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- **Song, Chi-Woo**
Jung-Gu
Incheon (KR)
- **Chung, Baik-Young**
213-2, Yongjong-dong
Gyeyang-Gu
Incheon (KR)
- **Chang, Se-Dong**
Gyeonggi-Do (KR)

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(71) Applicant: **LG Electronics Inc.**
Yongdungpo-gu
Seoul (KR)

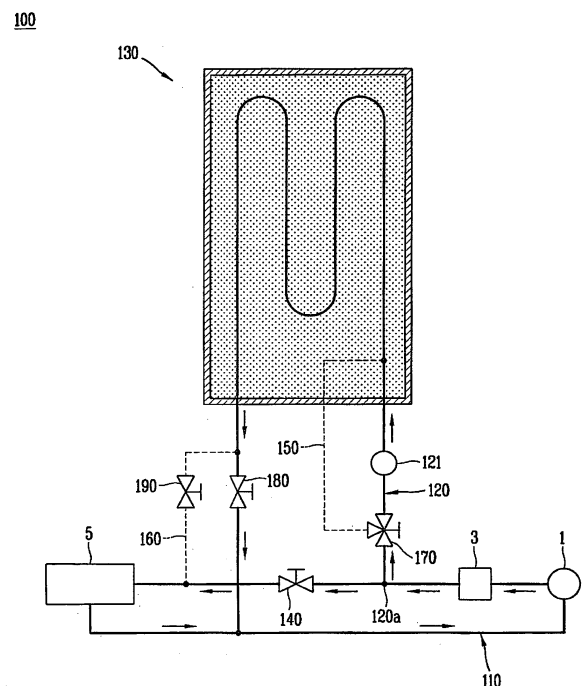
(74) Representative: **Vossius & Partner**
Siebertstrasse 4
81675 München (DE)

(72) Inventors:
• **Oh, Sai-Kee**
Dongan-gu
Anyang, Gyeonggi-do (KR)

(54) Regenerative cooling system and driving method thereof

(57) A regenerative cooling system capable of enhancing a cooling operation and capable of prolonging a lifespan thereof by preventing an overload of a compressor, in which cool heat is stored in a regenerative tank by applying a refrigerant used in a cooling operation when a cooling load is low even during the daytime, and then the stored cool heat is utilized when the cooling load is high, that is, when a great amount of cool heat is required indoors, and a driving method thereof.

FIG. 2



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Description

[0001] The present invention relates to a regenerative cooling system and a driving method thereof, and more particularly, to a regenerative cooling system capable of effectively performing a cooling operation by storing cool heat in a regenerative tank by applying a refrigerant used in the cooling operation when a cooling load is low even during the daytime, and then by utilizing the stored cool heat when the cooling load is high, and a driving method thereof.

[0002] Generally, a regenerative cooling system represents a cooling system that effectively performs a cooling operation by storing cold heat in a regenerative tank at night when a power consumption amount is less, and then by utilizing the stored cold heat during the daytime.

[0003] Generally, the regenerative cooling system is constructed to perform a regenerating operation at night and to perform a cooling operation during the daytime. As shown in FIG. 1, when a driving rate of an indoor unit (indoor unit capacitance/ compressor capacitance) is in a range of 40~80%, a cooling coefficient (cop) is high and thus a cooling operation is performed with an optimum state. However, when the driving rate of an indoor unit (indoor unit capacitance/compressor capacitance) is less than 40%, the cooling coefficient (cop) is low and a refrigerant provided from a compressor is fed back to the compressor. Accordingly, a cooling operation is inefficiently performed. Furthermore, when the driving rate of an indoor unit is more than 80%, an overload is applied to the compressor and thus a lifespan of the system is shortened.

[0004] Therefore, an object of the present invention is to provide a regenerative cooling system capable of enhancing a cooling operation and capable of prolonging a lifespan thereof by preventing an overload of a compressor, in which cool heat is stored in a regenerative tank by applying a refrigerant used in a cooling operation when a cooling load is low even during the daytime, and then the stored cool heat is utilized when the cooling load is high, that is, when a great amount of cool heat is required indoors, and a driving method thereof.

[0005] To achieve these and other advantages and in accordance with the purpose of the present invention, as embodied and broadly described herein, there is provided a regenerative cooling system, comprising: a cooling line for feeding-back a refrigerant compressed by a compressor to the compressor via a condenser and an indoor unit, sequentially; a regenerating line having one end diverged between the condenser and the indoor unit and another end merged between the indoor unit and the compressor, for phase-converting a refrigerant condensed by the condenser via an expansion valve when the cooling line is operated; a regenerative tank installed outside the regenerating line for accumulating cold heat generated from the regenerating line; a cooling line switching valve installed between the indoor unit and a divergence point of the regenerating line; a first bypass

pipe installed at an inlet of the regenerating line for bypassing the expansion valve; and a second bypass pipe having one end diverged from an outlet of the regenerating line and another end merged between the indoor unit and the cooling line switching valve, for supplying a refrigerant that has passed through the regenerating line to the indoor unit.

[0006] To achieve these and other advantages and in accordance with the purpose of the present invention, as embodied and broadly described herein, there is also provided a method for driving a regenerative cooling system, comprising: performing a cooling operation so that a refrigerant compressed and condensed by a compressor and a condenser can be supplied to an indoor unit, and the refrigerant heat-exchanged in the indoor unit can be fed back to the compressor under a state that a cooling line switching valve is opened; performing a regenerating operation so that cold heat generated when the refrigerant condensed by the condenser passes through an expansion valve of a regenerating line can be stored in a regenerative tank; and performing a cooling operation by using the cold heat stored in the regenerative tank so that the refrigerant compressed by the compressor can be introduced into the regenerating line via the condenser, and then the refrigerant can be fed back to the compressor via a first bypass pipe, a second bypass pipe, and the indoor unit, sequentially under a state that the cooling line switching valve and an outlet of the regenerating line are closed.

[0007] The foregoing and other objects, features, aspects and advantages of the present invention will become more apparent from the following detailed description of the present invention when taken in conjunction with the accompanying drawings.

[0008] The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and together with the description serve to explain the principles of the invention.

[0009] In the drawings:

FIG. 1 is a graph showing a cooling coefficient according to a driving rate of an indoor unit in a cooling system in accordance with the conventional art;

FIG. 2 is a view showing a method for simultaneously performing a cooling operation and a regenerating operation in a regenerative cooling system according to a first embodiment of the present invention;

FIG. 3 is a view showing a method for performing a cooling operation by using cold heat stored in a regenerative tank in the regenerative cooling system according to a first embodiment of the present invention;

FIG. 4 is a view showing a method for performing a regenerating operation in the regenerative cooling system according to a first embodiment of the present invention;

FIG. 5 is a view showing a method for simultaneously performing a cooling operation and a regenerating operation, and a relation between a load and a cooling efficiency in a regenerative cooling system according to a first embodiment of the present invention;

FIG. 6 is a view showing a method for simultaneously performing a cooling operation and a regenerating operation in a regenerative cooling system according to a second embodiment of the present invention; and

FIG. 7 is a view showing a method for performing a cooling operation by using cold heat stored in a regenerative tank in the regenerative cooling system according to a second embodiment of the present invention.

[0010] Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings.

[0011] Hereinafter, a regenerative cooling system and a driving method thereof will be explained in more detail with reference to the attached drawings.

[0012] FIG. 2 is a view showing a method for simultaneously performing a cooling operation and a regenerating operation in a regenerative cooling system according to a first embodiment of the present invention; FIG. 3 is a view showing a method for performing a cooling operation by using cold heat stored in a regenerative tank in the regenerative cooling system according to a first embodiment of the present invention; FIG. 4 is a view showing a method for performing a regenerating operation in the regenerative cooling system according to a first embodiment of the present invention; and FIG. 5 is a view showing a method for simultaneously performing a cooling operation and a regenerating operation, and a relation between a load and a cooling efficiency in a regenerative cooling system according to a first embodiment of the present invention.

[0013] As shown, a regenerative cooling system 100 according to a first embodiment of the present invention comprises a cooling line 110 for feeding-back a refrigerant compressed by a compressor 1 to the compressor 1 via a condenser 3 and an indoor unit 5, sequentially; a regenerating line 120 having one end diverged between the condenser 3 and the indoor unit 5 and another end merged between the indoor unit 5 and the compressor 1, for phase-converting a refrigerant condensed by the condenser 3 via an expansion valve 121; a regenerative tank 130 installed outside the regenerating line 120 for accumulating cold heat generated from the regenerating line 120; a cooling line switching valve 140 installed between the indoor unit 5 and a divergence point 120a of the regenerating line 120; a first bypass pipe 150 installed at an inlet of the regenerating line 120 for bypassing the expansion valve 121; and a second bypass pipe 160 having one end diverged from an outlet of the regenerating line 120 and another end merged between the indoor

unit 5 and the cooling line switching valve 140, for supplying a refrigerant that has passed through the regenerating line 120 to the indoor unit 5. In the cooling line and the regenerating line, a position into which a refrigerant is introduced is referred to as an inlet and a position from which a refrigerant is discharged is referred to as an outlet.

[0014] A three-way valve 170 for selectively passing a refrigerant that has been introduced into the regenerating line 120 to the expansion valve 121 or the first bypass pipe 150 is installed at an inlet of the first bypass pipe 150.

[0015] A regenerating line outlet switching valve 180 is installed at an outlet of the regenerating line 120, and a second bypass switching valve 190 is installed at the second bypass pipe 160.

[0016] Referring to FIG. 1, in the regenerative cooling system according to the first embodiment of the present invention, cool heat is stored in the regenerative tank 130 by applying a refrigerant used in a cooling operation to the regenerative tank 130 when a cooling load is low even during the daytime, that is, when a small amount of cool heat is required indoors, that is, when a driving rate of the indoor unit is less than 40%, and then the stored cool heat is utilized when the cooling load is high (when a great amount of cool heat is required indoors), that is, when the driving rate of the indoor unit is more than 80%, thereby maintaining the driving rate of the indoor unit as 40~80% and thus enhancing energy efficiency. Also, the regenerative cooling system according to the present invention prevents an overload of the compressor thus to prolong a lifespan thereof.

[0017] Referring to FIG. 2, if a cooling load is low when a cooling operation is performed during the daytime, a refrigerant used to the cooling operation is partially stored in the regenerative tank. Accordingly, when a cooling operation and a regenerating operation are simultaneously performed, a refrigerant compressed by the compressor 1 is heat-exchanged via the condenser 3 and the indoor unit 5. Then, the refrigerant that has been heat-exchanged via the indoor unit 5 is fed back to the compressor 1. A part of the refrigerant that has passed through the condenser 3 passes through the expansion valve 121 by the three-way valve 170 thus to be expanded. Then, the expanded refrigerant flows to the regenerative tank 130 thus to be regenerated, then flows to the outlet of the regenerating line 120, and then is fed back to the compressor 1.

[0018] Referring to FIG. 3, when a cooling operation is performed by using cold heat stored in the regenerative tank due to a high cooling load, a refrigerant that has passed through the compressor 1 and the condenser 3 does not flow to the indoor unit 5 under a state that the cooling line switching valve 140 and the regenerating line outlet switching valve 180 are closed. The refrigerant passes through the first bypass pipe 150 by the three-way valve 170, and flows to the regenerative tank 130. Then, the refrigerant using the cold heat stored in the regenerative tank 130 is introduced into the indoor unit

5 via the second bypass pipe 160 thus to be heat-exchanged, and then is fed back to the compressor 1.

[0019] Referring to FIG. 4, at the time of performing only a regenerating operation, under a state that the cooling line switching valve 140 and the second bypass switching valve 190 are closed, a refrigerant that has passed through the compressor 1 and the condenser 3 does not flow to the cooling line 110 but passes through the expansion valve 121 by the three-way valve 170 thereby to be expanded. The expanded refrigerant flows to the regenerative tank 130 thus to be regenerated, then flows to the outlet of the regenerating line 120, and then is fed back to the compressor 1.

[0020] FIG. 5 is a view showing a method for simultaneously performing a cooling operation and a regenerating operation, and a relation between a load and a cooling efficiency in a regenerative cooling system according to a first embodiment of the present invention.

[0021] Referring to FIG. 5, a curved line 1 represents the regenerative cooling system according to the present invention, a curved line 2 represents a load, and a curved line 3 represents a cooling efficiency. When the load is low or high, the cooling efficiency is decreased. However, the cooling efficiency is maximized at a normal load by storing cold heat when a small load is applied to the compressor and then by utilizing the stored cold heat when a large load is applied to the compressor.

[0022] A method for driving a regenerative cooling system according to a first embodiment of the present invention comprises: performing a cooling operation so that a refrigerant compressed and condensed by a compressor and a condenser can be supplied to an indoor unit, and the refrigerant heat-exchanged in the indoor unit can be fed back to the compressor under a state that a cooling line switching valve is opened; performing a regenerating operation so that cold heat generated when the refrigerant condensed by the condenser passes through an expansion valve of a regenerating line can be stored in a regenerative tank; and performing a cooling operation by using the cold heat stored in the regenerative tank so that the refrigerant compressed by the compressor can be introduced into the regenerating line via the condenser, and then the refrigerant can be fed back to the compressor via a first bypass pipe, a second bypass pipe, and the indoor unit, sequentially under a state that the cooling line switching valve and the outlet of the regenerating line are closed.

[0023] The three-way valve installed at the regenerating line converts a refrigerant flow. Instead of the three-way valve, a switching valve can be used.

[0024] FIG. 6 is a view showing a method for simultaneously performing a cooling operation and a regenerating operation in a regenerative cooling system according to a second embodiment of the present invention, and FIG. 7 is a view showing a method for performing a cooling operation by using cold heat stored in a regenerative tank in the regenerative cooling system according to a second embodiment of the present invention.

[0025] As shown in FIGS. 6 and 7, a regenerative cooling system 200 according to a second embodiment of the present invention comprises: a cooling line 210 for feeding-back a refrigerant compressed by a compressor 1 to the compressor 1 via a condenser 3 and an indoor unit 5, sequentially; a regenerating line 220 having one end diverged between the condenser 3 and the indoor unit 5 and another end merged between the indoor unit 5 and the compressor 1, for phase-converting a refrigerant condensed by the condenser 3 via an expansion valve 221 when the cooling line 210 is operated; a regenerative tank 230 installed outside the regenerating line 220 for accumulating cold heat generated from the regenerating line 220; a cooling line switching valve 240 installed between the indoor unit 5 and a divergence point 220a of the regenerating line 220; a first bypass pipe 250 installed at an inlet of the regenerating line 220 for bypassing the expansion valve 221; and a second bypass pipe 260 having one end diverged from an outlet of the regenerating line 220 and another end merged between the indoor unit 5 and the cooling line switching valve 240, for supplying a refrigerant that has passed through the regenerating line 220 to the indoor unit 5.

[0026] A regenerating line inlet switching valve 270 is installed at an inlet of the regenerating line 220, and a first bypass switching valve 271 is installed at the first bypass pipe 250.

[0027] Referring to FIG. 6, at the time of simultaneously performing a cooling operation and a regenerating operation, a refrigerant compressed by the compressor 1 is heat-exchanged via the condenser 3 and the indoor unit 5. Then, the heat-exchanged refrigerant is fed back to the compressor 1. Under a state that the regenerating line inlet switching valve 270 is opened and the first bypass switching valve 271 is closed, the refrigerant that has passed through the condenser 3 passes through the expansion valve 121 thus to be expanded. Then, the expanded refrigerant flows to the regenerative tank 230 thus to be regenerated, then flows to the outlet of the regenerating line 220, and then is fed back to the compressor 1.

[0028] As shown in FIG. 7, when a cooling operation is performed by using cold heat stored in the regenerative tank, under a state that the cooling line switching valve 240, the regenerating line inlet switching valve 270, and the regenerating line outlet switching valve 280 are closed, the refrigerant that has passed through the compressor 1 and the condenser 3 does not flow to the cooling line 210 but flows to the first bypass pipe 250 via the inlet of the regenerating line 220. Then, the refrigerant flows to the regenerative tank 230, then is introduced into the indoor unit 5 via the second bypass pipe 260 thus to be heat-exchanged, and then is fed back to the compressor 1.

[0029] As aforementioned, in the present invention, cool heat is stored in the regenerative tank by applying a refrigerant used in a cooling operation to the regenerative tank when a cooling load is low even during the

daytime, that is, when a small amount of cool heat is required indoors, and then the stored cool heat is utilized when the cooling load is high, that is, when a great amount of cool heat is required indoors, thereby maintaining the driving rate of the indoor unit as 40~80% and thus enhancing energy efficiency. Also, the regenerative cooling system according to the present invention prevents an overload of the compressor thus to prolong a lifespan thereof.

Claims

1. A regenerative cooling system, comprising:

a cooling line for feeding-back a refrigerant compressed by a compressor to the compressor via a condenser and an indoor unit, sequentially;
a regenerating line having one end diverged between the condenser and the indoor unit and another end merged between the indoor unit and the compressor, for phase-converting a refrigerant condensed by the condenser via an expansion valve when the cooling line is operated;
a regenerative tank installed outside the regenerating line for accumulating cold heat generated from the regenerating line;
a cooling line switching valve installed between the indoor unit and a divergence point of the regenerating line;
a first bypass pipe installed at an inlet of the regenerating line for bypassing the expansion valve; and
a second bypass pipe having one end diverged from an outlet of the regenerating line and another end merged between the indoor unit and the cooling line switching valve, for supplying a refrigerant that has passed through the regenerating line to the indoor unit.

2. The system of claim 1, further comprising:

a three-way valve installed at an inlet of the first bypass pipe for selectively passing a refrigerant that has been introduced into the regenerating line to the expansion valve or the first bypass pipe;
a regenerating line outlet switching valve installed at an outlet of the regenerating line; and
a second bypass pipe switching valve installed at the second bypass pipe.

3. The system of claim 1 or 2, further comprising:

a regenerating line inlet switching valve installed at an inlet of the regenerating line; and
a first bypass pipe switching valve installed at the first bypass pipe.

4. A method for driving a regenerative cooling system, comprising:

performing a cooling operation so that a refrigerant compressed and condensed by a compressor and a condenser can be supplied to an indoor unit, and the refrigerant heat-exchanged in the indoor unit can be fed back to the compressor under a state that a cooling line switching valve is opened; and
performing a regenerating operation so that cold heat generated when the refrigerant condensed by the condenser passes through an expansion valve of a regenerating line can be stored in a regenerative tank.

5. The method of claim 4, further comprising performing a cooling operation by using the cold heat stored in the regenerative tank so that the refrigerant compressed by the compressor can be introduced into the regenerating line via the condenser, and then the refrigerant can be fed back to the compressor via a first bypass pipe, a second bypass pipe, and the indoor unit, sequentially under a state that the cooling line switching valve and the outlet of the regenerating line are closed.

6. A method for driving a regenerative cooling system comprising:

a cooling line for feeding-back a refrigerant compressed by a compressor to the compressor via a condenser, a cooling line switching valve, and an indoor unit, sequentially;
a regenerating line having one end diverged between the condenser and the cooling line switching valve, and another end merged between the indoor unit and the compressor, for feeding back a refrigerant to the compressor via the compressor, the condenser, a three-way valve, an expansion valve, and a regenerating line outlet switching valve; and
a cooling line using stored cold heat having a first bypass pipe at an inlet of the regenerating line and a second bypass pipe at an outlet of the regenerating line, for feeding-back a refrigerant to the compressor via the compressor, the condenser, the three-way valve, the first bypass pipe, the second bypass pipe, and the indoor unit.

7. The method of claim 6, comprising:

simultaneously performing a cooling operation and a regenerating operation by opening the cooling line and the regenerating line and by closing the cooling line using stored cold heat; and

performing a cooling operation by closing the cooling line and the regenerating line and by opening the cooling line using stored cold heat.

8. The method of claim 7, further comprising performing a regenerating operation by opening the regenerating line and by closing the cooling line and the cooling line using stored cold heat.

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FIG. 1

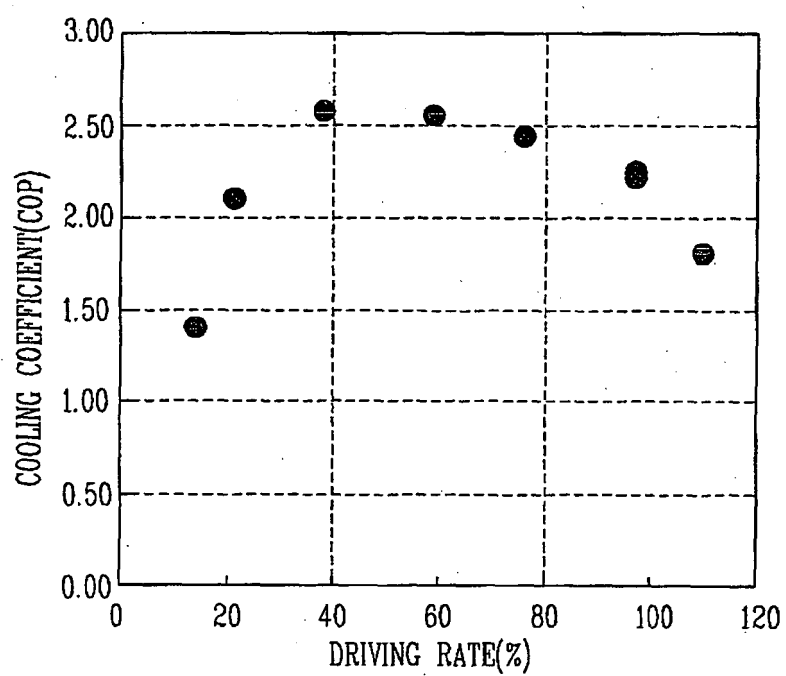


FIG. 2

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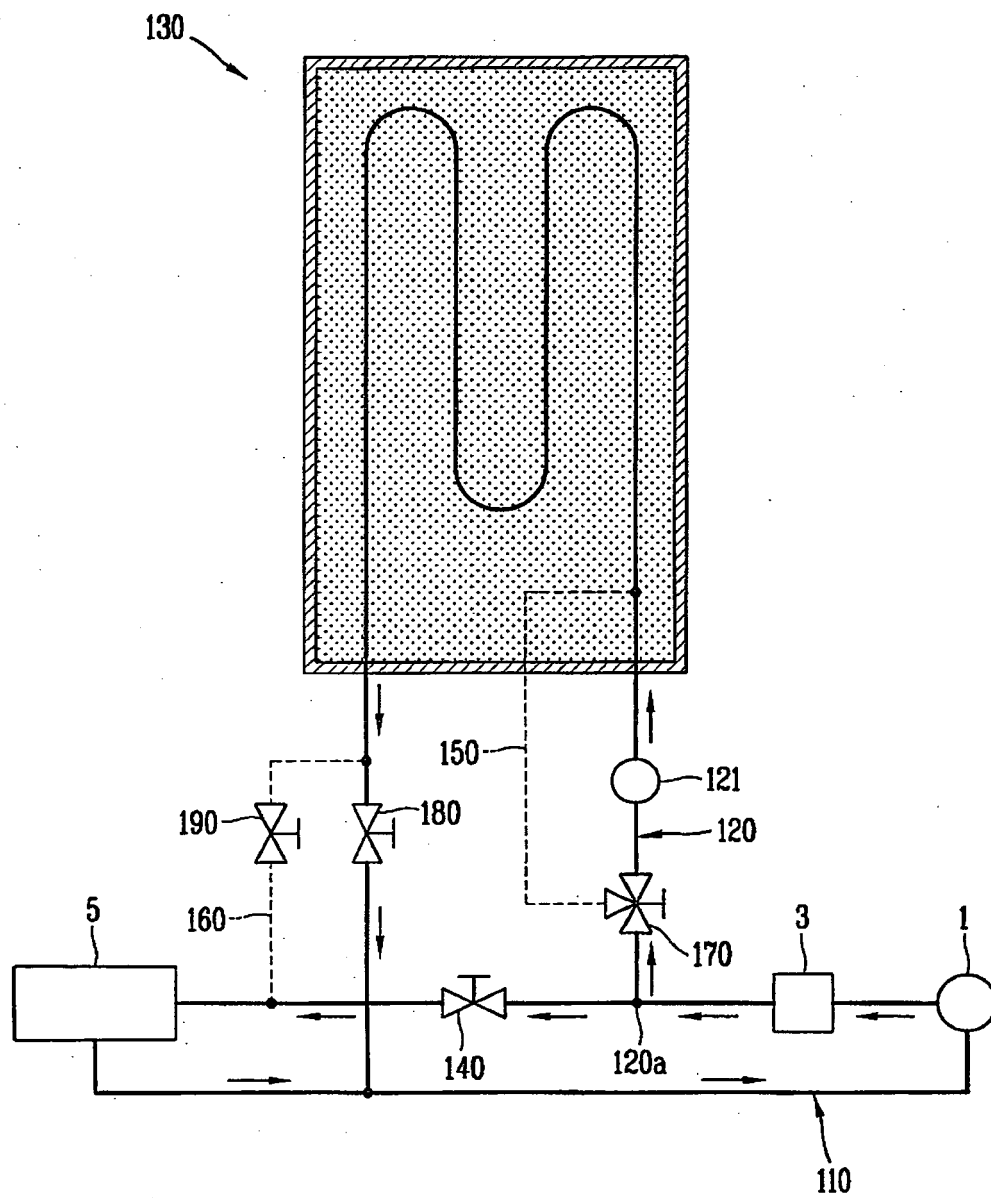


FIG. 3

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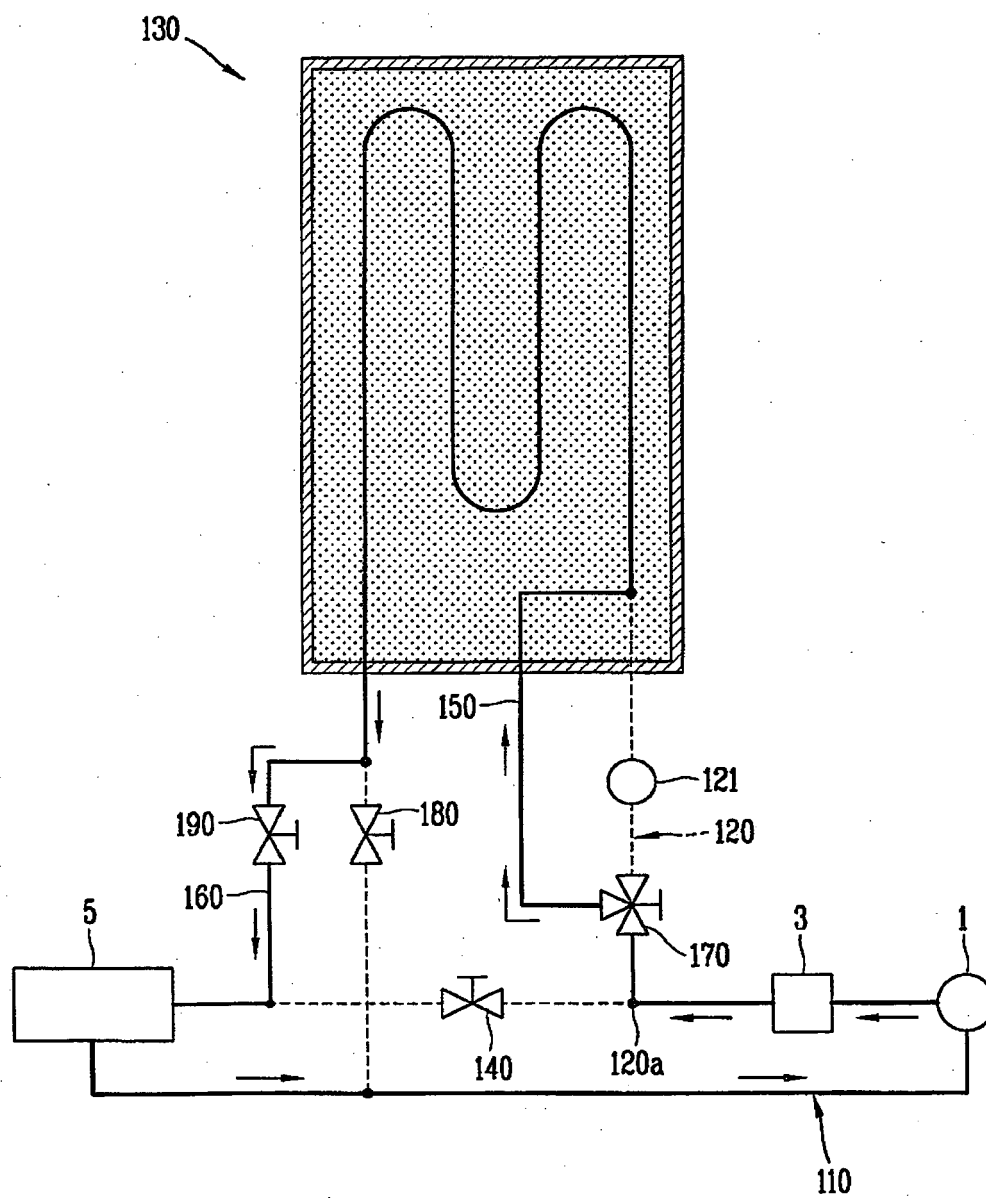


FIG. 4

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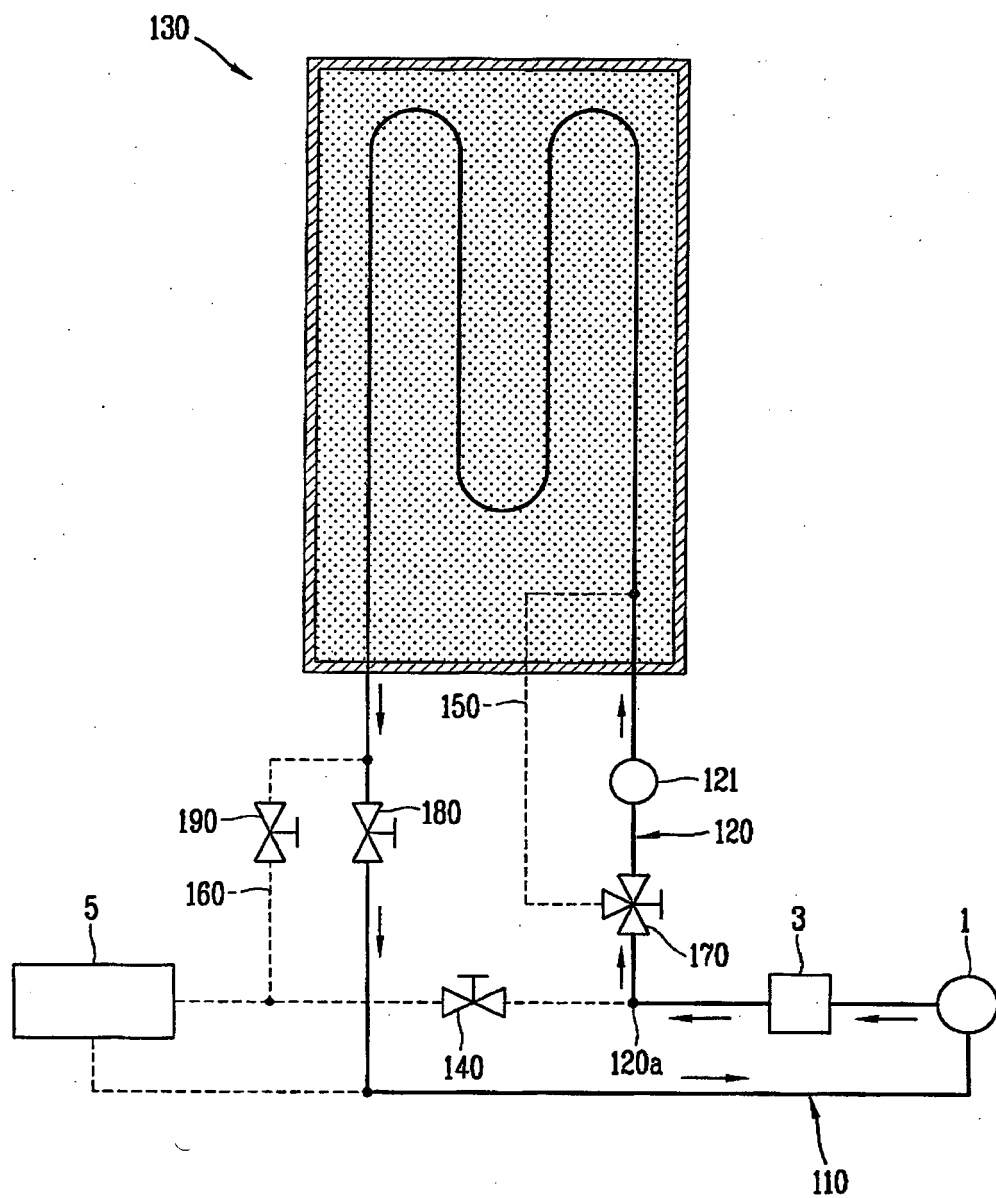


FIG. 5

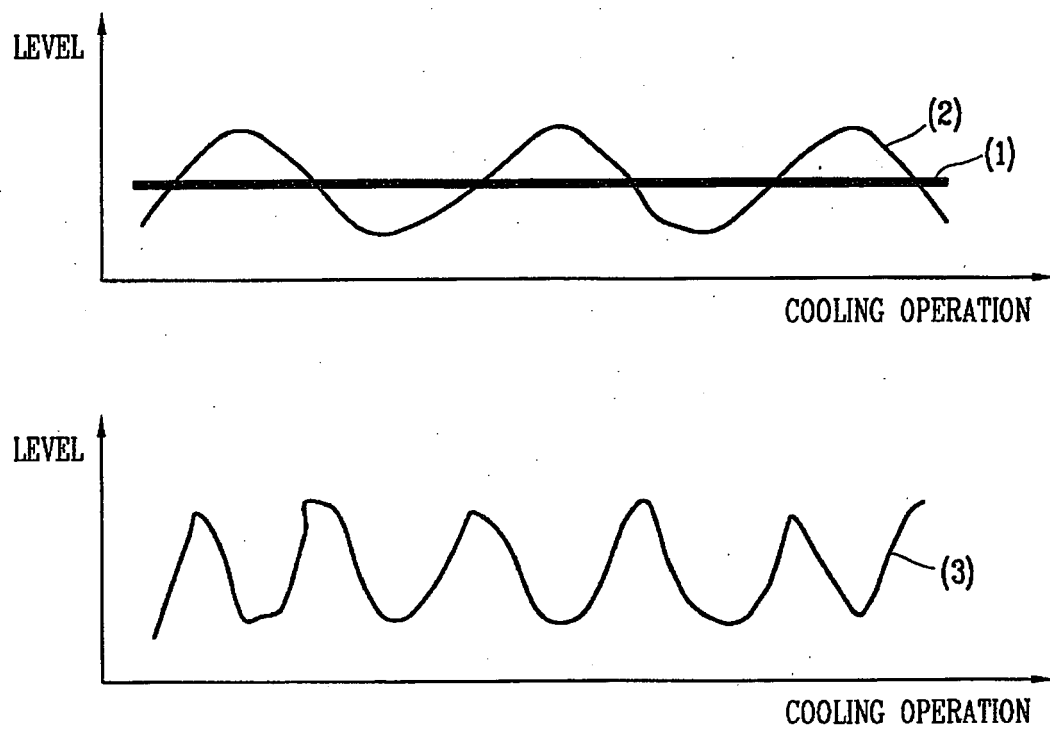


FIG. 6

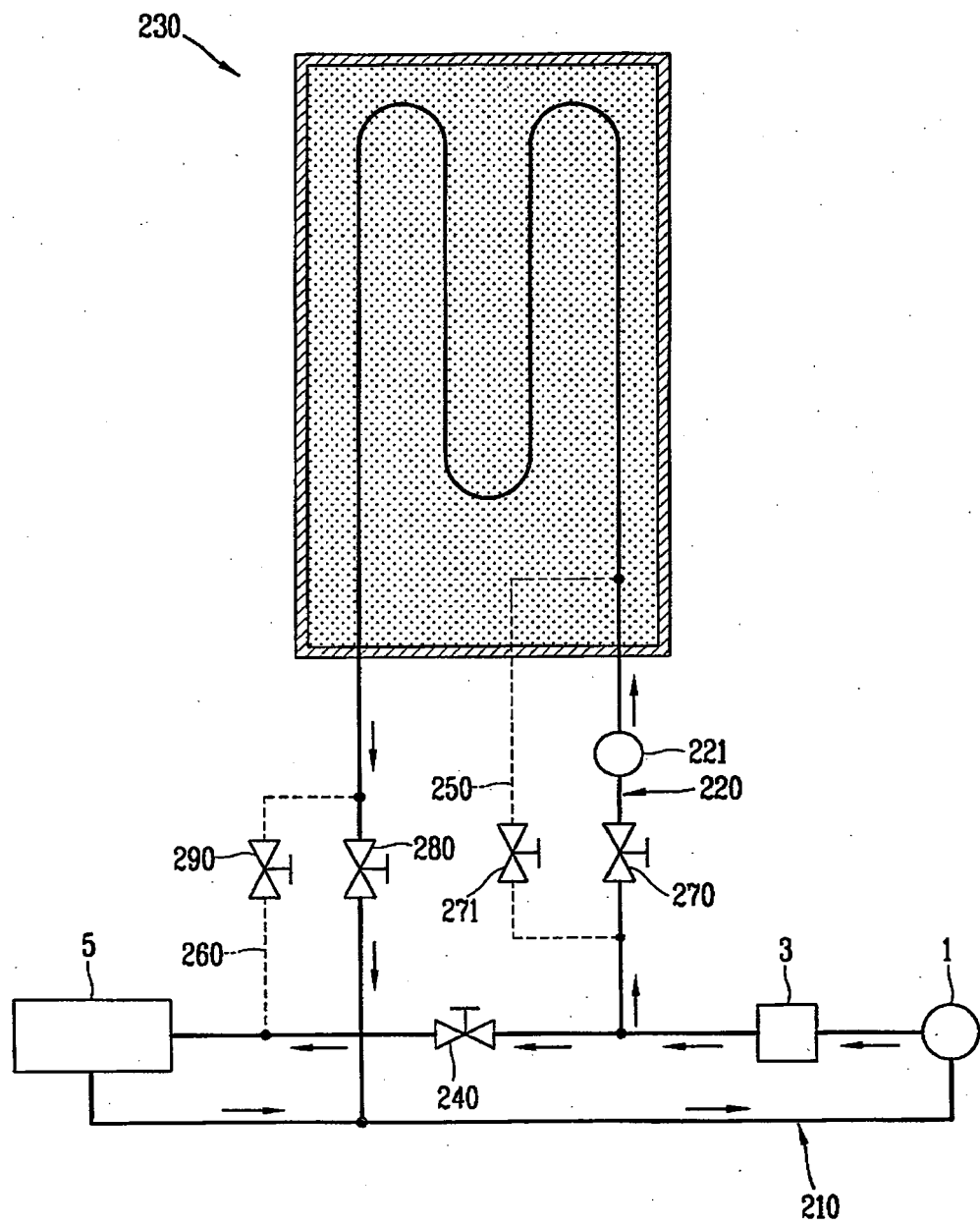
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FIG. 7

200

