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(54) CONDENSER

(75) Inventors: **Ki Soo Hong**, Seoul (KR); **Sim Won Chin**, Gwangmyeng-si (KR); **Dong Soo Moon**, Seoul (KR)

Correspondence Address:
GREENBLUM & BERNSTEIN, P.L.C.
1950 ROLAND CLARKE PLACE
RESTON, VA 20191 (US)

(73) Assignee: **LG ELECTRONICS INC., Seoul, Republic Korea**

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(57) ABSTRACT

A condenser where a refrigerant introduced from a compressor is coexisting in super-heated vapor, two-phase and super-cooled liquid states combines a plurality of refrigerant paths within at least one of super-heated vapor and two-phase regions to output the refrigerant to the super-cooled liquid region, and provides a proper percentage of the super-cooled liquid region.

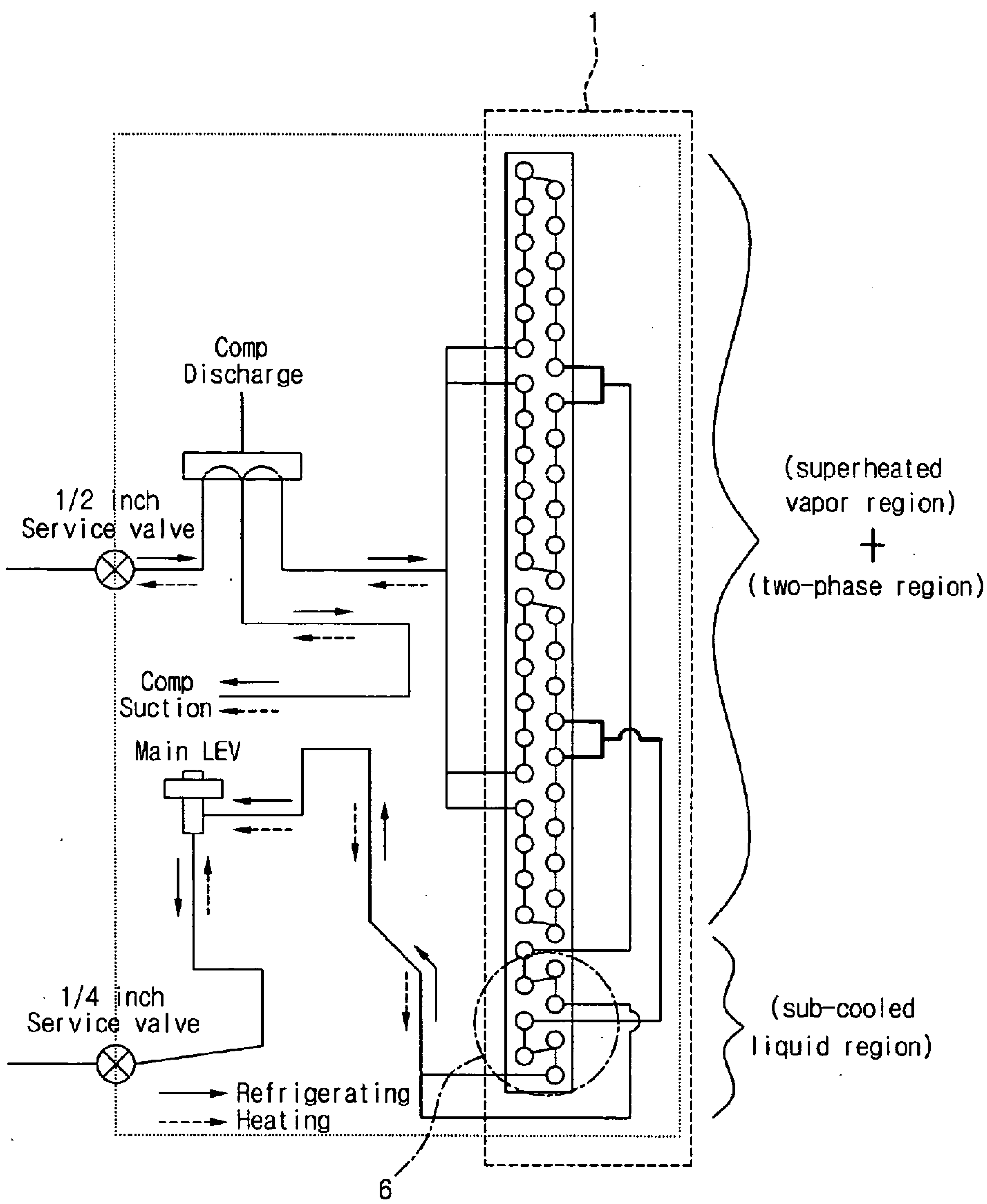


Fig. 1
Related Art

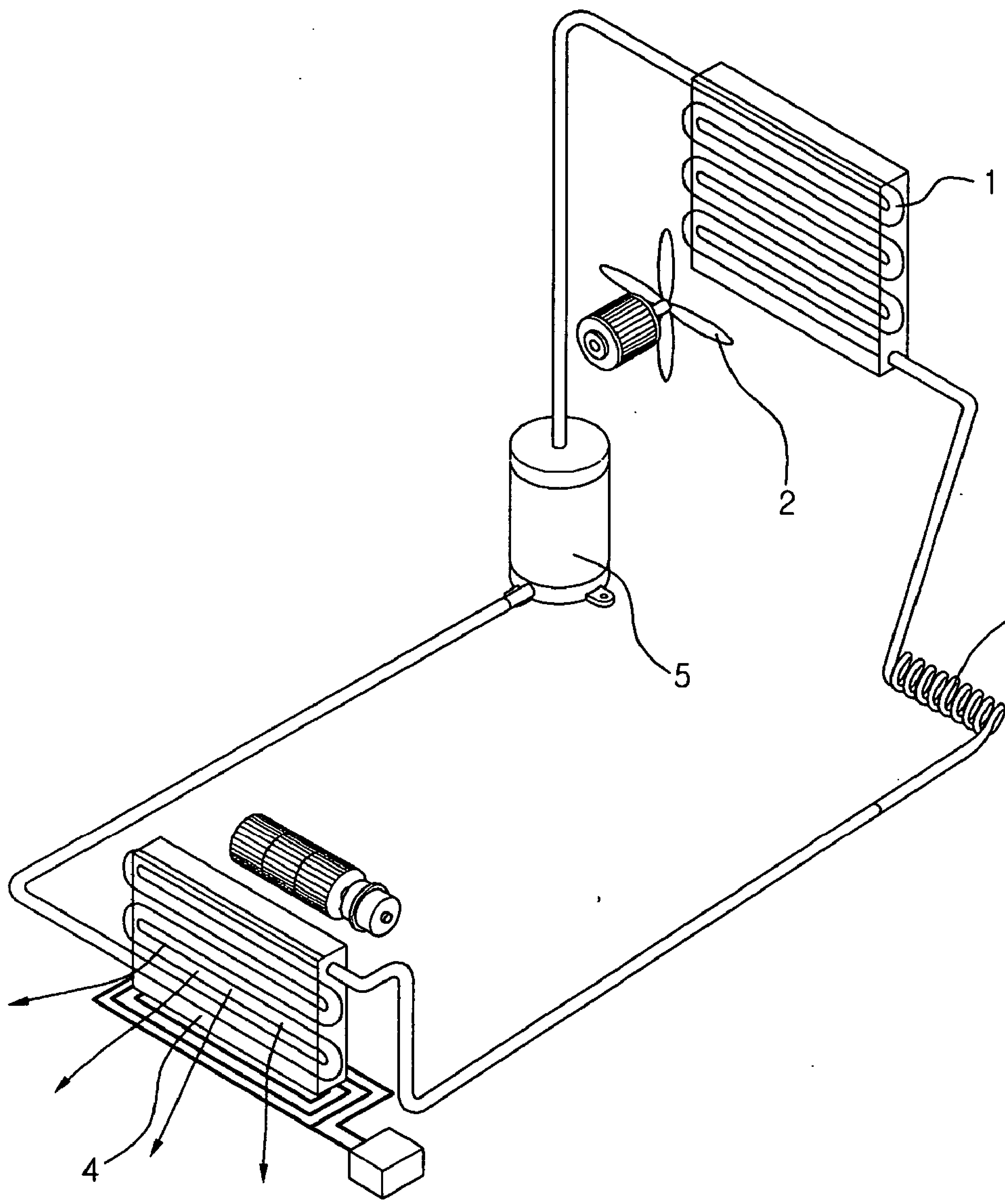


Fig.2
Related Art

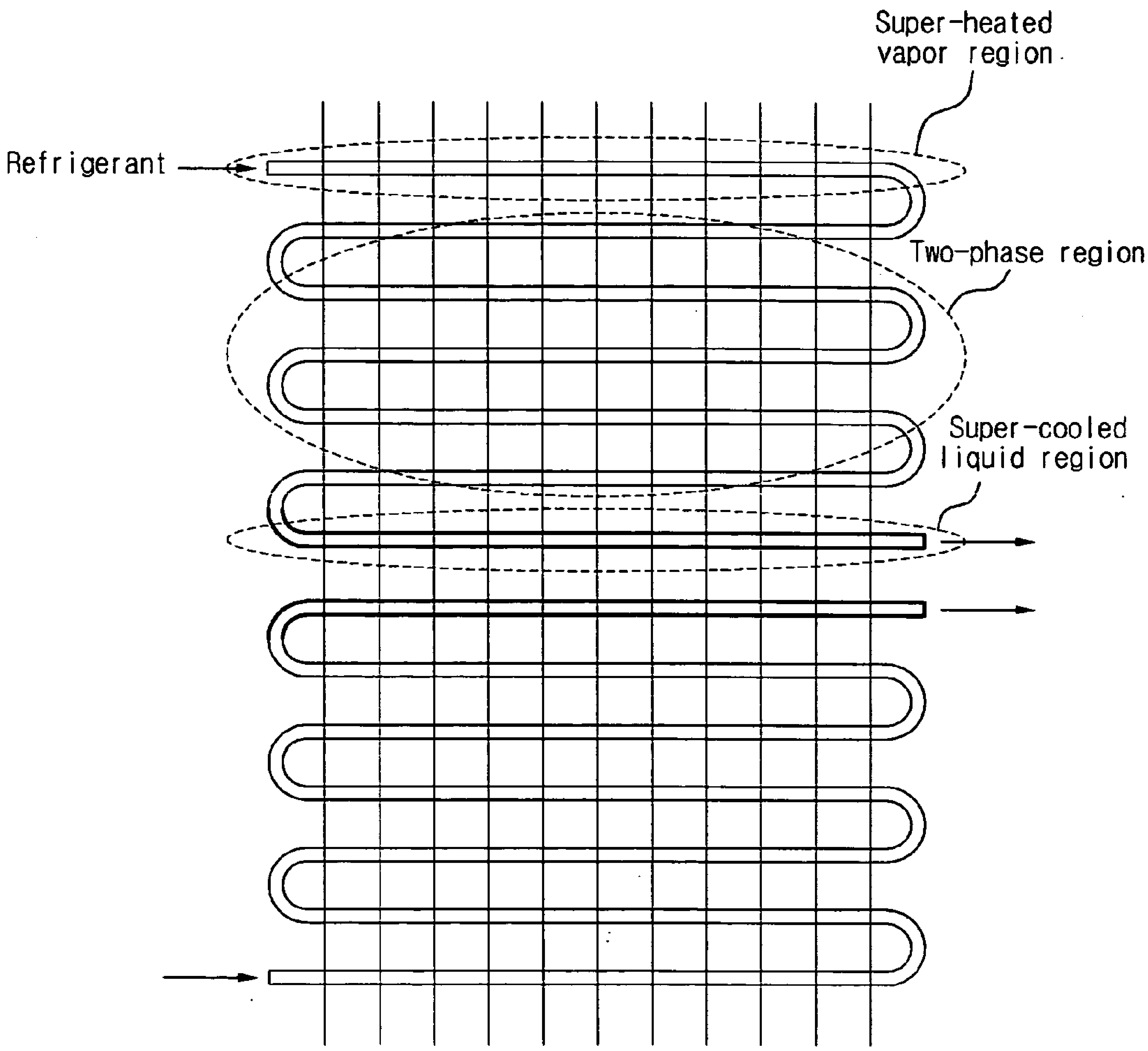


Fig.3

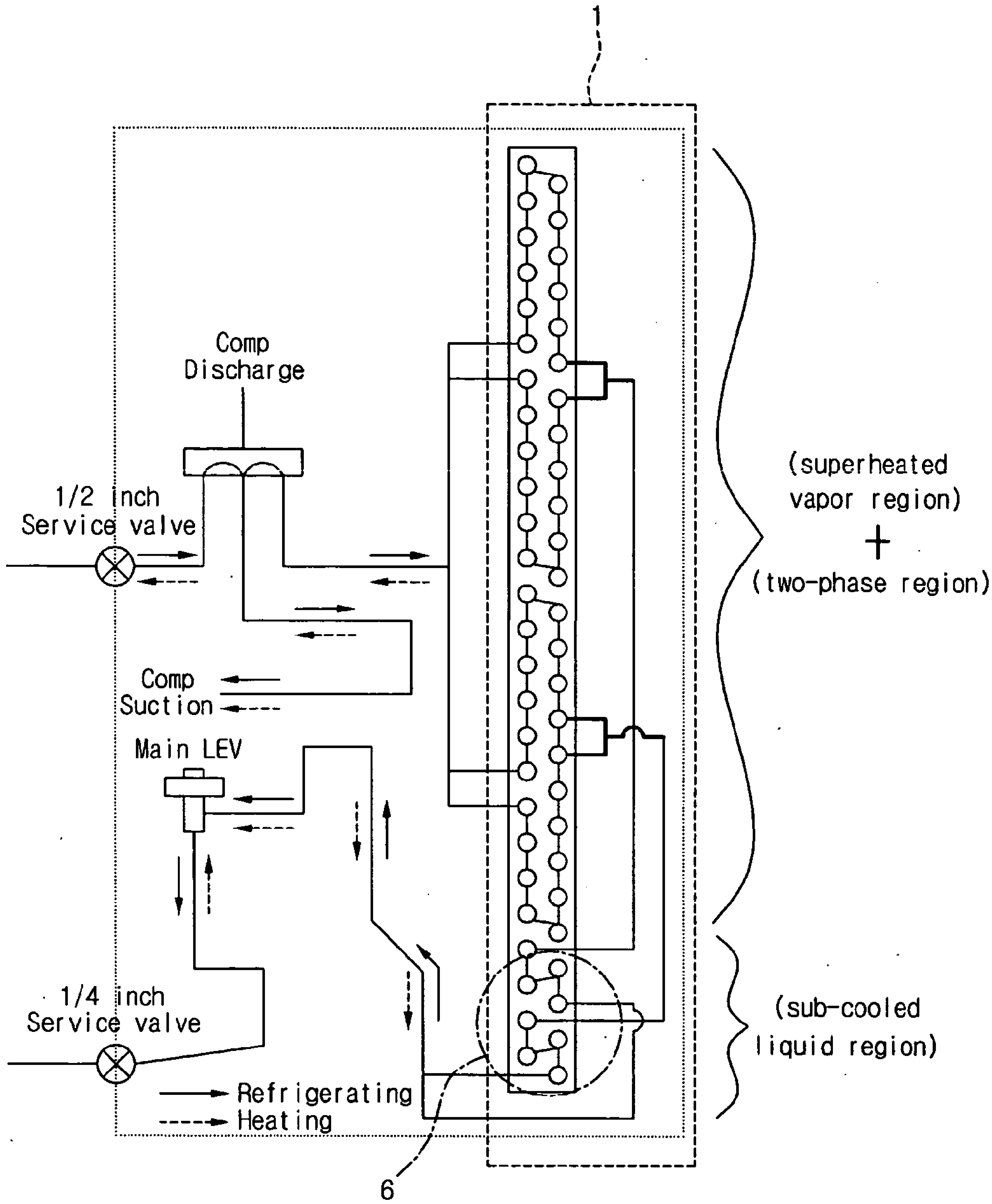

1
Comp
Discharge
1/2 inch
Service valve
Comp
Suction
Main LEV
1/4 inch
Service valve
Refrigerating
Heating
6
(superheated
vapor region)
+
(two-phase region)
(sub-cooled
liquid region)

Fig.4a

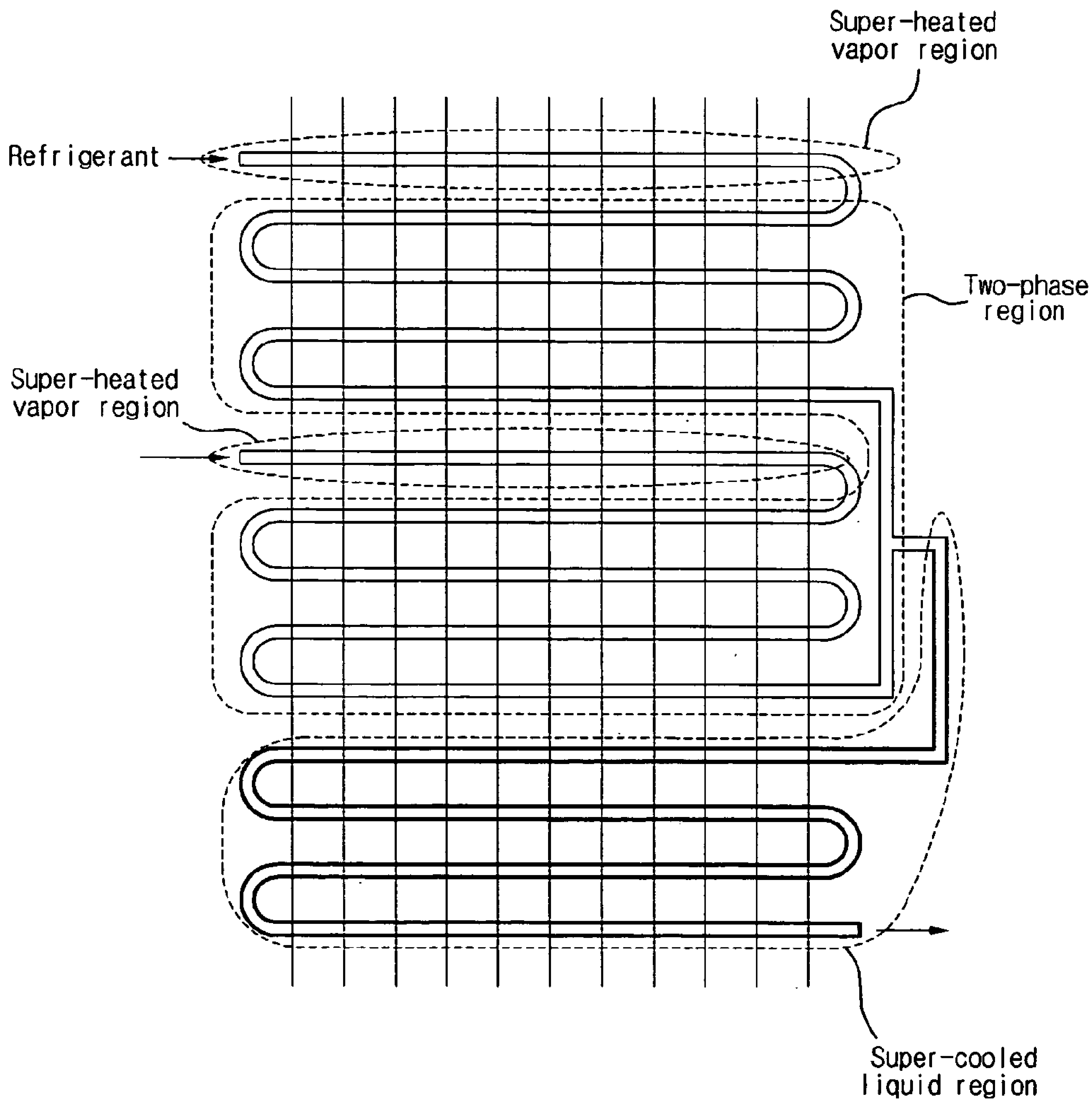

Super-heated
vapor region
Refrigerant
Two-phase
region
Super-heated
vapor region
Super-cooled
liquid region

Fig.4b

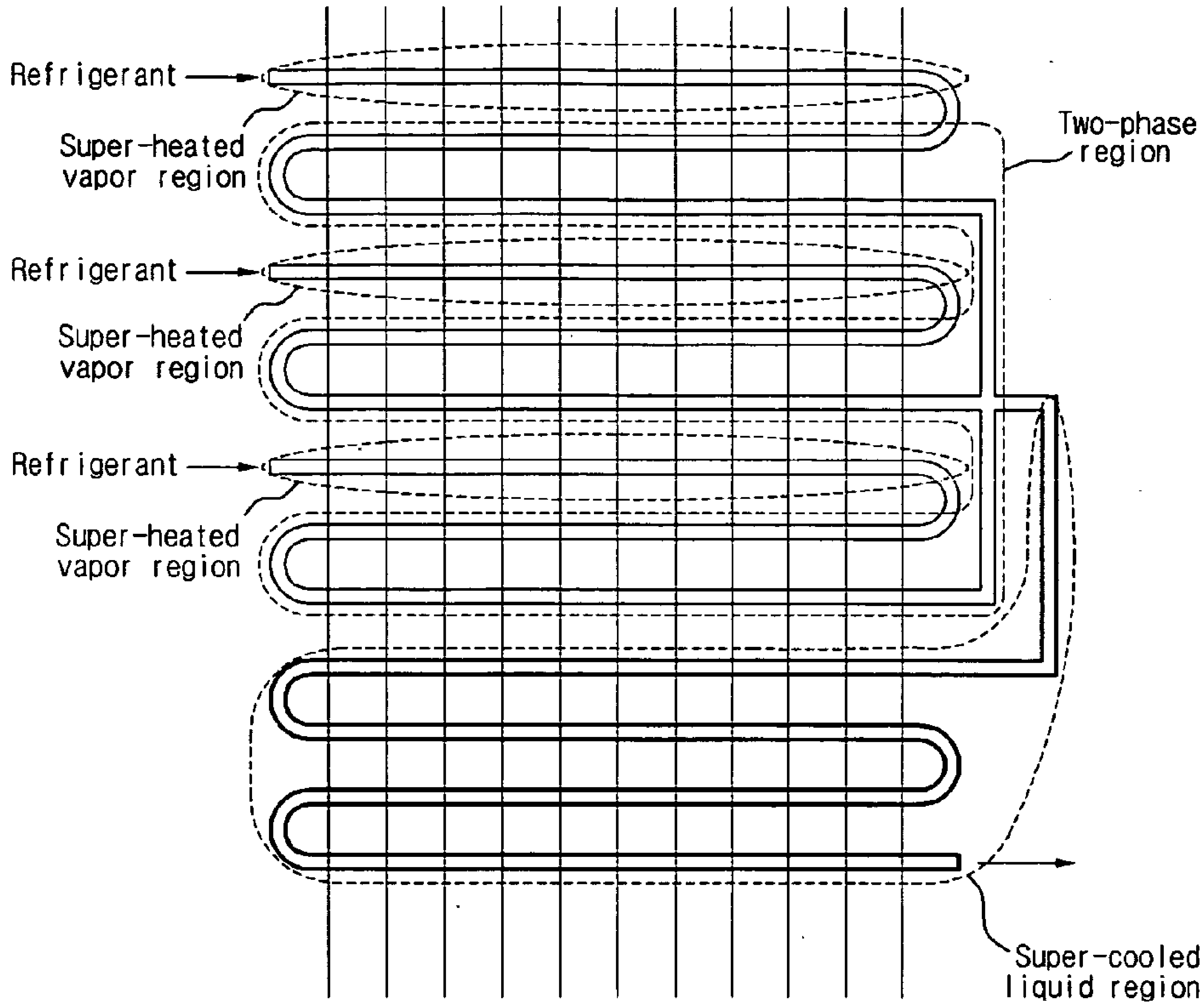
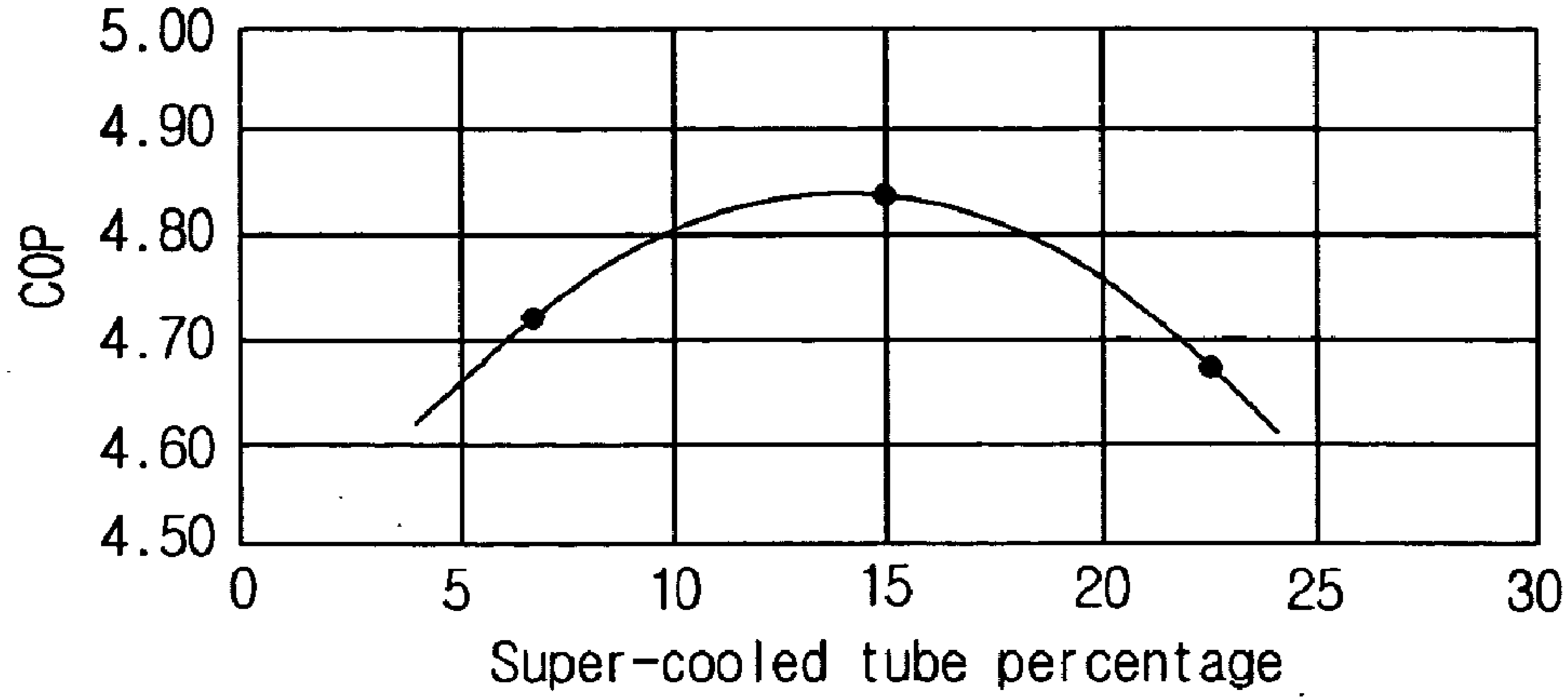


Fig.5a

Super-cooled tube portion	7%	15%	23%
Refrigerating capability(W)	2692	2745	2726
Power(W)	569	567	586
COP(W/W)	4.73	4.84	4.65

Fig.5b



5.00
4.90
4.80
4.70
4.60
4.50
COP
0
5
10
15
20
25
30
Super-cooled tube percentage

CONDENSER

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a condenser, and more particularly to a condenser outputting a refrigerant to a super-cooled liquid region by combining a plurality of refrigerant paths on at least one of a super-heated vapor region and a two-phase region in the condenser where the refrigerant introduced from a compressor coexists in super-heated vapor, two-phase, and super-cooled liquid states, and providing a proper percentage of the super-cooled liquid region.

[0003] 2. Background of the Related Art

[0004] In general, a compression refrigerating cycle is completed by a compressor **5**, a condenser **1**, an expansion valve **3** and an evaporator **4**. Currently, a stronger attention is drawn to a demand that consumption electric power should be lowered to the maximum level in air conditioners composed of the compression refrigerating cycle.

[0005] Thus, various efforts have been propelled including improvement in performance of each of main components constituting the compression refrigerating cycle.

[0006] **FIG. 1** shows a main engine of a general compression refrigerating cycle.

[0007] Referring to the figure, an air conditioner, etc. exerts its performance by cooled air which is generated by the compression refrigerating cycle.

[0008] To be more specific, the compression refrigerating cycle is completed by a compressor **5** converting a gas refrigerant of low-temperature and low pressure into a gas refrigerant of high-temperature and high-pressure, a condenser **1** converting the gas refrigerant of high-temperature and high-pressure into a liquid refrigerant of middle-temperature and high-pressure, an expansion valve **3** converting the liquid refrigerant of middle-temperature and high-pressure into a liquid refrigerant of low-temperature and low-pressure, and an evaporator **4** converting the liquid refrigerant of low-temperature and low-pressure into the gas refrigerant of low-temperature and low pressure.

[0009] Here, the condenser **1** is provided with a cooling fan **2** in order to supply external or outdoor air.

[0010] The condenser **1** supplied with the gas refrigerant of high-temperature and high-pressure from the compressor **5** converting it into the liquid refrigerant of middle-temperature and high-pressure, and to transfers the converted result to the expansion valve **3**.

[0011] At this time, an actuating fluid undergoes a state change in the order of a vapor state and a two-phase state in the condenser **1**.

[0012] In the case of the vapor or two-phase state, a pressure drop is relatively very high compared to the liquid state. For this reason, many branches are provided in order to reduce the pressure drop.

[0013] Assuming that the fluids having the substantially same mass flow, the gas has a volume 1000 times as much as the liquid has, and thus has a flow speed about 1000 times. In this case, the pressure drop is generated, and the compressor **5** performs more work. To avoid this, a tube is branched off.

[0014] Explaining it more fully, either the vapor or the two-phase fluid has faster velocity of a flow than that of the liquid. Therefore, it is more advantageous to flow through a plurality of tubes divided, i.e. branched off, than to continuously flow through a single tube.

[0015] Because a flow rate is dispersed, so much is reduced in the pressure drop. In other words, the pressure drop is smaller when the flow rate is high than when the flow rate is low.

[0016] Further, because the fluid flows through the plurality of branched tubes which are shorter than and have the same flow rate as the single tube, the pressure drop becomes reduced.

[0017] The meaning that the pressure drop is reduced means that a work which a compressor performs is reduced so much, consumption electric power of the compressor is reduced.

[0018] Meanwhile, the liquid has a slower flow velocity and has merely one tenth of a thermal conductivity as compared to the vapor or the two-phase fluid, so that it is no necessary to flow with dispersion.

[0019] In other words, the more the liquid region is increased, the less the two-phase region having good thermal conductivity is decreased. Thus, the heat exchanger suffers more damage even when being the same size.

[0020] Therefore, in order to overcome this drawback, it will be sufficient to collect the liquid and flow through the shorter tube. Namely, the tube is branched off or the tubes are combined. It is a super-cooled tube that is used for this purpose.

[0021] As to a coefficient of performance (COP), the COP refers to a value dividing a value of refrigerating or heating capability by used consumption electric power. According to a domestic (i.e. Korean) industrial standard, the COP should be maintained to be at least 3.54 when the air conditioner such as a cooler and/or a heater should be certificated as a first class.

[0022] In order to enhance the COP, it has been devised to force the compressor **5** to do a less work by not only enhancing performance to each main component constituting the compression refrigerating cycle but also decreasing a pressure difference in such a way to decrease condensation pressure instead of increasing evaporation pressure. However, this approach has been limited to a certain extent.

[0023] **FIG. 2** shows a process where a refrigerant is introduced into a condenser and then outputted through a super-heated vapor region, a two-phase region and a super-cooled liquid region.

[0024] As shown in **FIG. 2**, the refrigerants branched and then introduced into the super-heated vapor region pass through respective two-phase regions and then are outputted through respective super-cooled liquid regions as they are branched.

[0025] Thus, as set forth above, although the liquid within the super-cooled liquid region is not required to flow with dispersion due to the slow flow velocity and the low thermal conductivity having merely one tenth over the two-phase region, the liquid is outputted through each tube, so that the liquid (or super-cooled) region is increased and so the two-phase region having good thermal conductivity is decreased. Consequently, the heat exchanger having the given size results in deteriorating performance and increasing the consumption electric power.

SUMMARY OF THE INVENTION

[0026] An object of the invention is to solve at least the above problems and/or disadvantages and to provide at least the advantages described hereinafter.

[0027] Accordingly, one objective of the present invention is to increase a two-phase region having good heat transmission on a path where a gas refrigerant introduced into a condenser is heat-exchanged, and to provide a proper percentage of a super-cooled liquid region capable of enhancing refrigerating capability and a coefficient of performance.

[0028] Another objective of the present invention to combine a plurality of refrigerant paths for a refrigerant outputted from a two-phase region to extend to a super-cooled liquid region.

[0029] Yet another objective of the present invention to further provide a super-cooled liquid region in a condenser performing a compression refrigerating cycle to thereby increase refrigerating capability in a refrigerating system such as an air conditioner.

[0030] The foregoing and other objects and advantages are realized by, in an apparatus including a compressor and a condenser where a refrigerant introduced from the compressor is coexisting in super-heated vapor, two-phase and super-cooled liquid states, providing the condenser combining a plurality of refrigerant paths within at least one of super-heated vapor and two-phase regions to extend to a super-cooled liquid region formed at a rear end portion of the two-phase region.

[0031] According to another aspect of the invention, the super-cooled liquid region of the condenser has a percentage ranging from 7% to 20% of the refrigerant path region.

[0032] According to the invention, the refrigerant is outputted to the super-cooled liquid region through the combined refrigerant path, so that the two-phase region having good heat transmission is substantially increased. Further, the super-cooled liquid region is provided at a proper percentage, so that a super-cooled degree is increased to thereby enhance performance of an air conditioner and to reduce its consumption electric power.

[0033] Additional advantages, objects, and features of the invention will be set forth in part in the description which follows and in part will become apparent to those having ordinary skill in the art upon examination of the following or may be learned from practice of the invention. The objects and advantages of the invention may be realized and attained as particularly pointed out in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0034] The invention will be described in detail with reference to the following drawings in which like reference numerals refer to like elements wherein:

[0035] **FIG. 1** illustrates main components of a general compression refrigerating cycle;

[0036] **FIG. 2** illustrates a process where a refrigerant is introduced into a condenser and then outputted through super-heated vapor, two-phase, and super-cooled liquid regions;

[0037] **FIG. 3** is a block diagram schematically showing a structure including a condenser according to the invention;

[0038] **FIG. 4** shows a state of a refrigerant, and path and region through which the refrigerant passes in a condenser; and

[0039] **FIG. 5** shows graph and table showing relation between a super-cooled tube and a coefficient of performance (COP).

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0040] The following detailed description will present a condenser according to a preferred embodiment of the invention in reference to the accompanying drawings.

[0041] **FIG. 3** is a block diagram schematically illustrating a structure including a condenser according to the present invention, **FIGS. 4A and 4B** show a state of a refrigerant in the condenser, and path and region through which the refrigerant passes, and **FIG. 5** is graph and table showing relation between a super-cooled tube and a coefficient of performance.

[0042] To begin with, description will be made with reference to **FIG. 3**.

[0043] A refrigerant outputted from an indoor unit (not shown) is branched off into one or more paths through a service valve and a discharge valve of a compressor, and then inputted into a condenser **1**.

[0044] The branched paths of the invention pass through tubes of super-heated vapor and two-phase regions and are combined into a tube of a super-cooled liquid region.

[0045] Further, the tube for the super-cooled liquid region has a proper percentage of 7-20% of the total length of the tubes. At this point, both a coefficient of performance (COP) of an air conditioner and performance of consumption electric power amounts to the highest.

[0046] In the condenser **1** according to the invention, a working fluid is subjected to change of its state into vapor, two-phase and liquid in that order.

[0047] For the liquid state, a drop of pressure is relatively low compared to the vapor or two-phase state. Hence, in order to reduce the pressure drop, it is not necessary to branch off the liquid.

[0048] In general, if the fluid having the same weight flows, the liquid has a volume of about 1/1000 as compared with the gas, thus having a flow velocity of only about 1/1000. For this reason, it will do if the liquid is not branched off

[0049] **FIGS. 4A and 4B** show a process where the refrigerant is introduced into the condenser through a plurality of paths (e.g. two or three paths) and outputted through the super-heated vapor region, the two-phase region and the super-cooled liquid region in the invention.

[0050] As shown in the figures, the refrigerants branched and introduced into the super-heated vapor region each pass through the two-phase regions to flow into the super-cooled liquid region on the combined refrigerant path, and then outputted to the expansion valve (main LEV of **FIG. 3**).

[0051] The tube for the super-cooled liquid region has a proper percentage when amounting to 7-20% of the length of the whole tubes. In this case, the air conditioner has the highest COP and performance of the consumption electric power.

[0052] **FIGS. 5A and 5B** are a graph and table showing relation between the super-cooled tube and the COP.

[0053] In **FIG. 3**, the number of the whole tubes within the condenser **1** is set to have two rows and 26 steps. Here, a test shows the relation between the super-cooled tube of the whole tubes and the COP. When the super-cooled tube was arranged in two steps (at this point, the super-cooled tube accounted for 7% of the whole tubes), the consumption electric power used was measured to be 569 W, while capability of refrigeration was measured to be 2692 W. Thus, it was found that the COP was 4.73.

[0054] When the super-cooled tube was arranged in four steps (at this point, the super-cooled tube accounted for 15% of the whole tubes), the consumption electric power used was measured to be 567 W, while capability of refrigeration was measured to be 2745 W. Thus, it was found that the COP was 4.84, which was a little increased compared to the super-cooled tube arranged in two steps. However, when the super-cooled tube was arranged in six steps (at this point, the super-cooled tube accounted for 23% of the whole tubes), the consumption electric power used was measured to be 586 W, while capability of refrigeration was measured to be 2726 W. Thus, it was found that the COP was 4.65, which was decreased again compared to the super-cooled tube arranged in two steps.

[0055] As seen from the foregoing, when the pencentage of the super-cooled tube installed in the condenser amounts to a range from 7% to 20% of the whole tubes, the COP can be obtained to the optimal level.

[0056] In the above-mentioned invention, the refrigerant paths of the two-phase region are combined to extend to the super-cooled liquid region, and the proper percentage of the super-cooled liquid region is represented, so that the two-phase region is increased. Consequently, it is possible to enhance the efficiency of heat transmission and the COP and to reduce the consumption electric power.

[0057] While the invention has been shown and described with reference to certain preferred embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention as defined by the appended claims.

[0058] For example, the invention may be applicable to a refrigerator performing condensation and other products performing the similar function.

[0059] Therefore, the description of the present invention is intended to be illustrative, and not to limit the scope of the claims.

1. In an apparatus including a compressor and a condenser where a refrigerant introduced from the compressor is coexisting in super-heated vapor, two-phase and super-cooled liquid states, the condenser combines a plurality of refrigerant paths within at least one of super-heated vapor and two-phase regions to extend to a super-cooled liquid region.

2. The condenser according to claim 1, wherein the super-cooled liquid region to which the refrigerant paths for the refrigerant outputted from the two-phase region are combined to extend is formed at a rear end of the tube for the two-phase region.

3. The condenser according to claim 2, wherein, as the plurality of refrigerant paths for the refrigerant outputted from the two-phase region are combined to extend to the super-cooled liquid region, the paths for the two-phase region are increased.

4. The condenser according to claim 3, wherein, as the two-phase region is increased, efficiency of heat transmission is increased.

5. The condenser according to claim 1, wherein the refrigerant which is branched off into one or more and introduced into the super-heated vapor region passes through each two-phase region to flow into the super-cooled liquid region on the path combined by one or more, being outputted to a device that reduces at least one of temperature and pressure.

6. The condenser according to claim 5, wherein the device that reduces at least one of temperature and pressure includes an expansion valve.

7. The condenser according to claim 1, wherein the super-cooled path region has a percentage ranging from 7% to 23% of the refrigerant path region of the condenser.

8. The condenser according to claim 7, wherein the tube for the super-cooled liquid region has a proper percentage ranging from 7% to 20% of the whole tubes, whereby a coefficient of performance (COP) and efficiency of consumption electric power become optimal in an air conditioner.

9. The condenser according to claim 1, wherein the number of the whole tubes within the condenser is set to have two rows and 26 steps, and the super-cooled tube accounts for 7% of the whole tubes when being arranged in two steps, 15% of the whole tubes when being arranged in four steps and 23% of the whole tubes when being arranged in six steps.

10. The condenser according to claim 1, wherein the refrigerant paths for the refrigerant outputted from the two-phase region are combined to allow the refrigerant to be inputted into the super-cooled liquid region through the one or more combined refrigerant paths.

* * * * *