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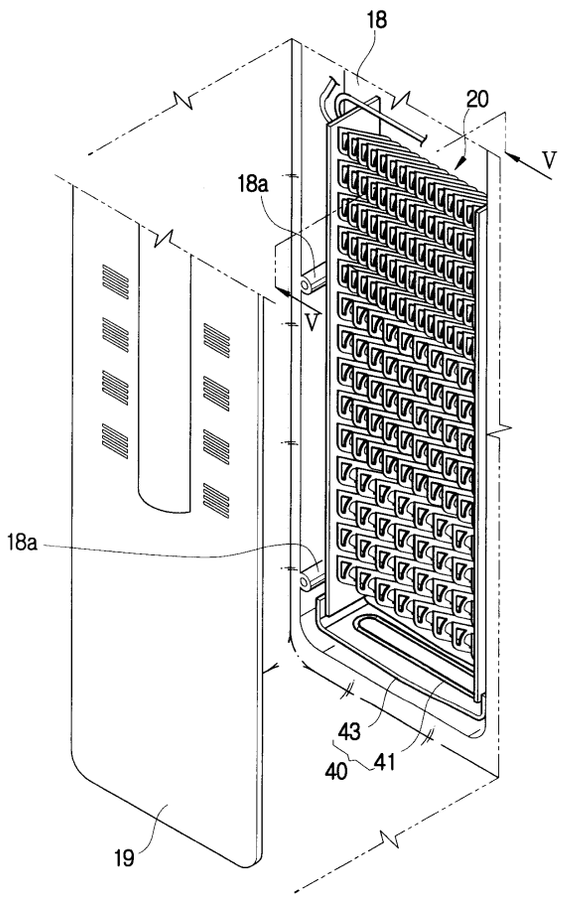
(54) **Evaporator Installation for a Heat Pump**

(57) A refrigeration apparatus generating cooling air, including an evaporator (20) having a coolant tube (23) with a plurality of bending parts, and heat exchange fins (30) formed with at least one coolant tube accommodating part (31) coupling with the coolant tube. The refrigeration apparatus also has a defrosting unit (40) adjacent to the evaporator (20) to remove frost formed on the evaporator, and each heat exchange fin (30) is inclined at an inclination angle so that a longitudinal direction of the heat exchange fin forms an acute angle relative to a vertical direction to enable the water drops defrosted by the defrosting unit (40) to flow downward to a bottom end (33) of the heat exchange fin (30). Opposite sides of each heat exchange fin have rounded corner parts (35). As described above, the evaporator has better performance and reduces power consumption.

FIG. 3



EP 1 541 946 A1

Description

[0001] The present invention relates to n evaporator installation for a heat pump, the installation comprising an evaporator having a coolant tube coupled to a heat exchange fm.

[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 by a surface down which liquid will flow and the fin having a lowest point positioned with respect to said surface such that liquid transfers readily from the fin to the surface.

[0010] There may be a plurality of similarly configured fins which are preferably inclined parallelograms.

[0011] Preferably, the corners of the or each fin over which liquid should flow are rounded to promote liquid flow thereover.

[0012] Additional preferred and optional features of the present invention are set forth in claims 5 to 25 appended hereto.

[0013] 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 according to the present invention;
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.

[0014] Referring to Figures 2 and 3, a refrigerator 1 according to the present invention 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.

[0015] 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.

[0016] 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.

[0017] 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).

[0018] 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) for 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 a 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.

[0019] The evaporator 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.

[0020] 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.

[0021] 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.

[0022] 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 falls 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.

[0023] 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.

[0024] 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.

[0025] 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.

[0026] 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.

[0027] 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.

[0028] 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.

[0029] A defrosting process with such a configuration of the evaporator provided in the refrigeration apparatus of a refrigerator according to the embodiment of the present invention will now be described.

[0030] 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.

[0031] Accordingly, the refrigeration apparatus according to invention 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.

[0032] Although this embodiment of the present invention describes a refrigeration apparatus applied to a refrigerator, such refrigeration apparatus may be applied not only to the refrigerator, but also to various heat exchangers such as an air conditioning apparatus.

[0033] As describe 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 to a heat exchange fin (30), **characterised by** a surface (18) down which liquid will flow and the fin (30) having a lowest point (33) positioned with respect to said surface (18) such that liquid transfers readily from the fin (30) to the surface (18).

2. An installation according to claim 1, including a plurality of heat exchange fins (30) coupled to the coolant tube (23), wherein each fin (30) has a lowest point (33) positioned with respect to said surface (18) such that liquid transfers readily from the fin (30) to the surface (18).

3. An installation according to claim 1 or 2, wherein the or each fin (30) is an inclined parallelogram.

4. An installation according to claim 1, 2 or 3, wherein corners (35) of the or each fin (30) over which liquid should flow are rounded to promote liquid flow thereover.

5. A refrigeration apparatus generating cooling air, comprising:

   an evaporator comprising a coolant tube having at least one bending part, and at least one heat exchange fin with at least one coolant tube accommodating part contacting the coolant tube; and
   a defrosting unit adjacent to the evaporator removing frost formed on the evaporator,
   the heat exchange fin being inclined by an inclination angle so that a longitudinal direction of the heat exchange fin forms an acute angle relative to a vertical direction, the inclination angle causing water drops defrosted by the defrosting unit to flow downward to a bottom end of the heat exchange fin, and
   opposite sides of the heat exchange fin including rounded corner parts.

6. The refrigeration apparatus according to claim 5, wherein the corner part of the heat exchange fin is rounded to have a radius between approximately 5 mm and 20 mm.

7. The refrigeration apparatus according to claim 6, wherein the inclination angle of the heat exchange fin is between approximately 50 degrees and 75 degrees.

8. The refrigeration apparatus according to claim 7, wherein the heat exchange fin includes at least one protrusion protruding orthogonally from a surface of the heat exchange fin.

9. The refrigeration apparatus according to claim 5, wherein the heat exchange fin is inclined toward one side relative to a vertical direction, and the bottom end of each heat exchange fin is adjacent to a wall on which the evaporator is installed.

10. The refrigeration apparatus according to claim 5, further comprising:

    at least two coolant tube supporters on opposite sides of the evaporator supporting the coolant tube.

11. The refrigeration apparatus according to claim 5, wherein the heat exchange fin has a substantially rectangular shape, and the at least one coolant tube accommodating part is positioned on a surface of the heat exchange fin in a pair.

12. A refrigerator comprising:

    a refrigeration apparatus comprising:

    an evaporator having a coolant tube including at least one bending part, and at least one heat exchange fin with at least one coolant tube accommodating part contacting the coolant tube, and
    a defrosting unit adjacent to the evaporator

and removing frost formed on the evaporator;
a main body including at least one storage compartment supplied with cooling air generated by the refrigeration apparatus; and
at least one door covering an opening of the storage compartment,

wherein the heat exchange fin is inclined by an inclination angle so that a longitudinal direction of the heat exchange fin forms an acute angle relative to a vertical direction, the inclination angle causing water drops defrosted by the defrosting unit to flow downward to a bottom end of the heat exchange fin, and

wherein opposite sides of the heat exchange fin include rounded corner parts.

13. A refrigerator comprising:

a refrigeration apparatus including:

an evaporator having a coolant tube including at least one bending part, and at least one heat exchange fin with at least one coolant tube accommodating part contacting the coolant tube, and
a defrosting unit adjacent to the evaporator and removing frost formed on the evaporator;
a main body formed with at least one storage compartment supplied with cooling air generated by the refrigeration apparatus; and
at least one door covering an opening of the storage compartment,

wherein the heat exchange fin is inclined by an inclination angle so that a longitudinal direction of the heat exchange fin forms an acute angle relative to a vertical direction, the inclination angle causing water drops defrosted by the defrosting unit to flow downward to a bottom end of the heat exchange fin,

wherein opposite sides of the heat exchange fin include rounded corner parts, and

wherein the heat exchange fin includes at least one protrusion protruding orthogonally from a surface of the heat exchange fin.

14. A refrigerator comprising:

a refrigeration apparatus including:

an evaporator having a coolant tube including at least one bending part, and at least one heat exchange fin with at least one coolant tube accommodating part contacting the coolant tube, and
a defrosting unit adjacent to the evaporator and removing frost formed on the evaporator;
a main body including at least one storage compartment supplied with cooling air generated by the refrigeration apparatus; and
at least one door covering an opening of the storage compartment,

wherein the heat exchange fin is inclined by an inclination angle so that a longitudinal direction of the heat exchange fin forms an acute angle relative to a vertical direction, the inclination angle causing water drops defrosted by the defrosting unit to flow downward to a bottom end of the heat exchange fin, and

wherein the heat exchange fin is inclined toward one side relative to a vertical direction, and the bottom end of each heat exchange fin is adjacent to a wall on which the evaporator is installed.

15. The refrigeration apparatus according to claim 5, wherein the inclination angle of the heat exchange fin is between approximately 40 degrees and 50 degrees.

16. The refrigeration apparatus according to claim 5, wherein the inclination angle of the heat exchange fin is set based on a ratio of a length of the heat exchange fin and a distance between a plurality of coolant tubes along a vertical direction.

17. The refrigerator according to claim 12, further comprising:

means for disposing of water in an evaporator accommodating part containing the evaporator.

18. The refrigeration apparatus according to claim 5, wherein the heat exchange fin has a polygonal shape.

19. A method of defrosting an evaporator having at least one heat exchange fin including at least a rounded edge and a sharply edged bottom, the evaporator being attached to an evaporator accommodating part, the method comprising:

forming frost in the evaporator during a refrigeration cycle;
defrosting the evaporator after each refrigeration cycle; and
collecting water formed in the defrosting on the sharply edged bottom of the heat exchange fin,

wherein the water flows along the rounded edge and a downwardly sloped length of the heat

exchange fin, and

wherein the water collected on the sharply edged bottom of the heat exchange fin flows down the evaporator accommodating part.

20. The method according to claim 19, further comprising:

disposing of the collected water through a discharge hole.

21. The method according to claim 19, further comprising:

disposing of the collected water with a water accommodating part at a bottom of the evaporator accommodating part.

22. An air conditioner comprising:

a refrigeration apparatus including:

an evaporator having a coolant tube including at least one bending part, and at least one heat exchange fin with at least one coolant tube accommodating part contacting the coolant tube, and
a defrosting unit adjacent to the evaporator and removing frost formed on the evaporator,

wherein the heat exchange fin is inclined by an inclination angle so that a longitudinal direction of the heat exchange fin forms an acute angle relative to a vertical direction, the inclination angle causing water drops defrosted by the defrosting unit to flow downward to a bottom end of the heat exchange fin, and

wherein opposite sides of the heat exchange fin include rounded corner parts.

23. The refrigeration apparatus according to claim 5, wherein the corner part of the heat exchange fin is rounded to have a radius between approximately 3 mm and 5 mm.

24. The refrigeration apparatus according to claim 5, wherein the corner part of the heat exchange fin is rounded to have a radius above 50 mm.

25. The refrigeration apparatus according to claim 5, wherein the heat exchange fm includes at least one sharply-edged corner.

FIG. 1
(PRIOR ART)

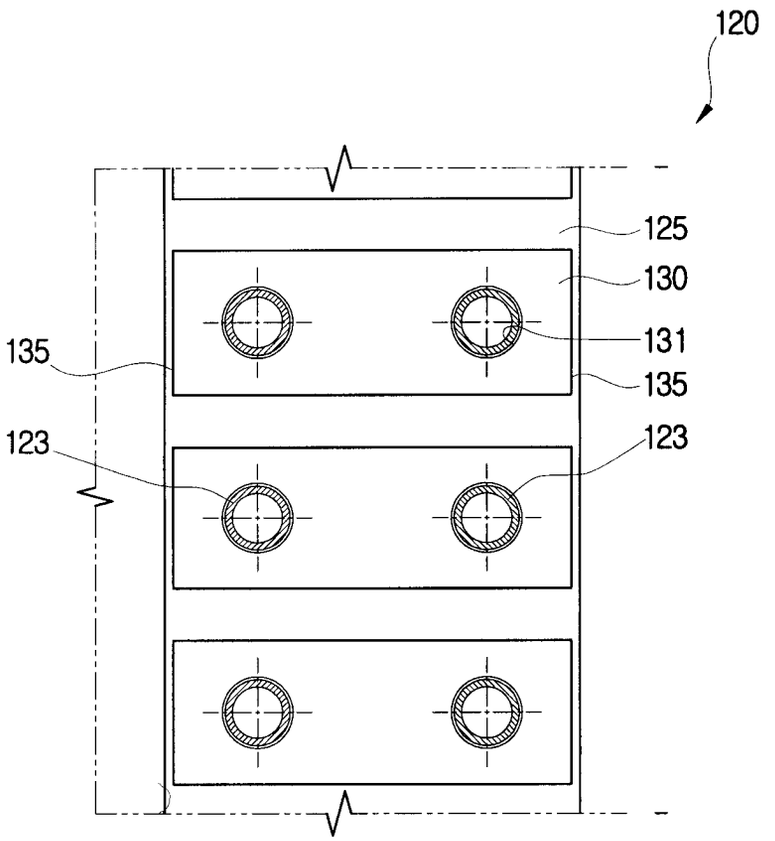


FIG. 2

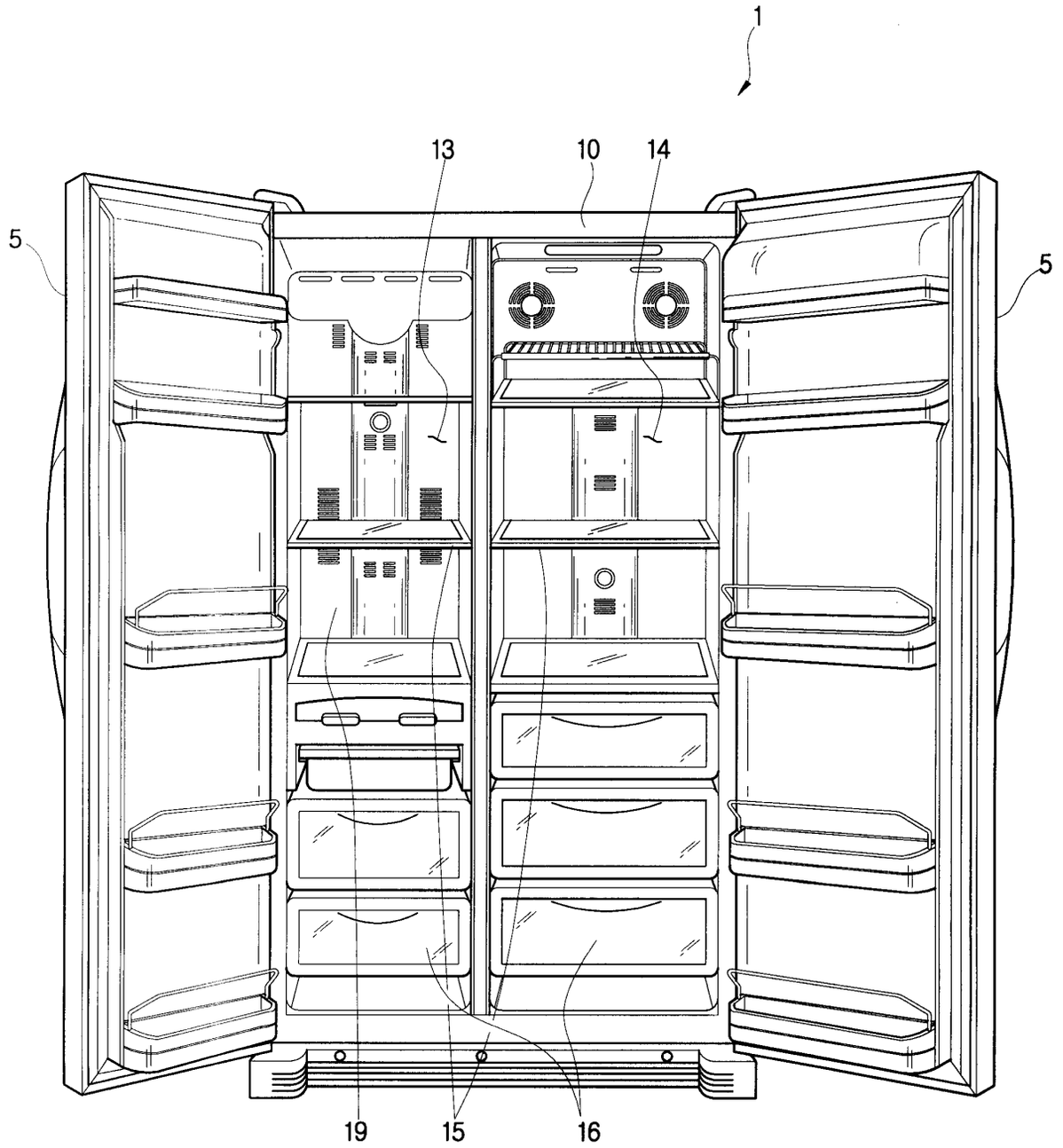


FIG. 3

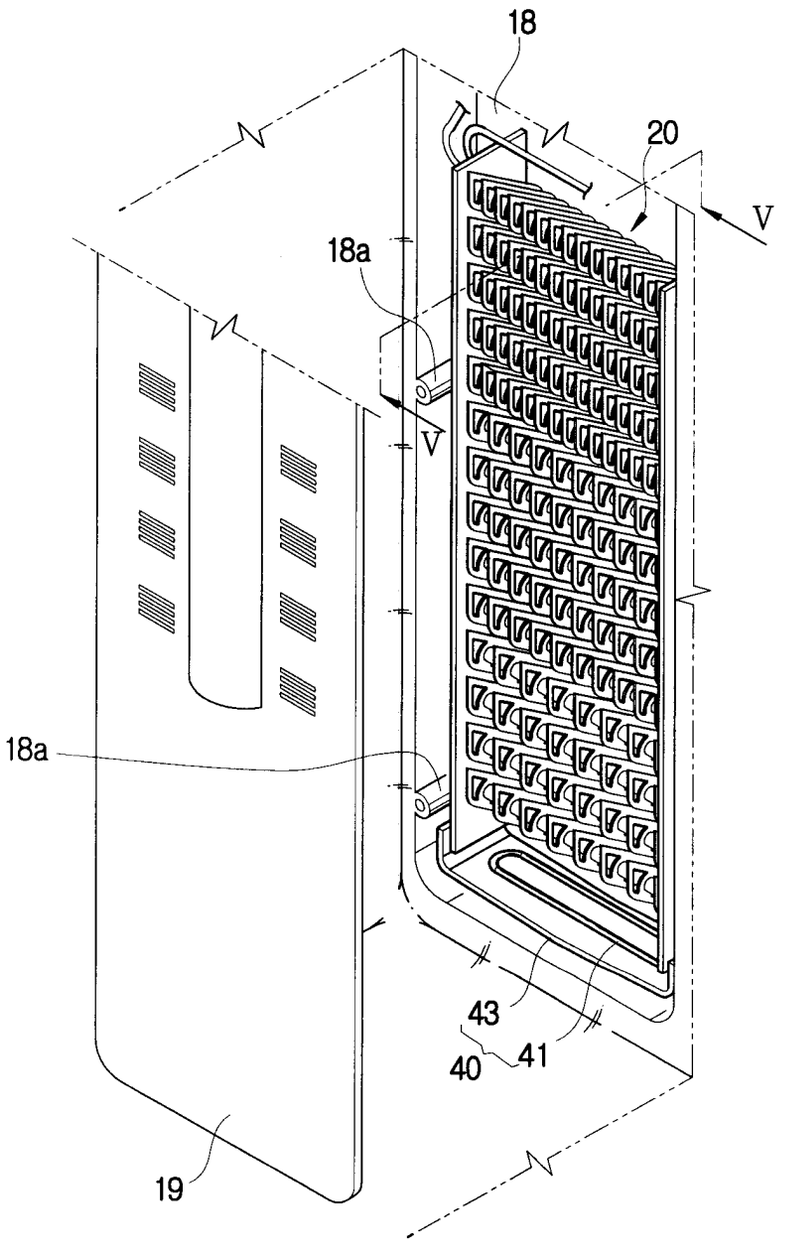


FIG. 4

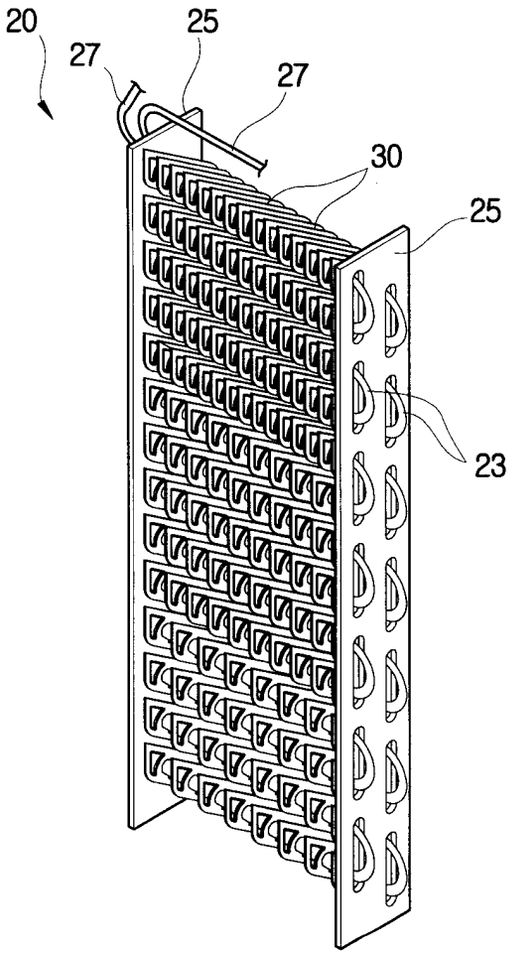


FIG. 5

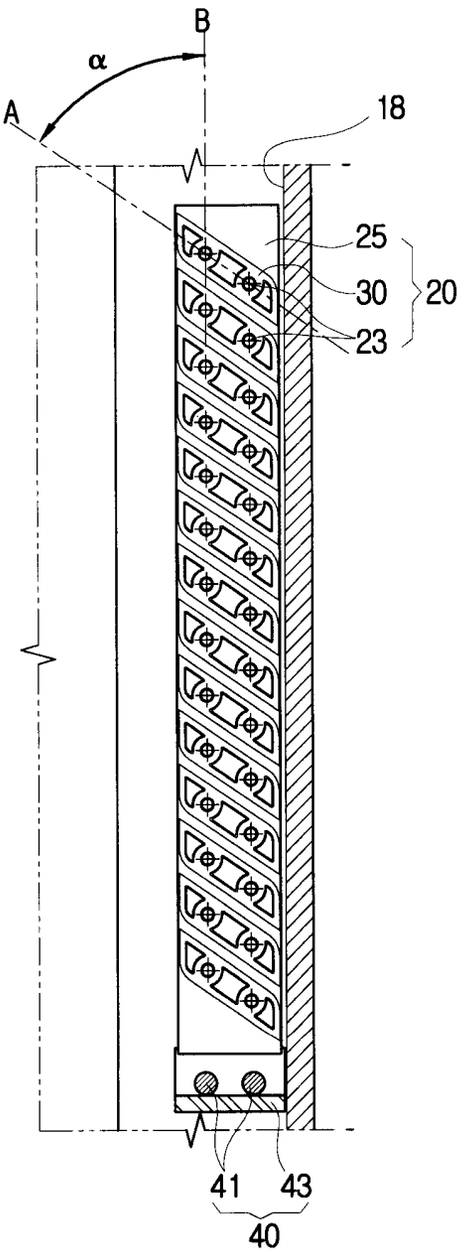
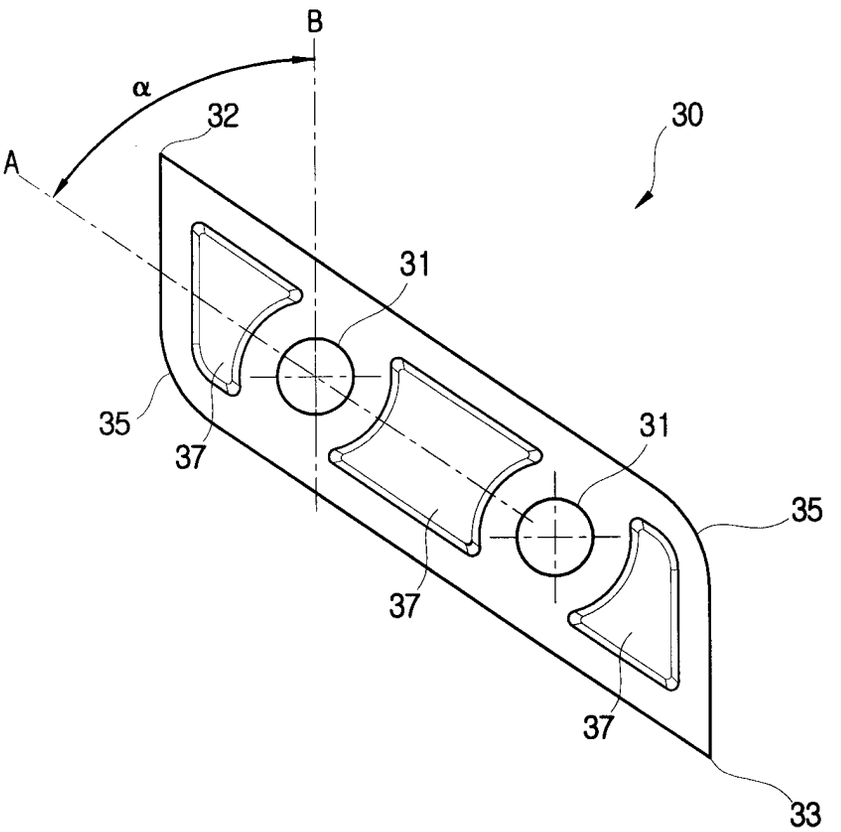


FIG. 6



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 04 10 1755

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	US 2002/195235 A1 (BHATTI MOHINDER SINGH ET AL) 26 December 2002 (2002-12-26) * page 3, paragraph 23 - page 3, paragraph 25; figure 4 *	1-4	F25D21/14
X	US 4 926 932 A (OHARA TOSHIO ET AL) 22 May 1990 (1990-05-22) * column 2, line 60 - column 4, line 45; figure 4 *	1-4	
X	US 4 041 727 A (MAUDLIN EUGENE WENDELL) 16 August 1977 (1977-08-16) * column 2, line 14 - column 3, line 12; figure 2 *	1,2	

TECHNICAL FIELDS SEARCHED (Int.Cl.7)

F25D
F28F

~~The present search report has been drawn up for all claims~~

Place of search	Date of completion of the search	Examiner
Munich	22 November 2004	Zanotti, L

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

European Patent Office

Application Number
EP 04 10 1755

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing more than ten claims.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☒ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

1-4

European Patent Office

LACK OF UNITY OF INVENTION
SHEET B

Application Number
EP 04 10 1755

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-4

   Evaporator installation comprising an evaporator having a coolant tube coupled to a heat exchange fin and a surface down which liquid flows, the fin having a lowest point positioned with respect to the surface such that liquid transfers readily.

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2. claims: 5-13, 15-18, 22-25

   Refrigeration apparatus, refrigerator and air conditioner with a refrigeration apparatus comprising an evaporator with a coolant tube having a bending part and a heat exchange fin and a defrosting unit, the fin being inclined by an acute angle causing water drops to flow downward to a bottom end of the fin and opposite side of the fin including rounded corner parts.

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3. claims: 14, 19-21

   Refrigerator with a refrigeration apparatus comprising an evaporator and method of defrosting an evaporator having at least one exchange fin inclined downwardly causing water drops to flow downward to a bottom end of the fin, the bottom of the fin being adjacent to a wall on which the evaporator is installed so that water flows down the wall.

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 04 10 1755

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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22-11-2004

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82