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

(11) **EP 1 309 261 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
03.01.2007 Bulletin 2007/01

(21) Application number: **01956702.3**

(22) Date of filing: **16.08.2001**

(51) Int Cl.:
A47F 3/04 *(2006.01)*

(86) International application number:
PCT/GB2001/003675

(87) International publication number:
WO 2002/015752 (28.02.2002 Gazette 2002/09)

(54) **COOLING METHOD**

KÜHLVERFAHREN

PROCEDE DE REFROIDISSEMENT

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE TR

(30) Priority: **17.08.2000 GB 0020171**

(43) Date of publication of application:
14.05.2003 Bulletin 2003/20

(73) Proprietor: **SOUTH BANK UNIVERSITY ENTERPRISES LTD.**
London SE1 0AA (GB)

(72) Inventor: **MAIDMENT, Graeme, Gregery**
Kent DA2 7EN (GB)

(74) Representative: **Lucas, Brian Ronald et al**
Lucas & Co.
135 Westhall Road
Warlingham,
Surrey CR6 9HJ (GB)

(56) References cited:
FR-A- 2 755 359
FR-A- 2 778 733
US-A- 5 486 703

EP 1 309 261 B1

Description

[0001] The present invention relates to a method and equipment for keeping articles, particularly foods, cold.

[0002] When food is displayed which has to be kept cool or cold it can be displayed in a refrigerated cabinet which has an open or glass or transparent plastic front. In conventional cabinets the food is displayed on shelves or decks and is cooled by cold air supplied from within the cabinet. The air is circulated through the cabinet using fans and the bulk of the air is directed into the display area as a jet which forms an air curtain across the cabinet opening. The air is then recirculated within the cabinet where it is cooled by a plate fin and tube heat exchanger containing a low temperature refrigerant with a saturated refrigerant temperature of approximately -7°C. The evaporator is normally in counterflow with the air, which enters the evaporator at approximately 5°C and leaves at approximately -5°C, the exact temperatures will vary with the make and type of cabinet the temperature variations may be for example ± 3K.

[0003] It has been found that, in practice it is difficult to maintain display cabinets at low temperatures e.g. below 5°C and as result food is stored on display at higher temperatures. This is because convection is, however not an effective cooling mechanism. This is due in part to the low heat transfer coefficient caused by low velocity air, but it is also because the air close to the cabinet front is warm due to air ingress. As a result convective cooling systems maintain a large spread of temperatures within the cabinet, with the higher temperature food near to the front opening. Lower food temperatures are achievable with conventional systems, however, this requires the use of lower temperature air, and because of the large temperature spread with the cabinet, low temperature air will lead to localised freezing of some food products and frost damage to food.

[0004] Providing more powerful cooling systems, as well as being expensive can lead to local freezing and ice formation so that defrosting is required.

[0005] Although the food is normally delivered to the cabinet at the required food storage temperature, cooling is required to offset gains to the food which are purely a result of radiant interchange between the food and the external supermarket/shop environment. The cooling load necessary to offset these gains is only a fraction of that delivered to the cabinet. At best this low heat transfer rate results in excessive energy use, high equipment costs and reduces food shelf life. At worst, the low efficiency can result in failure to meet food hygiene temperatures which can present food safety issues.

[0006] It has been proposed to provide significant additional cooling to the food by positioning the food directly in contact with a cold base. This was achieved by siting the food on a base in contact with the evaporator. Significantly increasing heat transfer to the food in this way enables the cabinet to operate more efficiently and results in significant reductions in energy consumption, as well as improvements in food quality/safety. However as most chilled cabinets utilise adjustable shelving, producing conduction by sitting the food shelves onto a fixed evaporator surface is not a practical option.

[0007] French Patent FR-A-2 755 359 discloses the use of heat pipe to cool food placed on a shelf by incorporating the heat pipe in the shelf. However this patent does not disclose the use a heat pipe to aid the convective cooling of food stored in a cool cabinet.

[0008] We have now devised a method of providing conductive cooling to the food but still maintaining adjustable shelving.

[0009] According to the invention there is provided a method of cooling food in a cabinet in which the food is positioned on a shelf or deck in the cabinet which shelf or deck incorporates a heat pipe, at least a part of which heat pipe is cooled and heat is conducted from the food by conduction by the cooling effect of the heat pipe and the food placed on the said shelf or deck is also cooled by a convective cooling means.

[0010] The invention also provides equipment for keeping food cool which equipment which comprises a cabinet incorporating at least one shelf or deck on which food can be placed, in which the shelf or deck incorporates a heat pipe and there is a cooling means to cool at least part of the heat pipe and, when food is positioned on the shelf, there is heat conduction from the food to the shelf and in which there is also a convective cooling means to cool food placed on the said shelf or deck.

[0011] The heat pipe is used because it is a passive, highly efficient heat transfer mechanism with a reported conductivity equivalent to approximately 500 times that of copper. Heat pipes are robust, simple and maintenance free devices that operate isothermally, require no pumping power and can transfer heat over a long distance. Heat pipes are described in an Article by Dunn P.D. and Reay D.A. (1994) in Heat Pipes 4th Edition pp 1-3, 100, Elsevier Science Ltd. Oxford UK.

[0012] In use the food is placed on the shelf which incorporates the heat pipe and preferably the end of the heat pipe at the rear of the shelf is cooled e.g. by blowing cold air over the pipe from the cabinet's cooling system. The heat pipe cools the shelf and keeps the food cool by conduction from the shelf to the food.

[0013] The shelf can comprise one flat heat pipe or a series of connected heat pipes.

[0014] Preferably the cooling means is a conventional cooling system in which air is recirculated within the cabinet where it is cooled by a plate fin and tube heat exchanger containing a low temperature refrigerant e.g. with a saturated refrigerant temperature of approximately -7°C. The evaporator is in counterflow with the air, which enters the evaporator at approximately 5°C and leaves at approximately -5°C.

[0015] In use in a cabinet for keeping food cool there is conventional convective cooling which is supplemented by conductive heat transfer provided by a shelf cooling mechanism incorporating a heat pipe so that the shelf is

used to display the food and also to transfer heat from it to the cabinet supply air duct.

[0016] Preferably the shelf is constructed as a heat pipe and positioning through the display area back plate into the supply air duct, which is at approximately-5°C.

[0017] There can be phase change materials incorporated in the shelves or adjacent the shelves so as to provide extra cooling capacitance in case of power or other failure so that the change of phase provides a cooling effect in the case of such failure.

[0018] The invention can be applied to conventional cabinets by replacing the existing shelves with shelves incorporating heat pipe or pipes and it is a feature of the invention that it can contribute to lower core food temperatures e.g. of up to approximately 2.5 to 3K which would lead to significant reductions in energy and capital costs as well as improvements in food quality and shelf life. Furthermore using heat pipe shelving could result in avoiding electric defrost, which is energy intensive.

[0019] The invention can be used with any type of cabinet e.g. open fronted, closed cabinets and all types of frozen food cabinets.

[0020] The invention is described in the accompanying drawings in which: -

Fig. 1 shows the principle of operation of the simple heat pipe

Fig. 2 shows a conventional cool cabinet

Fig. 3 shows a cabinet incorporating the invention and

Fig. 4 shows a shelf in detail

[0021] Referring to fig. 1 a heat pipe comprises a sealed tube (1) containing a wick (2) and a working fluid. When heat is applied, the working fluid evaporates to form vapour (5) at heat source (4) and moves to the heat sink (3) where it condenses. The wick then returns the condensed liquid to the heat source (4) by capillary action.

[0022] Referring to fig. 2 a typical cool cabinet comprises an insulated cabinet (15) with a transparent or open front. At the bottom of the cabinet are an evaporator (10) and a fan (11). Food is stored on shelves (12). In use the fan (11) blows air over evaporator (10) which cools the air and cold air e.g. at approximately -5°C passes over the back of the shelves in a duct (14) and over the food as shown to cool the food. The food is warmed by radiant heat, which is then transferred to the cooling air, which is recirculated over the evaporator to cool it.

[0023] Referring to fig. 3 the cabinet (21), evaporator (22) and fan (23) are as in fig. 2, but the shelves are replaced by shelves (20) incorporating a heat pipe, shown in detail in fig. 4. The ends of the heat pipes (20a) protrude through the back of the display section into duct through which cooled air from the evaporator passes. As well as the cooling effect of the air, the heat pipe removes heat from the food on shelves (20) and so aids the convective cooling effect. The air is recirculated as in fig. 2.

[0024] Referring to fig. 4 the shelves (20) incorporating a heat pipe (23) have food (21) placed on them. Heat from the food is conducted by the heat pipe to the back of the heat pipe (20a), which is in the cold airflow from evaporator (22). The heat pipe rapidly conducts heat from the food to the cold part of the heat pipe (20a) and thus aids the convective cooling of the food.

Claims

1. Equipment for keeping food cool which equipment comprises a cabinet (21) incorporating at least one shelf or deck (20) on which food can be placed, in which the shelf or deck (20) incorporates a heat pipe (23) and there is a cooling means to cool at least part (20a) of the heat pipe so that, when food is positioned on the shelf, there is heat conduction from the food to the shelf **characterised in that** there is also a convective cooling means to cool food placed on the said shelfor deck.

2. Equipment as claimed in claim 1 **characterised in that** there are cooling means to cool the end of the heat pipe (20a) at the rear of the shelf or deck remote from the front of the cabinet.

3. Equipment as claimed in claim 2 **characterised in that** the cooling means are means for blowing cold air over the heat pipe from a cooling system (23).

4. Equipment as claimed in claim 3 **characterised in that** the cabinet has a back plate behind which is a duct for supply of cool air, the said shelf or deck is constructed as a heat pipe and the end of the heat pipe passes through the cabinet back plate into the duct for the supply for cold air.

5. Equipment as claimed in any one of the preceding claims **characterised in that** there are means to recirculate the air within the cabinet and the cooling means is a tube heat exchanger containing a low temperature refrigerant incorporating an evaporator which evaporator is in counterflow with the air.

6. Equipment as claimed in any one of the preceding claims **characterised in that** phase change materials are incorporated in the shelves or decks or adjacent the shelves or decks so as to provide extra cooling capacitance.

7. Equipment as claimed in any one of the preceding claims **characterised in that** the shelving is adjustable.

8. A method of cooling food in a cabinet (21) in which the food is positioned on a shelf or deck (20) in the cabinet which shelf or deck incorporates a heat pipe

at least a part of which heat pipe (20a) is cooled and heat is conducted from the food by conduction by the cooling effect of the heat pipe **characterised in that** the food placed on the said shelf or deck is also cooled by a convective cooling means.

9. A method as claimed in claim 8 for cooling food **characterised in that** the food is placed on the shelf or deck (20) which incorporates the heat pipe and the end of the heat pipe at the rear of the shelf or deck remote from the front of the cabinet (20a) is cooled by blowing cold air over the pipe from a cooling means in the cabinet (22).

10. A method as claimed in claim 8 or 9 **characterised in that** phase change materials incorporated in the shelves or decks or adjacent the shelves or decks provide extra cooling capacitance.

Patentansprüche

1. Gerät zum Kühlhalten von Lebensmitteln, wobei das Gerät ein Gehäuse (21) umfasst, das wenigstens ein Tablett oder einen Fachboden (20), auf denen Lebensmittel abgelegt werden können, enthält, wobei das Tablett oder der Fachboden (20) ein Wänneubertragungsrohr (23) aufweisen und ein Kühlmittel vorhanden ist, um wenigstens einen Teil (20a) des Wänneübertragungsrohrs zu kühlen, so dass dann, wenn auf dem Tablett Lebensmittel angeordnet sind, eine Wärmeleitung von dem Lebensmittel zu dem Tablett erfolgt, **dadurch gekennzeichnet, dass** außerdem ein Konvektionskühlungsmittel vorhanden ist, um auf dem Tablett oder Fachboden abgelegte Lebensmittel zu kühlen.

2. Gerät nach Anspruch 1, **dadurch gekennzeichnet, dass** Kühlmittel vorhanden sind, um das Ende des Wärmeübertragungsrohrs (20a) am hinteren Ende des Tabletts oder Fachbodens, das von der Vorderseite des Gehäuses beabstandet ist, zu kühlen.

3. Gerät nach Anspruch 2, **dadurch gekennzeichnet, dass** die Kühlungsmittel Mittel sind, um kalte Luft von einem Kühlungssystem (23) über das Wärmeübertragungsrohr zu blasen.

4. Gerät nach Anspruch 3, **dadurch gekennzeichnet, dass** das Gehäuse eine Rückwandplatte besitzt, hinter der sich eine Rohrleitung für die Zufuhr von Kühlungsluft befindet, wobei das Tablett oder der Fachboden als ein Wärmeübertragungsrohr konstruiert ist und das Ende des Wärmeübertragungsrohrs durch die Gehäuse-Rückwandplatte in die Rohrleitung für die Zufuhr kalter Luft verlauft.

5. Gerät nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** Mittel vorhanden sind, um die Luft in dem Gehäuse zirkulieren zu lassen, und das Kühlungsmittel ein Rohr-Wärmetauscher ist, der ein Tieftemperatur-Kälteraittel enthält und einen Verdampfer umfasst, der mit der Luft in einer Gegenströmung steht.

6. Gerät nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** in den Tabletts oder Fachböden oder in deren Umgebung Phasenänderungsmaterialien vorhanden sind, um eine zusätzliche Kühlkapazität zu schaffen.

7. Gerät nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Tabletthöhe einstellbar ist.

8. Verfahren zum Kühlen von Lebensmitteln in einem Gehäuse (21), bei dem Lebensmittel auf einem Tablett oder Fachboden (20) im Gehäuse angeordnet werden, wobei das Tablett oder der Fachboden ein Wärmeübertragungsrohr aufweist, wobei wenigstens ein Teil (20a) des Wämieübertragungsrohrs gekühlt wird und Wärme durch die Kühlungswirkung des Wänneübertragungsrohrs vom Lebensmittel abgeleitet wird, **dadurch gekennzeichnet, dass** die Lebensmittel, die auf dem Tablett oder Fachboden abgelegt sind, außerdem durch Konvektionskühlungsmittel gekühlt werden.

9. Verfahren nach Anspruch 8 zum Kühlen von Lebensmitteln, **dadurch gekennzeichnet, dass** die Lebensmittel auf dem Tablett oder Fachboden (20) abgelegt werden, das bzw. der das Wärmeübertragungsrohr enthält, dessen Ende am hinteren Ende des Tabletts oder Fachbodens, das von der Vorderseite des Gehäuses (20a) beabstandet ist, durch Blasen von kalter Luft von einem Kühlungsmittel im Gehäuse (22) über das Rohr gekühlt wird.

10. Verfahren nach Anspruch 8 oder 9, dass Phasenänderungsmaterialicn, die in den Tabletts oder Fachböden oder in deren Umgebung vorhanden sind, eine zusätzliche Kühlkapazität schaffen.

Revendications

1. Appareil pour maintenir de la nourriture au froid, lequel appareil comprend une armoire (21) dans laquelle est incorporée au moins une étagère ou tablette (20) sur laquelle on peut placer de la nourriture, dans lequel l'étagère ou tablette (20) comprend un caloduc (23) et dans lequel sont prévus des moyens de refroidissement pour refroidir au moins une partie (20a) du caloduc de sorte que, lorsque de la nourriture est placée sur l'étagère, une conduction thermique a lieu depuis la nourriture jusqu'à l'étagère, **ca-**

ractérisé en ce qu'un moyen de refroidissement par convection est également prévu pour refroidir de la nourriture placée sur ladite étagère ou tablette.

2. Appareil selon la revendication 1, **caractérisé en ce que** des moyens de refroidissement sont prévus pour refroidir l'extrémité (20a) du caloduc à l'arrière de l'étagère ou du plateau, éloigné de l'avant de l'armoire.

3. Appareil selon la revendication 2, **caractérisé en ce que** les moyens de refroidissement sont des moyens destinés à souffler de l'air froid sur le caloduc provenant d'un système de refroidissement (23).

4. Appareil selon la revendication 3, **caractérisé en ce que** l'armoire a un panneau arrière derrière lequel se trouve une conduite pour l'alimentation en air froid, **en ce que** ladite étagère ou tablette est construite sous forme de caloduc et **en ce que** l'extrémité du caloduc traverse le panneau arrière de l'armoire et arrive dans la conduite pour l'alimentation en air froid.

5. Appareil selon l'une quelconque des revendications précédentes, **caractérisé en ce que** des moyens pour recycler l'air sont prévus à l'intérieur de l'armoire et **en ce que** le moyen de refroidissement est un échangeur thermique à tube contenant un fluide frigorigène à basse température, dans lequel est incorporé un évaporateur, lequel évaporateur est à contre-courant de l'air.

6. Appareil selon l'une quelconque des revendications précédentes, **caractérisé en ce que** des matières à changement de phase sont incorporées dans les étagères ou tablettes ou se trouvent à côté des étagères ou tablettes de manière à fournir une capacité de refroidissement supplémentaire.

7. Appareil selon l'une quelconque des revendications précédentes, **caractérisé en ce que** le rayonnage est ajustable.

8. Procédé de refroidissement de nourriture dans une armoire (21), dans lequel la nourriture est placée sur une étagère ou tablette (20) dans l'armoire, laquelle étagère ou tablette comprend un caloduc, au moins une partie (20a) du caloduc est refroidie et la chaleur est conduite à partir de la nourriture par conduction sous l'effet de refroidissement du caloduc, **caractérisé en ce que** la nourriture placée sur ladite étagère ou tablette est également refroidie par des moyens de refroidissement par convection.

9. Procédé selon la revendication 8 pour refroidir de la nourriture, **caractérisé en ce que** de la nourriture est placée sur l'étagère ou tablette (20) qui comprend le caloduc, et **en ce que** l'extrémité (20a) du caloduc à l'arrière de l'étagère ou tablette, éloignée de l'avant de l'armoire, est refroidie par de l'air froid soufflé sur le caloduc à partir de moyens de refroidissement situés dans l'armoire (22).

10. Procédé selon la revendication 8 ou 9, **caractérisé en ce que** des matières à changement de phase incorporées dans les étagères ou tablettes ou se trouvant à côté des étagères ou tablettes fournissent une capacité de refroidissement supplémentaire.

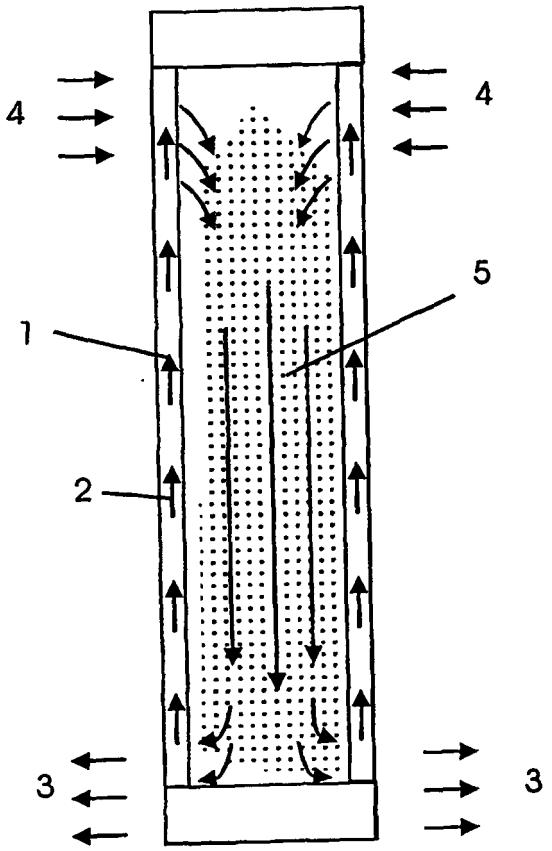

Fig. 1

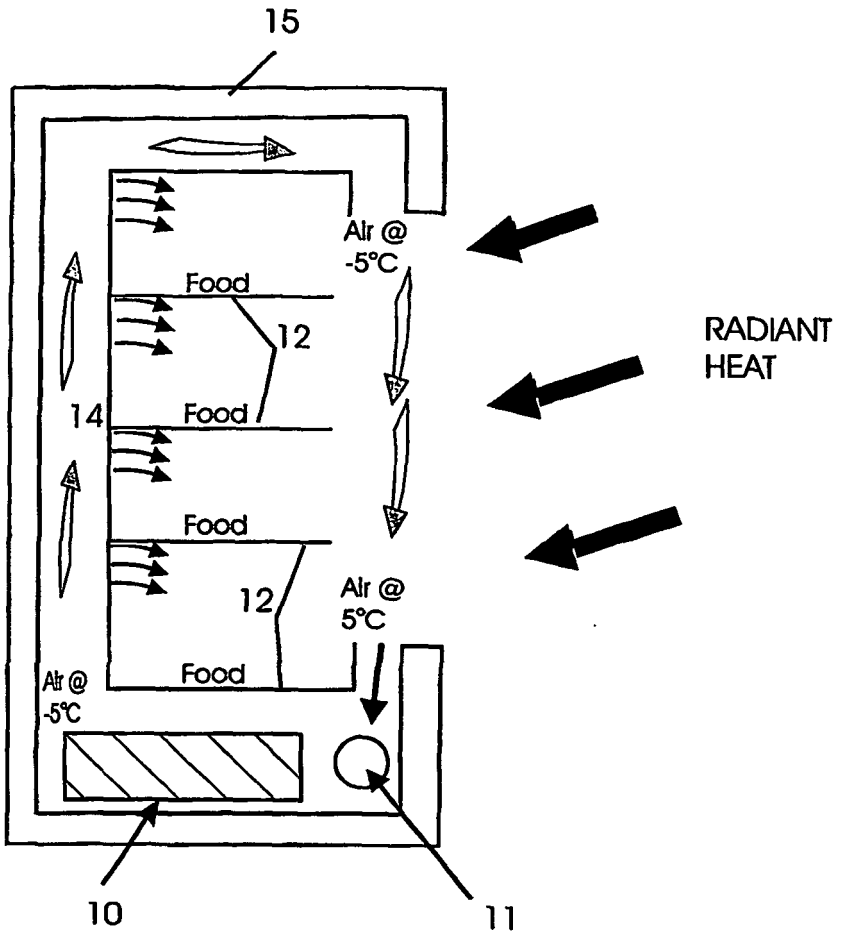
15
Air @
-5°C
Food
12
RADIANT
HEAT
14
Food
Food
12
Air @
5°C
Air @
-5°C
Food
10
11

FIG. 2

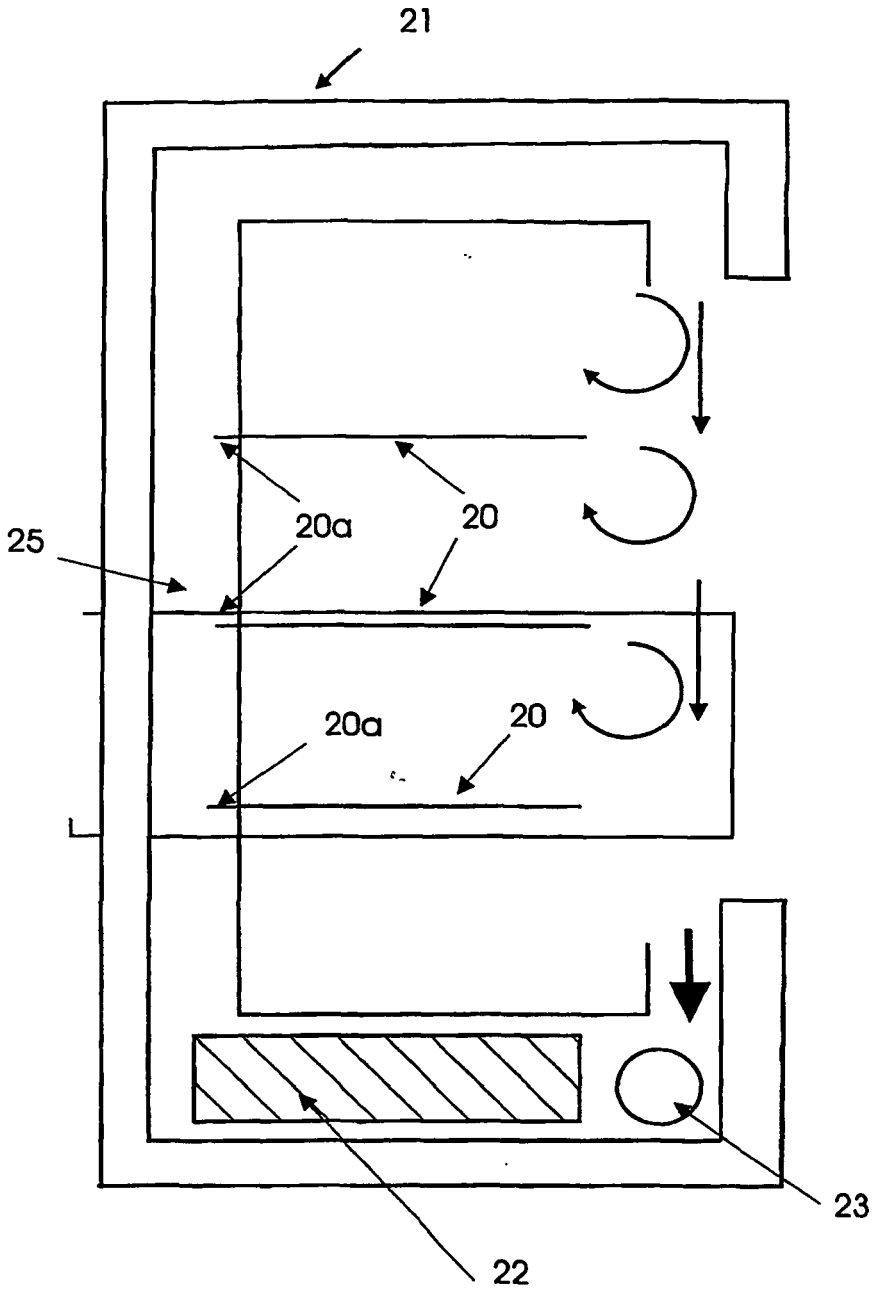

Fig. 3

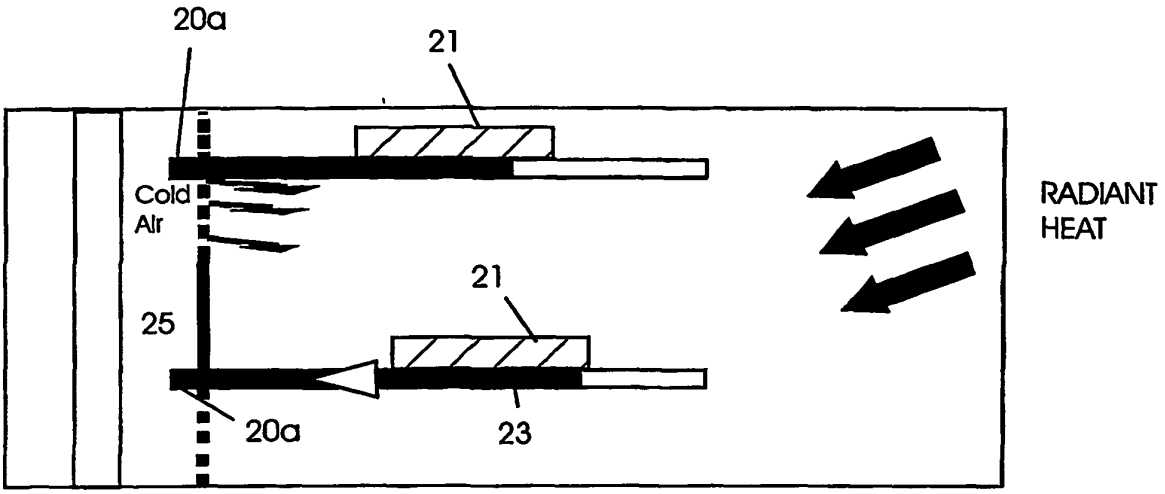

FIG. 4