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

(11) **EP 1 541 946 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
20.08.2008 Bulletin 2008/34

(51) Int Cl.:
F25D 21/14 *(2006.01)*

(21) Application number: **04101755.9**

(22) Date of filing: **27.04.2004**

(54) Evaporator Installation for a Heat Pump

Verdampfungsanlage für eine Wärmepumpe

Installation d'évaporation pour une pompe à chaleur

(84) Designated Contracting States:
DE FR GB

(30) Priority: **12.12.2003 KR 2003090470**

(43) Date of publication of application:
15.06.2005 Bulletin 2005/24

(73) Proprietor: **SAMSUNG ELECTRONICS CO., LTD.**
Suwon-si,
Gyeonggi-do (KR)

(72) Inventors:
- **Kim, Jin-ho**
  643-1, Shinyong-dong,
  Buk-gu,
  Kwangju (KR)
- **Kang, Sung-chul**
  769-1, Unnam-dong,
  Kwangsan-gu,
  Kwanju (KR)

(74) Representative: **Grey, Ian Michael et al**
Venner Shipley LLP
20 Little Britain
London EC1A 7DH (GB)

(56) References cited:
US-A- 4 041 727
US-A- 4 926 932
US-A1- 2002 195 235

EP 1 541 946 B1

Description

[0001] The present invention relates to an evaporator installation for a heat pump, the installation comprising an evaporator having a coolant tube coupled to a plurality of parallelogram or polygonal shaped heat exchange fins each having a bottom tip and a plurality of corners, said evaporator installation further comprising a surface down which liquid will flow from the heat exchange fins, said heat exchange fins being inclined at an angle such that said bottom tip is positioned adjacent to said surface for transfer of liquid readily from the bottom tip to the surface. Such an evaporator installation is known from US 4 041 727 .

[0002] A known heat pump includes a compressor for compressing coolant vapour, a condenser for condensing the coolant vapour, a capillary tube for reducing the pressure and temperature of the liquefied coolant and an evaporator for in which heat is drawn from the surrounding air to evaporate the low pressure, low temperature liquefied coolant.

[0003] Such heat pumps may be used in refrigerator, freezers and air-conditioning apparatuses.

[0004] Generally, refrigerators include a main body partitioned into a freezer compartment and a refrigerator compartment, a door or doors providing access to the freezer and refrigerator compartments and a heat pump for cooling the freezer and refrigeration compartments. The freezer and refrigerator compartments are cooled by circulating air, cooled by the evaporator of the heat pump.

[0005] Figure 1 is a cross sectional view of the evaporator of a conventional heat pump.

[0006] As shown in Figure 1, the evaporator 120 of a conventional heat pump has a coolant tube 123, through which coolant circulates, and a heat exchange fins 130. Frost tends to form on the coolant tube 123 and heat exchange fins 130. The frost decreases the efficiency of the evaporator and generally a defrosting apparatus (not shown) such as a heater is provided to remove the frost.

[0007] The evaporator 120 includes a plurality of exchange fins 130 and the coolant tube 123 passes through coolant tube accommodating parts 131 in the fins 130. Also, the coolant tube 123 is supported in the refrigerator by a coolant tube supporter 125. Accordingly, in the conventional refrigerator, the heat exchange efficiency is determined by the heat exchange area provided by the coolant tube 123 and the heat exchange fins 130.

[0008] Water drops, formed during defrosting, accumulate in lower corner parts 135 of the heat exchange fins 130. These water drops are frozen again when defrosting ends.

[0009] An evaporator installation, according to the present invention, is characterised in that the corners on opposite sides of each fin are rounded to promote liquid flow thereover down towards the bottom tip.

[0010] Additional preferred and optional features of the present invention are set forth in claims 2 and 3 appended hereto.

[0011] An embodiment: of the present invention will now be described, by way of example, with reference to Figures 2 to 6 of the accompanying drawings, in which:

Figure 1 is a partial cross-sectional view of a conventional evaporator;
Figure 2 is a front view of a refrigerator including a heat pump;
Figure 3 is a perspective view of the refrigerator in Figure 2;
Figure 4 is a perspective view of the evaporator of the heat pump in Figure 3;
Figure 5 is a cross sectional view of the evaporator of the heat pump in Figure 3, taken along line V-V; and
Figure 6 is a front view of a heat exchange fin of the evaporator in Figure 4.

[0012] Referring to Figures 2 and 3, a refrigerator 1 includes a main body 10 having a freezer compartment 13 and a refrigerator compartment 14, doors 5 providing access to the freezer and refrigerator compartments 13, 14, a heat pump, provided at the back of the main body 10 and equipped with an evaporator 20 to generate cooling air for cooling the freezer compartment 13 and the refrigerator compartment 14, and a defrosting apparatus 40 to remove frost that has formed on the evaporator 20.

[0013] The freezer compartment 13 and the refrigerator compartment 14 have shelves 15 and drawers 16 to accommodate items such as food. An evaporator accommodating part 18, located at the back of the body 10, accommodates the evaporator 20. The evaporator accommodating part 18 is covered by an accommodating part cover 19.

[0014] The evaporator accommodating part 18 is provided on a rear of the freezer compartment 13. However, the evaporator accommodating part 18 may also be provided on a rear of the refrigerator compartment 14, or on both of the rear areas of the freezer compartment 13 and the refrigerator compartment 14.

[0015] The evaporator accommodating part 18 includes bosses 18a coupling the evaporator accommodating part 18 to the evaporator 20 and the accommodating part cover 19 by screws (not shown).

[0016] Referring to Figure 4, the refrigeration apparatus has a compressor (not shown) for compressing coolant vapour, a condenser (not shown) for condensing the compressed coolant to liquefy it, a capillary tube (not shown) fot reducing the pressure and temperature of the liquefied coolant, the evaporator 20 in which the low pressure, low temperature coolant is evaporated using heat taken from the surrounding air and connecting pipes 27 connecting the compressor, the capillary tube and the evaporator 20 to enable the coolant to circulate. Accordingly, the freezer compartment 13 and the refrigerator compartment 14 are cooled by circulating air, cooled by the evaporator 20, through the freezer compartment 13

and the refrigerator compartment 14.

[0017] The evaporator installation according to the present invention has a coolant tube 23, which conveys the coolant, and heat exchange fins 30. The heat exchange fins 30 each have at least one coolant tube accommodating part 31 where they are coupled to the coolant tube 23, as shown in Figure 5. Also, the evaporator 20 is provided with coolant tube supporters 25 on opposite sides of the evaporator 20 to support the coolant tube 23.

[0018] The coolant tube 23 is coupled with the connecting pipe 27 and the coolant tube 23 is bent so that it extends back and forth across the evaporator from top to bottom at the front and then bottom to top at the back. U-shaped portions of the coolant tube 23 project through the coolant tube supporters 25. However, the coolant tube 23 may be provided in different configurations such as a single structure, or a triple structure.

[0019] The coolant tube supporters 25 are provided on opposite sides of the evaporator to support the coolant tube 23 in the correct shape. The coolant tube supporters 25 are coupled to the evaporator accommodating part 18 by screws.

[0020] Referring to Figure 6, each heat exchange fin 30 is substantially a parallelogram which is inclined at an angle 'a' so that a longitudinal direction of the heat exchange fin 30 forms an acute angle relative to the vertical to make defrosted water drops flow to a bottom tip 33 of the heat exchange fin. In other words, a longitudinal direction line 'A' of the heat exchange fin 30 and a vertical direction line 'B' along which the water drops fall should form an acute angle 'a'. Furthermore, the acute angle should be between 50 degrees and 75 degrees. However, the angle 'a' formed by the longitudinal direction line 'A' of the heat exchange fin 30 and the vertical direction line 'B' may be between 40 degrees and 50 degrees so that the water drops formed on the heat exchange fin 30 can flow to the bottom tip 33 easily. Also, the angle 'a' and the vertical direction line 'B' may be determined according to the length of the heat exchange fin 30 and the distance between the coolant tubes 23 set along the vertical direction. Furthermore, each heat exchange fin 30 is inclined to one side relative to the vertical direction, and the bottom tip 33 of each heat exchange fin 30 is adjacent to a wall where the evaporator 20 is installed. In other words, the bottom tip 33 of the heat exchange fin 30 is inclined so that the bottom tip 33 is adjacent to an inner wall of the evaporator accommodating part 18. Accordingly, the water drops that flowed to the bottom tip 33 of the heat exchange fin 30 can flow downward along the wall of the evaporator accommodating part 18. Also, a lower area of the evaporator accommodating part 18 may include a discharging hole (not shown) to discharge the water from the heat exchange fin 30. However, the lower area of the evaporator accommodating part 18 may alternatively be provided with an additional water accommodating part (not shown) to gather the water drops.

[0021] Round corner parts 35 are provided on opposite sides of the heat exchange fins 30. Although the heat exchange fins 30 may be thin parallelogram-shaped plates, they may also have different polygonal shapes. Also, the surfaces of the heat exchange fins 30 may have at least one protrusion 37 protruding orthogonally from the surface of the heat exchange fin 30.

[0022] The bottom tip 33 of the heat exchange fin 30 may be in contact with the wall of the evaporator accommodating part 18. Also, an end of the bottom tip 33 is formed to be sharp so that the water drops formed on the heat exchange fin 30 flow along toward the wall of the evaporator accommodating part 18 easily.

[0023] The corner parts 35 include left and right areas between the top and bottom tips 32, 33 of the heat exchange fin 30, and may be rounded so that the water drops formed on top areas of the heat exchange fins 30 flow toward the bottom tip 33 easily. Also, the corner parts 35 are preferably rounded to form a partial circle with a radius between 5 mm and 20 mm. However, the radius may be between 3 mm and 5 mm, or between 20 mm and 50 mm, or over 50 mm according to a size of the heat exchange fin 30, so that the water drops formed on the top area of the heat exchange fins 30 flow toward the bottom tips 33 easily.

[0024] The coolant tube accommodating parts 31 are formed through the heat exchange fins 30 to accommodate the coolant tube 23, and may be provided in pairs. However, there may be one or three coolant tube accommodating parts 31 according to a shape of the coolant tube 23.

[0025] The protrusions 37 function to prevent the heat exchange fins 30 being bent easily. Also, the protrusions 37 can improve heat exchange efficiency by causing turbulence in the air flow around the heat exchange fins 30. Although three protrusions 37 are shown, a different number, e.g. one, two or four, may be provided on each heat exchange fin 30.

[0026] The defrosting apparatus includes a defrosting heater 41 and a heater supporter 43 supporting the defrosting heater 41. The heater supporter 43 is installed at the bottom of the evaporator accommodating part 18 so that the defrosting heater 41 is positioned below the evaporator 20. However, the defrosting apparatus 40 may be provided to the front or rear of the evaporator 2, and it may include different heating means other than the defrosting heater 41.

[0027] A defrosting process with such a configuration of the evaporator provided in the refrigeration apparatus of a refrigerator will now be described.

[0028] First, the compressor (not shown) provided in the refrigeration apparatus stops operating and the defrosting heater 41 is energised. Water drops form as the frost, stuck on the coolant tube 23 and the heat exchange fin 30 in the evaporator 20, melts. As the water drops get bigger, the water drops flow toward the bottom tips 33 easily along the surfaces and rounded edges of the heat exchange fins 30 by gravity. The water drops that reach

the bottom tips 33 keep flowing downward along the wall of the evaporator accommodating part 18 to be discharged easily. In other words, the water drops formed on the heat exchange fins 30 can flow to the bottom tips 33 easily without accumulating on the corner parts 35 because the heat exchange fins 30 are provided with an inclination and the corner part 35 is rounded.

[0029] Accordingly, the refrigeration apparatus can improve performance of the evaporator by preventing the water drops from accumulating and being frozen on the heat exchange fins and on the coolant tube. Also, a refrigerator provided with such refrigeration apparatus uses less power.

[0030] Such refrigeration apparatus, as described above, may be applied not only to the refrigerator, but also to various heat exchangers such as an air conditioning apparatus.

[0031] As described above, the embodiment of the present invention can improve the performance of the evaporator provided in the refrigeration apparatus. Also the refrigerator provided with such refrigeration apparatus can reduce power consumption.

Claims

1. An evaporator installation for a heat pump, the installation comprising an evaporator (20) having a coolant tube (23) coupled co a plurality of parallelogram or polygonal shaped heat exchange fins (30) each having a bottom tip (33) and a plurality of corners (35), said evaporator installation further comprising a surface (18) down which liquid will flow from the heat exchange fins (30), said heat exchange fins (30) being inclined at an angle such that said bottom tip (33) is positioned adjacent to said surface (18) for transfer of liquid readily from the bottom tip (33) to the surface (18) **characterised in that** corners (35) on opposite sides of each fin (30) are rounded to promote liquid flow thereover down towards the bottom tip (33).

2. An installation according to claim 1 including an evaporator accommodating part (18) located on one side of the evaporator (20), the surface down which liquid will flow being formed from an inner wall of the evaporator accommodating part (18).

3. An installation according to any preceding claim wherein each fin (30) comprises at least one protrusion protruding orthogonally therefrom.

Patentansprüche

1. Verdampferanlage für eine Wärmepumpe, wobei die Anlage einen Verdampfer (20) mit einem Kühlmittelrohr (23) umfasst, das mit mehreren parallelogrammförmigen oder mehreckigen Wärmetauschrippen (30) gekoppelt ist, welche jeweils eine untere Spitze (33) und mehrere Ecken (35) aufweisen, wobei die Verdampferanlage des Weiteren eine Oberfläche (18) umfasst, an der Flüssigkeit von den Wärmetauschrippen (30) herunterfließen wird, wobei die Wärmetauschrippen (30) in einem solchen Winkel geneigt sind, dass die untere Spitze (33) für den einfachen Transport der Flüssigkeit von der unteren Spitze (33) zur Oberfläche (18) neben der Oberfläche (18) positioniert ist, **dadurch gekennzeichnet, dass** Ekken (35) auf gegenüberliegenden Seiten jeder Rippe (30) abgerundet sind, um das Strömen der Flüssigkeit darüber zur unteren Spitze (33) hinunter zu beschleunigen.

2. Anlage nach Anspruch 1, die einen Verdampferaufnahmeteil (18) aufweist, der sich auf einer Seite des Verdampfers (20) befindet, wobei die Oberfläche, an der Flüssigkeit herunterfließen wird, von einer Innenwand des Verdampferaufnahmeteils (18) gebildet wird.

3. Anlage nach einem der vorhergehenden Ansprüche, bei der jede Rippe (30) mindestens einen Vorsprung umfasst, der orthogonal davon vorsteht.

Revendications

1. Installation d'évaporation pour une pompe à chaleur, l'installation comprenant un évaporateur (20) ayant un tube à fluide frigorigène (23) couplé à une pluralité d'ailettes échangeuses de chaleur (30) en forme de parallélogramme ou de polygone, chacune pourvue d'une pointe inférieure (33) et d'une pluralité de coins (35), ladite installation d'évaporation comprenant de plus une surface (18) le long de laquelle un liquide va s'écouler de haut en bas depuis les ailettes échangeuses de chaleur (30), lesdites ailettes échangeuses de chaleur (30) étant inclinées selon un angle tel que ladite pointe inférieure (33) est adjacente à ladite surface (18) pour faciliter le transfert depuis la pointe inférieure (33) jusqu'à la surface (18) **caractérisée en ce que** les coins (35) situés sur des côtés opposés de chaque ailette (30) sont arrondis pour encourager l'écoulement du liquide par-dessus ceux-ci, vers le bas et vers la pointe inférieure (33).

2. Installation selon la revendication 1, qui comprend un élément récepteur (18) d'évaporateur situé sur un côté de l'évaporateur (20) et dont la surface le long de laquelle le liquide va s'écouler vers le bas est formée à partir d'une paroi intérieure de l'élément récepteur de l'évaporateur (18).

3. Installation selon l'une quelconque des revendications précédentes, dans laquelle chaque ailette (30)

comprend au moins une saillie qui avance perpendiculairement à l'ailette.

FIG. 1
(PRIOR ART)

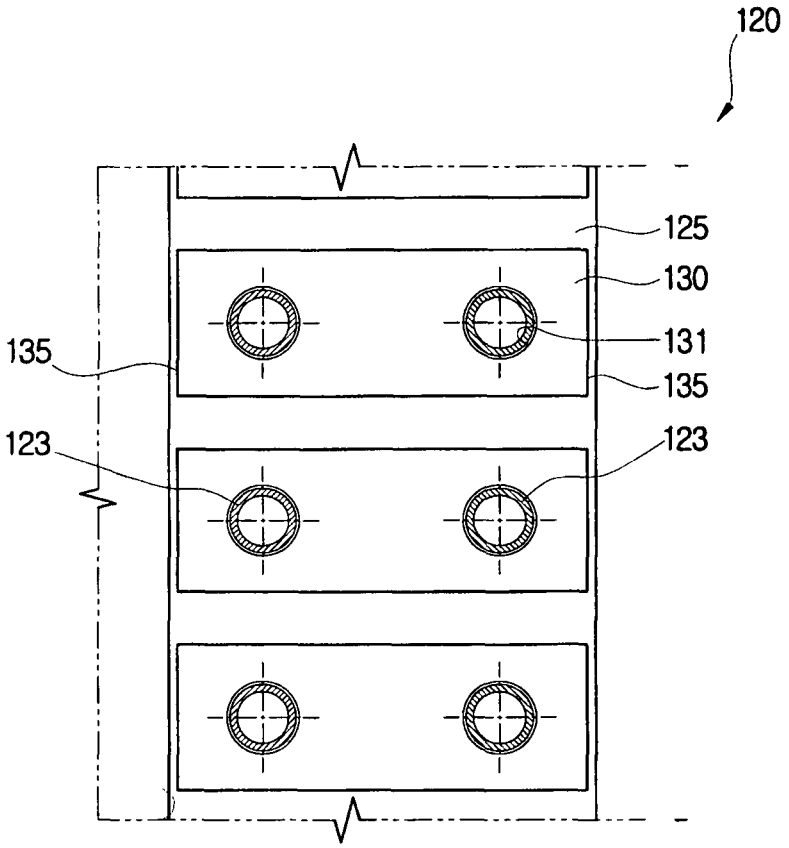


FIG. 2

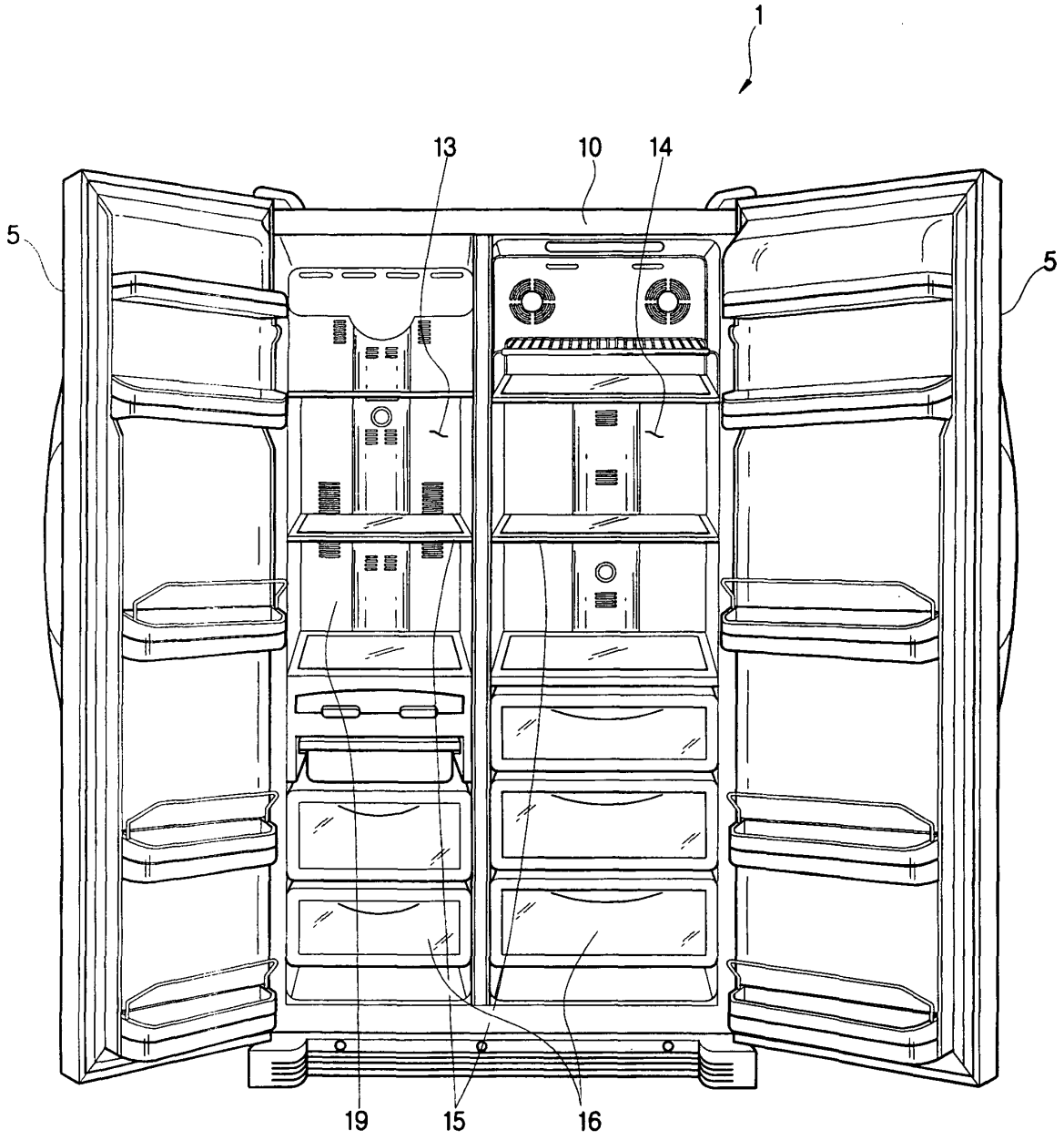


FIG. 3

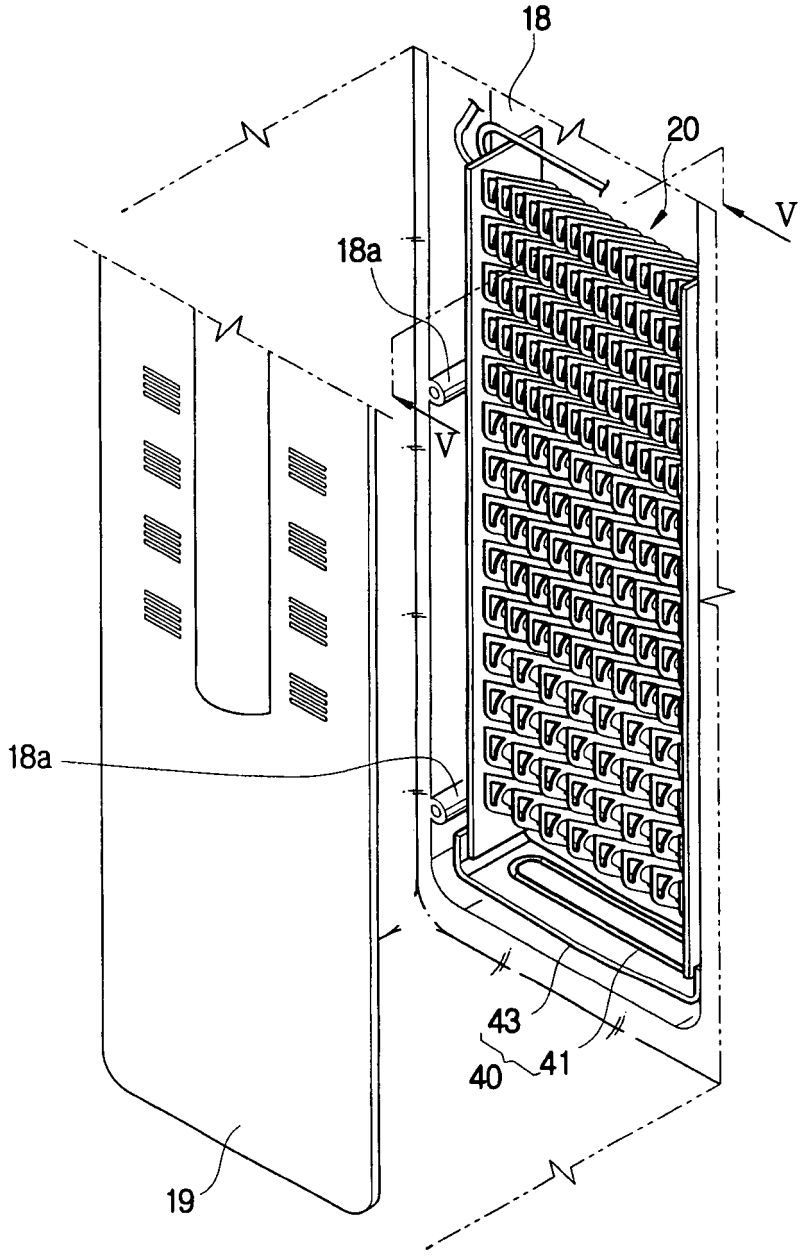


FIG. 4

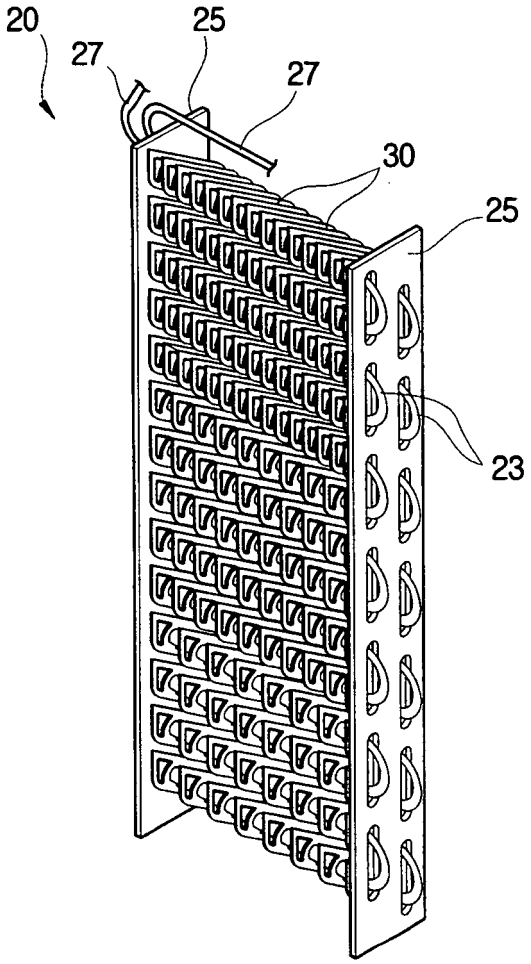


FIG. 5

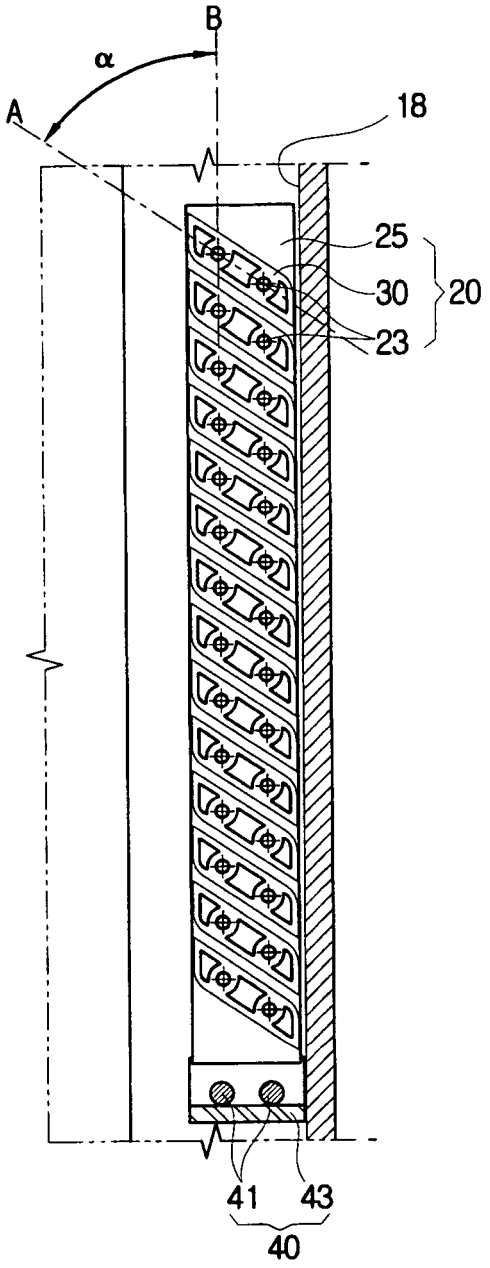
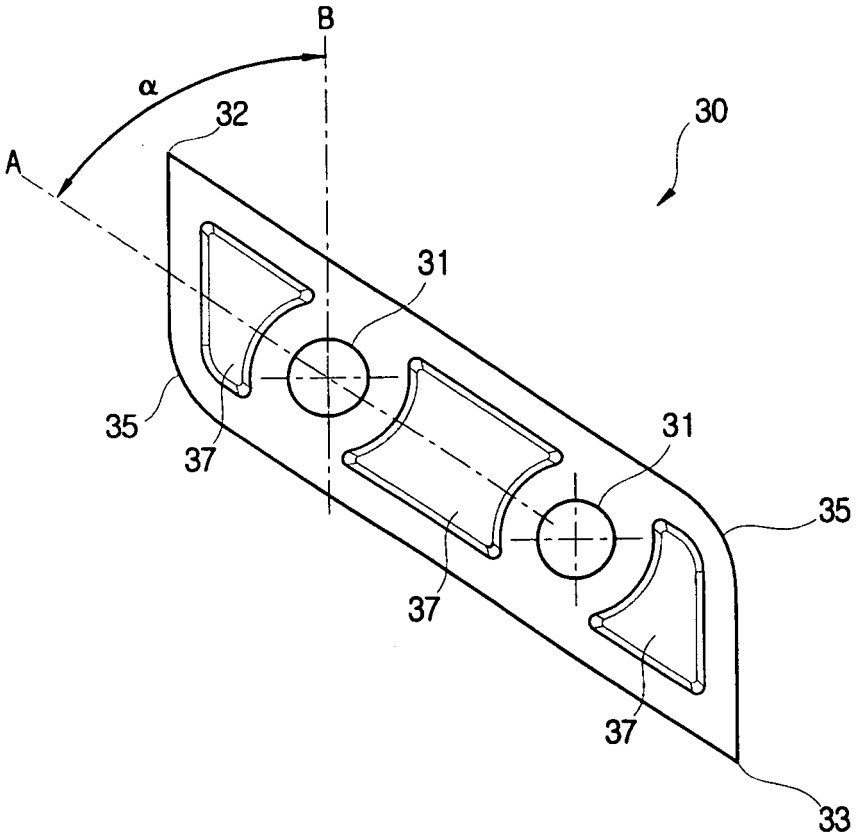


FIG. 6



REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 4041727 A **[0001]**