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(54) REFRIGERATOR AND COOLING PROCESS

KÜHLSCHRANK UND KÜHLVERFAHREN

RÉFRIGÉRATEUR ET PROCÉDÉ DE REFROIDISSEMENT

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Description

[0001] The invention relates to a refrigerator comprising a cold storage, e.g., of a phase change material, in particular ice. The invention also relates to a process for cooling medicinal products, such as vaccines.

[0002] GB 2514622 A discloses a refrigerator with a thermal store ice bank. The refrigerator comprises two evaporators: a first one for cooling a cooling chamber and a second one for cooling the thermal store. The thermal store is used to improve the efficiency of the first evaporator cooling the cooling chamber. Fans circulate air through the cooling chamber and past the thermal store. The refrigerator comprises a battery to run the vapour compression system in the event of a power failure. In view of the power consumption of the vapour compression system, the battery should be large and can be used only for short power cuts.

[0003] CN 1773201 discloses a refrigerator with a cold storage and a battery for operation during power failure.

[0004] EP 1 236 960 discloses An apparatus particularly for preserving perishable products at a pre-set temperature, which comprises a chamber which is delimited by thermally insulating walls and accommodates heat exchanger means. The heat exchanger means comprise a heat accumulator which has at least one inner tubular element for the passage of a refrigerating fluid and at least one outer tubular element which surrounds the at least one inner tubular element and forms with it an interspace for containing a heat capacity mass. The outer surface of the outer tubular element defines the surface for heat exchange with the air inside the chamber.

[0005] US 4,951,481 discloses cold preserving container including an inner box forming a heat insulating chamber, an outer box, heat insulating material between the boxes, a cooling evaporating tube disposed on the outer surface of the inner box, and a cold accumulator enclosing a cold regenerative material and disposed between the evaporating tube and the heat insulating material. The cold accumulator directly contacts the evaporating tube substantially without any air therebetween and thus can be cooled rapidly and efficiently by the tube. The cold accumulator is disposed between the boxes, and thus its capacity can be easily increased, thereby increasing the cold preserving time of the container.

[0006] GB 2514622 discloses A refrigerated cabinet, which may have a door or may have an open front, uses a cold thermal store so as to be able to better cope with the high cooling loads. This is particularly useful for display cabinets intended for commercial premises or shops which have doors that may be used frequently. The refrigerator has a first evaporator through which a refrigerant flows to cool the chamber holding items, such as beverages. A phase change material acting as a thermal store is cooled by second evaporator through which refrigerant flows. The phase change material may be water that is cooled to form ice. The refrigerator may include an air fan to circulate cooled air past the thermal store which may be provide within a duct.

[0007] WO 2014/195720 discloses a cooling cabinet comprising: top, bottom and side walls having internal surfaces defining a storage enclosure; least one of said top or said sides comprising a door; a thermoelectric cooling device having a cold side in thermal contact with at least one of said internal surfaces for cooling the storage enclosure and a hot side opposite said cold side, wherein said hot side is covered by a thermal insulation material; a temperature sensor and a control device for maintaining a temperature in the range of from about l2°C to about 25°C in said storage enclosure, and a thermal diode having a heat input end in thermal contact with the hot side of said thermoelectric cooling device and underlying said thermal insulation material and a heat output end located outside said thermal insulation material.

[0008] US 2009/0064707 discloses a refrigeration appliance includes an insulated cabinet forming an interior cavity and a refrigeration system for cooling the interior cavity. A thermally conductive shelf forms a support surface within the interior cavity, and a thermal sink is operatively coupled to the conductive shelf. The thermal sink is adapted to facilitate the transfer of thermal energy from the thermally conductive shelf. In one example, the thermal sink includes a plurality of thermal sinks operatively coupled to the conductive shelf. In another example, the thermal sink is removable from the interior cavity.

[0009] WO 2004/059228 discloses a refrigerator comprising one or more doors for one or more compartments, and for one or more compartments between doors.

[0010] DE102010041952A1 discloses a refrigeration device, which has an inner container with a coolable interior for storing refrigerated goods, an air duct, a cold accumulator arranged within the air duct with a storage material, and a refrigeration circuit with an evaporator arranged in the air duct. The air duct and the coolable interior are separated from one another by a heat-insulating wall.

[0011] KR20150057109A discloses a refrigerator with a cold-storage material comprising: a refrigerator body wherein a storing compartment is formed; a door opening and closing the storage compartment; a cold-air circulating passage wherein the cold air of the storage compartment is circulated; the cold-storage material formed in the storage compartment or the cold-air circulating passage; a freezing cycle device including an evaporator arranged in the cold-air circulating passage and a compressor compressing a coolant; a circulating fan formed inside the cold-air circulating passage; a storage battery capable of charging and discharging and connected to the circulating fan to provide electricity to the circulating fan; and a control unit selectively controlling the freezing cycle device and the circulating fan to freeze the storage compartment by using one between the freezing cycle device and the cold-storage material. Accordingly, the present refrigerator is capable of reducing energy consumption by selectively controlling the freezing cycle device and the cold-storage material.

[0012] The drawback of these prior art systems is their relatively large energy consumption when they use the battery during a power cut. As a result, they can only deliver effective cooling during relatively short power cuts. Notwithstanding the cold storage, the temperature in the cooling chamber tends to increase gradually during longer power failures. This would make these systems unsuitable for cooling products that must be stored at very constant temperatures, such as for example vaccines.

[0013] In an ice-lined refrigerator for medicinal products, for example vaccines, the products often freeze over, because the temperature in the cooling chamber can locally be much lower than acceptable temperature limits for vaccines, causing vaccines to freeze and become useless. In countries with long power outages an extra icepack freezer is operational besides the normal ice-lined refrigerator to provide an extra buffer in case of power outages. Filling the refrigerator with icepacks is done manually, which leads to many failures to provide the necessary cooling, e.g. too late insertion of icepacks or incorrect placement of icepacks which may lead to freezing.

[0014] It is the object of the present invention to provide a refrigerator which facilitates rapid cooling and/or maintaining a constant and uniform cool temperature, e.g., close to the freezing point of water, during longer power failures without local temperature peaks. A further object, particularly in case of use for medicinal products, is to reduce or eliminate the need for icepack freezers.

[0015] The object of the invention is achieved with a refrigerator comprising:

- a cooling chamber
- a cold storage chamber in fluid communication with a top section and with a bottom section of the cooling chamber;
- a cold storage in the cold storage chamber
- a fan for circulating air through the cooling chamber and the cold storage chamber;
- a vapour compression system connectable to the mains comprising an evaporator in the cold storage;
- a battery operatively connected to the fan;
- a control unit configured to activate the battery to feed the fan in the event of a power failure of the mains.

[0016] It was found that heat exchange can significantly be improved, not by just increasing the amount of ice, but by using a cold storage having an heat exchange surface of at least 4 m^2, e.g., at least 6 m^2, e.g., at least 8 m^2, e.g., up to about 12 m^2 per m^3 of cooling chamber volume. It has been found that this results in a stable temperature difference of 4 K between the temperature of the cold storage and the temperature of cooled products in the cooling chamber. This allows for prolonged storage of sensitive products, such as vaccines, even in areas where there is at most 8 hours of electricity per day, as described in WHO PQS devices catalogue Prequalified equipment for the Expanded Programme on Immunization (EPI), published by World Health Organization, December 4, 2015.

[0017] If the ratio of heat exchange surface to volume of the cooling chamber is at least 4 m2/m3 any desired temperature can be obtained in relatively short time. If the heat exchange surface to volume ratio of the cooling chamber is below 12 m2/m3, the cooling chamber can be kept at the desired temperature during a sufficiently long time during a power cut.

[0018] It has also been found that a refrigerator with such a cold storage can cool down warm food or beverage products, such as fresh cow milk, in a very short time, even during power cuts.

[0019] In a specific embodiment the cold storage has a volume which is at least 10 % of the volume of the cooling chamber. Surprisingly, it was found that a cold storage with such a volume avoids the need to use a second evaporator to cool the cooling chamber. All cooling can be done via the cold storage, either during normal operation, e.g., after a reload with fresh foodstuff or drinks, or during a power failure. Even in case of an enduring power cut, e.g., lasting for 6 - 40 hours, the cooling chamber can still be kept at a very constant low temperature.

[0020] The cold storage volume can for example be at least 15 %, or at least 20 %, e.g., about 40 % of the volume of the cooling chamber.

[0021] The vapour compression system comprises a closed circuit of a compressor, a condenser, an expansion and an evaporator within the cold storage reservoir. A refrigerant is circulated through the system to absorb heat in the evaporator and to discharge heat at the compressor, which is typically positioned at an outer side of the refrigerator.

[0022] The cold storage will typically be a reservoir filled or fillable with a phase change material, such as water. The use of water has the advantage that the cold storage can be emptied or re-used by a user. To this end the cold storage may be provided with a drain at a lower side of the cold storage and/or a refill-opening at a top section of the cold storage. The refill opening may for example be accessible for a user via the cooling chamber. This way, the refrigerator can be transported when empty so its weight is minimized. Optionally, the water may comprise further constituents, such as agents adjusting the freezing point.

[0023] The cold storage comprises the evaporator of the vapour compression system. This results in very good heat transfer between the evaporator and the phase change material. Starting at the evaporator surface, an icebank will gradually grow until the full volume of the cold storage has frozen.

[0024] In a specific embodiment the cold storage chamber is positioned at a rear section of the refrigerator. For instance, the cold storage chamber may extend from a top side of the refrigerator to a bottom side of the re-

frigerator and have the same height as the cooling chamber. The cold storage may for example have the same height and/or the same width as the rear side of the cooling chamber. This maximizes the heat exchange surface of the cold storage.

[0025] The heat exchange surface of the cold storage can be increased by ribs. In a specific embodiment the ribs should be substantially parallel to a main air flow direction during use, so as reduce air flow resistance or turbulence.

[0026] In an alternative embodiment the cold storage chamber may be a lateral section, bottom section or a top section of the refrigerator or it may be divided over two or more sections of the refrigerator.

[0027] The refrigerator may for example comprise an empty space above and/or below the cooling chamber and/or the cold storage chamber. Such empty spaces equalize the pressure in the air flow. The air flow is evenly distributed over cooling chamber and/or over the cold storage chamber. A more equal cooling is achieved.

[0028] Optionally, the vapour compression system may comprise a thermostatic control with a temperature sensor, which may for instance be arranged at a wall of the cold storage, e.g. near an exit of the evaporator, which is the last position where the water will freeze. This results in a very simple and effective temperature control system. Alternatively, or additionally, a temperature sensor may be provided in the cooling chamber.

[0029] Various temperature control options are possible. In a first embodiment the fans may run continuously, while the compressor only runs when the temperature in the cooling chamber is above a set point. Such a temperature control is simple and low cost. In a second embodiment the fans may run continuously, while the compressor only runs when the temperature of the cold storage is above a set point. This may also result in a simple low costs system which makes better use of the cold storage. In a third embodiment the fans and the compressor run only when the temperature of the cooling chamber exceeds a set level. This allows a more accurate temperature control. In a fourth embodiment the fans run only when the temperature of the cooling chamber exceeds a set level, while the compressor runs only when the temperature of the cold storage exceeds a set level. Alternatively, the fans run only when the temperature of the cold storage exceeds a set level, while the compressor runs only when the temperature of the cold storage or the temperature in the cooling chamber exceeds a set level.

[0030] Suitable batteries, may for instance include lithium ion batteries, lead acid batteries or any other suitable battery type. The battery, or batteries, may be provided with a battery charger, so they are always fully charged at the start of a power failure. The battery charger may be charged by the mains, and/or by any other power supply, such as a solar panel. Such a solar panel may for example form part of the refrigerator.

[0031] Optionally the refrigerator may comprise a light source in the cooling chamber, e.g., configured to shine during a power failure, for instance when the fans are still running and the temperature of the cold storage is still below a given upper limit.

[0032] In a further embodiment, the refrigerator may comprise a temperature indicator, e.g., a display, showing the temperature in the cooling chamber.

[0033] The refrigerator will typically have an insulating housing to minimize heat absorption. The cooling chamber will typically have a door, e.g., a front door for loading, unloading and reloading. The door may for example be transparent, e.g., with a glass window.

[0034] Reloading the refrigerator may require much work, particularly if the refrigerator is used for a limited number of product types, e.g., one or two types of beverages.

[0035] The invention also relates to a refrigerator, for instance as disclosed above, comprising a cooling chamber and a panel positionable at different positions at a doorside of the cooling chamber for selectively covering different sections of the cooling chamber. If a section of the cooling chamber is reloaded with fresh products, e.g., beverages, the panel can be put in front of the freshly loaded section, while a second section with earlier cooled products is left exposed. This way, a user may always grab a cooled product instead of a freshly loaded product that may not yet be cooled sufficiently. Such a panel may for example be a flap, which is hingeable between a first position covering a first half of the cooling chamber, and a second position covering a second half of the cooling chamber. The hinging axis may for example be vertical between two cooling chamber sections of equal width. Alternatively, slideable panels or removable panels may be used.

[0036] Optionally, the cooling chamber can be split into two or more compartments separated by one or more partitions, with passages for circulation of air from the cold storage. The compartments may have separate doors or have a common door. The compartments can be reloaded separately, so they stay cool when another compartment is reloaded. Optionally, each compartment may comprise a separate fan for creating an air flow from the cold storage and/or have a separate thermostatic control.

[0037] The refrigerator according to the present invention can be used for cooling any type of product, in particular drinks, such as beer or non-alcoholic drinks, or other types of foodstuff or non-food products that require cooling, particularly in areas where longer lasting power failures occur. The refrigerator is particularly useful for cooling medicinal products, in particular vaccines or insulin. Such medicinal products can be cooled in a closable container, such as the refrigerator described above, comprising a cold storage, a fan configured to provide an air flow along the cold storage and subsequently, along the product, and a battery for feeding the fan.

[0038] The invention will be further explained with reference to the accompanying drawings, showing an ex-

emplary embodiment.

Figure 1: shows a refrigerator according to the invention in perspective view;
Figure 2: shows the refrigerator of Figure 1 in cross section;
Figure 3: shows an exemplary cold storage for the refrigerator of Figure 1;
Figure 4: shows an alternative embodiment of a refrigerator;
Figure 5: shows a diagram of the cooling process;
Figure 6: shows in cross section the interface between a cold storage and a passing air flow.

[0039] Figure 1 shows a refrigerator with an open door. The same refrigerator 1 is shown in Figure 2 in a cross section along a plane perpendicular to a front side 3 and a rear wall 5 of the refrigerator 1. The refrigerator 1 comprises a cooling chamber 7, accessible via a door 9, shown in an open position in the figures 1 and 2. The refrigerator 1 further comprises a cold storage chamber 11 housing a cold storage 13. The cold storage chamber 11 is separated from the cooling chamber 7 by a rear wall 15 of the cooling chamber 7. The cold storage chamber 11 is in fluid communication with a top section of the cooling chamber 7 via an opening 17 in the rear wall 15 of the cooling chamber 7. A fan 19 is positioned within the opening 17 in the rear wall 15. The fan 19 is configured to blow air from the cold storage chamber 11 into the cooling chamber 7. A bottom section of the cooling chamber 7 is also in fluid communication with the cold storage chamber 11, to define a circuit for air circulation from the fan via the cooling chamber 7 to a bottom section of the cold storage chamber 11 along the cold storage 13 back upward to the fan 19.

[0040] A vapour compression system comprising a compressor (not shown), a condenser (not shown) and an evaporator 21 is fed by the mains. The evaporator 21 is positioned in the cold storage 13. A battery (not shown) is operatively connected to the fan. A control unit (not shown) is configured to activate the battery to feed the fan in the event of a power failure of the mains.

[0041] Figure 3 shows a cold storage 13 comprising a reservoir with vertically extending ribs 25 at a front side 26 and a back side 27 of the reservoir for increasing the heat exchange surface. The cold storage 13 comprises a closeable refill opening 28 at its top side and a closeable drain 29 at the lower side. This makes it possible to empty the cold storage, for instance when it has to be moved, and to refill it when it is to be installed for use. Alternatively, the drain and/or refill openings can be positioned at the front side of the cold storage to make them easier accessible via the cooling chamber.

[0042] Figures 4A - 4c show an alternative embodiment of a refrigerator 30 with a cooling chamber 32 which is divided by a central vertical partition 34 in two equally sized compartments 35, 36. A main door 37 is used to close the cooling chamber 32 as a whole. A swing door 39 is accessible after opening the main door 37 and is hinged to a vertical front edge of the partition 34 and can be hinged between a first position closing off the left compartment 35, and a second position closing off the right compartment 36. The swing door 39 can close off the compartments 35, 36 alternately. When one of the compartments 35, 36 has been refilled it can be closed off by the swing door 39, so a user will only take cooled products from the other compartment 35, 36. When that compartment is empty, it can be refilled and closed off by the swing door 39. By that time, the products in the first compartment have been cooled and are ready for consumption.

[0043] Figure 5 shows a diagram of the temperature in the cooling chamber of a refrigerator according to the invention filled with a batch of products, such a as drinks or vaccines or the like. The diagram spans a time period of 60 hours. The upper dashed line shows the ambient temperature, floating around about 35°C. Power was available only at a first time interval between t = 16 h and t = 24 h, and at a second time interval between t = 40 h and t = 48 h. The cold storage was formed by a block of ice.

Claims

1. Refrigerator (1) comprising:

- a cooling chamber (7);
- a cold storage chamber (11) in fluid communication with a top section and with a bottom section of the cooling chamber (7) for housing a cold storage;
- a cold storage (13) in the cold storage chamber (11);
- a fan (19) for circulating air through the cooling chamber (7) and the cold storage chamber (11) and configured to blow air from the cold storage chamber (11) into the cooling chamber (7);
- a vapour compression system connectable to the mains comprising an evaporator (21) in the cold storage chamber (11);
- a battery operatively connected to the fan (19); and
- a control unit configured to activate the battery to feed the fan (19) in the event of a power failure of the mains,

characterised in that the cold storage (13) has a heat exchange surface between 4 m2 per m3 of cooling chamber volume and 12 m2 per m3 of cooling chamber volume.

2. Refrigerator according to claim 1, wherein the cold storage (13) has a volume which is at least 10 % of the volume of the cooling chamber (7).

3. Refrigerator according to any preceding claim, wherein the cold storage is provided with a refill-opening (28) at a top side of the cold storage and/or with a drain (29) at a lower side of the cold storage.

4. Refrigerator according to any preceding claim, wherein the cold storage comprises at least one surface with one or more extensions, in particular one or more ribs (25).

5. Refrigerator according to any preceding claim, comprising a thermostatic control with a temperature sensor, which may for instance be arranged at a wall of the cold storage, preferably near an exit of the evaporator.

6. Refrigerator according to any preceding claim, comprising a control unit configured to control the temperature in the cooling chamber (7) by controlling the fan (19), preferably by controlling fan speed or by switching the fan (19).

7. Refrigerator according to any preceding claim, comprising a panel positionable at different positions at a door side of the cooling chamber for selectively covering different sections of the cooling chamber.

8. Refrigerator according to claim 7, wherein the panel is a flap hingeable between a first position covering a first half of the cooling chamber (7), and a second position covering a second half of the cooling chamber (7).

9. Refrigerator according to any preceding claim, wherein the cooling chamber is split into two or more compartments (35, 36) separated by one or more partitions (34).

10. Refrigerator according to claim 9, wherein each compartment comprises a separate fan for creating an air flow from the cold storage.

11. Refrigerator according to claims 9 or 10, wherein each compartment has a separate thermostatic control.

12. Process for cooling medicinal products, such as vaccines or insulin, wherein the medicinal products are cooled in a refrigerator (1) according to any preceding claim, comprising a cold storage, a fan configured to provide an air flow along the cold storage and subsequently, along the medicinal product, and a battery for feeding the fan.

Patentansprüche

1. Kühlschrank (1), umfassend:

- eine Kühlkammer (7);
- eine Kältespeicherkammer (11) in Fluidverbindung mit einem oberen Abschnitt und mit einem unteren Abschnitt der Kühlkammer (7) zum Aufnehmen eines Kältespeichers;
- einen Kältespeicher (13) in der Kältespeicherkammer (11);
- einen Ventilator (19) zum Zirkulieren von Luft durch die Kühlkammer (7) und die Kältespeicherkammer (11), der dazu konfiguriert ist, Luft aus der Kältespeicherkammer (11) in die Kühlkammer (7) zu blasen;
- ein mit dem Stromnetz verbindbares Dampfkompressionssystem, umfassend einen Verdampfer (21) in der Kältespeicherkammer (11);
- eine betriebsfähig mit dem Ventilator (19) verbundene Batterie; und
- eine Steuereinheit, die zum Aktivieren der Batterie konfiguriert ist, um den Ventilator (19) im Falle eines Stromausfalls des Netzes zu speisen,

dadurch gekennzeichnet, dass der Kältespeicher (13) eine Wärmeaustauschfläche zwischen 4 m2 pro m3 Kühlkammervolumen und 12 m2 pro m3 Kühlkammervolumen aufweist.

2. Kühlschrank nach Anspruch 1, wobei der Kältespeicher (13) ein Volumen aufweist, das mindestens 10 % des Volumens der Kühlkammer (7) beträgt.

3. Kühlschrank nach einem der vorstehenden Ansprüche, wobei der Kältespeicher mit einer Nachfüllöffnung (28) an einer Oberseite des Kältespeichers und/oder mit einem Ablauf (29) an einer Unterseite des Kältespeichers bereitgestellt ist.

4. Kühlschrank nach einem der vorstehenden Ansprüche, wobei der Kältespeicher mindestens eine Oberfläche mit einer oder mehreren Verlängerungen, insbesondere einer oder mehreren Rippen (25), umfasst.

5. Kühlschrank nach einem der vorstehenden Ansprüche, umfassend eine Thermostatsteuerung mit einem Temperatursensor, der beispielsweise an einer Wand des Kältespeichers, vorzugsweise in der Nähe eines Ausgangs des Verdampfers, angeordnet sein kann.

6. Kühlschrank nach einem der vorstehenden Ansprüche, umfassend eine Steuereinheit, die dazu konfiguriert ist, die Temperatur in der Kühlkammer (7) durch Steuern des Ventilators (19), vorzugsweise durch Steuern der Ventilatordrehzahl oder durch Schalten des Ventilators (19), zu steuern.

7. Kühlschrank nach einem der vorstehenden Ansprü-

che, umfassend eine Platte, die an verschiedenen Positionen an einer Türseite der Kühlkammer positionierbar ist, um selektiv verschiedene Abschnitte der Kühlkammer abzudecken.

8. Kühlschrank nach Anspruch 7, wobei die Platte eine Klappe ist, die zwischen einer ersten Position, in der sie eine erste Hälfte der Kühlkammer (7) abdeckt, und einer zweiten Position, in der sie eine zweite Hälfte der Kühlkammer (7) abdeckt, schwenkbar ist.

9. Kühlschrank nach einem der vorstehenden Ansprüche, wobei die Kühlkammer in zwei oder mehr Fächer (35, 36) unterteilt ist, die durch eine oder mehrere Trennwände (34) voneinander getrennt sind.

10. Kühlschrank nach Anspruch 9, wobei jedes Fach einen separaten Ventilator zum Erzeugen eines Luftstroms aus dem Kältespeicher umfasst.

11. Kühlschrank nach Anspruch 9 oder 10, wobei jedes Fach eine separate Thermostatsteuerung aufweist.

12. Verfahren zum Kühlen von medizinischen Produkten, wie Impfstoffen oder Insulin, wobei die medizinischen Produkte in einem Kühlschrank (1) gemäß einem der vorstehenden Ansprüche gekühlt werden, umfassend einen Kältespeicher, einen Ventilator, der zum Bereitstellen eines Luftstroms entlang des Kältespeichers und anschließend entlang des medizinischen Produkts konfiguriert ist, und eine Batterie zum Speisen des Ventilators.

Revendications

1. Réfrigérateur (1) comprenant :

- une chambre de refroidissement (7) ;
- une chambre d'entreposage frigorifique (11) en communication fluide avec une section supérieure et avec une section inférieure de la chambre de refroidissement (7) destinée à contenir une chambre froide ;
- une chambre froide (13) dans la chambre d'entreposage frigorifique (11) ;
- un ventilateur (19) pour faire circuler de l'air dans la chambre de refroidissement (7) et dans la chambre d'entreposage frigorifique (11) et configuré pour souffler de l'air de la chambre d'entreposage frigorifique (11) vers la chambre de refroidissement (7) ;
- un système à compression de vapeur pouvant être branché sur le secteur, comprenant un évaporateur (21) dans la chambre d'entreposage frigorifique (11) ;
- une batterie reliée fonctionnellement au ventilateur (19) ; et
- une unité de commande configurée pour activer la batterie pour alimenter le ventilateur (19) en cas de panne du secteur,

caractérisé en ce que la chambre froide (13) a une surface d'échange de chaleur entre 4 m2 par m3 de volume de chambre de refroidissement et 12 m2 par m3 de volume de chambre de refroidissement.

2. Réfrigérateur selon la revendication 1, dans lequel la chambre froide (13) a un volume qui est égal à au moins 10 % du volume de la chambre de refroidissement (7).

3. Réfrigérateur selon l'une quelconque des revendications précédentes, dans lequel la chambre froide est pourvue d'une ouverture de remplissage (28) sur un côté supérieur de la chambre froide et/ou d'un orifice d'évacuation (29) sur un côté inférieur de la chambre froide.

4. Réfrigérateur selon l'une quelconque des revendications précédentes, dans lequel la chambre froide comprend au moins une surface ayant une ou plusieurs extension(s), en particulier une ou plusieurs nervure(s) (25).

5. Réfrigérateur selon l'une quelconque des revendications précédentes, comprenant une commande thermostatique avec un capteur de température, qui peut être placé par exemple sur une paroi de la chambre froide, de préférence près d'une sortie de l'évaporateur.

6. Réfrigérateur selon l'une quelconque des revendications précédentes, comprenant une unité de commande configurée pour régler la température dans la chambre de refroidissement (7) en commandant le ventilateur (19), de préférence en commandant la vitesse du ventilateur ou en commutant le ventilateur (19).

7. Réfrigérateur selon l'une quelconque des revendications précédentes, comprenant un panneau pouvant être positionné dans différentes positions du côté d'une porte de la chambre de refroidissement pour couvrir au choix différentes sections de la chambre de refroidissement.

8. Réfrigérateur selon la revendication 7, dans lequel le panneau est un rabat pouvant pivoter entre une première position qui couvre une première moitié de la chambre de refroidissement (7) et une deuxième position qui couvre une deuxième moitié de la chambre de refroidissement (7).

9. Réfrigérateur selon l'une quelconque des revendications précédentes, dans lequel la chambre de re-

froidissement est divisée en deux compartiments ou plus (35, 36) séparés par une ou plusieurs cloison(s) (34).

10. Réfrigérateur selon la revendication 9, dans lequel chaque compartiment comprend un ventilateur distinct pour créer un flux d'air depuis la chambre froide.

11. Réfrigérateur selon la revendication 9 ou 10, dans lequel chaque compartiment a une commande thermostatique distincte.

12. Procédé pour refroidir des produits médicaux, comme des vaccins ou de l'insuline, dans lequel les produits médicaux sont refroidis dans un réfrigérateur (1) selon l'une quelconque des revendications précédentes, comprenant une chambre froide, un ventilateur configuré pour fournir un flux d'air le long de la chambre froide et ensuite le long du produit médical, et une batterie pour alimenter le ventilateur.

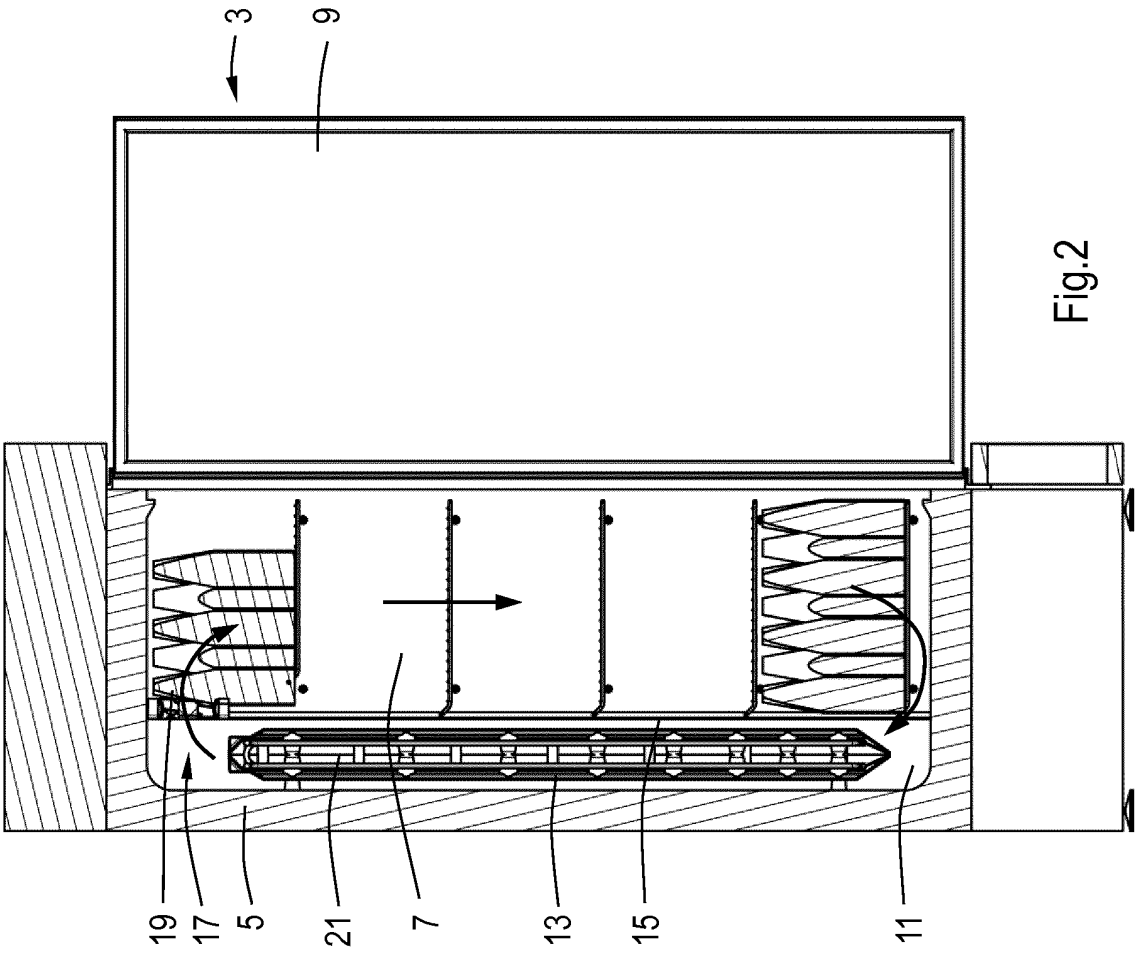

Fig.2

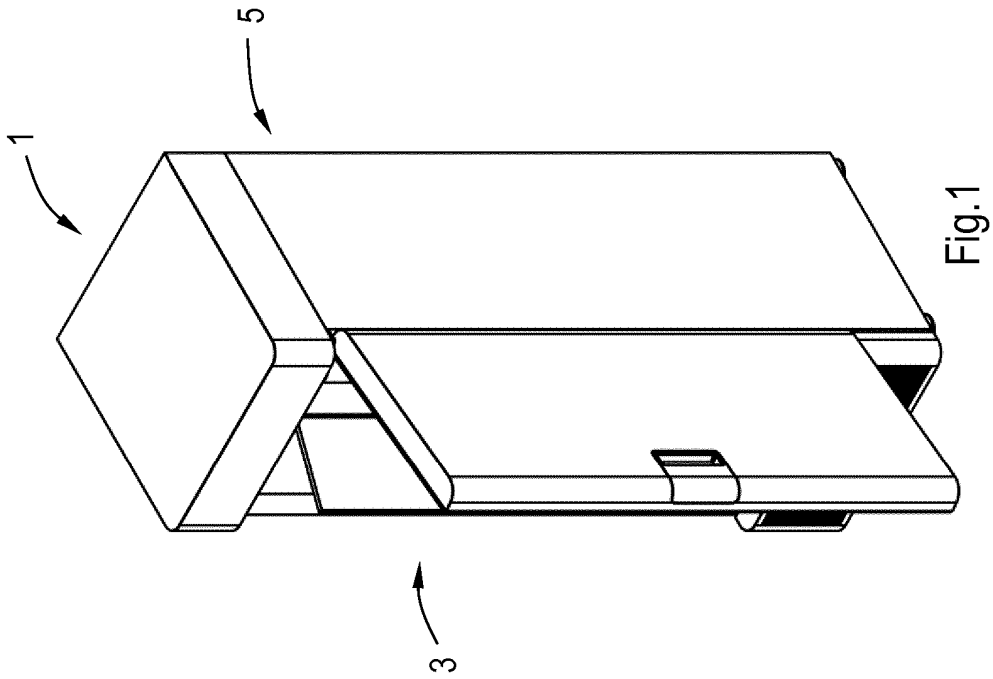

Fig.1

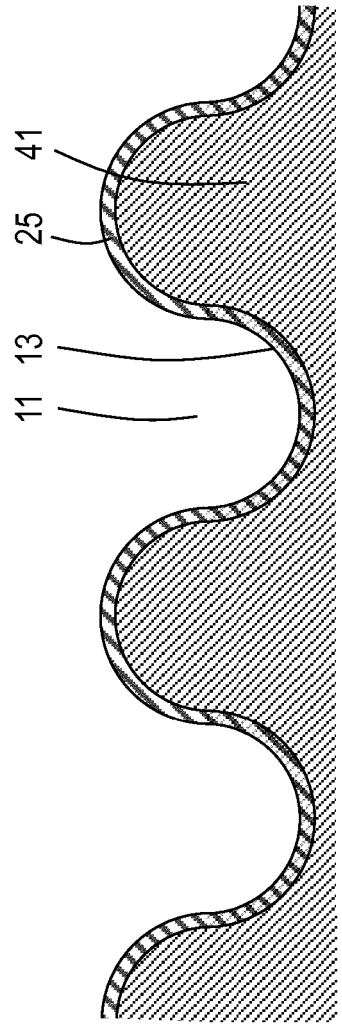

Fig.6

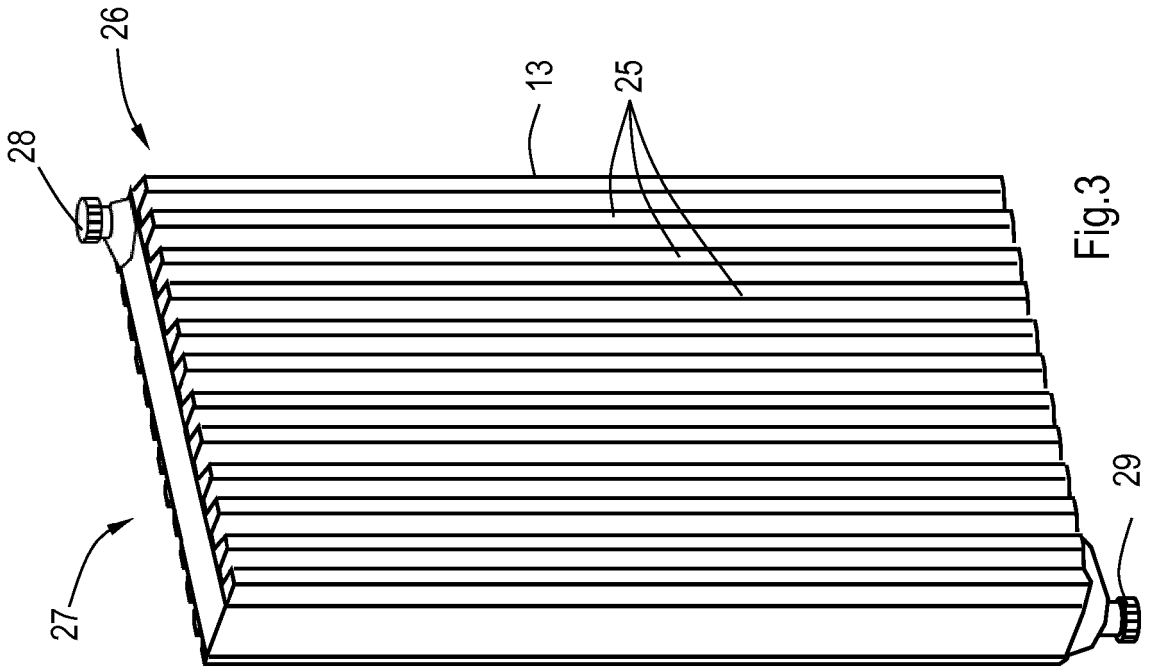

Fig.3

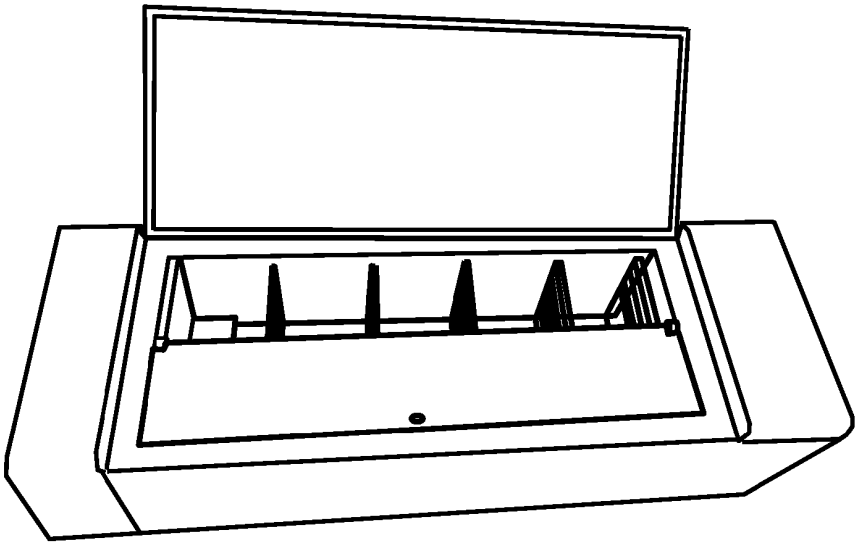

Fig.4C

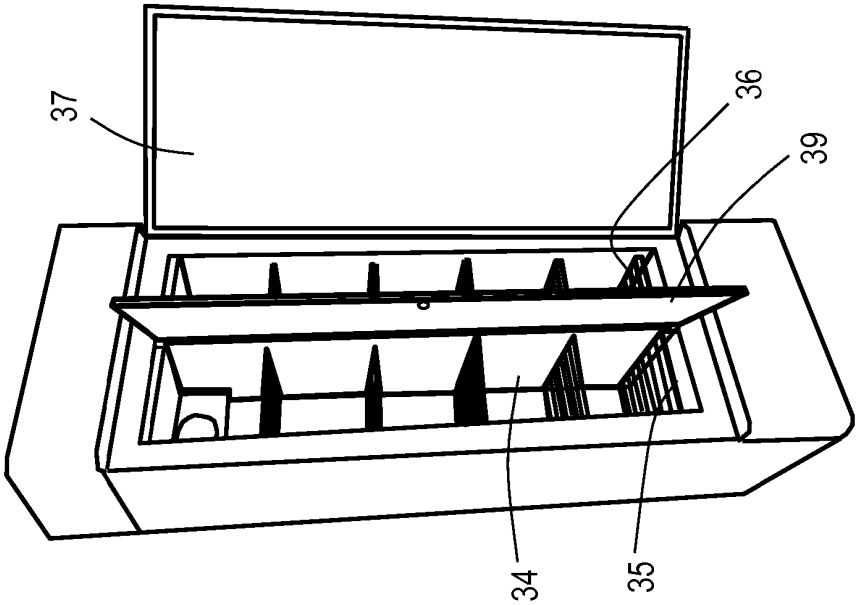

Fig.4B

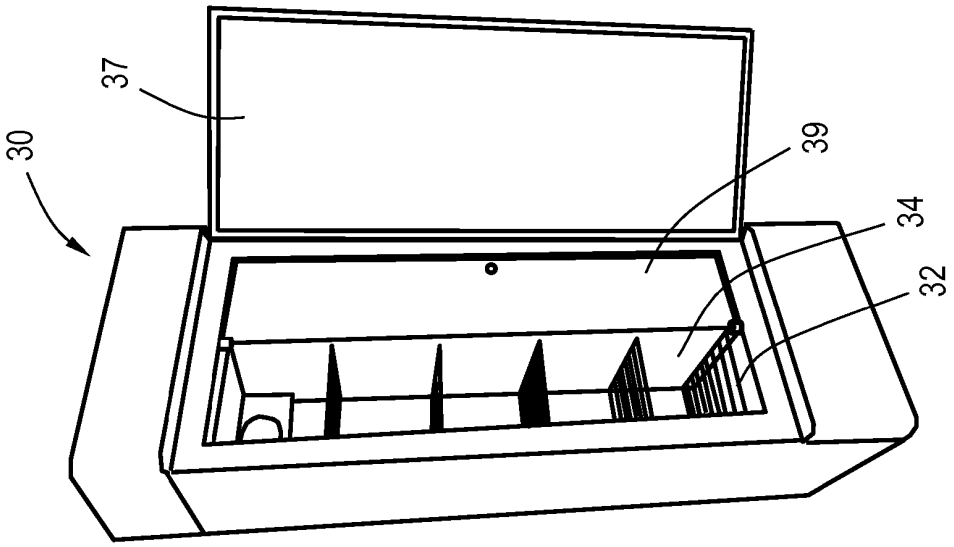

Fig.4A

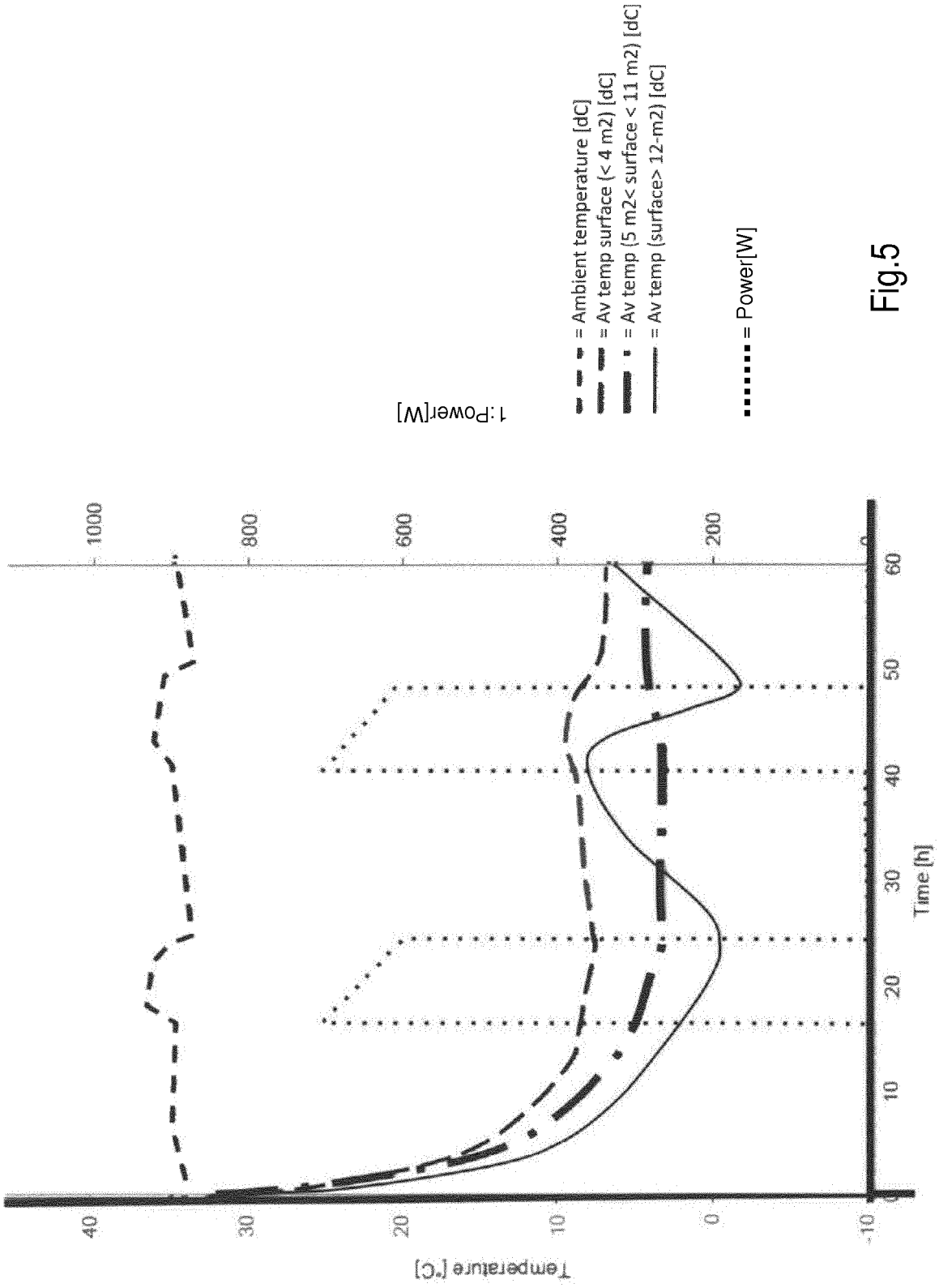
= Ambient temperature [dC]
= Av temp surface (< 4 m2) [dC]
= Av temp (5 m2< surface < 11 m2) [dC]
= Av temp (surface> 12-m2) [dC]
= Power[W]
1:Power[W]
Temperature [°C]
Time [h]
40
30
20
10
0
-10
1000
800
600
400
200
0
10
20
30
40
50
60

Fig.5

REFERENCES CITED IN THE DESCRIPTION

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