiment, the housing 10 may include a circular upper plane portion and a hemispheric-shaped container provided under the upper plane portion. That is

considering that a circular structure has the highest heat radiation area than the other structures including a rectangular structure. The hemispheric container is filled with the phase change material.

- [79] The housing 10 is filled with the phase change material 20 which is the material emitting cold if necessary after accumulating cold heat from a refrigerant flowing in the heat exchange pipe 30 as a fluid.
- [80] The heat exchange pipe 30 may be formed of a metallic material containing copper and aluminum with a high heat conductivity.
- [81] A heat insulation material may be coated on a predetermined portion of the heat exchange pipe 30 exposed outside the housing 10.
- [82] The phase change material 20 has a freezing temperature below $-26 \sim -29$. The phase change material 20 storing cold below the freezing temperatures and accumulating the cold may emit the cold, when a temperature nearby is over the freezing temperatures by the deteriorated cooling ability of the phase change material.
- [83] The phase change material 20 may not be filled in an internal space of the housing 10 by 100%. In other words, there may be a spare except the space filled with the phase change material 20.
- [84] Air or inert gas may be injected into the spare space and the spare space may be used in heat insulation. Specifically, when the cold storage module 100 is mounted via the coupling hole 12 provided in the mounting portion 11, the top surface of the housing 10 is coupled to the coupling portion and the top surface of the housing 10 may be affected by the heat sucked from outside, compared with the bottom surface and the lateral surfaces. Accordingly, the top surface of the housing 10 requires an auxiliary heat insulation structure and the spare space inside the housing 10 may satisfy such an auxiliary heat insulation structure.
- [85] The phase change material 20 may be fabricated of an inorganic-based material (e.g., inorganic salt and inorganic-based water molecule containing material), an organic-based material (e.g., paraffin, polyethylene and alcohol) or a compound mixed with the inorganic-based material and the organic-based material. The material of the phase change material 20 may not be limited thereto.
- [86] Examples of the compounds combined with the inorganic-based material and the organic-based material include water and urea or other additional agents may be used in forming Eutectic Point or Cryohydric Point as the freezing temperature.
- [87] Urea used in the compound of the inorganic-based material and the organic-based material is water-soluble. When urea dissolves in water, a much quantity of urea dissolves with heat generation reaction. Accordingly, in the present disclosure, the phase change material 20 containing Urea dissolved in water is filled in the housing 10 basically. Here, the water may be distilled water.

- [88] Alternatively, the phase change material 20 formed of the compound of Urea dissolved in water and an additional material formed of A_xB_y may be filled in the housing 10.
- [89] In the material of A_xB_y , A refers to a metallic element contained in Na, Mg, K, Ca and Ba and B refers to Cl, CO_3 , NO_3 , SO_4 , OH and $COOH$. x and y refer to 1 or 2.
- [90] The additional material of A_xB_y is dissolved in water in an ionized state (a negative ion state or a positive ion state) and has an effect of lowering the freezing temperature point of the solution having the additional material of A_xB_y .
- [91] In the present disclosure, the compound mixed of Urea dissolved in water may be used as the phase change material 20 according to the use purpose of the cold storage module 100.
- [92] When a relatively low phase change temperature is required, the compound of Urea dissolved in water and the additional material of A_xB_y mentioned above may be used as the phase change material 20.
- [93] The internal space of the housing filled with the phase change material 20 may have a minus pressure (-P). That is to prevent expansion generated in the lower portion or the lateral portion of the housing 10 by volume change generated in cooling the phase change material 20, as the housing 10 is formed of the composite material having a predetermined strength and a predetermined ductility.
- [94] A minus pressure (-P) is applied to the spare space except the space filled with the phase change material 20 in the housing 10, such that an internal pressure is formed in the housing 10.
- [95] Meanwhile, the quantity of the phase change material 20 filled in the space of housing 10 except the spare space is determined at a ratio set to minimize the deformation of the housing 10 according to a rate of volume increase, when the phase change material 20 is cooled. For example, the phase change material 20 may be filled by 90 ~ 95% of the internal volume of the housing 10.
- [96] The heat exchange pipe 30 is the pipe in which a low temperature refrigerant flows to cool the phase change material 20 filled in the housing 10 and it penetrates the housing 10.
- [97] As the heat exchange pipe 30 penetrates the housing 10, a leakage preventing member 31 may be provided to prevent the phase change material 20 from leaking through the housing 10.
- [98] The leakage preventing member 31 is provided in a coupled portion between the heat exchange pipe 30 and the lateral surface of the housing 10.
- [99] The heat exchange pipe 30 includes an inlet hole 34 for drawing the refrigerant and an outlet hole 35 for exhausting the refrigerant. Coupling members 32 and 33 are provided in the inlet hole 34 and the outlet hole 35, respectively.

- [100] The coupling members 32 and 33 are configured to connect two heat exchange pipes with each other so as to form a heat exchange pipe line 300 which will be described later.
- [101] Meanwhile, the heat exchange pipe line 300 may be formed by coupling the heat exchange pipes, regardless of the directions of the inlet hole 34 and the outlet hole 35 provided in the cold storage module 100. That is because the structure of the cold storage module 100 has the symmetrical structure shown in FIGS. 1, 2, 3 and 4.
- [102] FIG. 3 is a longitudinal sectional diagram of a cold storage module having an unequal gap mesh metal structure according to one embodiment of the present disclosure. FIG. 4 is a longitudinal sectional diagram of a cold storage module having an unequal gap mesh metal structure according to another embodiment of the present disclosure. FIG. 5 is a perspective diagram of the cold storage module having the unequal gap mesh metal structure according to one embodiment of the present disclosure.
- [103] Referring to FIGS. 3, 4, and 5, the cold storage module 100 according to the embodiments of the present disclosure includes an unequal gap mesh metal 40 provided in the housing 10.
- [104] The mesh metal 40 consists of a plurality of wires alternatively coupled to each other in unequal gaps to distribute the cold heat energy to the phase change material 20 filled in the housing 10 uniformly.
- [105] The plurality of the wires consists of horizontal wires and vertical wires. Specifically, the horizontal wires are arranged in a horizontal direction and gaps are getting smaller toward outer portions from an outer circumferential surface of the heat exchange pipe 30. The vertical wires are arranged in a vertical direction and gaps between each two of them are getting smaller toward outer portions from the outer circumferential surface of the heat exchange pipe 30.
- [106] The reason why the gaps between the horizontal wires and the gaps between the vertical wires are formed getting narrower from the heat exchange pipe 30 is the heat transfer characteristic which is in inverse proportion to a distance from the heat exchange pipe 30. In other words, as getting farther from the heat exchange pipe 30, the cold heat transferred to the phase change material 20 is getting reduced more and more.
- [107] The outermost wire of the horizontal wires from the outer circumferential surface of the heat exchange pipe 30 is defined as N wire and the outermost wire of the horizontal wires from the outer circumferential surface of the heat exchange pipe 30 is defined as M wire. In this instance, a gap between the first one and the second one of the vertical wires is a and a gap between the second wire and the third wire is b. A gap between the third vertical wire and the fourth vertical wire is c. A relation of the sizes among a, b

and c may be $a > b > c$. When a gap between the first one and the second one of the horizontal wires is A and a gap between the second horizontal wire and the third horizontal wire is B, a relation of the sizes between A and B may be $A > B$.

[108] However, a gap between the N wire and an inner lateral surface of the housing 10 or a gap between the M wire and the bottom or top surface of the housing 10 are not getting smaller unlimitedly.

[109] For example, when the outermost one of the horizontal wires from the outer circumferential surface of the heat exchange pipe 30 is defined as the N wire and the outermost one of the vertical wires from the outer circumferential surface of the heat exchange pipe 30 is defined as the M wire, a gap between the N wire and the inner lateral surface of the housing 10 may be corresponding to a gap between the K horizontal wire and the (K-1) horizontal wire. A gap between the bottom surface of the housing 10 and the M wire may be corresponding to a gap between the k vertical wire and the (k-1) vertical wire. At this time, K may be $1 \leq K \leq N$ and k may be $1 \leq k \leq M$.

[110] For example, the gap between the inner lateral surface of the housing 10 and the N wire may be one of the gaps between any two wires of the horizontal wires. Also, the gap between the bottom surface of the housing 10 and the M wire may be one of gaps between any two vertical wires. It is preferred that the gap between the inner lateral surface of the housing 10 is corresponding to the gap between the N wire and the (N-1) wire of the horizontal wires and that the gap between the bottom surface of the top surface of the housing 10 and the M wire is corresponding to a gap between the M wire and the (M-1) wire of the vertical wires.

[111] FIG. 6 is a diagram illustrating phase change of a phase change material cold storage material in the cold storage module according to the exemplary embodiments of the present disclosure. Case 1 shows phase change of the phase change material when an equal gap mesh metal structure is applied and Case 2 shows phase change of the phase change material when an unequal gap mesh metal structure is applied.

[112] The phase change time of the phase change material 20 when the mesh metal 40 with the equal gap structure is applied is longer than the phase change time of the phase change material when the mesh metal 40 with the unequal gap structure is applied, in the phase change between liquid-solid states of the phase change material 20 by the mesh metal 40 within the housing 10.

[113] The mesh metal 40 is a medium for transferring the thermal energy of the refrigerant flowing in the heat exchange pipe 30 to the phase change material 20 uniformly. Considering the overall weight of the cold storage module 100, the metal 40 is formed in a mesh shape.

[114] At least one of ends of the mesh metal 40 may be directly in contact with the heat exchange pipe 30 and the mesh metal 40 is distributed to an entire inner space of the

housing 10. Specifically, one or more of the horizontal wires provided in the mesh metal 40 are in contact with the outer circumferential surface of the heat exchange pipe 30 or one or more of the vertical wires provided in the mesh metal 40 are in contact with the outer circumferential surface of the heat exchange pipe 30. The horizontal wires and the vertical wires are alternatively coupled to each other, one or more of the entire wires may contact with the heat exchange pipe 30.

- [115] However, to transfer the thermal energy of the refrigerant from the heat exchange pipe 30 uniformly, two of the horizontal wires are arranged to contact with an upper portion and a lower portion of the outer circumferential surface of the heat exchange pipe 30, respectively, and two of the vertical wires are arranged to contact with a left portion and a right portion of the outer circumferential surface, respectively.
- [116] FIG. 3 shows the horizontal wires and the vertical wires in contact with the outer circumferential surface of the heat exchange pipe 30 in parallel with a tangent line and FIG. 4 shows the horizontal wire and the vertical wires in contact with the outer circumferential surface of the heat exchange pipe 30 with respect to a normal line.
- [117] The mesh metal 40 is fabricated of a metallic material and it may be formed of copper or stainless steel with a high heat conductivity.
- [118] Unless the mesh metal 40 is provided in the cold storage module 100, the phase change material 20 is cooled near the heat exchange pipe 30 where the low temperature refrigerant is flowing first. Then, as the phase change material 20 is frozen around the heat exchange pipe 30 first, an iced layer is formed around the heat exchange pipe 30 and the iced layer performs heat insulation for shutting the heat insulation via the heat exchange pipe 30, which might be the cause of disturbing the cold heat from being transferred to the housing uniformly.
- [119] The mesh metal 40 may transfer the cold heat to the phase change material uniformly, even when the phase change of the phase material is changed near the heat exchange pipe 30.
- [120] Accordingly, the iced layer is formed in the mesh metal 40 as well as around the heat exchange pipe 30, such that the cold heat can be transferred to freeze the phase change material in the cold storage module 100 uniformly.
- [121] FIG. 7 is a horizontal sectional diagram of a refrigerator container having a plurality of cold storage modules according to one embodiment of the present disclosure and FIG. 8 is a horizontal sectional diagram of a refrigerator container having a plurality of cold storage modules according to another embodiment of the present disclosure.
- [122] FIG. 9 is a diagram illustrating the structure in which the plurality of the cold storage modules is mounted in the refrigerator container according to the embodiment. FIG. 9 illustrates a vehicle in which the refrigerator container shown in FIG. 7 is mounted.
- [123] FIGS. 7 and 8 are diagrams illustrating that a plurality of unit cold storage modules

- 100 are arranged in an upper portion of the refrigerator container 200.
- [124] The plurality of the cold storage modules 100 may be arranged in A rows and B columns. Hereafter, the plurality of the cold storage modules arranged in the upper portion of the refrigerator container 200, specifically, on the ceiling of the refrigerator container 200 may include first to P cold storage modules.
- [125] In the present disclosure, the plurality of the cold storage modules 100 arranged in the upper portion of the refrigerator container 200 may have a higher heat insulation effect, compared with the cold storage modules arranged in a lateral portion or a lower portion of the refrigerator container 200.
- [126] FIG. 7 shows that eight unit cold storage modules 100 are arranged in four rows and two columns with respect to the position of the refrigerator 500. FIG. 8 shows that eight unit cold storage modules are arranged in two rows and fourth columns with respect to the position of the refrigerator 500.
- [127] The arrangement structure and the number of the cold storage modules 100 may be determined based on an overall area of the ceiling of the refrigerator container 200 and not limited to a specific arrangement structure.
- [128] First to P cold storage modules are connected with each other in the refrigerator container 200 such that one heat exchange pipe line 300 can be formed to flow the refrigerator therein.
- [129] The heat exchange pipe line 300 are formed of heat exchange pipes connected between two neighboring ones of the first to P cold storage modules. The heat exchange pipe line 300 includes the heat exchange pipes provided in the first to P cold storage modules, respectively, and it further includes a U-pipe 310 for connecting two of the first to P cold storage modules.
- [130] Neighboring cold storage modules of the heat exchange pipeline 300 are connected with each other by connection members 32 and 33 and predetermined cold storage modules are connected by the U-pipe 310.
- [131] As the plurality of the cold storage modules are arranged and connected with each other, the heat exchange pipeline 300 includes one or more U-pipes 310 corresponding to a gently curved portion, such that the heat exchange pipeline 300 can have a gently curved zigzag shape.
- [132] The refrigerator container 200 includes a refrigerant inlet hole 210 formed in a lateral portion thereof to draw the refrigerant and a refrigerant outlet hole 220 formed to exhaust the refrigerant. At this time, the refrigerant inlet hole 210 and the refrigerant outlet hole 220 may be connected to the refrigerator 500 provided outside the refrigerator container 200. Especially, an inlet hole of the heat exchange pipe provided in the first one of the first to P cold storage modules is connected to the refrigerant inlet hole 210 and an outlet hole of the heat exchange pipe provided in the P cold storage

- module which is the last storage module is connected to the refrigerant outlet hole 220.
- [133] The refrigerator 500 may be connected to the refrigerant inlet hole 210 and the refrigerant outlet hole 220 via a connection pipe, such that the refrigerant may be circulated via the heat exchange pipeline 300 passing the heat exchange pipes of the first to P cold storage modules and the refrigerant outlet hole 220.
- [134] The refrigerator 500 is driven by the dump electric power (e.g., midnight electric power) and the cold heat is circulated via the heat exchange pipeline mentioned above. Accordingly, the refrigerator 500 is proper for efficient energy usage.
- [135] As shown in FIG. 9, the refrigerator container 200 in which the plurality of the cold storage modules are mounted is mounted in the vehicle. Accordingly, fuel loss of the refrigerator container vehicle can be reduced. The refrigerator 500 additionally provided outside is driven in a midnight time zone and the cold storage is processed in the refrigerator 500. Accordingly, the driving of the vehicle is not requested so as to perform the cold storage and no harmful gas is emitted.
- [136] According to the embodiments of the present disclosure, the thermal energy transfer characteristic may be maximized, using the mesh metal structure with the unequal gap. The cold heat is transferred to the phase change material filled in the cold storage module rapidly and uniformly at the same time. Accordingly, the time taken to accumulate the cold heat can be reduced. In other words, the mesh metal with the unequal gap structure is provided and the time taken for the temperature of the phase change material to reach the freezing temperature point may be reduced. Accordingly, the refrigerating cycle or freezing cycle can be reduced and freshness of loads loaded in the container can be kept.
- [137] 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.
- [138] 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.

Mode for the Invention

- [139] 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.

[140] 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

- [Claim 1] A cold storage module comprising a mesh metal of an unequal gap structure comprising:
a housing comprising a phase change material (PCM) provided therein;
a heat exchange pipe arranged through the housing, in which a low temperature refrigerant flows to cool the phase change material; and
a mesh metal configured to transfer a cold heat energy generated from the heat exchange pipe to the phase change material in the housing, wherein the mesh metal comprises a plurality of wires alternatively coupled to each other in unequal gaps.
- [Claim 2] The cold storage module according to claim 1, wherein the plurality of the wires comprises horizontal wires arranged in a horizontal direction and vertical wires arranged in a vertical direction.
- [Claim 3] The cold storage module according to claim 2, wherein one or more of the horizontal wires contact with an outer circumferential surface of the heat exchange pipe.
- [Claim 4] The cold storage module according to claim 2, wherein one or more of the vertical wires contact with an outer circumferential surface of the heat exchange pipe.
- [Claim 5] The cold storage module according to claim 1, wherein gaps between each two neighboring ones of the horizontal wires and gaps between each two neighboring ones of the vertical wires are getting narrower outwardly from an outer circumferential surface of the heat exchange pipe.
- [Claim 6] The cold storage module according to claim 5, wherein when the outermost one of the horizontal wires from the outer circumferential surface is defined as N wire and the outermost one of the vertical wires from the outer circumferential surface is defined as M wire, a gap between an inner lateral surface of the housing and the N wire is corresponding to a gap between the K wire and the (K-1) wire of the horizontal wires and a gap between a bottom or top surface of the housing and the M wire is corresponding to a gap between the k wire and the (k-1) wire of the vertical wires, and the K is $1 \leq K \leq N$ and the k is $1 \leq k \leq M$.
- [Claim 7] The cold storage module according to claim 1, wherein the plurality of the wires are formed of a metallic material comprising copper and stainless steel.

- [Claim 8] The cold storage module according to claim 1, wherein the housing is fabricated of a carbon fiber-based material, a graphite fiber-based material or a glass fiber-based material.
- [Claim 9] The cold storage module according to claim 8, wherein the housing is formed of a compound combined with one of the carbon fiber-based material and the graphite fiber-based material and Cyclic Butylenes Terephthalate (CBT).
- [Claim 10] The cold storage module according to claim 1, wherein the heat exchange pipe is formed of a metallic material comprising copper and aluminum.
- [Claim 11] The cold storage module according to claim 1, wherein a longitudinal length of the housing corresponding to a direction in which the heat exchange pipe penetrates is relatively larger than a traverse length.
- [Claim 12] The cold storage module according to claim 1, wherein air or inert gas is injected into a spare space inside the housing except the space filled with the phase change material.
- [Claim 13] The cold storage module according to claim 1, wherein an internal pressure of the housing is a minus pressure.
- [Claim 14] A refrigerator container comprising the plurality of the cold storage modules according to one of claims 1 to 13 mounted in an upper portion thereof.
- [Claim 15] The refrigerator container according to claim 14, wherein the plurality of the arranged cold storage modules comprise first to P cold storage modules, and
the heat exchange pipe is connectedly arranged between two neighboring ones of the first to P cold storage modules and a heat exchange pipeline in which the refrigerant flows from the first cold storage module to the P cold storage module is formed.
- [Claim 16] The refrigerator container according to claim 15, wherein a refrigerant outlet hole for exhausting a refrigerant and a refrigerant inlet hole for drawing the refrigerant are provided in a lateral portion of the refrigerator container, and
an inlet hole of a heat exchange pipe provided in the first cold storage module is connected to the refrigerant inlet hole and an outlet hole of a heat exchange pipe provided in the P cold storage module is connected to the refrigerant outlet hole.
- [Claim 17] The refrigerator container according to claim 16, wherein the refrigerant inlet hole and the refrigerant outlet hole are provided to

connect the refrigerator container to a refrigerator provided outside the refrigerant container.

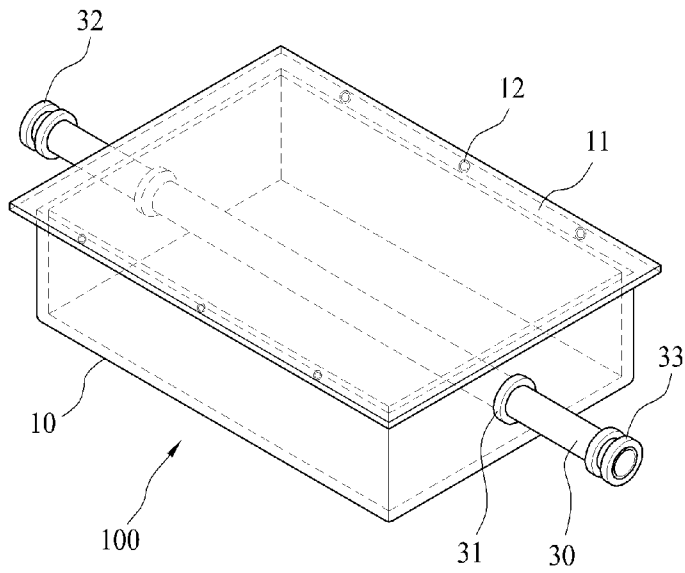
[Claim 18]

The refrigerator container according to claim 15, wherein the heat exchange pipeline comprises,
heat exchange pipes provided in the first to P cold storage modules, respectively; and
an U-pipe configured to connect predetermined ones of the first to P cold storage modules to each other.

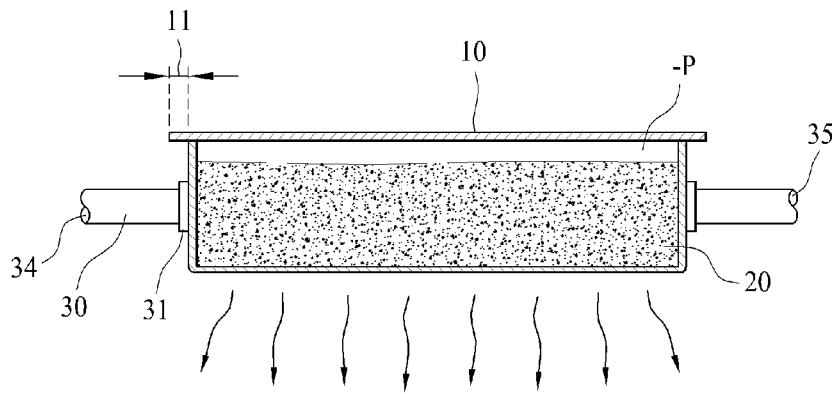
[Claim 19]

A refrigerator container vehicle comprising:
the refrigerator container mounted therein according to one of claims 14 to 18.

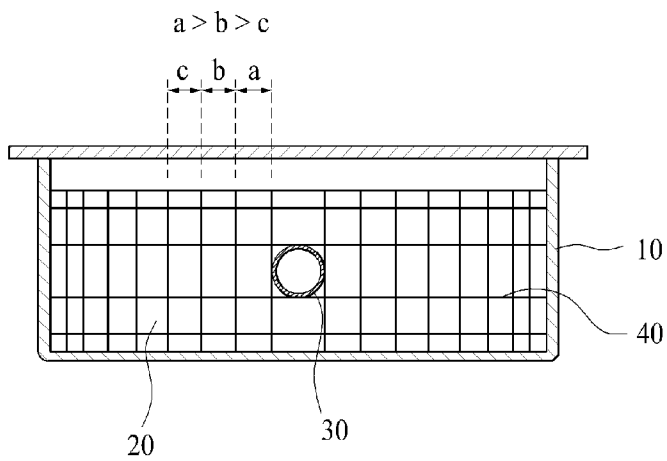
[Fig. 1]



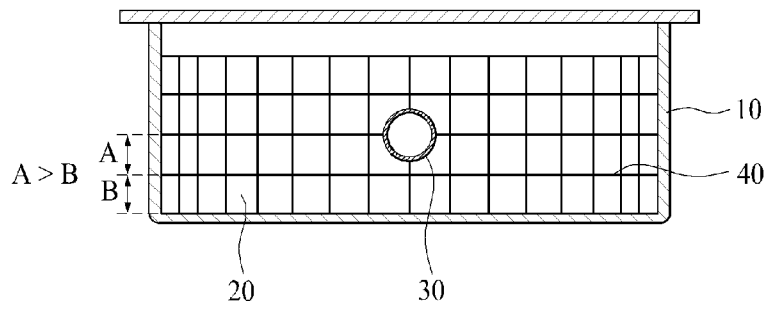
[Fig. 2]



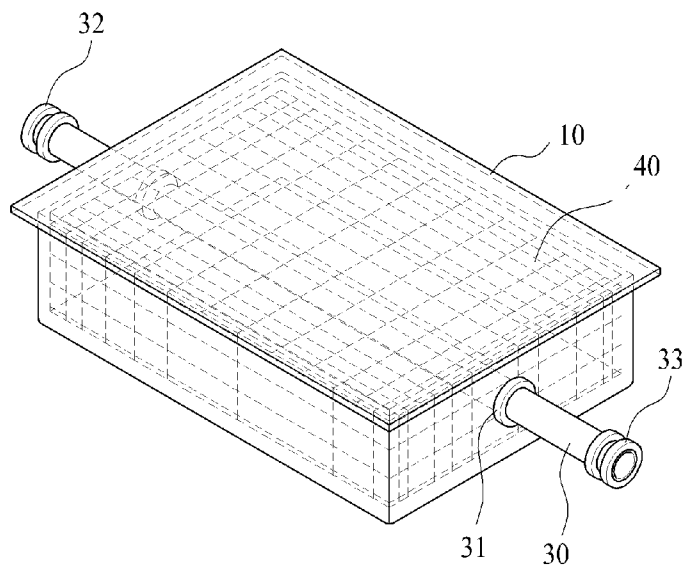
[Fig. 3]



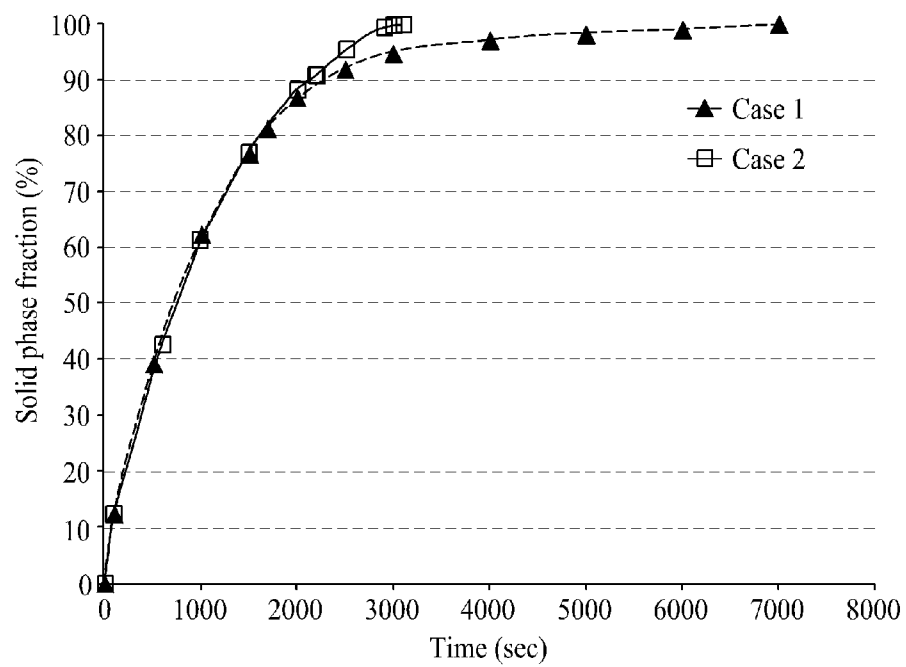
[Fig. 4]



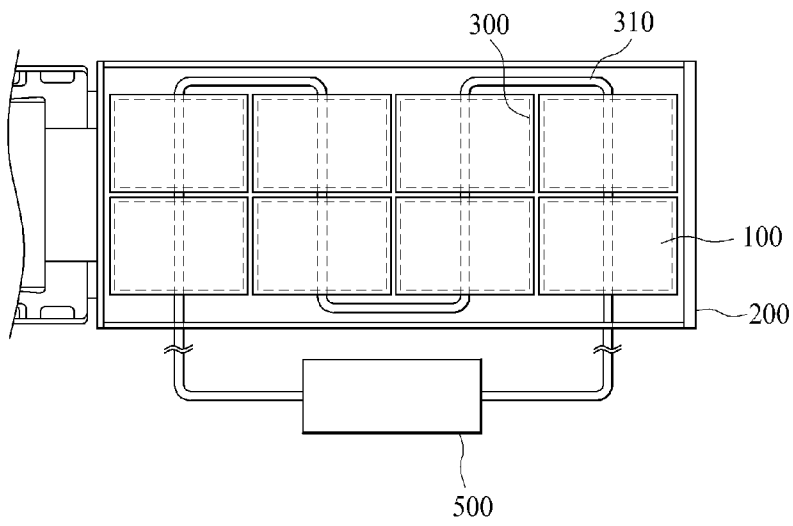
[Fig. 5]



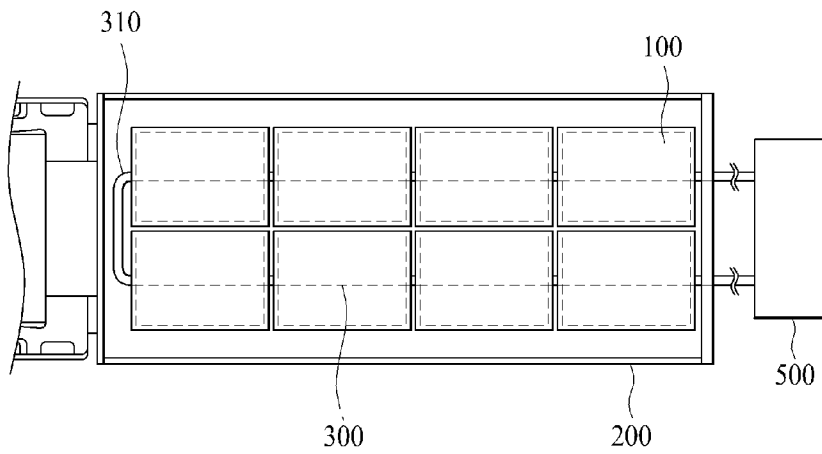
[Fig. 6]



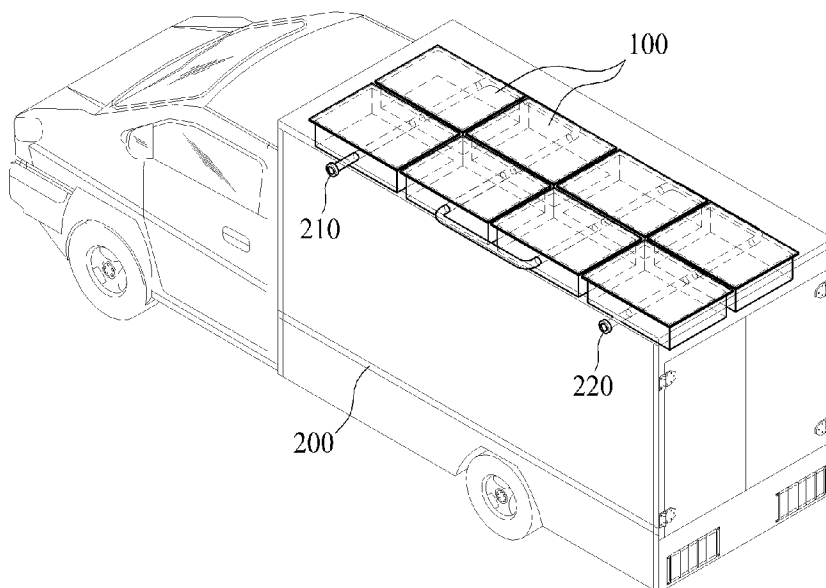
[Fig. 7]



[Fig. 8]



[Fig. 9]



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2013/011146**A. CLASSIFICATION OF SUBJECT MATTER****F28D 20/02(2006.01)i, B60P 3/20(2006.01)i, F25D 11/00(2006.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F28D 20/02; B60P 3/00; H05K 7/20; F25B 21/02; B60P 3/20; F25B 21/04; F28D 15/02; F25D 11/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & keywords: phase change material, cold storage, refrigerant, wire, pipe, and unequal mesh

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2012-112050 A1 (FLAMCO B.V.) 23 August 2012 See abstract; pages 4-8; claims 1-3, 28 and figures 1-5B.	1-19
Y	JP 2010-151354 A (SONY CORP.) 08 July 2010 See abstract; paragraphs 19-52 and figures 1-6.	1-19
Y	KR 10-1171848 B1 (FMS-KOREA CO., LTD.) 14 August 2012 See abstract; paragraphs 17-34 and figures 1-5.	14-19
A	US 2010-0157525 A1 (ULLMAN et al.) 24 June 2010 See abstract; paragraphs 30-50, 58-80 and figures 1-6.	1-19
A	WO 2005-019747 A1 (THE BOEING COMPANY) 03 March 2005 See abstract; pages 8-10, 12-15 and figures 1-12.	1-19



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier application or patent but published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

23 May 2014 (23.05.2014)

Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/KR2013/011146

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