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(11) **EP 1 640 682 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
29.03.2006 Bulletin 2006/13

(51) Int Cl.:
F28D 1/053 ^(2006.01) **F28F 9/02** ^(2006.01)
F28F 27/02 ^(2006.01)

(21) Application number: **05253858.4**

(22) Date of filing: **22.06.2005**

(84) Designated Contracting States:
**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR
HU IE IS IT LI LT LU MC NL PL PT RO SE SI SK TR**
Designated Extension States:
AL BA HR LV MK YU

(30) Priority: **15.09.2004 KR 2004073993**

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

(72) Inventors:
• **Kim, Jeung Hoon**
Suwon-Si
Gyeonggi-do (KR)
• **Cho, Hong Gi,**
No. 304 Shyalrom Artvil
Suwon-Si
Gyeonggi-Do (KR)
• **Kil, Seong Ho,**
No. 621-704 Hwasung Apt.
Seongnam-Si
Gyeonggi-Do (KR)

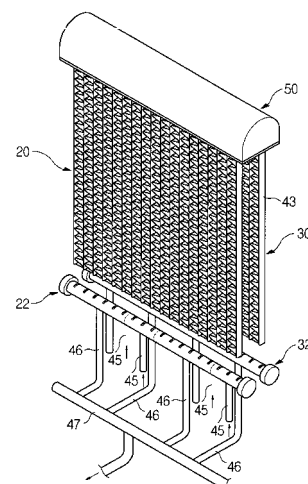
• **Cho, Keum Nam**
Gwacheon-Si
Gyeonggi-Do (KR)
• **Youn, Baek,**
No. 102-1105 Hyundai Apt.
Suwon-Si
Gyeonggi-Do (KR)
• **Koo, Hyoung Mo,**
No. 111-1901 Daewoo Apt.
Anyang-Si
Gyeonggi-Do (KR)
• **Lee, Jai Kwon,**
No. 644-1203 Shinwon Apt.
Suwon-Si
Gyeonggi-Do (KR)

(74) Representative: **Waddington, Richard et al**
Appleyard Lees,
15 Clare Road
Halifax HX1 2HY (GB)

(54) **Evaporator using micro-channel tubes**

(57) An evaporator utilizes micro-channel tubes (43), and more particularly, has a structure of a heat exchanger using micro-channel tubes (43), which is applied to an evaporator of a household air conditioner. The evaporator, using micro-channel tubes (43), includes a plurality of heat exchanging units, each heat exchanging unit including a plurality of the micro-channel tubes (43) installed between a pair of headers, and an integral header to transmit refrigerant between the neighboring heat exchanging units.

FIG. 3



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Description

[0001] The present invention relates to a heat exchanger using micro-channel tubes, and more particularly to a structure of a heat exchanger using micro-channel tubes, which is applied to an evaporator of a household air conditioner.

[0002] Generally, a heat exchanger using micro channel tubes is a heat exchanger, in which refrigerant flows along a plurality of tubes having a diameter of less than several mm. Such a heat exchanger is widely used by a condenser of a vehicle air conditioner.

[0003] Korean Patent Publication No. 1996-0009342 discloses a structure of a heat exchanger using micro-channel tubes. Hereinafter, with reference to FIG. 1, the heat exchanger using micro-channel tubes will be described.

[0004] The heat exchanger using the micro-channel tubes comprises a plurality of tubes 1 laid in a horizontal direction. The tubes 1 are vertically arranged, and corrugated pins 2 are interposed between the tubes 1. Headers 3 and 4 for distributing refrigerant into the tubes 1 or for collecting the refrigerant from the tubes 1 are placed at both ends of the tubes 1. The headers 3 and 4 are made of an aluminum rod member having a circular cross-section, and placed perpendicularly at both ends of the tubes 1. The tubes 1 communicate with the headers 3 and 4, and separators 10 and 11 for dividing the tubes 1 into several channel groups A, B, and C are installed in the headers 3 and 4.

[0005] The plural tubes 1 are divided into an inlet-side channel group A, through which the refrigerant enters to the evaporator, an outlet-side channel group C, through which the refrigerant is discharged from the evaporator, and an intermediate channel group B.

[0006] With reference to FIG. 2, the overall flow of the refrigerant in the heat exchanger is described. The refrigerant flows along all of the tubes 1 of each of the channel groups A, B, and C in one direction, and then flows along the tubes 1 of the next groups B and C. That is, the refrigerant, having entered into the tubes 1 through a refrigerant inlet 6, is uniformly distributed into all of the tubes 1 of the inlet-side channel group A, and flows toward the upper portion of the right header 4 above the separator 11. In the upper portion of the right header 4 above the separator 11, the inlet-side channel group A and the intermediate channel group B communicate with each other, the entered refrigerant flows toward the intermediate channel group B and is transmitted to the lower portion of the left header 3 below the separator 10. Then, the refrigerant, having been transmitted to the left header 3 through the intermediate channel group B, enters into the lower portion of the right header 4 below the separator 11 through the outlet-side channel group C, and is discharged to the outside through a refrigerant outlet 8.

[0007] Here, non-described reference numerals 7 and 9 represent caps for closing the ends of the headers 3

and 4, and non-described reference numerals 13 and 14 represent side plates placed on the outer surfaces of the outermost corrugated pins 2.

[0008] In the above-described heat exchanger using micro-channel tubes, the refrigerant in a gaseous state, having entered into the heat exchanger through the refrigerant inlet 6, flows in each of the tubes 1 from the inlet-side channel group A to the outlet-side channel group C, exchanges heat with air in the tubes 1 to be condensed to a liquid state, and the refrigerant in the liquid state is discharged to the outside through the refrigerant outlet 8.

[0009] The heat exchanger using micro-channel tubes is called various names, i.e., an aluminum heat exchanger due to the material thereof, a flat tube-type heat exchanger due to the shape of the tubes thereof, and a PFC (parallel flow condenser) due to the flow of the refrigerant.

[0010] The heat exchanger using micro-channel tubes is advantageous in that it has heat transfer efficiency higher than that of a pin tube-type heat exchanger, and is miniaturized. However, the heat exchanger using micro-channel tubes cannot be used as an evaporator of a household air conditioner due to several problems, as follows.

[0011] Since the evaporator exchanges heat with air of a high temperature rather than air of the temperature thereof, moisture in air is condensed and condensation of water occurs on the surface of the evaporator. In the conventional heat exchanger using micro-channel tubes, which comprises the tubes laid in the horizontal direction, the condensed water formed on the surface of the heat exchanger is gathered in hollow portions of the corrugated pins between the tubes, thus decreasing heat exchanging efficiency.

[0012] While the flow rate of air around the vehicle condenser is comparatively rapid, such as 3~4 m/s, the flow rate of air around the evaporator of the household air conditioner is comparatively slow, such as 0.5~1.5 m/s, thus reducing a heat transfer rate per unit hour. Accordingly, the conventional heat exchanger using micro-channel tubes requires a large heat transfer area.

[0013] While the flow of the refrigerant, flowing in the heat exchanger, from the entrance of the refrigerant into the upper portion of one header to the discharge of the refrigerant from the lower portion of the other header, has an S shape, the refrigerant, flowing in the condenser, is condensed from a gaseous state to a liquid state, thus naturally having an S-shaped flow. As shown in FIG. 2, the number of the tubes 1 of the outlet-side channel group C is smaller than the number of the tubes of the inlet-side channel group A due to the phase change of the refrigerant, thus minimizing pressure loss in the heat exchanger. However, since the refrigerant flowing in the evaporator is vaporized from the liquid state to the gaseous state, it is difficult to apply the channel structure of the condenser to the evaporator.

[0014] In spite of the above problems, several methods have been proposed for applying the heat exchanger us-

ing micro-channel tubes to an evaporator of a household air conditioner.

[0015] Korean Patent Laid-open No. 2003-0063980 discloses a heat exchanger, in which headers are erected horizontally and micro-channel tubes are laid perpendicularly between the headers. Drain holes and line grooves for facilitating the discharge of condensed water are formed in the heat exchanger. Korean Patent Laid-open Nos. 2004-0017447, 2004-0017449, 2004-0017920, and 2004-0019628 disclose structures of heat exchangers for facilitating the discharge of condensed water under the condition that headers and micro-channel tubes are disposed in the same manner as that of the preceding Patent.

[0016] As disclosed by the above Patents, an evaporator, in which the headers are erected horizontally and the micro-channel tubes are laid perpendicularly between the headers, may discharge a sufficient quantity of the condensed water, but has disadvantages, such as a small heat transfer area and a difficulty in achieving uniform flow of the refrigerant.

[0017] Since the refrigerant at an inlet of the evaporator is in a two-phase state, the refrigerant, which enters into the header of the evaporator, cannot be uniformly distributed to the respective tubes due to the difference of speeds of flow between the gaseous phase and the liquid phase. Particularly, the transmission of the refrigerant from one channel group to another channel group is performed in one header, thus accelerating the above problems.

[0018] The present invention provides an evaporator of a household air conditioner using compact micro-channel tubes having a high heat transfer efficiency.

[0019] The present invention provides an evaporator of a household air conditioner uses micro-channel tubes, from which condensed water is easily discharged, and into which refrigerant is uniformly distributed.

[0020] In one aspect of the present invention, an evaporator uses micro-channel tubes and comprises a plurality of heat exchanging units, each heat exchanging unit including a plurality of the micro-channel tubes installed between a pair of non-integral headers, and an integral header for transmitting refrigerant between the neighboring heat exchanging units.

[0021] The headers of each of the heat exchanging units may be laid horizontally, and the micro-channel tubes may be erected vertically.

[0022] The integral header may be divided into a header unit for one heat exchanging unit and a header unit for the other heat exchanging unit, and may include a partition having openings for communicating the refrigerant between the two header units.

[0023] Each of the headers may be divided by a plurality of separators so that the micro-channel tubes of each of the heat exchanging units form a plurality of channel groups.

[0024] The channel groups of one heat exchanging unit may be connected to the channel groups of the neigh-

boring heat exchanging unit; and a plurality of refrigerant circuits may be formed by the connection between the channel groups of the heat exchanging units.

[0025] The cross-sectional areas of flow channels of a downstream channel group may be greater than or equal to those of flow channels of an upstream channel group.

[0026] The flow directions of the neighboring refrigerant circuits may be opposite to each other.

[0027] In another aspect of the present invention, an evaporator uses micro-channel tubes and comprises a first heat exchanging unit including a plurality of the micro-channel tubes installed between a pair of upper and lower headers laid horizontally, and a second heat exchanging unit, installed adjacent to the first heat exchanging unit, including a plurality of the micro-channel tubes installed between a pair of upper and lower headers laid horizontally, wherein the upper header of the first heat exchanging unit and the upper header of the second heat exchanging unit are formed integrally with each other, thus producing one integral upper header, and wherein the lower header of the first heat exchanging unit and the lower header of the second heat exchanging unit are non-integral headers.

[0028] The integral upper header may include a base, to which the micro-channel tubes of the first and second heat exchanging units are bonded, a cover forming a closed space together with the base, and a partition, to divide the closed space, formed by the base and the cover, into a first upper header unit for the first heat exchanging unit and a second upper header unit for the second heat exchanging unit, and including openings for communicating refrigerant between the first and second upper header units.

[0029] Each of the integral upper header and the lower headers of the first and second heat exchanging units may be divided by a plurality of separators so that the micro-channel tubes of each of the first and second heat exchanging units form a plurality of channel groups.

[0030] One channel group of one heat exchanging unit may be connected to the one channel group of the neighboring heat exchanging unit; and a plurality of refrigerant circuits may be formed by the connection between the channel groups of the heat exchanging units.

[0031] The cross-sectional areas of flow channels of a channel group located at an inlet of each of the refrigerant circuits, through which the refrigerant enters into the evaporator, may be smaller than or equal to the cross-sectional areas of flow channels of a channel group located at an outlet of the refrigerant circuit, through which the refrigerant is discharged to the outside.

[0032] Additional aspects and/or advantages of the invention will be set forth in part in the description which follows and, in part, will be obvious from the description, or may be learned by practice of the invention.

[0033] These and/or other aspects and advantages of the invention will become apparent and more readily appreciated from the following description of the embodi-

ments, taken in conjunction with the accompanying drawings of which:

FIG. 1 is a front view of a conventional heat exchanger using micro-channel tubes;
 FIG. 2 is a schematic view illustrating the flow of refrigerant in the heat exchanger of FIG. 1;
 FIG. 3 is an exploded perspective view of an evaporator using micro-channel tubes in accordance with a preferred embodiment of the present invention;
 FIG. 4 is an exploded perspective view of an upper header of the evaporator of FIG. 3;
 FIG. 5 is a perspective view of a lower header of the evaporator of FIG. 3;
 FIG. 6 is a plan view illustrating the flow of refrigerant in the upper header of the evaporator of FIG. 3;
 FIG. 7 is a top view of the evaporator of FIG. 3;
 FIG. 8 is a schematic view illustrating the flow of refrigerant in the evaporator of FIG. 3;
 FIGS. 9a and 9b are plan views illustrating the flow of refrigerant in upper headers of evaporators in accordance with other embodiments of the present invention; and
 FIGS. 10a, 10b, and 10c are front views illustrating structures of a partition of the upper header of the evaporator using micro-channel tubes in accordance with a preferred embodiment of the present invention.

[0034] Reference will now be made in detail to the embodiments of the present invention, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to the like elements throughout. The embodiments are described below to explain the present invention by referring to the figures.

[0035] As shown in FIG. 3, an evaporator using micro-channel tubes in accordance with a preferred embodiment of the present invention comprises two heat exchanging units 20 and 30, each of which includes a plurality of micro-channel tubes 43 vertically erected between a pair of headers laid horizontally. Hereinafter, the heat exchanging unit, which is placed at the front position, is referred to as a first heat exchanging unit 20, and the heat exchanging unit, which is placed at the rear position, is referred to as a second heat exchanging unit 30.

[0036] An integral upper header 50 is placed on the upper surfaces of the first heat exchanging unit 20 and the second heat exchanging unit 30, thus transmitting refrigerant between the first and second heat exchanging units 20 and 30.

[0037] As shown in FIG. 4, the upper header 50 includes base 53 provided with a plurality of longitudinal holes 58 formed therethrough perpendicularly to the longitudinal direction of the base 53, a cover 54 having an arc-shaped cross section placed above the upper surface of the base 53 for forming a closed space together with the base 53, a partition 55 for dividing the space formed by the base 53 and the cover 54, in the longitudinal di-

rection of the base 53, into a first upper header unit 51 forming a part of the first heat exchanging unit 20 and a second upper header unit 52 forming a part of the second heat exchanging unit 30, and separators 57 for dividing each of the first upper header unit 51 and the second upper header unit 52 into plural portions. Openings 56 for transmitting refrigerant between the first and second heat exchanging units 20 and 30 therethrough are formed through the partition 55.

[0038] A plurality of micro-channel tubes (hereinafter, abbreviated to 'tubes') 43, which are erected vertically, are connected to the lower part of the upper header 50. Upper ends of the tubes 43 are bonded to the upper header 50 under the condition that designated lengths of the upper ends of the tubes 43 are inserted into the longitudinal holes 58. The insides of the tubes 43 are divided into plural portions so as to form fine channels. Since the cross-sections of the tubes 43 are similar to the structure of a harmonica, the tubes 43 are referred to as harmonica tubes.

[0039] Corrugated pins 44 are intercalated between the micro-channel tubes 43. Preferably, louvers 44a are formed on the corrugated pins 44 for facilitating heat transfer.

[0040] Generally, when the evaporator is installed, the surface of the evaporator is perpendicular to the flow direction of air. As shown in FIG. 4, water condensed on the surface of the evaporator flows down along the surfaces of the tubes 43, which are erected vertically, by its own weight. Water condensed on the corrugated pins 44 flows down by the gradient of the corrugated pins 44, and then flows down along the surfaces of the tubes 43 or flows down again along the corrugated pins 44 at contacts between the corrugated pins 44 and the tubes 43.

[0041] A first lower header 22 is placed below the tubes 43 of the first heat exchanging unit 20, and a second lower header 32 is placed below the tubes 43 of the second heat exchanging unit 30.

[0042] As shown in FIG. 5, the first lower header 22 is made of an aluminum pipe having a circular cross-section. Since the inside of the first lower header 22 is divided into plural portions by a plurality of separators 23, it is possible to cut off the flow of the refrigerant between the neighboring portions of the inside of the first lower header 22. A plurality of longitudinal holes 24 are formed through the upper surface of the first lower header 22 such that the longitudinal holes 24 are perpendicular to the longitudinal direction of the first lower header 22, and the lower ends of the tubes 43 are bonded to the first lower header 22 under the condition that designated lengths of the lower ends of the tubes 43 are inserted into the longitudinal holes 43. The second lower header 32 has the same structure as that of the first lower header 22.

[0043] Inlet pipes 45, for inhaling the refrigerant, having passed through an expansion valve (not shown) of the conventional refrigerating cycle, into the evaporator, and outlet pipes 46, for discharging the refrigerant, having vaporized by the evaporator, to the outside of the

evaporator, are connected to the lower parts of the first lower header 22 and the second lower header 32. The refrigerants discharged from the outlet pipes 46 are gathered in a collecting manifold 47 connected to the lower ends of the outlet pipes 46, and transmitted to a compressor (not shown) (with reference to FIG. 7).

[0044] Hereinafter, with reference to FIG. 8, the flow of the refrigerant in the evaporator using the micro-channel tubes with reference to the above embodiment of the present invention will be described.

[0045] An upper portion of FIG. 8 illustrates the flow of the refrigerant in the second heat exchanging unit 30, a lower portion of FIG. 8 illustrates the flow of the refrigerant in the first heat exchanging unit 20, and a middle portion of FIG. 8 illustrates the flow of the refrigerant in the upper header 50.

[0046] As described above, the inside of each of the upper header 50 and the first and second lower headers 22 and 32 is divided into several portions by a plurality of the corresponding separators 57, 23, or 33. In the evaporator in this embodiment, the inside of each of the upper header 50 and the first and second lower headers 22 and 32 is divided into four portions, and the four portions have different sizes so as to form the flow of the refrigerant as shown in FIG. 8.

[0047] In FIG. 8, a left portion 32a of the second lower header 32 and a left portion 52a of the second upper header unit 52 have the same size, and the tubes 43, which are installed between the left portion 32a of the second lower header 32 and the left portion 52a of the second upper header unit 52, form one channel group G1. The remaining portions 32b, 32c, and 32d of the second lower header 32 and the corresponding remaining portions of 52b, 52c, and 52d of the second upper header unit 52 respectively have the same sizes, so as to form channel groups G2, G3, and G4. In the same manner as the second lower header 32 and the second upper header unit 52, the first upper header unit 51 is divided into four portions 51a, 51b, 51c, and 51d, and the first lower header 22 is divided into four portions 22a, 22b, 22c, and 22d, so as to form channel groups G5, G6, G7, and G8 in order.

[0048] The number of the tubes 43 of any one of the channel groups G1, G3, G6, and G8 is smaller than that of the tubes 43 of any one of the channel groups G2, G4, G5, and G7. The above difference of numbers of the tubes 43 among the channel groups G1, G2, G3, G4, G5, G6, G7, and G8 reduces the decrease in the pressure of the refrigerant in the evaporator in consideration of the expanded volume of the refrigerant when the refrigerant is vaporized in the evaporator.

[0049] The inlet pipe 45 is connected to the portion 32a of the second lower header 32 connected to the channel group G1. The refrigerant, having entered into the second lower header 32 through the inlet pipe 45, is distributed at the portion 32a into the tubes 43 of the channel group G1. The divided parts of the refrigerant flowing along the tubes 43 of the channel group G1 are collected at the portion 52a of the second upper header unit 52, and the

collected refrigerant is transmitted to the portion 51a of the first upper header unit 51 through the opening 56 of the partition 51. The refrigerant is divided again into the tubes 43 of the channel group G5 and transmitted to the portion 22a of the first lower header 22. The refrigerant at the portion 22a of the first lower header 22 is discharged to the outside through the outlet pipe 46 connected to the portion 22a.

[0050] When the refrigerant passes through the channel groups G1 and G5, the refrigerant is vaporized by exchanging heat with peripheral air. The channel group G1, through which the refrigerant enters to the evaporator, is an inlet-side channel group, and the channel group G5, through which the refrigerant is discharged from the evaporator, is an outlet-side channel group. The route of the refrigerant from one inlet pipe 45 to the opposite outlet pipe 46 is referred to as a refrigerant circuit. In the same manner as the channel groups G1 and G5, the channel groups G3, G6, and G8 are inlet-side channel groups, and the channel groups G2, G4, and G7 are outlet-side channel groups, thus forming three refrigerant circuits. Accordingly, a total of four refrigerant circuits is formed in the evaporator, and the flow directions of the refrigerant of the neighboring refrigerant circuits are opposite to each other. The flow directions are designed in consideration of the difference of the numbers of the tubes 43 among the channel groups G1, G2, G3, G4, G5, G6, G7, and G8.

[0051] As described above, the number of the tubes 43 of any one of the channel groups G1, G3, G6, and G8 is smaller than that of the tubes 43 of any one of the channel groups G2, G4, G5, and G7. The above difference of numbers of the tubes 43 among the channel groups G1, G2, G3, G4, G5, G6, G7, and G8 denotes that the cross sectional areas of flow channels of the outlet-side channel groups G2, G4, G5, and G7 are greater than those of the flow channels of the inlet-side channel groups G1, G3, G6, and G8. Since the evaporator receives the refrigerant in a liquid state and discharges the refrigerant in a gaseous state, the evaporator generally has the above-described structure to reduce the decrease of the pressure in the evaporator.

[0052] When the refrigerant is transmitted from one channel group to the next channel group in a conventional evaporator, since the refrigerant flows in the header and is distributed into the tubes 43, it is difficult to uniformly distribute the refrigerant. In the evaporator in accordance with this embodiment, since the refrigerant is transmitted through the opening 56 formed through the partition 55 of the upper header 50, the refrigerant may be uniformly distributed (with reference to FIG. 6).

[0053] FIGs. 9a and 9b illustrate internal structures of integral upper headers of evaporators in accordance with other embodiments of the present invention. In the same manner as the evaporator in accordance with the preceding embodiment, each of the evaporators in accordance with other embodiments comprises two heat exchanging units. However, each of the evaporators has a

refrigerant channel structure differing from that of the evaporator of the preceding embodiment. The evaporator of the embodiment shown in FIG. 9a has a total of three refrigerant circuits. Each of a first upper header unit 61 and a second upper header unit 62 of an upper header 60 is divided into three portions by two separators 63. In the same manner as that of the evaporator of the preceding embodiment, the cross sectional areas of the flow channels of outlet-side channel groups are greater than the cross sectional areas of the flow channels of the inlet-side channel groups. The transmission of the refrigerant between the heat exchanging units is achieved through openings of a partition 64 of the upper header 60, and the flow directions of the refrigerant of the neighboring refrigerant circuits are opposite to each other, as shown by the arrows. The evaporator of the embodiment shown in FIG. 9b has a total of two refrigerant circuits. Each of a first upper header unit 71 and a second upper header unit 72 of an upper header 70 is divided into two portions by one separator 73, the cross sectional areas of the flow channels of outlet-side channel groups are greater than those of the flow channels of inlet-side channel groups, and the flow directions of the refrigerant of the neighboring refrigerant circuits are opposite to each other, as shown by the arrows.

[0054] FIGS. 10a, 10b, and 10c illustrate various modifications of shapes, sizes, and positions of openings formed through the partition of the upper header. A partition 81 as shown in FIG. 10a includes circular-shaped openings 82, a partition 83 as shown in FIG. 10b includes an opening 84 formed through the upper part thereof, and a partition 85 as shown in FIG. 10c includes an opening 86 formed through the whole part thereof.

[0055] The headers, the tubes, and the corrugated pins of the above evaporator using micro-channel tubes are made of aluminum material, and manufactured by a furnace brazing process.

[0056] As apparent from the above description, the present invention provides an evaporator using micro-channel tubes, which has a small size and a high efficiency, thus being capable of miniaturizing a household air conditioner.

[0057] The evaporator of the present invention comprises a plurality of heat exchanging units, thus having a sufficient heat transfer area.

[0058] The evaporator of the present invention uniformly distributes refrigerant in the installed direction thereof and the upper header to transmit the refrigerant between the heat exchanging units.

[0059] The evaporator of the present invention easily discharges condensed water by the installed direction thereof.

[0060] Although a few preferred embodiments have been shown and described, it will be appreciated by those skilled in the art that various changes and modifications might be made without departing from the scope of the invention, as defined in the appended claims.

[0061] Attention is directed to all papers and docu-

ments which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this specification, and the contents of all such papers and documents are incorporated herein by reference.

[0062] All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

[0063] Each feature disclosed in this specification (including any accompanying claims, abstract and drawings) may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

[0064] The invention is not restricted to the details of the foregoing embodiment(s). The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

Claims

1. A heat exchanging device comprising:
 - a combining header (50);
 - a plurality of singular headers (51/52) arranged horizontally in parallel with and below the combining header (50); and
 - micro-channel tubes (43) extending from the combining header (50) to each singular header, wherein the combining header (50) transmits refrigerant from one singular header (51/52) to another singular header (51/52) via the micro-channels.
2. The heat exchanging unit according to claim 1, wherein the combining header (50) and the singular headers (51/52) are each laid approximately perpendicular with respect to the micro-channel tubes (43).
3. The heat exchanging unit according to claim 1, wherein the combining header (50) is divided into a first header unit (51) and a second header unit (52), and includes a partition having openings for communicating the refrigerant between the first header unit (51) and the second header unit (52).
4. The heat exchanging unit according to claim 3, wherein the first and second header units (51,52) are each associated with a plurality of micro-channel tubes (43), and

each of the first and second header units (51/52) is divided by a plurality of separators (57), forming the micro-channel tubes (43) associated with the first and second header units (51/52) respectively into a plurality of channel groups.

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5. The heat exchanging unit according to claim 4, further comprising:

a plurality of heat exchanger units (20,30) are defined, each by the micro-channel tubes (43) extending from the combining header (50) to one of the singular headers (51/52); connections connecting the channel groups of one heat exchanging unit (20) to channel groups of a neighboring heat exchanging unit (30); and a plurality of refrigerant circuits that are formed by the connections between the channel groups.

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6. The heat exchanging unit according to claim 5, wherein refrigerant flows from upstream micro-channel tubes (43) to downstream micro-channel tubes (43), and wherein downstream micro-channel tubes (43) have a cross-sectional area greater than or equal to that of upstream micro-channel tubes (43).

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7. The heat exchanging unit according to claim 5, wherein neighboring refrigerant circuits have flow directions that are opposite to each other.

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FIG. 1
PRIOR ART

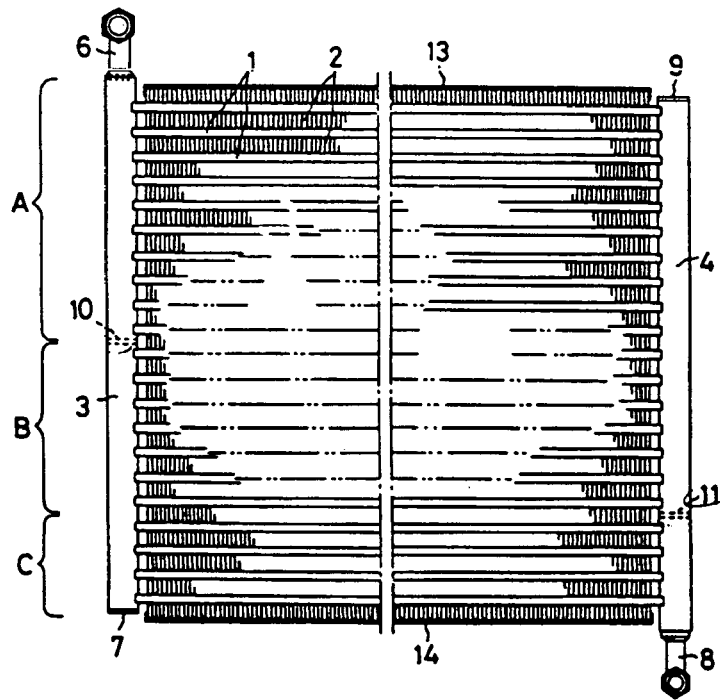


FIG. 2
PRIOR ART

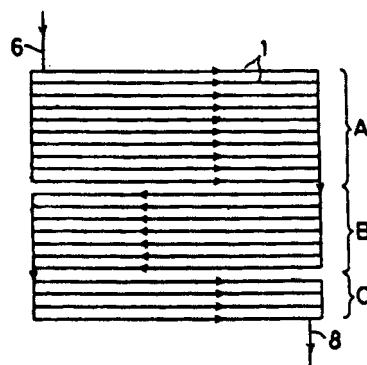


FIG. 3

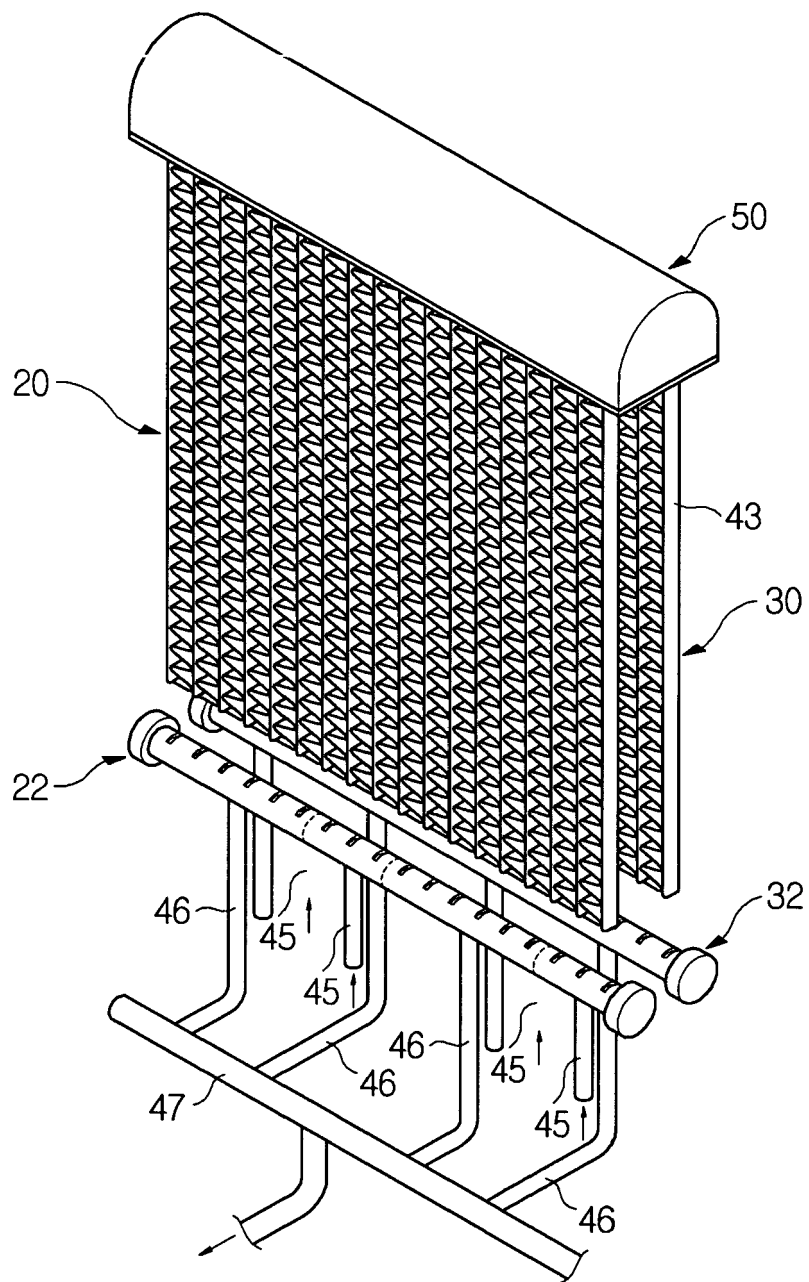


FIG. 4

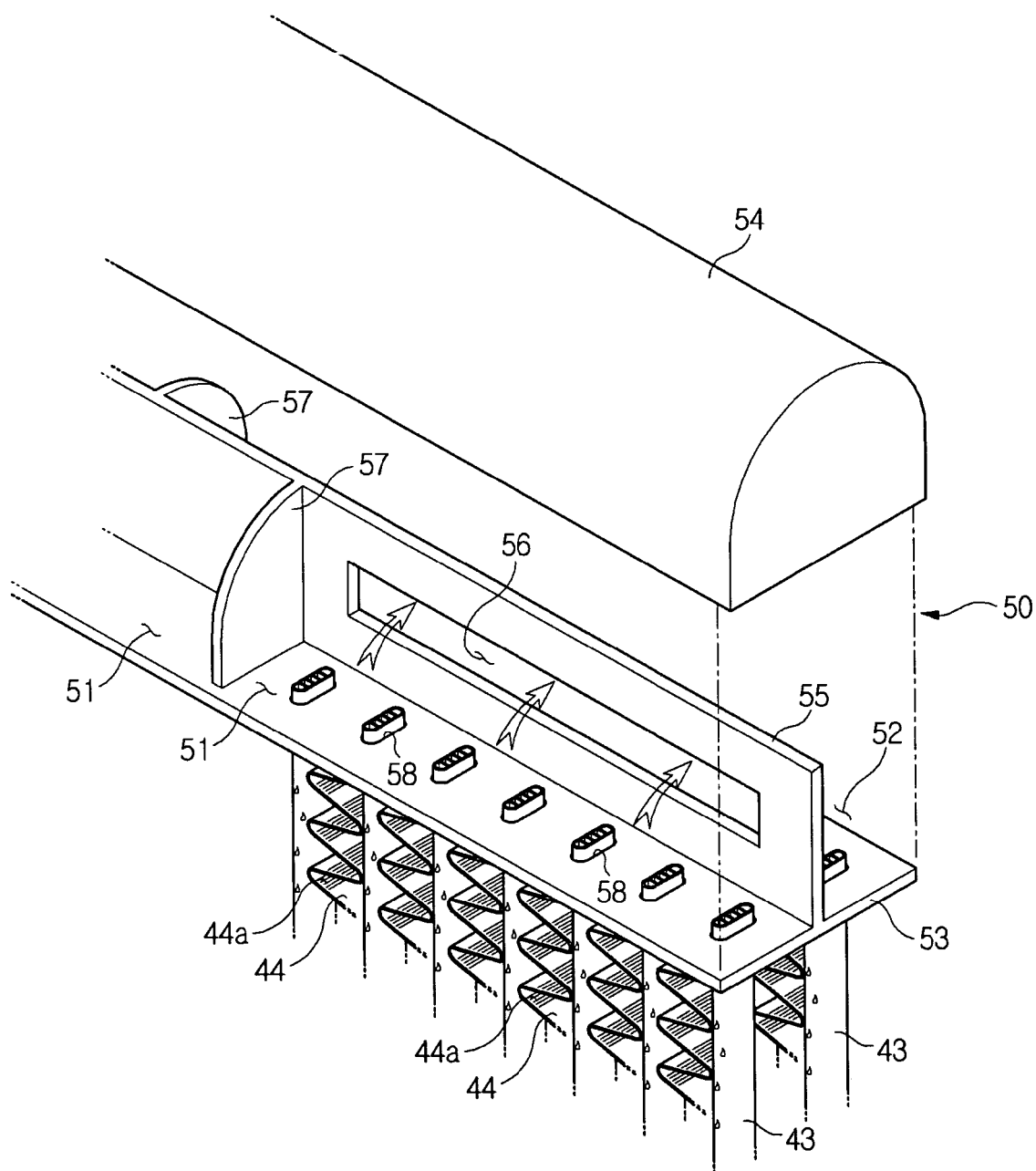


FIG. 5

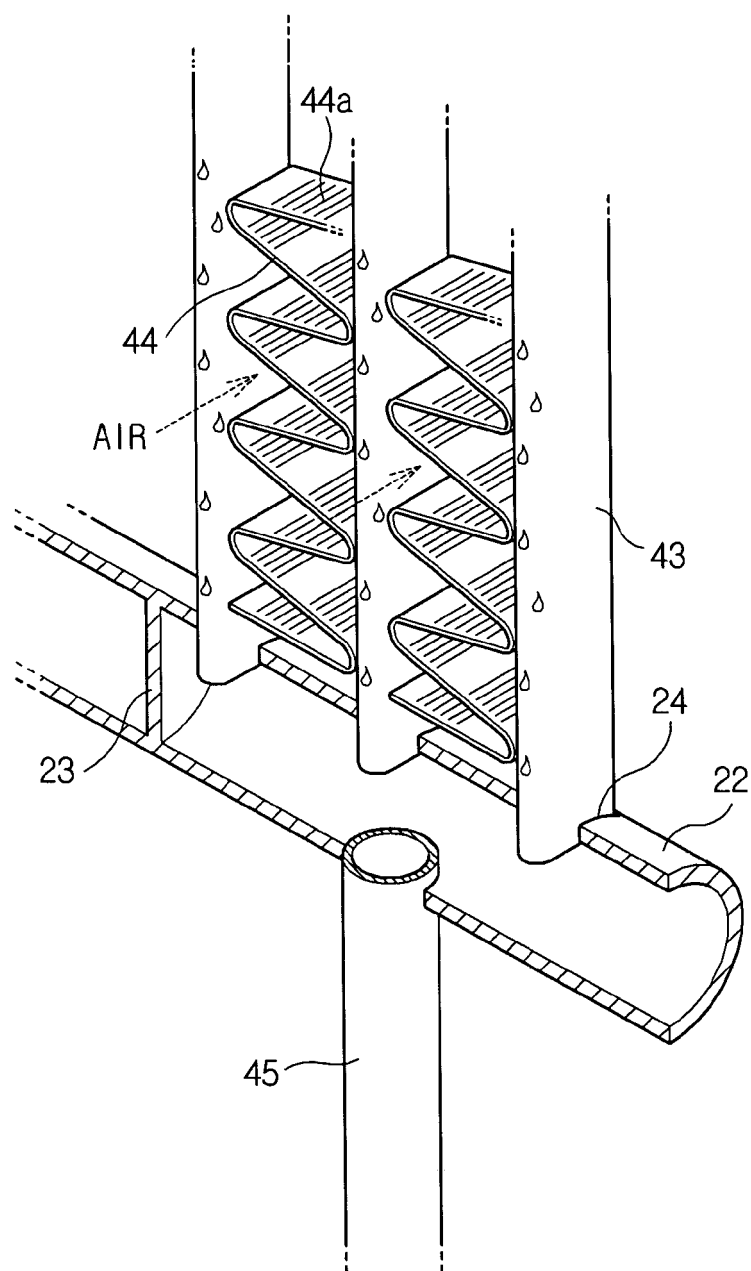


FIG. 6

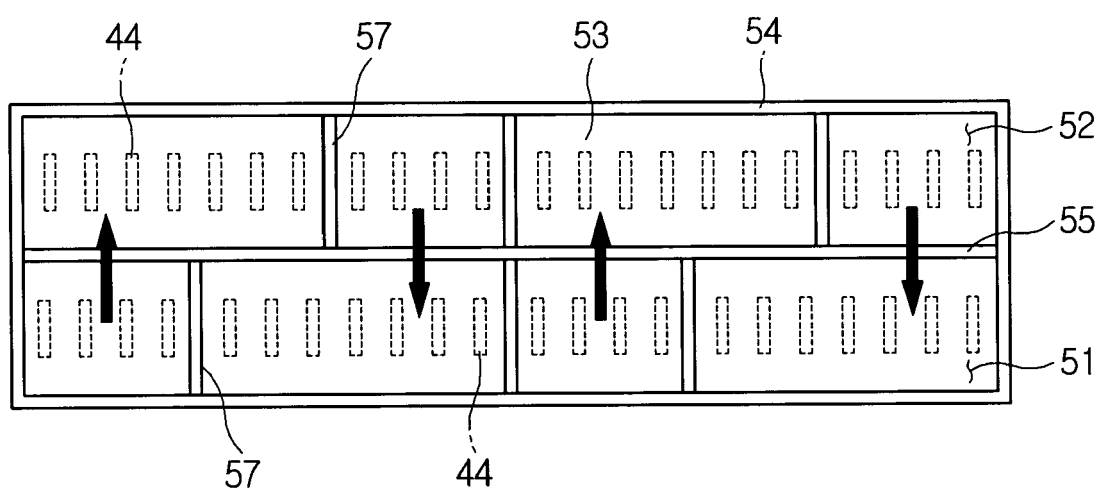


FIG. 7

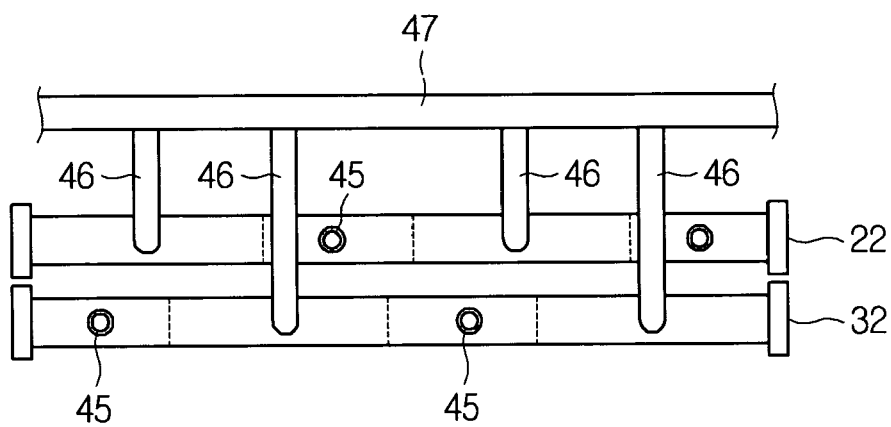


FIG. 8

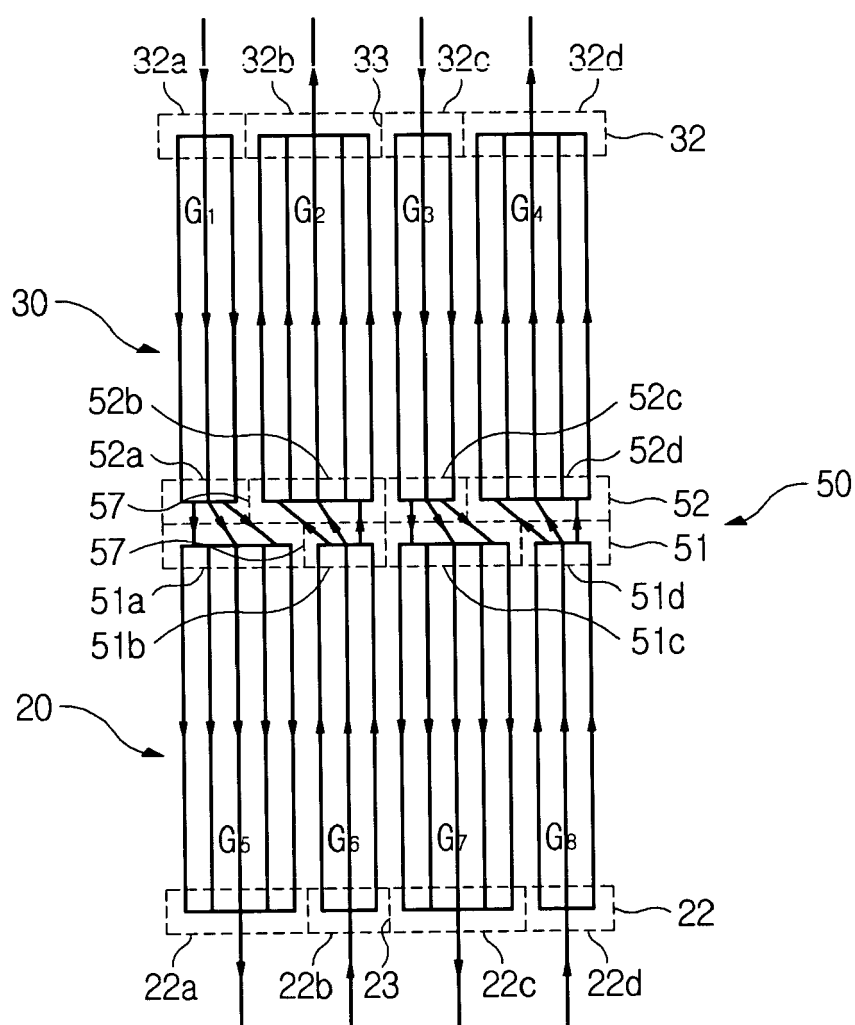


FIG. 9a

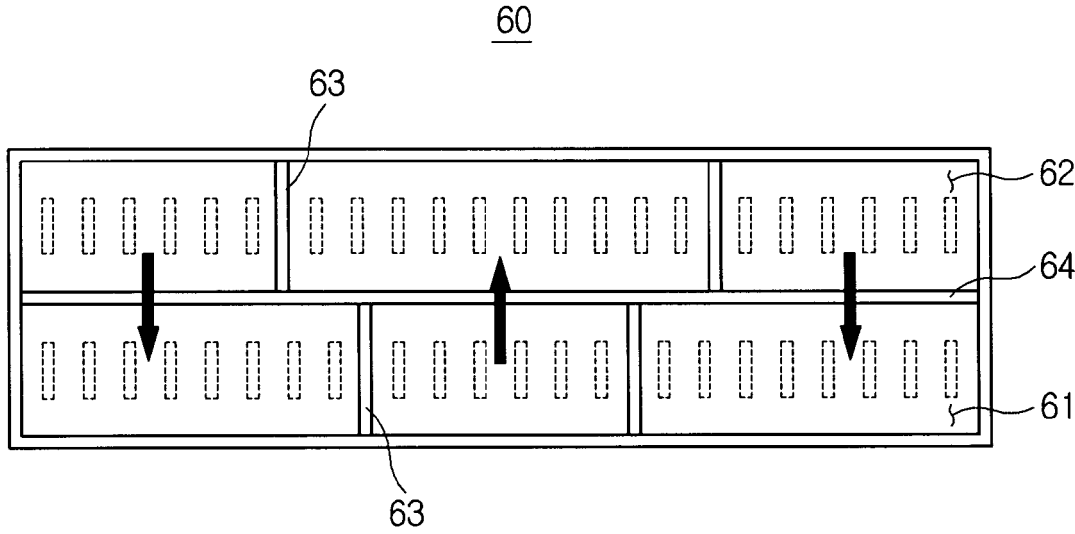


FIG. 9b

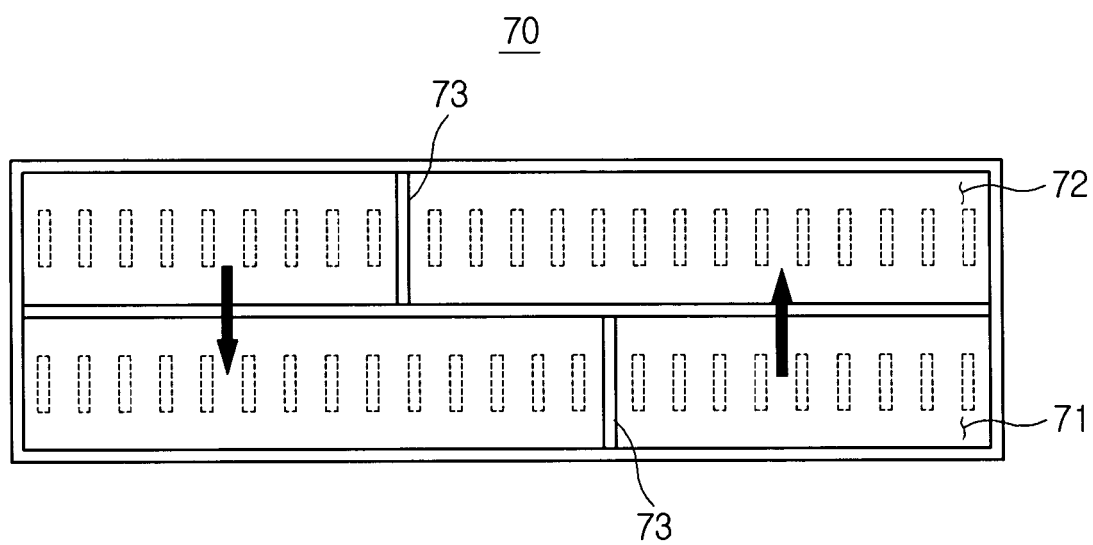


FIG. 10a

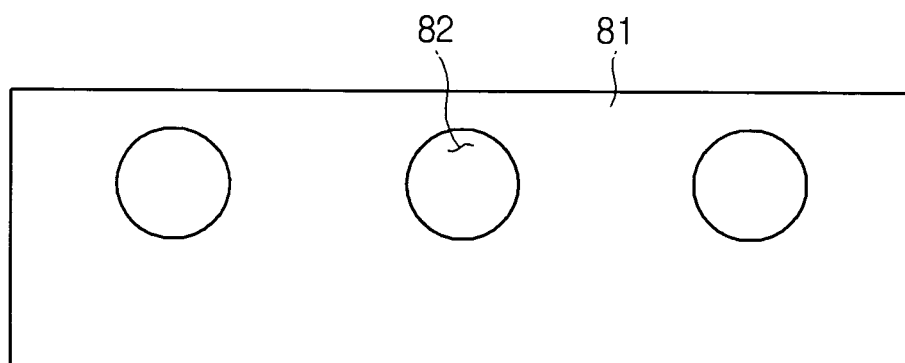


FIG. 10b

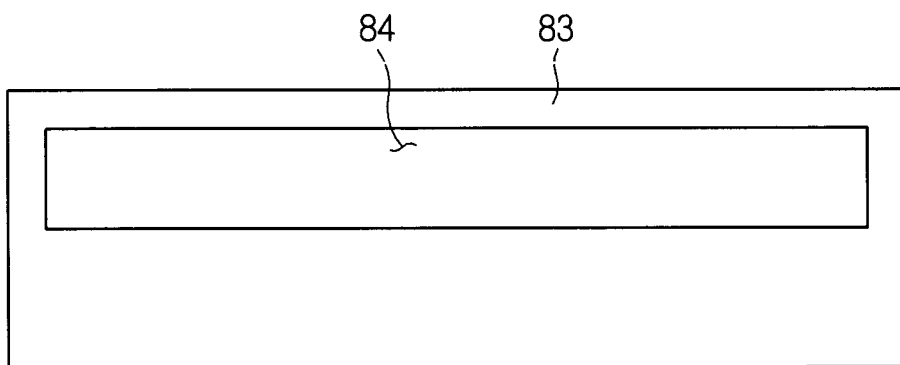
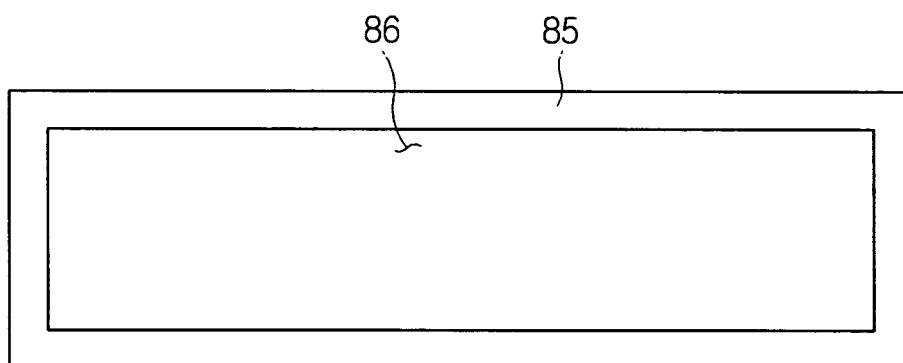


FIG. 10c





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EUROPEAN SEARCH REPORT

Application Number
EP 05 25 3858

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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 10 January 2006	Examiner Mellado Ramirez, J
<p>CATEGORY OF CITED DOCUMENTS</p> <p>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</p> <p>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</p> <p>& : member of the same patent family, corresponding document</p>			

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10-01-2006

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