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(54) **AIR-CONDITIONING SYSTEM**

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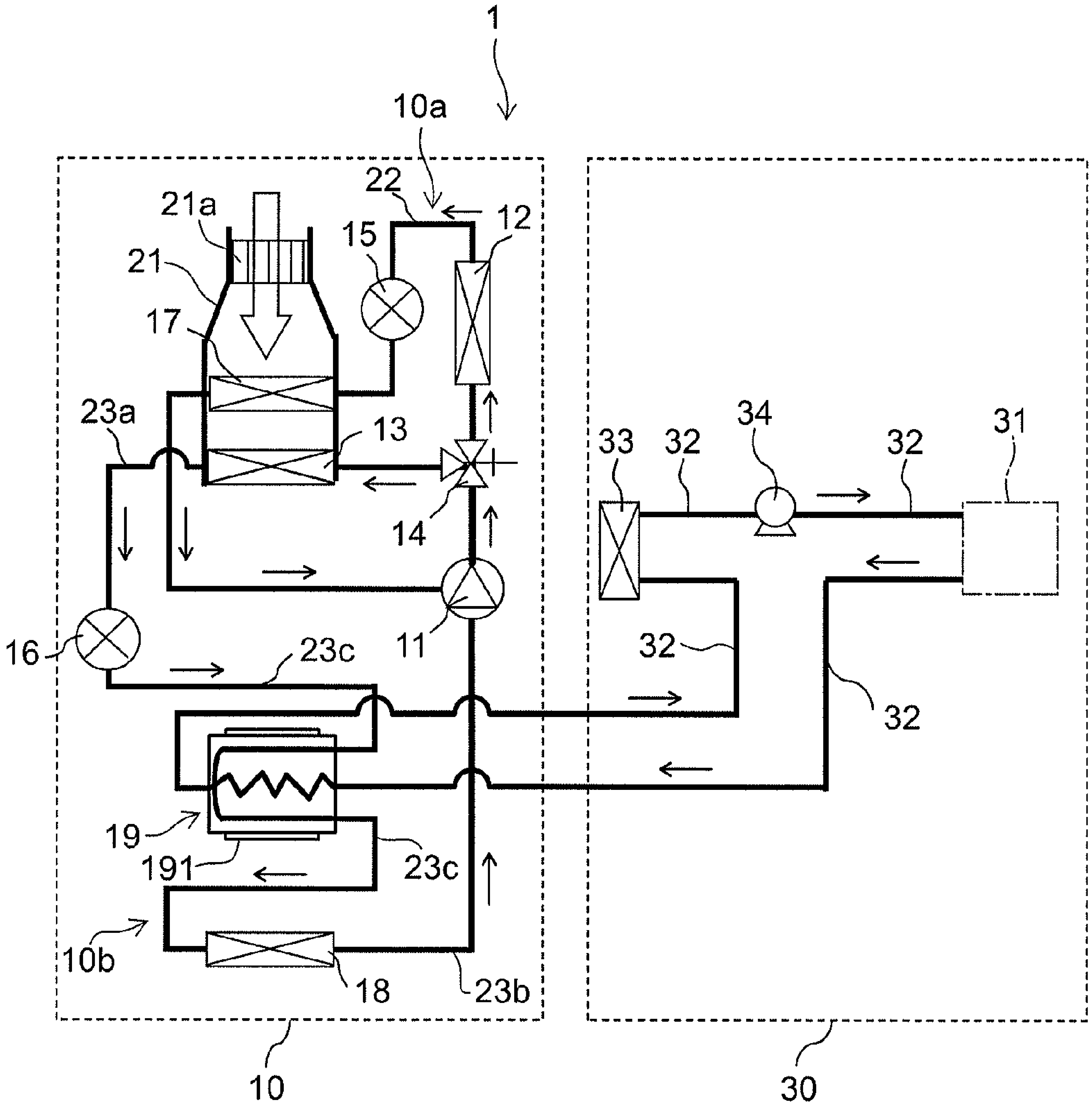
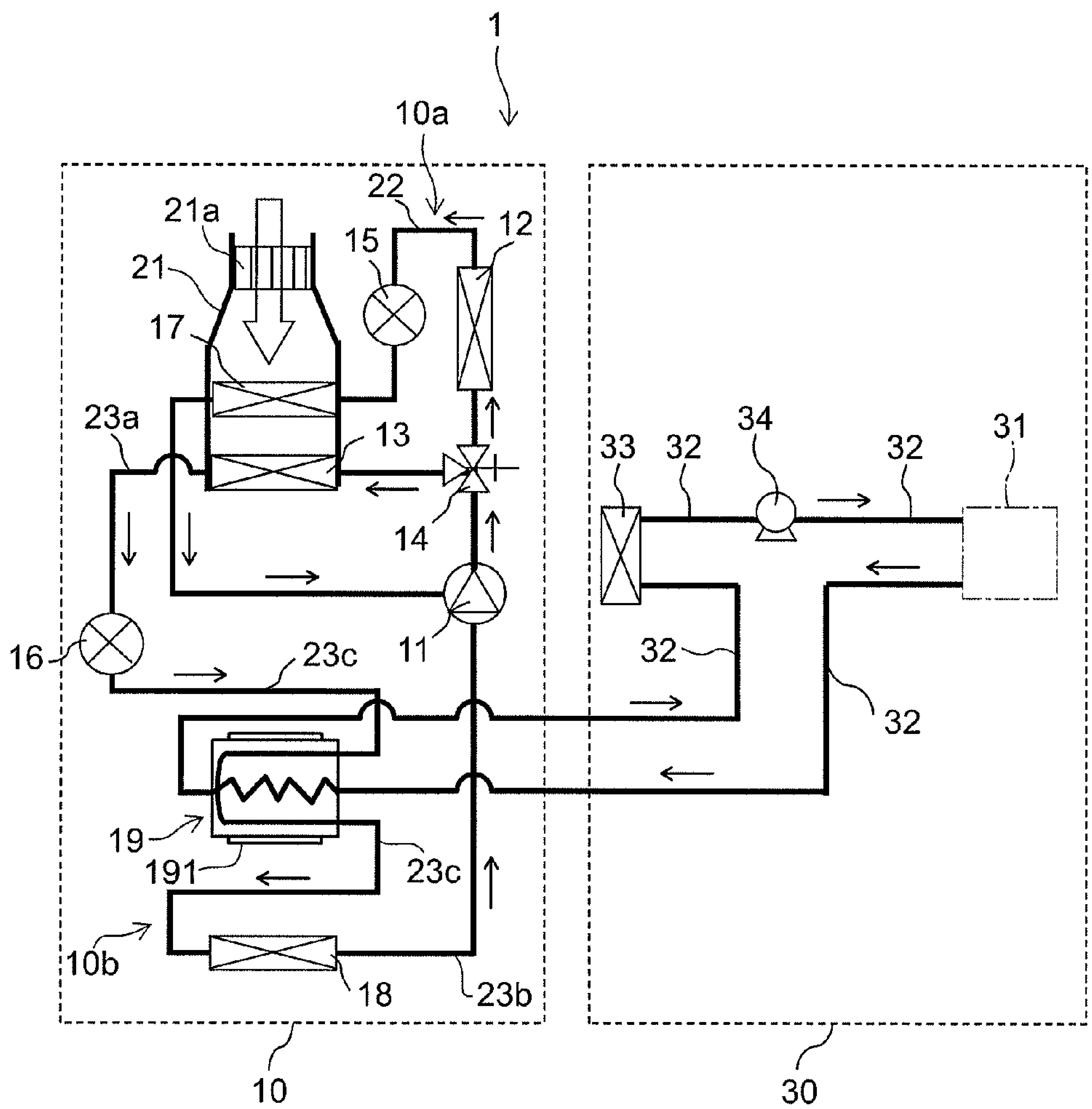
(57) **ABSTRACT**

According to one embodiment, an air conditioning system includes a compressor, a condenser, an expansion valve, a switching valve, an evaporator, a pump, a radiator, and a heat storage unit. The switching valve performs switching so that a first heat medium flows through either a first flow path or a second flow path. The pump supplies a second heat medium to the heat source. The heat storage unit has a heat storage material. The heat storage unit has a first heat exchange region in which heat is exchanged between the first heat medium flowing through the first flow path and the heat storage material. The heat storage unit has a second heat exchange region which is provided upstream of the radiator and in which heat is exchanged between the second heat medium supplied to the heat source and the heat storage material.




1
10a
22
21a
12
15
21
17
23a
13
14
33
32
34
32
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11
16
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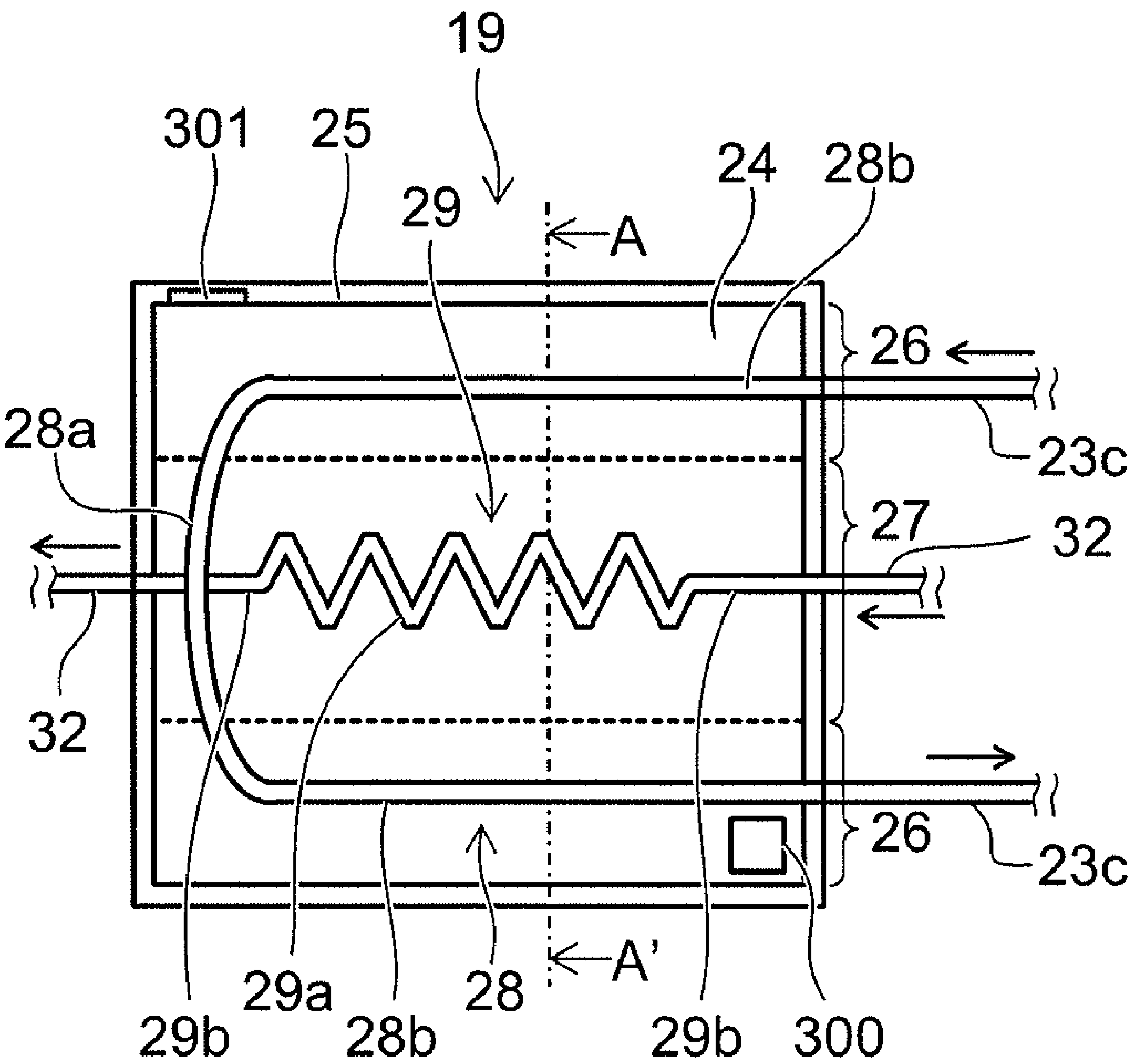
32
19
191
23c
10b
18
23b
10
30

FIG. 1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301
25
29
A
24
28b
26
28a
23c
27
32
32
26
23c
29b
29a
28b
28
A'
29b
300

FIG. 2A

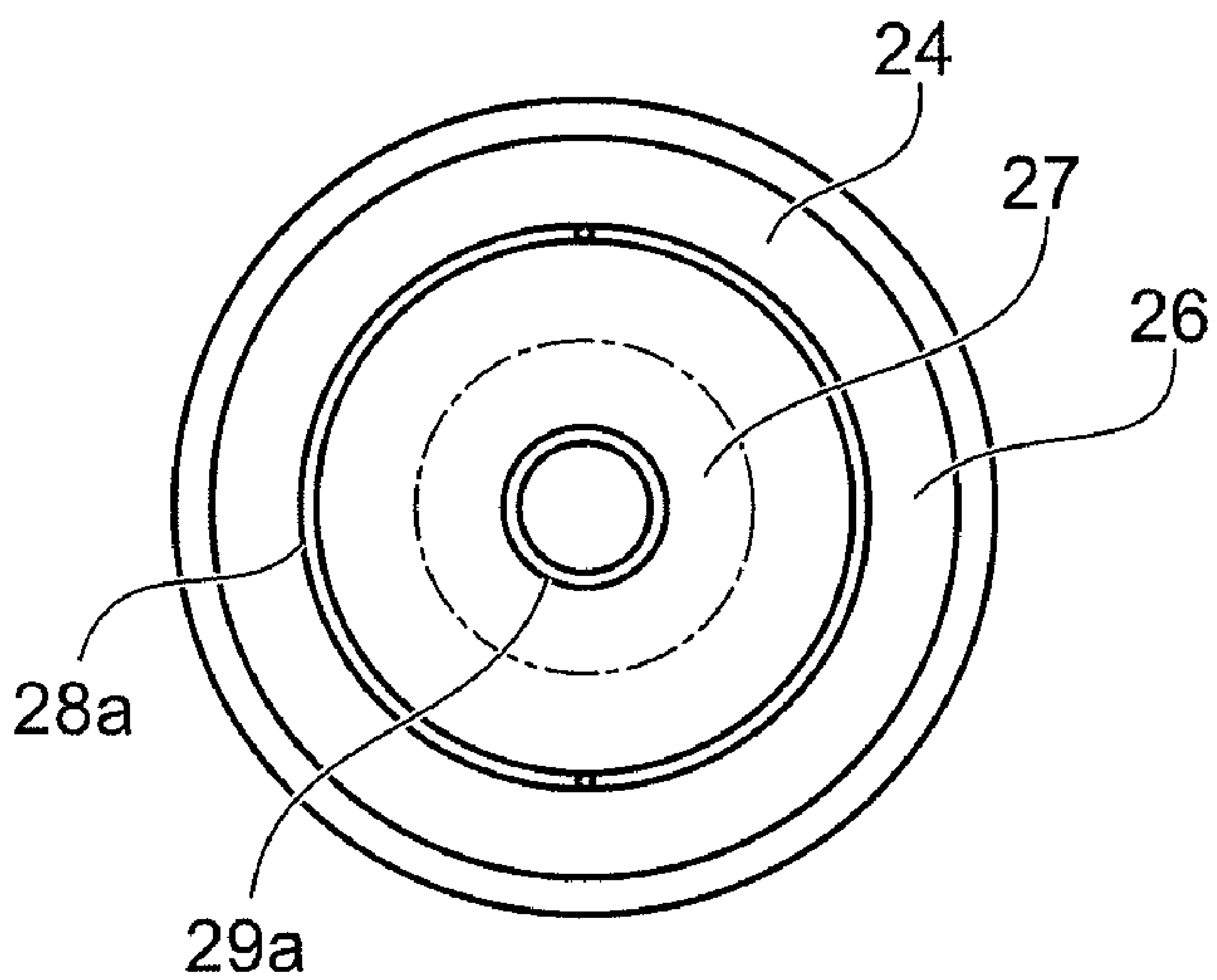

24
27
26
28a
29a

FIG. 2B

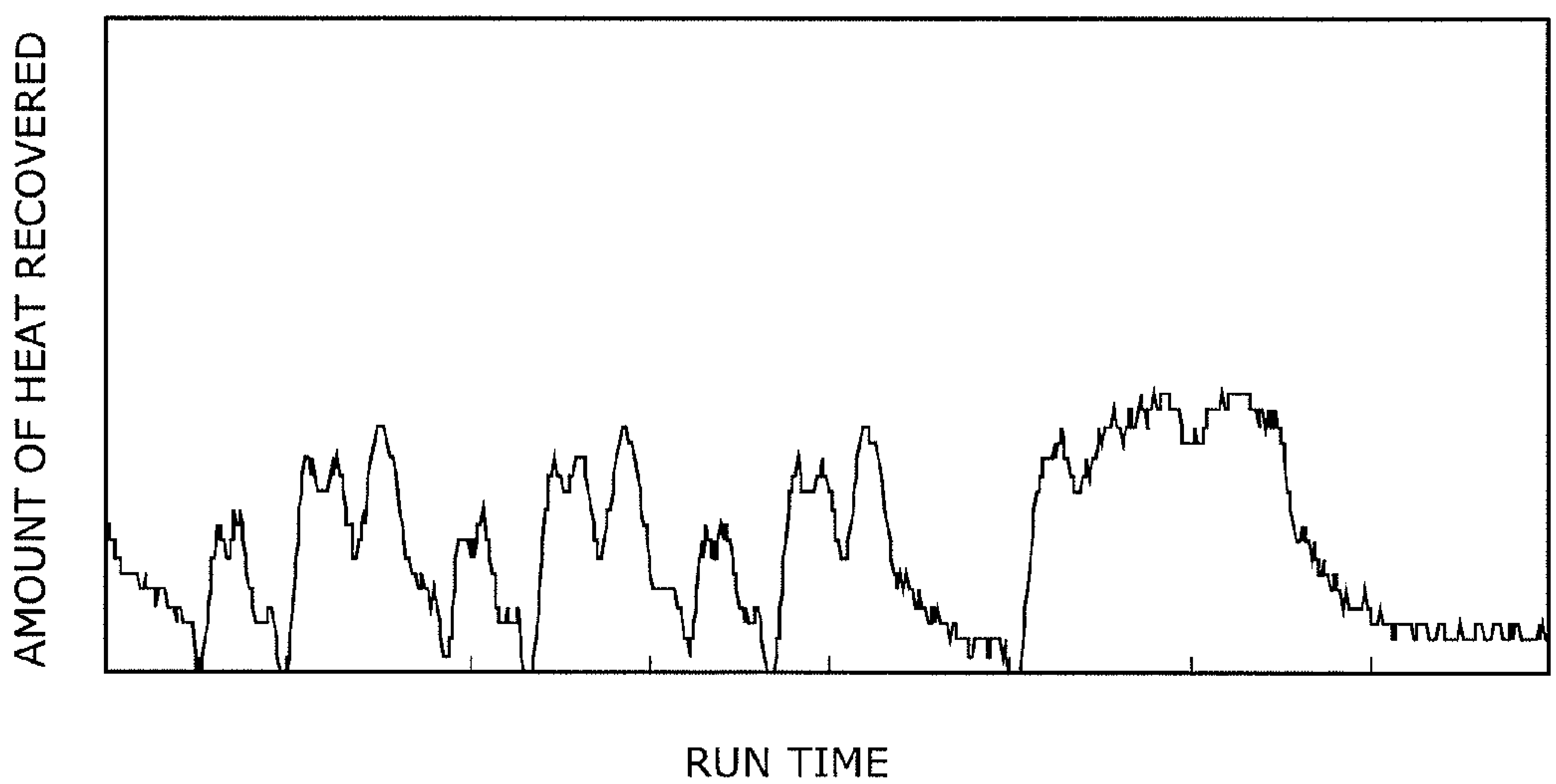


FIG. 3

FIG. 4A

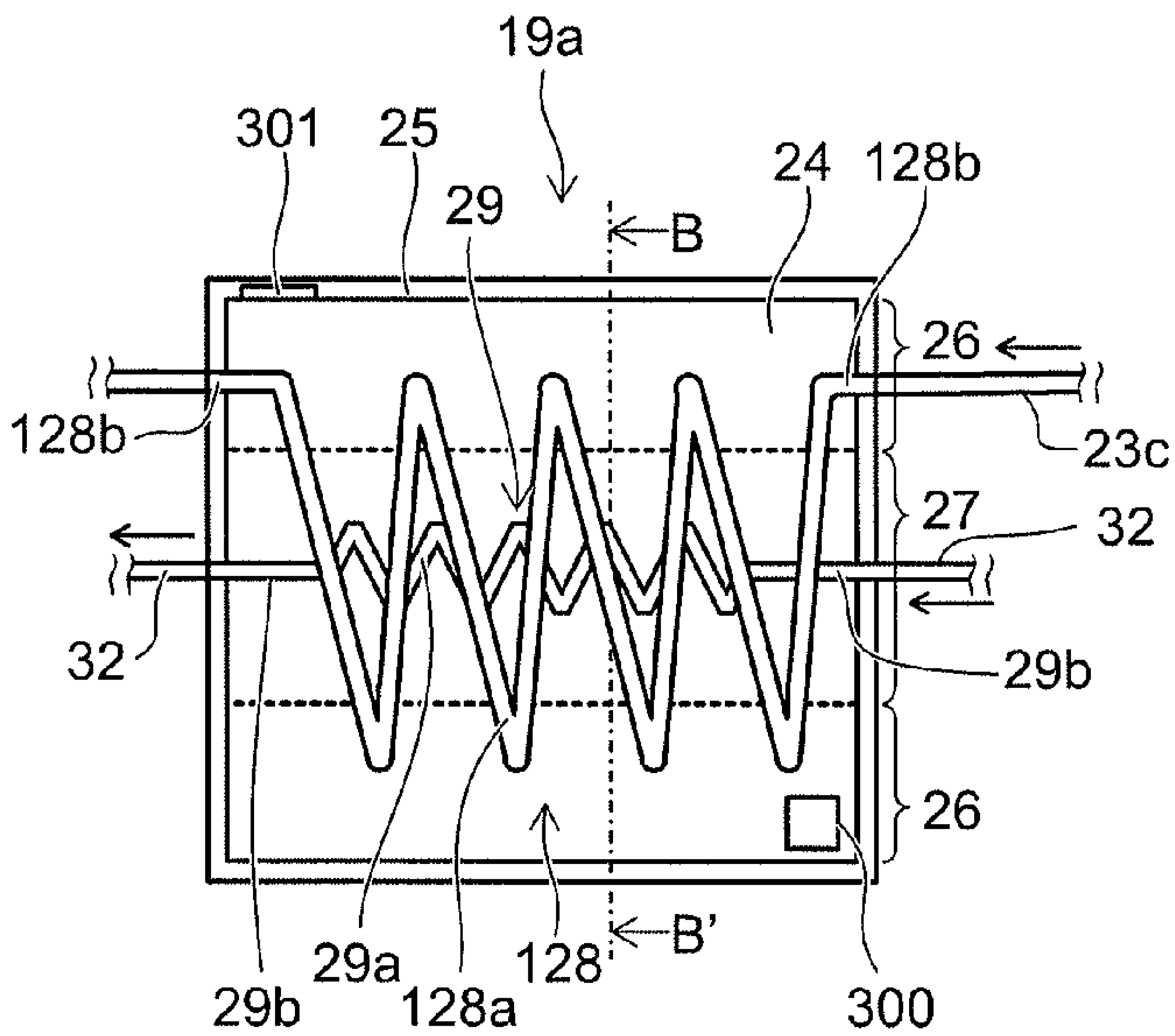


FIG. 4B

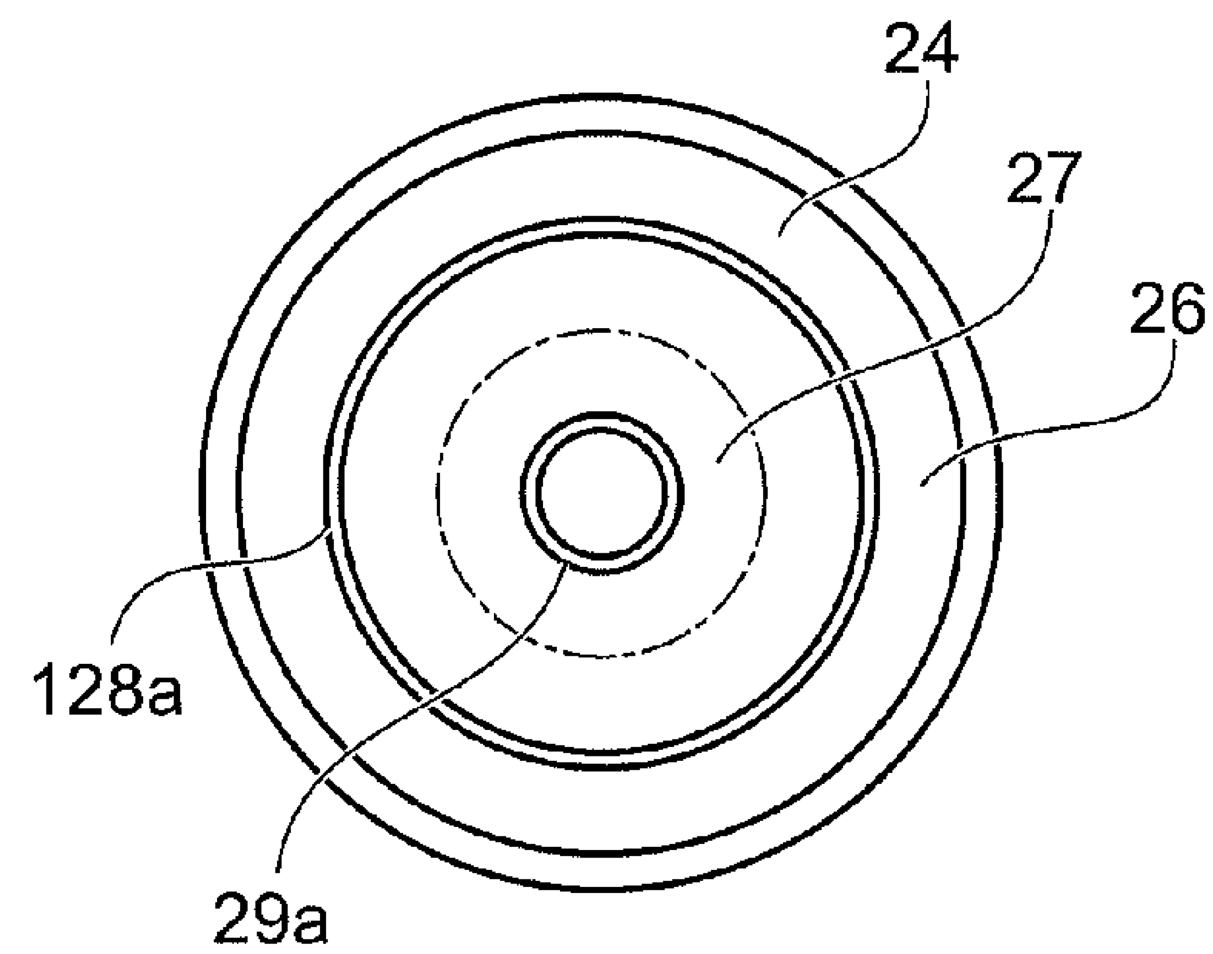
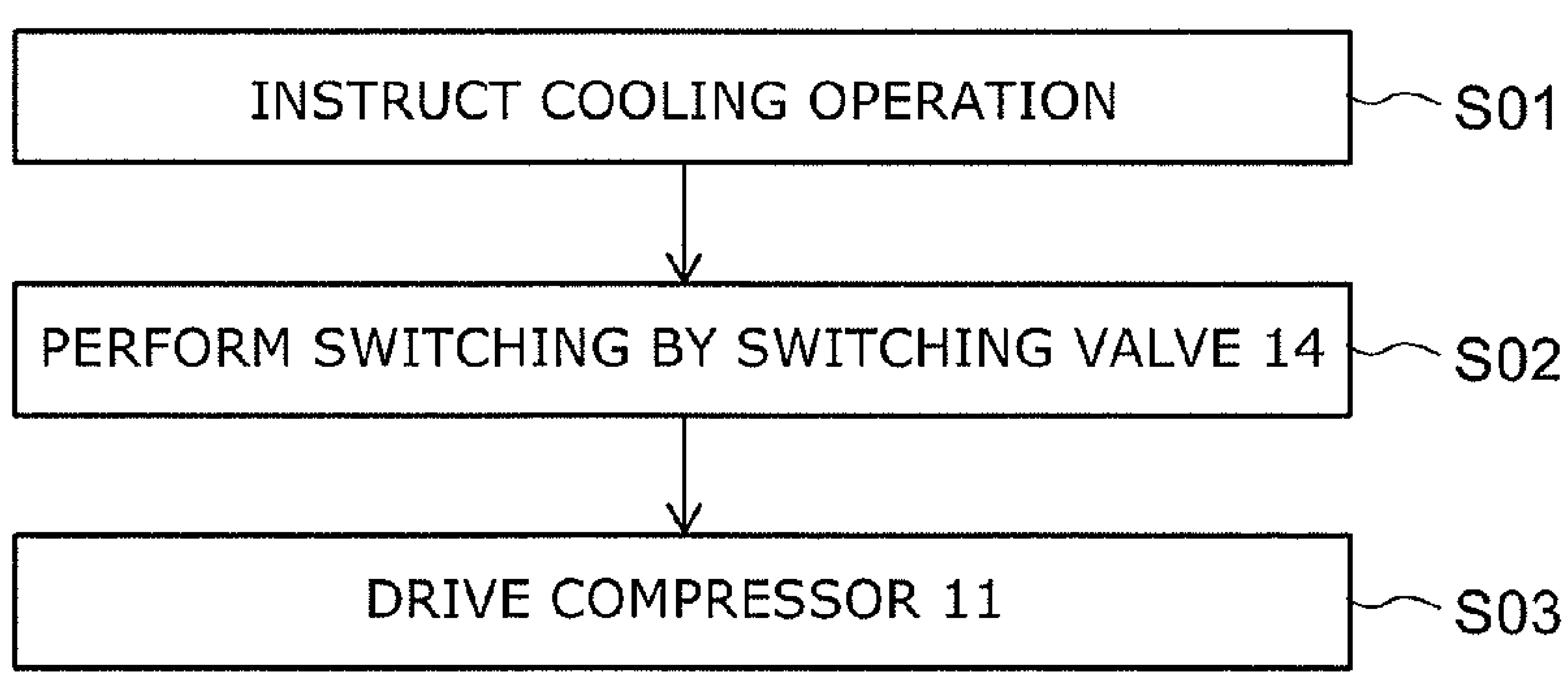


FIG. 5



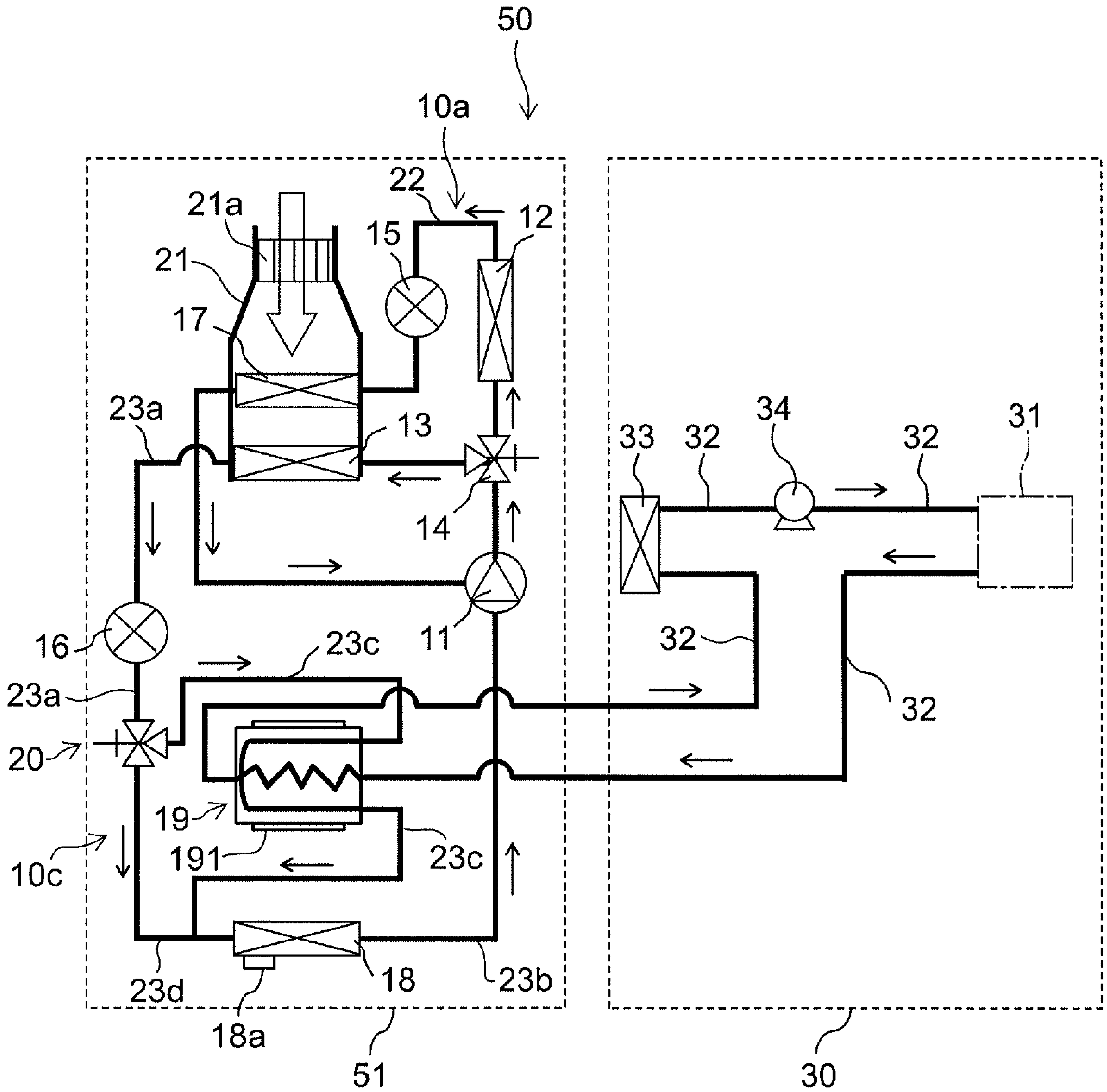

50
10a
22
12
21a
15
21
17
23a
13
33
32
34
32
31
14
11
16
23c
32
32
23a
20
19
191
23c
10c
23d
18
23b
18a
51
30

FIG. 6

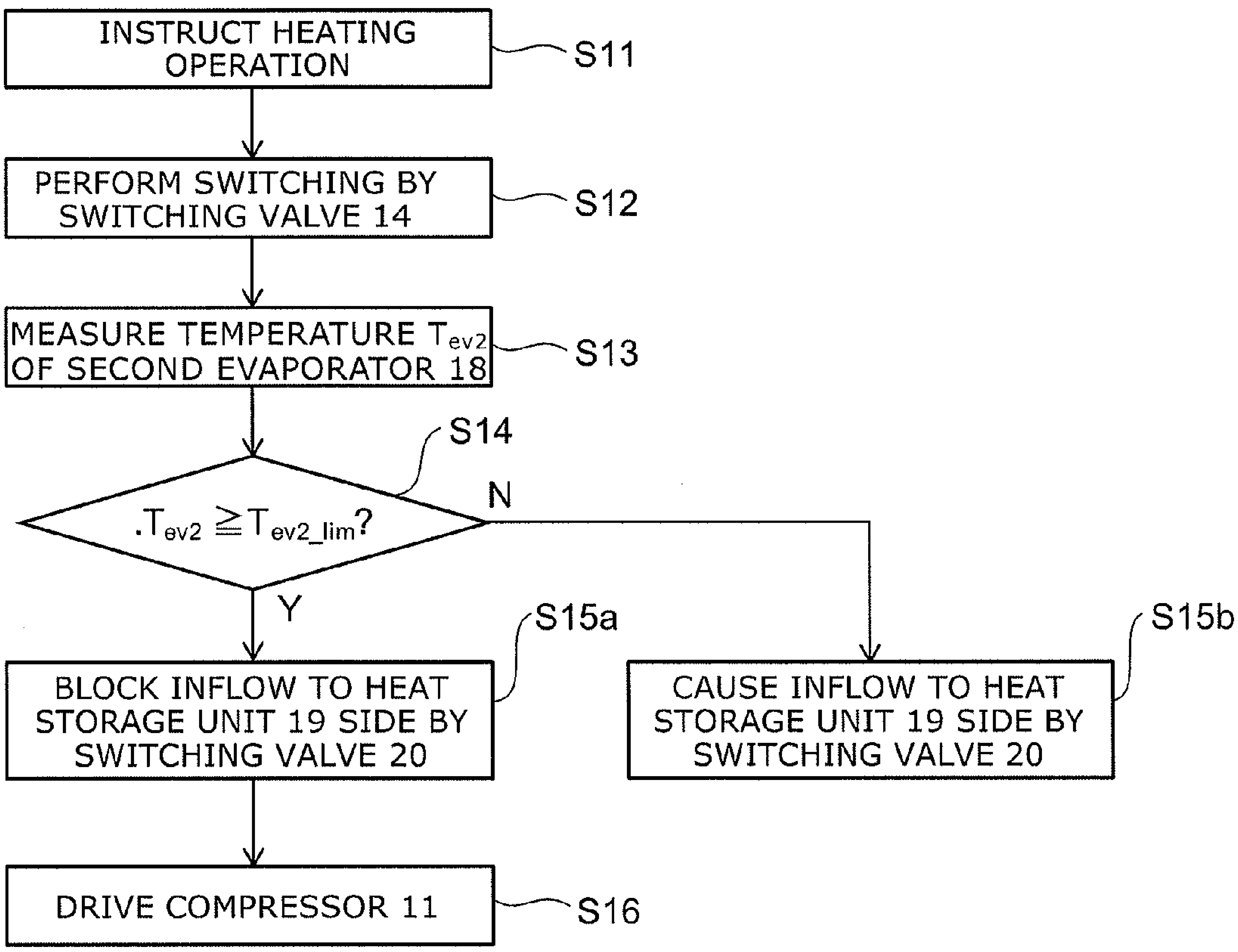

INSTRUCT HEATING OPERATION
S11
PERFORM SWITCHING BY SWITCHING VALVE 14
S12
MEASURE TEMPERATURE T_{ev2} OF SECOND EVAPORATOR 18
S13
S14
N
$T_{ev2} \geqq T_{ev2\_lim}$?
Y
S15a
BLOCK INFLOW TO HEAT STORAGE UNIT 19 SIDE BY SWITCHING VALVE 20
S15b
CAUSE INFLOW TO HEAT STORAGE UNIT 19 SIDE BY SWITCHING VALVE 20
DRIVE COMPRESSOR 11
S16

FIG. 7

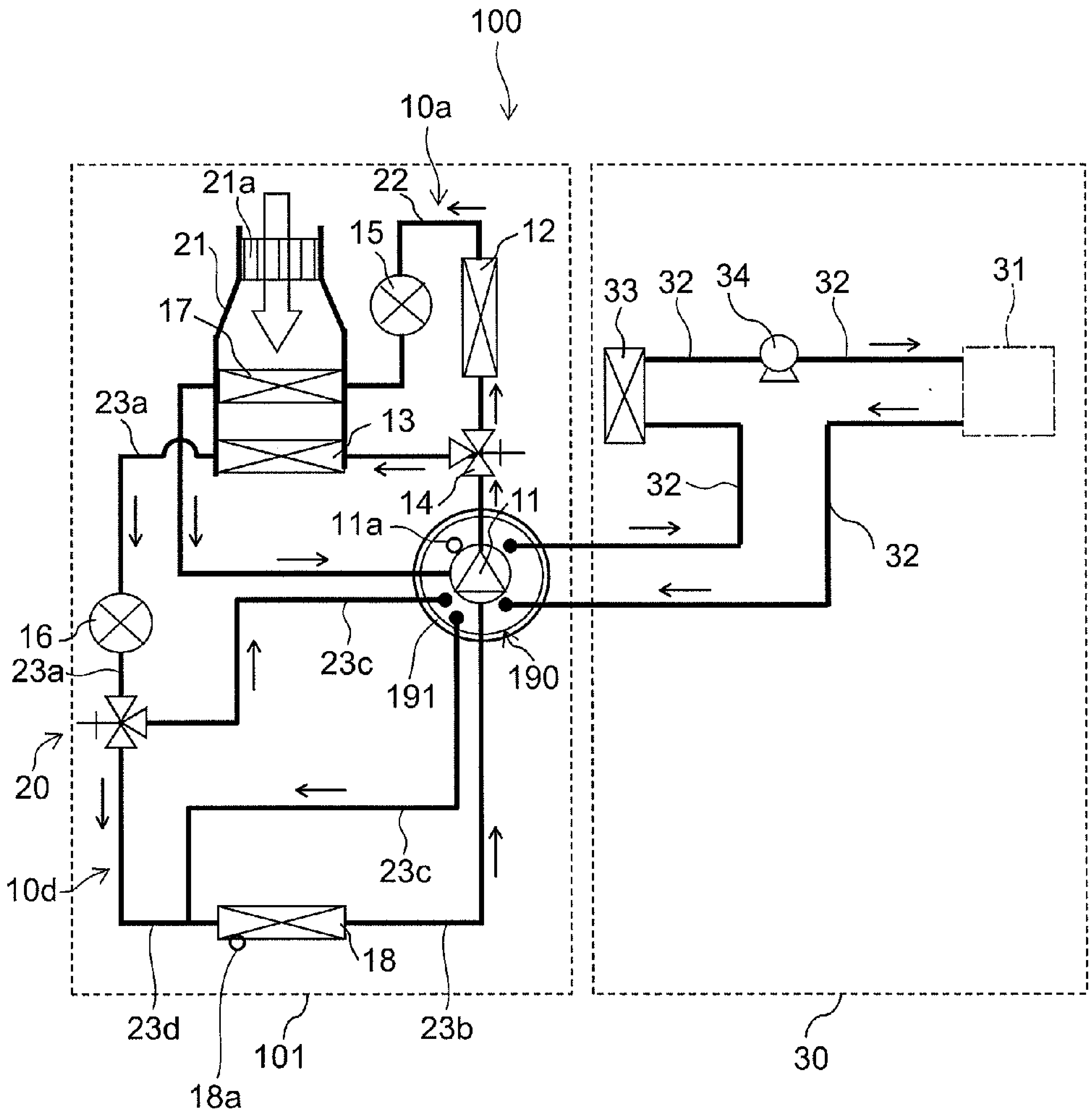

100
10a
22
21a
21
15
12
17
13
23a
14
11
11a
16
23a
23c
191
190
20
23c
10d
18
23d
101
23b
18a
33
32
34
32
31
32
32
30

FIG. 8

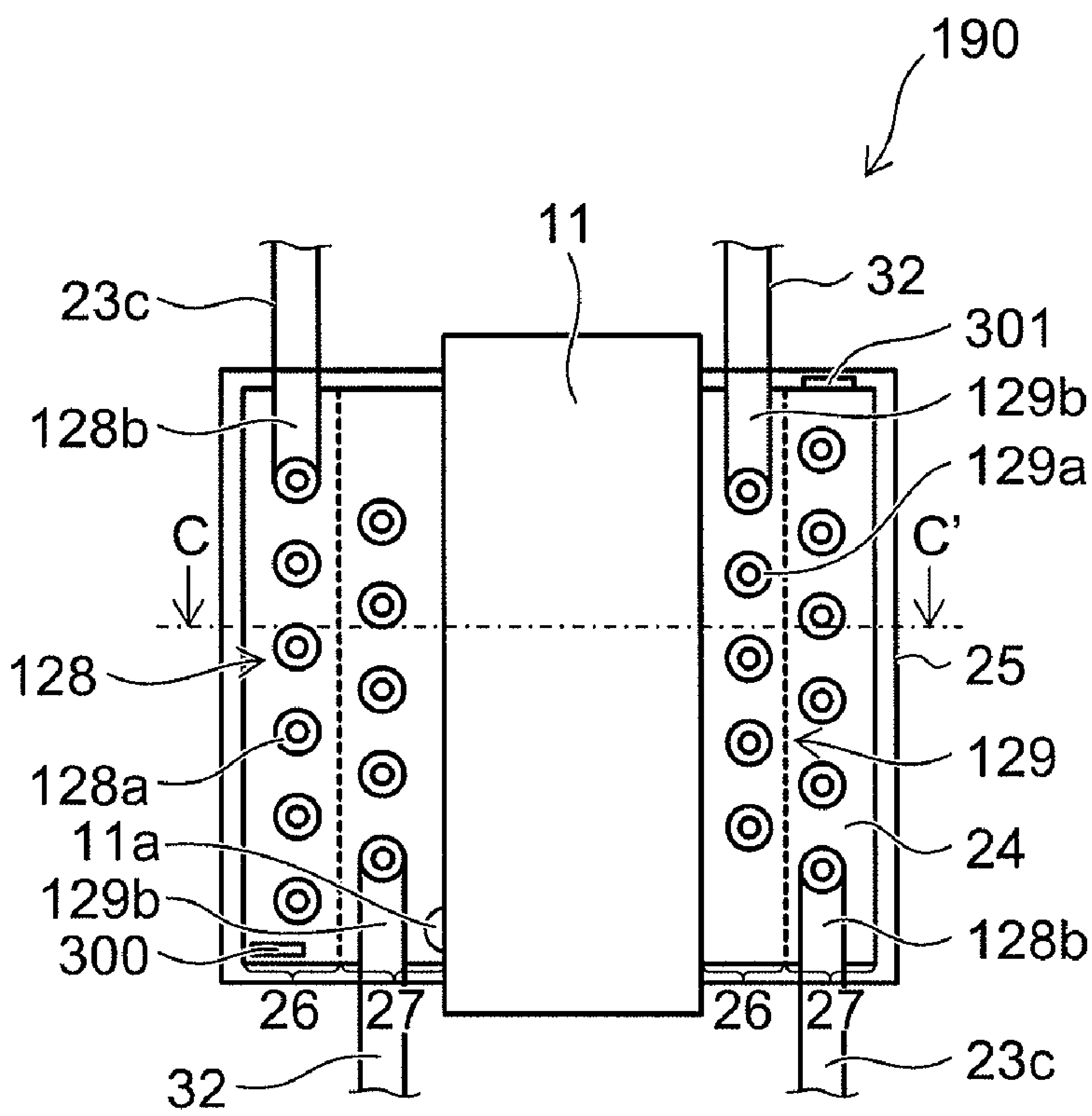

190
11
23c
32
301
128b
129b
129a
C
C'
128
25
128a
129
24
11a
129b
128b
300
26
27
26
27
32
23c

FIG. 9A

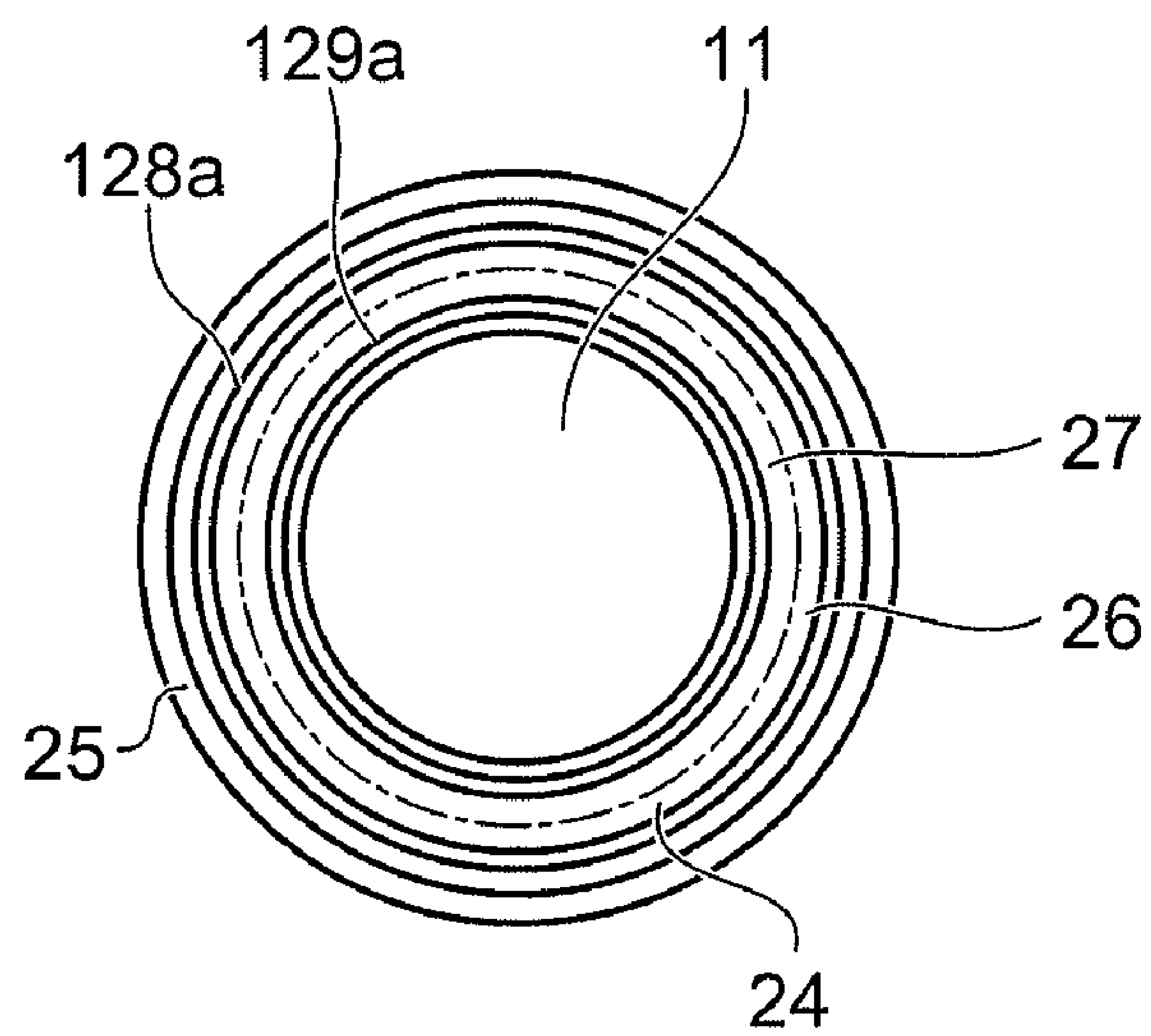

129a
11
128a
27
26
25
24

FIG. 9B

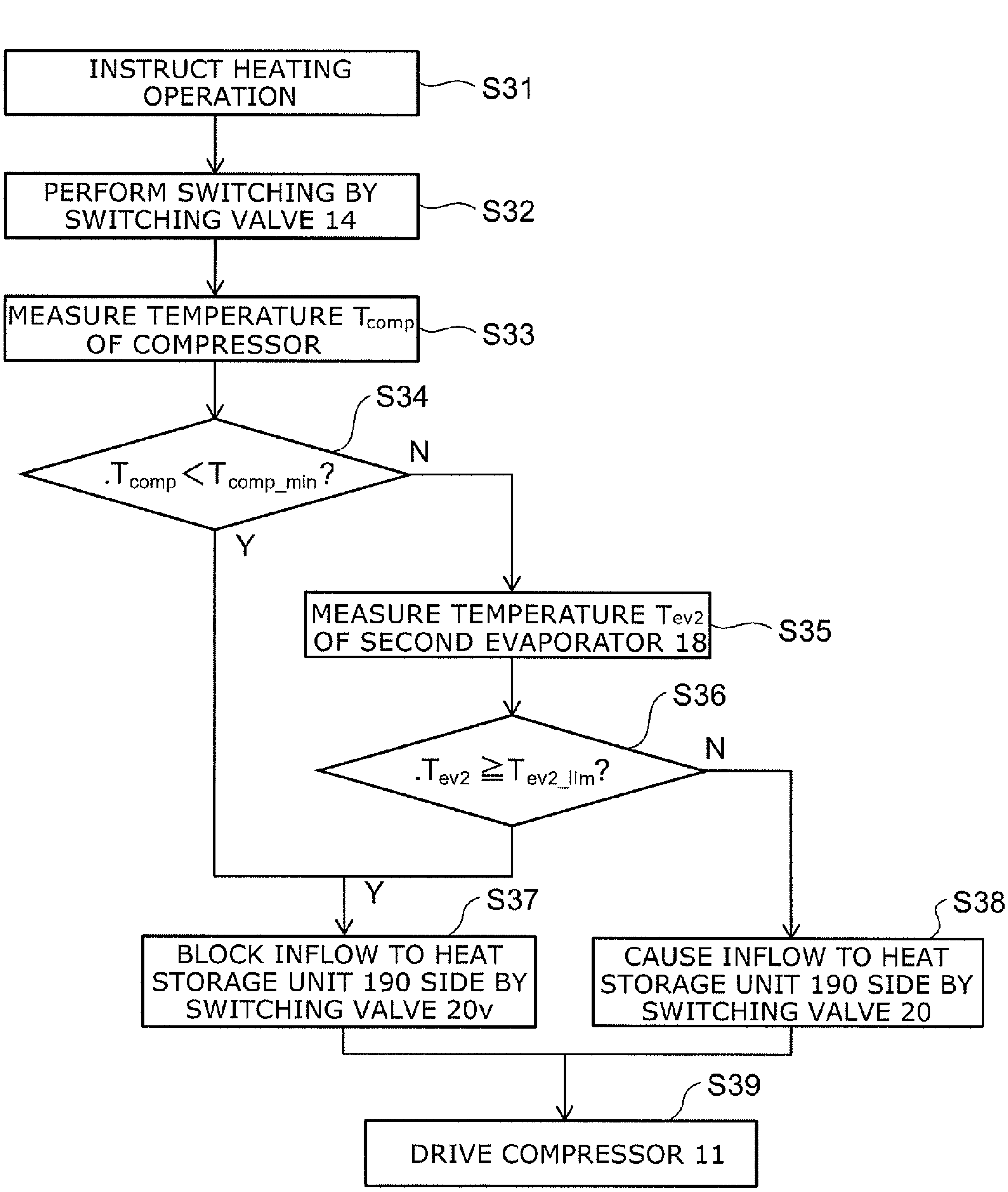

INSTRUCT HEATING OPERATION
S31
PERFORM SWITCHING BY SWITCHING VALVE 14
S32
MEASURE TEMPERATURE T_{comp} OF COMPRESSOR
S33
S34
$.T_{comp} < T_{comp\_min}$?
N
Y
MEASURE TEMPERATURE T_{ev2} OF SECOND EVAPORATOR 18
S35
S36
$.T_{ev2} \geqq T_{ev2\_lim}$?
N
Y
S37
BLOCK INFLOW TO HEAT STORAGE UNIT 190 SIDE BY SWITCHING VALVE 20v
S38
CAUSE INFLOW TO HEAT STORAGE UNIT 190 SIDE BY SWITCHING VALVE 20
S39
DRIVE COMPRESSOR 11

FIG. 10

AIR-CONDITIONING SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is based upon and claims the benefit of priority from the prior Japanese Patent Application No. 2011-210318, filed on Sep. 27, 2011; the entire contents of which are incorporated herein by reference.

FIELD

[0002] Embodiments described herein relate generally to an air-conditioning system.

BACKGROUND

[0003] To cool a heating element such as a fuel cell mounted on a vehicle, there exists a cooling system which utilizes, as a heat sink, a heat medium used for indoor cooling by an air conditioning system.

[0004] For example, there is proposed a cooling system which utilizes, as a heat sink, a heat medium used for indoor cooling to cool a heating element mounted on a vehicle via a heat exchanger, in which an evaporator for indoor cooling by an air conditioning system and the heat exchanger provided with a heat storage material are connected in parallel via a switching valve.

[0005] Here, in an air conditioning system, there may be a case where indoor heating is required in addition to indoor cooling. In this case, frosting of the evaporator for indoor heating in a cold district may cause decrease of heating efficiency, damage of the evaporator or the like.

[0006] However, in the above-mentioned air conditioning system, using the heat of a heating element such as a fuel cell to remove the attached frost has not been considered. Therefore it becomes necessary to use a heater or the like to remove the frost, which may increase power consumption.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] FIG. **1** is a block diagram illustrating an air conditioning system according to a first embodiment.

[0008] FIG. **2**A is a schematic cross-sectional view illustrating the heat storage unit and FIG. **2**B is a cross-sectional view taken along the line between the arrows A-A' in FIG. **2**A.

[0009] FIG. **3** is a schematic graph illustrating a temporal change in the amount of heat of the second heat medium recovered from the heat source **31** (amount of heat recovered) when the vehicle is running.

[0010] FIG. **4**A is a schematic cross-sectional view illustrating the heat storage unit and FIG. **4**B is a cross-sectional view taken along the line between the arrows B-B' in FIG. **4**A.

[0011] FIG. **5** is a flowchart illustrating an operation method of the cooling side circuit **10***a*.

[0012] FIG. **6** is a block diagram illustrating an air conditioning system according to a second embodiment.

[0013] FIG. **7** is a flowchart illustrating an operation method in the heating side circuit **10***c*.

[0014] FIG. **8** is a block diagram illustrating an air conditioning system according to a third embodiment.

[0015] FIG. **9**A is a schematic cross-sectional view illustrating the heat storage unit and FIG. **9**B is a cross-sectional view taken along the line between the arrows C-C' in FIG. **9**A.

[0016] FIG. **10** is a flowchart illustrating an operation method in the heating side circuit **10***d*.

DETAILED DESCRIPTION

[0017] In general, according to one embodiment, an air conditioning system includes a compressor, a condenser, an expansion valve, a switching valve, an evaporator, a pump, a radiator, and a heat storage unit. The compressor compresses a first heat medium taken therein. The compressor discharges the first heat medium. The condenser is provided on a discharge side of the compressor. The expansion valve is provided on the outflow side of the condenser. The switching valve which is provided on the outflow side of the expansion valve and which performs switching so that the first heat medium flows through either a first flow path or a second flow path. The evaporator is provided downstream of confluence position of the first flow path and the second flow path, on the intake side of the compressor. The pump supplies a second heat medium to the heat source. The radiator releases heat of the second heat medium supplied to the heat source. The heat storage unit has a heat storage material. The heat storage unit has a first heat exchange region in which heat is exchanged between the first heat medium flowing through the first flow path and the heat storage material. The heat storage unit has a second heat exchange region which is provided upstream of the radiator and in which heat is exchanged between the second heat medium supplied to the heat source and the heat storage material.

[0018] Embodiments of the invention will now be described with reference to the drawings. In the specification and the drawings of the application, components similar to those described in regard to a drawing thereinabove are marked with like reference numerals, and a detailed description is omitted as appropriate.

[0019] In the following, an air conditioning system installed in an Electric Vehicle (EV) or a fuel cell car (FCV) will be described as an example.

[0020] In addition, while there is a case where the state of a first heat medium is liquid, gas, or gas-liquid two-phase state, it may also be simply referred to as the first heat medium.

[0021] In addition, while there is a case where the state of a second heat medium is liquid or gas-liquid two-phase state, it may also be simply referred to as the second heat medium.

First Embodiment

[0022] FIG. **1** is a block diagram illustrating an air conditioning system according to a first embodiment.

[0023] As shown in FIG. **1**, an air conditioning system **1** is provided with a heat pump circuit **10** and a heat recovery circuit **30**.

[0024] The heat pump circuit **10** is provided with a cooling side circuit **10***a* and a heating side circuit **10***b*. The cooling side circuit **10***a* lowers the temperature of the air used for cooling inside the vehicle by absorbing heat from the air supplied into the vehicle.

[0025] The heating side circuit **10***b* raises the temperature of the air used for heating inside the vehicle by causing the air supplied into the vehicle to absorb heat.

[0026] First, the cooling side circuit **10***a* will be illustrated. The cooling side circuit **10***a* is provided with a compressor **11**, a switching valve **14**, a condenser **12**, an expansion valve **15**, an evaporator **17**, and a piping **22**.

[0027] The intake side of the compressor **11** has both the outflow side of the evaporator **17** and the outflow side of an evaporator **18** provided in the heating side circuit **10***b* connected thereto. The discharge side of the compressor **11** has the inflow side of the switching valve **14** connected thereto.

[0028] The compressor **11** compresses gas of the first heat medium supplied from the evaporator **17** and the evaporator **18**. The compressor **11** can be configured to compress, for example, gas of the first heat medium taken in from the intake side to thereby generate high-temperature, high-pressure gas of the first heat medium, and discharge the generated high-temperature and high-pressure gas of the first heat medium from the discharge side.

[0029] The outflow side of the switching valve **14** has both the inflow side of the condenser **12** and the inflow side of a condenser **13** provided in the heating side circuit **10***b* connected thereto.

[0030] The switching valve **14** switches the supply of the gas of the high-temperature and high-pressure first heat medium discharged from the compressor **11**, to either of the condenser **12** and the condenser **13**. The switching valve **14** can be set as, for example, a three-way valve which is provided with an electromagnetic coil and which switches the flow path by supplying or terminating power to the electromagnetic coil or the like.

[0031] The outflow side of the condenser **12** has the inflow side of the expansion valve **15** connected thereto.

[0032] The condenser **12**, having a blower fan (not shown), for example, can be configured to exchange heat between the air blown by the blower fan from outside the vehicle, and the high-temperature and high-pressure gas of the first heat medium discharged from the compressor **11**. The high-temperature and high-pressure gas of the first heat medium discharged from the compressor **11** is condensed by having its heat absorbed by the air blown from outside the vehicle.

[0033] The outflow side of the expansion valve **15** has the inflow side of the evaporator **17** connected thereto.

[0034] The expansion valve **15** adiabatically expands the first heat medium condensed by the condenser **12** to thereby reduce its pressure, and gasifies a part of the first heat medium to thereby be turned into the first heat medium in a gas-liquid two-phase state.

[0035] The outflow side of the evaporator **17** has the intake side of the compressor **11** connected thereto.

[0036] The evaporator **17** is provided inside a ventilation duct **21** having provided therein a blower fan **21***a* for supplying air into the vehicle. The evaporator **17** exchanges heat between the air blown by the blower fan **21***a* and the first heat medium in a gas-liquid two-phase state which has flown in from the expansion valve **15**. The first heat medium in a gas-liquid two-phase state turns into gas of the first heat medium by absorbing heat from the blown air and is supplied to the compressor **11**. In addition, the air having its heat absorbed by the evaporator **17** is supplied into the vehicle to be used for cooling inside the vehicle.

[0037] The piping **22** connects the components provided in the cooling side circuit **10***a* and serves as a flow path of the first heat medium.

[0038] Next, the heating side circuit **10***b* will be described.

[0039] The heating side circuit **10***b* is provided with the compressor **11**, the switching valve **14**, the condenser **13**, an expansion valve **16**, a heat storage unit **19**, the evaporator **18**, and pipings **22***a* to **23***c*.

[0040] The condenser **13** is provided on the discharge side of the compressor **11**. The outflow side of the condenser **13** has the inflow side of the expansion valve **16** connected thereto via the piping **23***a*.

[0041] The condenser **13** is provided inside the above-mentioned ventilation duct **21**.

[0042] The condenser **13** may be configured to exchange heat between the air blown by the blower fan **21***a* and the high-temperature and high-pressure gas of the first heat medium discharged from the compressor **11** via the switching valve **14**. The high-temperature and high-pressure gas of the first heat medium discharged from the compressor **11** is condensed by having its heat absorbed by the blown air. In addition, the air blown to the condenser **13** is heated by absorbing heat from the gas of the first heat medium, and the heated air is supplied into the vehicle to be used for heating inside the vehicle.

[0043] The expansion valve **16** is provided on the outflow side of the condenser **13**. The outflow side of the expansion valve **16** has the inflow side of the evaporator **18** connected thereto via the piping **23***c*.

[0044] The expansion valve **16** adiabatically expands the first heat medium condensed by the condenser **13**, to reduce its pressure, and gasifies a part of the first heat medium to thereby be turned into the first heat medium in a gas-liquid two-phase state.

[0045] The outflow side of the evaporator **18** has the intake side of the compressor **11** connected thereto via the piping **23***b*. The evaporator **18** is provided with, for example, a blower fan (not shown), and can be configured to exchange heat between the air blown by the blower fan from outside the vehicle and the first heat medium in a gas-liquid two-phase state which has flown in from the expansion valve **16** via the heat storage unit **19**. The first heat medium in a gas-liquid two-phase state turns into gas of the first heat medium by absorbing heat from the blown air and is supplied to the compressor **11**.

[0046] The heat storage unit **19** is provided between the expansion valve **16** and the evaporator **18**.

[0047] A heat storage material **24** is provided inside the heat storage unit **19** and stores the heat supplied from the heat recovery circuit **30**. In addition, the heat storage unit **19** supplies the heat stored in the heat storage material **24** to the first heat medium in a gas-liquid two-phase state, which is supplied to the evaporator **18** from the expansion valve **16**. Supplying, to the evaporator **18**, the first heat medium in a gas-liquid two-phase state which has been heated by supplying heat thereto can raise the temperature of the evaporator **18**. Accordingly, frost can be prevented from sticking to the evaporator **18** in cold areas. In addition, even when there is frost sticking to the evaporator **18** at the time of start-up, the frost can be removed. As a result, decrease of heating efficiency, damage of the evaporator, or the like can be suppressed.

[0048] Details about the heat storage unit **19** will be described below.

[0049] In addition, the first heat medium used for the cooling side circuit **10***a* and the heating side circuit **10***b* can be, for example, ammonia, hydrofluorocarbon (HFC), hydrochlorofluoro carbon (HCFC), or the like.

[0050] Next, the heat recovery circuit **30** will be illustrated.

[0051] The heat recovery circuit **30** is provided with a pump **34**, a radiator **33**, and a piping **32**.

[0052] The heat recovery circuit **30** cools a heat source **31** by absorbing heat of the heat source **31**, and stores heat in the heat storage unit **19** by supplying the absorbed heat to the heat storage unit **19**.

[0053] The intake side of pump **34** has the outflow side of the radiator **33** connected thereto. The heat source **31** is connected to the discharge side of the pump **34**.

[0054] The pump **34** supplies the second heat medium to the heat source **31**. In addition, the pump **34** circulates the second heat medium among the heat source **31**, the heat storage unit **19**, and the radiator **33**.

[0055] The radiator **33** releases the heat of the second heat medium supplied to the heat source **31**. The radiator **33** is provided with, for example, a blower fan (not shown), and can be configured to exchange heat between the air blown by the blower fan from outside the vehicle and the second heat medium which has flown in from the heat source **31** via the heat storage unit **19**.

[0056] The radiator **33**, for example, can be a radiator provided in an electric vehicle or a fuel-cell vehicle.

[0057] The second heat medium which has absorbed heat from the heat source **31** causes its heat to be absorbed by the heat storage unit **19**, and further causes its heat to be absorbed by the air from outside the vehicle, blown by the radiator **33**. Subsequently, the second heat medium which has been cooled by causing its heat to be absorbed is supplied to the heat source **31** and used for cooling the heat source **31**.

[0058] The piping **32** connects the pump **34**, the radiator **33**, the heat storage unit **19**, and the heat source **31**, and serves as a flow path of the second heat medium.

[0059] The heat source **31** can be configured to generate heat for the motor, inverter, fuel-cell stack or the like provided in a electric vehicle or a fuel-cell vehicle, for example.

[0060] The second heat medium can be water, for example.

[0061] Next, the heat storage unit **19** will be further illustrated.

[0062] FIG. **2** is a schematic view illustrating the heat storage unit. Here, FIG. **2**A is a schematic cross-sectional view illustrating the heat storage unit and FIG. **2**B is a cross-sectional view taken along the line between the arrows A-A' in FIG. **2**A.

[0063] FIG. **3** is a schematic graph illustrating a temporal change in the amount of heat of the second heat medium recovered from the heat source **31** (amount of heat recovered) when the vehicle is running.

[0064] FIG. **3** illustrates a case of a vehicle running at the 10-15 driving mode.

[0065] In addition, the temperature at the intake port and the outlet port of the second heat medium in the heat source **31** was measured by an experiment, and thus the amount of heat recovered was tried to be calculated from the difference between the temperatures at the outlet port and the intake port of the second heat medium.

[0066] As can be seen from FIG. **3**, the amount of heat generated in the heat source **31** varies with run time.

[0067] Here, the amount of heat exchange between the heat storage material **24** provided in the heat storage unit **19** and the first heat medium flowing inside the flow path **28** (heat absorption by the first heat medium from the heat storage material **24**) becomes larger as the difference of temperature is larger between the heat storage material **24** and the first heat medium. In this case, as shown in FIG. **3**, since the amount of heat generated from the heat source **31** varies depending on the running condition of the electric vehicle or fuel-cell vehicle, the temperature of the second heat medium flowing inside the flow path **29** also varies.

[0068] When, not via the heat storage material **24**, direct heat exchange is performed between the first heat medium flowing inside the flow path **28** and the second heat medium flowing inside the flow path **29**, it becomes difficult to supply heat to the first heat medium from the second heat medium when the amount of heat of the second heat medium is close to 0.

[0069] In contrast, when the temperature of the evaporator **18** (T_{ev2}) is not less than a predetermined lower limit (T_{min}), i.e, for example, it is not necessary to remove the frost sticking to the evaporator **18**, the heat absorbed by the second heat medium from the heat source **31** during a period during which heat exchange is not necessary is wasted because it is released from the radiator **33** to the outside.

[0070] Therefore, in the embodiment, the heat storage unit **19** having the heat storage material **24** is provided so that the heat generated in the heat source **31** during a period during which heat exchange is not necessary can be stored.

[0071] Providing the heat storage unit **19** causes the temperature of the evaporator **18** (T_{ev2}) to be less than a predetermined lower limit (T_{min}), and thus heat can be supplied from the heat storage material **24** to the first heat medium when it is necessary to cause the first heat medium to absorb the heat.

[0072] In addition, as described below, a latent heat storage material (phase-change heat storage material) is used as the heat storage material **24**, or a heat exchange region **26** (corresponding to an example of the first heat exchange region) in which the first heat medium and the heat storage material **24** exchange heat, and a heat exchange region **27** (corresponding to an example of the second heat exchange region) in which the second heat medium and the heat storage material **24** exchange heat are configured to be adjacent. Accordingly, since variation of the temperature of the second heat medium, if any, can be relaxed, the temperature of the heat storage material **24** can be maintained substantially constant. Therefore, the amount of heat exchanged at the time of heat exchange between the heat storage material **24** and the first heat medium can be maintained substantially constant, and thus it becomes possible to efficiently remove the frost sticking to the evaporator **18**.

[0073] When the amount of heat stored in the heat storage material **24** is less than the amount of heat which is necessary to be supplied to the first heat medium, a heating unit **191** (for example, a heater or the like) which heats the heat storage material **24** can be provided. In this case, heat from heating unit **191** is absorbed by the heat storage material **24**, and absorbed by the first heat medium in the heat exchange region **26**.

[0074] Next, returning to FIG. **2**, the heat storage unit **19** will be further described.

[0075] The heat storage unit **19** is provided with a casing **25**, the flow path **28**, the flow path **29**, the heat storage material **24**, and a nucleation unit **300**.

[0076] Furthermore, the heat storage unit **19** has the heat exchange region **26** which exchanges heat between the first heat medium flowing through the flow path **28** and the heat storage material **24**, and a heat exchange region **27** which is provided upstream of the radiator **33** and which exchanges heat between the second heat medium supplied to the heat source **31** and the heat storage material **24**.

[0077] The heat exchange region **27** is provided closer to the center of the heat storage unit **19** than the heat exchange region **26**.

[0078] The casing **25** has the flow path **28**, the flow path **29**, the heat storage material **24**, and nucleation unit **300** housed therein.

[0079] The inner wall of the casing **25** has a concave portion **301** provided thereon. The concave portion **301** will be described below.

[0080] The flow path **28** is formed of a tubular member. The flow path **28** has an annulus part **28***a* and a joint **28***b* connected to the annulus part **28***a*. The annulus part **28***a* is provided on the heat exchange region **26** located on the inner wall side of the casing **25**. The annulus part **28***a* is provided in the vicinity of one end of the casing **25**. The piping **23***c* is connected to an end on the side opposite to the side connected to the annulus part **28***a* of the joint **28***b*. Accordingly, the first heat medium can flow inside the flow path **28**. In addition, a plurality of the annulus part **28***a* can be provided.

[0081] The flow path **29** is formed of a tubular member. The flow path **29** has a spiral part **29***a* and joints **29***b* provided at both ends of the spiral part **29***a*.

[0082] The spiral part **29***a* is provided in the heat exchange region **27** provided inside the heat exchange region **26**. The joint **29***b* has the piping **32** connected thereto. Accordingly, the second heat medium can flow inside the flow path **29**.

[0083] In the heat storage unit **19** according to the embodiment, the flow path **29** through which the second heat medium having a high temperature flows is provided on the center side of the heat storage unit **19**, and the flow path **28** through which the first heat medium having a temperature lower than the temperature of the second heat medium flows is provided on the inner wall side of the heat storage unit **19**.

[0084] In this case, on the assumption that the flow path **29** through which the high-temperature second heat medium flows is provided on the inner wall side of the heat storage unit **19**, heat dissipation becomes larger. In contrast to this, on the assumption that the flow path **29** through which the high-temperature second heat medium flows is provided on the center side of the heat storage unit **19**, the distance to the surface of the casing **25** can be increased, and thus heat dissipation can be suppressed.

[0085] In addition, the ability (heat output) required when releasing heat to the first heat medium is generally higher than the ability required when storing the heat from the second heat medium. Therefore, it is preferred to increase the amount of heat exchanged between the heat storage material **24** and the first heat medium, by making the length of the flow path **28** through which the first heat medium flows longer. In this case, since the flow path **28** through which the first heat medium flows is provided on the inner wall side of the casing **25**, it becomes easy to make the length of the flow path **28** longer.

[0086] Accordingly, assuming the above-mentioned arrangement of the flow path **28** and the flow path **29**, the efficiency of heat exchange can be improved.

[0087] For the heat storage material **24**, a material having a heat-storing density higher than the second heat medium can be used. The heat storage material **24** can be, for example, a latent heat storage material. As the latent heat storage material, an inorganic hydrate material (sodium acetate hydrate or sodium sulphate hydrate), an organic material (paraffin or erythritol), for example, can be exemplified. The heat storage material **24** liquefies when the temperature is higher than the melting point of the material to be formed, and solidifies when the temperature is lower than the melting point. In this case, a large amount of heat is absorbed or released at the melting point (phase-change temperature) at which phase-change occurs.

[0088] In addition, some latent heat storage materials may be capable of supercooling. A latent heat storage material capable of supercooling maintains a liquid state without solidification even when it the temperature is lower than the melting point. Furthermore, an external stimulation (for example, mechanical nucleation, electric nucleation, etc.) or addition of a crystalline nucleus can release supercooling and cause solidification to occur. In this case, heat can be released from the latent heat storage material by releasing supercooling and causing solidification to occur.

[0089] As a latent heat storage material capable of supercooling, sodium acetate trihydrate or the like can be exemplified. On the assumption that a latent heat storage material capable of supercooling is used, supercooling can be stably maintained also in a subfreezing environment. Moreover, on the assumption that a latent heat storage material capable of supercooling is used, heat can be stored for a long time. Therefore, even when heating is started from a state in which the latent heat storage material is left in a low temperature environment in winter for a long time, frost sticking to the evaporator **18** can be removed. In addition, on the assumption that a latent heat storage material capable of supercooling is used, it becomes possible to release heat at a desired time by external stimulation or the like. Accordingly, it becomes possible, for example, to remove the frost sticking to the evaporator **18** at a fixed time interval, or remove the frost sticking to the evaporator **18** when needed.

[0090] Inside the casing **25** having housed the flow path **28**, the flow path **29**, and the nucleation unit **300** is filled with the heat storage material **24**. In this case, the flow path **28** is in contact with the heat storage material **24** located in the heat exchange region **26**. The flow path **29** contacts the heat storage material **24** located in the heat exchange region **27**. Therefore, the flow path **28** and the flow path **29** do not directly contact each other.

[0091] The second heat medium having absorbed heat by passing through the heat source **31** when the heat source **31** is generating heat, exchanges heat with the heat storage material **24** in the heat exchange region **27** of the heat storage unit **19**, and the heat storage material **24** absorbs heat (stores heat). In this case, the amount of heat that can be absorbed from the second heat medium by the heat storage material **24** decreases when the melting point of the heat storage material **24** is high. In contrast, the amount of heat that can be absorbed from the heat storage material **24** by the first heat medium increases.

[0092] In this case, after having preliminarily determined, from the relation between the temperature of the second heat medium and the temperature of the first heat medium, the amount of heat to be absorbed by the heat storage material **24** from the second heat medium, a material of the heat storage material **24** having a melting point satisfying the amount of heat can be selected.

[0093] In addition, when heat exceeding the amount that can be stored in latent heat is supplied from the second heat medium to the heat storage material **24**, the temperature of the heat storage material **24** rises higher than the melting point, and heat is stored by sensible heat.

[0094] In addition, when the temperature of the heat storage material **24** has risen higher than a predetermined value, the temperature of the heat storage material **24** can be prevented from becoming higher than the predetermined value by cooling the second heat medium by the radiator **33** provided in the heat recovery circuit **30**.

[0095] The nucleation unit **300** is provided inside the heat storage unit **19** and causes the heat storage material **24** to nucleate. The nucleation unit **300** can be provided in a case where a latent heat storage material capable of supercooling is used as the heat storage material **24**. As the nucleation unit **300**, for example, an electrode which applies voltage to the heat storage material **24**, or the like can be exemplified. When heat is desired to be absorbed from the heat storage material **24** into the first heat medium, i.e., for example, when the frost sticking to the evaporator **18** is removed, the nucleation unit **300** may apply a voltage to the heat storage material **24**. When a voltage is applied to the heat storage material **24** by the nucleation unit **300**, the heat storage material **24** is nucleated with the heat storage material **24** in the vicinity of the nucleation unit **300** being the starting point. Nucleation of the heat storage material **24** releases supercooling, and thus heat is released from the heat storage material **24**.

[0096] Providing the nucleation unit **300** also makes it possible to release heat from the heat storage material **24** at a desired time. Accordingly, it becomes possible, for example, to remove the frost sticking to the evaporator **18** at a fixed time interval, or remove the frost sticking to the evaporator **18** when needed.

[0097] The inner wall of the casing **25** is provided with a concave portion **301**, and the concave portion **301** is provided above the nucleation unit **300**. For example, the nucleation unit **300** is provided downward in the gravity direction, inside the heat storage unit **19**. In addition, the concave portion **301** is provided upward in the gravity direction, on the inner wall of the casing **25**. When the heat storage material **24** is nucleated, the heat storage material **24** is subject to phase change from liquid to solid, and on this occasion, change of volume (density) occurs. In the embodiment, nucleation is caused from the lower side of the heat storage unit **19**, by providing the nucleation unit **300** downward in the gravity direction. Then, the volume change having occurred by causing the heat storage unit **19** to nucleate from the lower side is absorbed by the concave portion **301** provided upward in the gravity direction of the heat storage unit **19**.

[0098] FIG. **4** is a schematic view illustrating the heat storage unit according to another embodiment. Here, FIG. **4**A is a schematic cross-sectional view illustrating the heat storage unit and FIG. **4**B is a cross-sectional view taken along the line between the arrows B-B' in FIG. **4**A.

[0099] As shown in FIG. **4**, the heat storage unit **19***a* is provided with the casing **25**, a flow path **128**, the flow path **29**, the heat storage material **24**, and the nucleation unit **300**.

[0100] The flow path **128** is formed of a tubular member. The flow path **128** has a spiral part **128***a* and joints **128***b* provided at both ends of the spiral part **128***a*.

[0101] The spiral part **128***a* is provided in the heat exchange region **26**. The joint **128***b* has the piping **32** connected thereto. Accordingly, the first heat medium can flow inside the flow path **128**.

[0102] The heat storage unit **19***a* according to the embodiment can obtain a function and effect similar to the above-mentioned heat storage unit **19**. In addition, the spiral part **128***a* being spiral-shaped can make circulation of the first heat medium smooth.

[0103] The form of the flow path provided in the heat storage unit is not limited to one which has been illustrated. For example, the flow path provided in the heat storage unit can be formed of a tubular member in a meandering manner.

[0104] Next, an operation method of the air conditioning system **1** will be illustrated.

(Cooling Operation)

[0105] FIG. **5** is a flowchart illustrating an operation method of the cooling side circuit **10***a*. When instructed to perform cooling inside the vehicle (step S**01**), the outflow side of the compressor **11** and the piping **22** are connected (step S**02**) by performing switching by the switching valve **14**. Subsequently, by driving the compressor **11**, the first heat medium is caused to circulate in the cooling side circuit **10***a* (step S**03**).

[0106] In this case, after having released heat to the outside of the vehicle in the condenser **12**, the first heat medium which has been compressed in the compressor **11** is expanded in the expansion valve **15** and draws heat from the air in the evaporator **17**. When the blower fan **21***a* operates, the air having heat drawn in the evaporator **17** is supplied into the vehicle. In this manner, cooling operation is performed.

(Heating Operation)

[0107] When instructed to perform heating, the outflow side of the compressor **11** and the piping **23***a* are connected by performing switching by the switching valve **14**. Subsequently, by driving the compressor **11**, the first heat medium is caused to circulate in the heating side circuit **10***b*.

[0108] In this case, the first heat medium which has been compressed in the compressor **11** is condensed in the condenser **13**, and causes the air supplied by the blower fan **21***a* to absorb the condensation heat. Subsequently, the first heat medium is expanded in the expansion valve **16**, circulates in the heating side circuit **10***b* by passing through the heat storage unit **19** and the evaporator **18**, and returning to the compressor **11** again.

[0109] The heat storage unit **19** is filled with the heat storage material **24** having a melting point higher than the temperature of the inflowing first heat medium.

[0110] Since a large amount of heat is generated in the heat source **31**, the heat can be recovered in the heat recovery circuit **30**. Then, by causing the first heat medium to absorb the recovered heat via the heat storage unit **19**, a part of the first heat medium can be vaporized. Accordingly, in the heat storage unit **19**, by vaporizing a part of the first heat medium, evaporation in the evaporator **18** can be assisted. As a result, it becomes possible to reduce power consumption in the evaporator **18**.

[0111] In addition, it is also possible to release heat from the heat storage material **24** by the above-mentioned nucleation unit **300** at a desired time. Accordingly, it is possible, for example, to remove the frost sticking to the evaporator **18** at a fixed time interval, or remove the frost sticking to the evaporator **18** when needed.

[0112] In contrast, in the heat recovery circuit **30**, the heat generated by the heat source **31** is absorbed by the heat storage unit **19**, and thus the amount of heat to be released by the radiator **33** is reduced. Therefore, it becomes possible to reduce power consumption for releasing heat in the radiator **33**.

[0113] Since functions of respective components for cooling and heating operations are similar to that mentioned above, detailed description thereof is omitted.

Second Embodiment

[0114] FIG. **6** is a block diagram illustrating an air conditioning system according to a second embodiment.

[0115] As shown in FIG. **6**, an air conditioning system **50** is provided with a heat pump circuit **51** and the heat recovery circuit **30**.

[0116] The heat pump circuit **51** is provided with the cooling side circuit **10***a* and a heating side circuit **10***c*. The cooling side circuit **10***a* lowers the temperature of the air used for cooling inside the vehicle by absorbing heat from the air supplied into the vehicle.

[0117] The heating side circuit **10***c* raises the temperature of the air used for heating inside the vehicle by causing the air supplied into the vehicle to absorb heat.

[0118] The heating side circuit **10***c* is provided with the compressor **11**, the switching valve **14**, the condenser **13**, the expansion valve **16**, a switching valve **20**, the heat storage unit **19**, the evaporator **18**, the pipings **23***a*, **23***b*, **23***c* (corresponding to an example of the first flow path), and **23***d* (corresponding to an example of the second flow path), and a temperature measuring unit **18***a* (corresponding to an example of the first temperature measuring unit).

[0119] One outflow side of the switching valve **20** has the inflow side of the heat storage unit **19** connected thereto via the piping **23***c*. The other outflow side of the switching valve **20** has the inflow side of the evaporator **18** connected thereto via the piping **23***d*. The inflow side of the switching valve **20** has the outflow side of the expansion valve **16** connected thereto via the piping **23***a*.

[0120] The switching valve **20** is provided on the outflow side of the expansion valve **16**, and switches between the piping **23***c* and the piping **23***d* so that the first heat medium in a gas-liquid two-phase state which has flown out from the expansion valve **16** flows into any of the piping **23***c* and the piping **23***d*. The switching valve **20** can be, for example, a three-way valve which is provided with an electromagnetic coil and which switches the flow path by supplying or terminating power to the electromagnetic coil. However, the switching valve **20** is not limited to a three-way valve, and may be, for example, an on-off valve provided to both the piping **23***c* and the piping **23***d*.

[0121] The evaporator **18** is provided downstream of the confluence point of the piping **23***c* and the piping **23***d*, on the intake side of the compressor **11**.

[0122] The temperature measuring unit **18***a* measures the temperature of the evaporator **18**. The switching valve **20** performs switching, based on the temperature of the evaporator **18** measured by the temperature measuring unit **18***a*, so that the first heat medium flows through either the piping **23***c* or the piping **23***d*.

[0123] In the embodiment, the heat storage unit **19** can be selectively used by switching the flow of the first heat medium by the switching valve **20**. Therefore, when the above-mentioned nucleation unit **300** is not provided, i.e., for example, even when latent heat storage material is not used as the heat storage material **24**, it is possible to cause the first heat medium to absorb heat in the heat storage unit **19** at a desired time. Accordingly, it becomes possible, for example, to remove the frost sticking to the evaporator **18** at a fixed interval, or to remove the frost sticking to the evaporator **18** when needed.

[0124] Controlling the switching by the switching valve **20** based on the measurement result by the temperature measuring unit **18***a* will be described below.

[0125] Operation by the driver or the like also makes it possible to perform switching by the switching valve **20**.

[0126] Next, an operation method of the air conditioning system **50** will be illustrated.

[0127] Since the cooling operation may be configured to be similar to the operation method in the cooling side circuit **10***a* illustrated in FIG. **5**, description thereof is omitted.

(Heating Operation)

[0128] In the following, as an example, a case of controlling the switching by the switching valve **20** based on the measurement result by the temperature measuring unit **18***a* will be illustrated.

[0129] FIG. **7** is a flowchart illustrating an operation method in the heating side circuit **10***c*.

[0130] When instructed to perform heating inside the vehicle (step S**11**), the inflow side of the condenser **13** and the outflow side of the compressor **11** are connected by performing switching by the switching valve **14** (step S**12**).

[0131] Next, the temperature of the evaporator **18** (T_{ev2}) is measured by the temperature measuring unit **18***a* (step S**13**). The measured temperature of the evaporator **18** can be converted into the temperature of the first heat medium flowing inside the evaporator **18**. In this case, by preliminarily obtaining the relation between the temperature of the evaporator **18** and the temperature of the first heat medium flowing inside the evaporator **18** from an experiment or the like, temperature conversion can be performed based on the obtained relation.

[0132] When the measured temperature of the evaporator **18** is higher than a predetermined value, the switching valve **20** performs switching so that the first heat medium flows through the piping **23***d*.

[0133] For example, when the temperature of the evaporator **18** (T_{ev2}) is not less than the predetermined lower limit (T_{min}), inflow of the first heat medium into the heat storage unit **19** side is blocked by the switching valve **20** (steps S**14** and S**15***a*).

[0134] Subsequently, by driving the compressor **11**, the first heat medium is caused to circulate through a predetermined path in the heating side circuit **10***c* (step S**16**). That is, the first heat medium is caused to circulate in the compressor **11**, the switching valve **14**, the condenser **13**, the expansion valve **16**, the switching valve **20**, and the evaporator **18**.

[0135] In this case, the air blown to the condenser **13** is heated by absorbing heat from the gas of the first heat medium, and the heated air is supplied into the vehicle to be used for heating inside the vehicle.

[0136] In addition, since the heat stored in the heat storage material **24** in the heat storage unit **19** is not absorbed by the first heat medium, the heat from the heat recovery circuit **30** can be stored in the heat storage material **24**.

[0137] In contrast, when the measured temperature of the evaporator **18** is lower than the predetermined value, switching is performed so that the first heat medium flows through the piping **23***c*.

[0138] For example, when the temperature of the evaporator **18** (T_{ev2}) is lower than the predetermined lower limit (T_{min}), inflow of the first heat medium into the heat storage unit **19** side is carried out by the switching valve **20** (steps S**14** and S**15***b*).

[0139] Subsequently, by driving the compressor **11**, the first heat medium is caused to circulate through a predetermined path in the heating side circuit **10***c* (step S**16**). That is, the first heat medium is caused to circulate in the compressor

11, the switching valve **14**, the condenser **13**, the expansion valve **16**, the switching valve **20**, the heat storage unit **19**, and the evaporator **18**.

[0140] Also in this case, the air blown to the condenser **13** is heated by absorbing heat from the gas of the first heat medium, and the heated air is supplied into the vehicle to be used for heating inside the vehicle.

[0141] Here, under a low-temperature and high-humidity environment such as in cold areas, freezing of moisture in the air may cause frost to stick to the evaporator **18**. Since frost sticking to the evaporator **18** decreases the heat exchange efficiency (ability of vaporizing the first heat medium) in the evaporator **18**, heating performance may significantly degrade.

[0142] Therefore, the embodiment is configured to determine whether or not frost is sticking by measuring the temperature of the evaporator **18** (T_{ev2}) by the temperature measuring unit **18***a* provided in the evaporator **18**.

[0143] For example, when the temperature of the evaporator **18** (T_{ev2}) is lower than the predetermined lower limit (T_{min}), it is determined that frost is sticking, and the first heat medium is caused to flow into the heat storage unit **19** side. As described above, the first heat medium which has flown into the flow path **28** of the heat storage unit **19** absorbs heat from the heat storage material **24**. Therefore, load on the evaporator **18** is reduced, and thus the amount of sticking frost can be reduced. In addition, a heater may be provided in the evaporator **18**.

[0144] Furthermore, a latent heat storage material capable of supercooling is used as the heat storage material **24**, and when the latent heat storage material is in a supercooled state, supercooling is released by the nucleation unit **300** after it has been determined that the temperature of the evaporator **18** (T_{ev2}) is lower than the predetermined lower limit (T_{min}). Accordingly, even when the period from storing heat in the heat storage material **24** to releasing the heat is long, heat at the melting point can be released from the heat storage material **24**, and thus the first heat medium can absorb sufficient heat.

Third Embodiment

[0145] FIG. **8** is a block diagram illustrating an air conditioning system according to a third embodiment.

[0146] As shown in FIG. **8**, the air conditioning system **100** is provided with the heat pump circuit **101** and the heat recovery circuit **30**.

[0147] The heat pump circuit **101** is provided with the cooling side circuit **10***a* and the heating side circuit **10***d*.

[0148] The cooling side circuit **10***a* lowers the temperature of the air used for cooling inside the vehicle drop by absorbing heat from the air supplied into the vehicle.

[0149] The heating side circuit **10***d* raises the temperature of the air used for heating inside the vehicle by causing the air supplied into the vehicle to absorb heat.

[0150] The heating side circuit **10***d* is provided with the compressor **11**, the switching valve **14**, the condenser **13**, the expansion valve **16**, the switching valve **20**, the heat storage unit **190**, the evaporator **18**, the pipings **22***a* to **23***d*, the temperature measuring unit **18***a*, and a temperature measuring unit **11***a* (corresponding to an example of the second temperature measuring unit).

[0151] One outflow side of the switching valve **20** has the inflow side of the heat storage unit **190** connected thereto via the piping **23***c*. The other outflow side of the switching valve **20** had the inflow side of the evaporator **18** connected thereto via the piping **23***d*. The inflow side of the switching valve **20** has the outflow side of the expansion valve **16** connected thereto via the piping **23***a*.

[0152] The switching valve **20** switches the supply of the first heat medium in a gas-liquid two-phase state, flown out from the expansion valve **16**, to either of the heat storage unit **190** and the evaporator **18**.

[0153] The temperature measuring unit **11***a* measures the temperature of the compressor **11**.

[0154] The switching valve **20** performs switching, based on the temperature of the compressor **11** measured by the temperature measuring unit **11***a*, so that the first heat medium flows through either the piping **23***c* or the piping **23***d*. In addition, the switching valve **20** performs switching, based on the temperature of the compressor **11** measured by the temperature measuring unit **11***a* and the temperature of the evaporator **18** measured by the temperature measuring unit **18***a*, so that the first heat medium flows through either the piping **23***c* or the piping **23***d*.

[0155] Also in the air conditioning system **100** according to the embodiment, the heat storage unit **190** can be selectively used by switching the flow of the first heat medium by the switching valve **20**.

[0156] Controlling the switching by the switching valve **20** based on the measurement result by the temperature measuring unit **11***a* and the temperature measuring unit **18***a* will be described below.

[0157] Operation by the driver or the like also makes it possible to perform switching by the switching valve **20**.

[0158] Next, the heat storage unit **190** will be further illustrated.

[0159] FIG. **9** is a schematic view illustrating the heat storage unit. FIG. **9**A is a schematic cross-sectional view illustrating the heat storage unit and FIG. **9**B is a cross-sectional view taken along the line between the arrows C-C' in FIG. **9**A.

[0160] As shown in FIG. **9**, the heat storage unit **190** is provided with the casing **25**, the flow path **128**, a flow path **129**, the heat storage material **24**, the nucleation unit **300**, and the temperature measuring unit **11***a*.

[0161] The flow path **129** is formed of a tubular member. The flow path **129** has a spiral part **129***a* and joints **129***b* provided at both ends of the spiral part **129***a*.

[0162] The spiral part **129***a* is provided in the heat exchange region **27** provided inside the heat exchange region **26**. The joint **129***b* has the piping **32** connected thereto. Accordingly, the second heat medium can flow inside the flow path **129**.

[0163] The compressor **11** is thermally connected to the heat storage unit **190**.

[0164] With regard to that illustrated in FIG. **9**, the compressor **11** is provided in a manner penetrating the center of the casing **25**, and the heat storage material **24** and the casing **25** contact the outer face of the compressor **11**. Then, the outer periphery side of the compressor **11** inside the casing **25** becomes the heat exchange region **27**.

[0165] Since the compressor **11** generates heat when the compressor **11** is operated, the compressor **11** also serves as the heat source. Therefore, in the heat storage unit **190**, heat generated from the compressor **11** can also be stored in the heat storage material **24**.

[0166] In this case, when the temperature of the heat storage material **24** is lower than the temperature of the compressor **11**, heat from the compressor **11** is absorbed (stored), via the casing **25** or directly, in the heat storage material **24**. In contrast, when the temperature of the heat storage material **24** is higher than the temperature of the compressor **11**, heat from the heat storage material **24** will be absorbed by the compressor **11**.

[0167] Next, an operation method of the air conditioning system **100** will be illustrated.

[0168] Since the cooling operation can be configured to be similar to the operation method in the cooling side circuit **10***a* illustrated in FIG. **5**, description thereof is omitted.

(Heating Operation)

[0169] In the following, as an example, a case of controlling the switching by the switching valve **20** based on the measurement result by the temperature measuring unit **11***a* and the temperature measuring unit **18***a* will be illustrated.

[0170] FIG. **10** is a flowchart illustrating an operation method in the heating side circuit **10***d*.

[0171] When instructed to perform heating inside the vehicle (step S**31**), the inflow side of the condenser **13** and the outflow side of the compressor **11** are connected by performing switching by the switching valve **14** (step S**32**).

[0172] Next, the temperature of the compressor **11** (T_{comp}) is measured by the temperature measuring unit **11***a* (step S**33**).

[0173] When the measured temperature of the compressor **11** is lower than a predetermined value, the switching valve **20** performs switching so that the first heat medium flows through the piping **23***d*.

[0174] For example, when the temperature of the compressor **11** (T_{comp}) is lower than a predetermined lower limit (T_{comp_min}), inflow of the first heat medium into the heat storage unit **190** side is blocked by the switching valve **20** (steps S**34** and S**37**).

[0175] In this case, by driving the compressor **11** (step S**39**), the first heat medium is caused to circulate through a predetermined path in the heating side circuit **10***d*. That is, the first heat medium is caused to circulate in the compressor **11**, the switching valve **14**, the condenser **13**, the expansion valve **16**, the switching valve **20**, and the evaporator **18**.

[0176] In this case, the air blown to the condenser **13** is heated by absorbing heat from the gas of the first heat medium, and the heated air is supplied into the vehicle to be used for heating inside the vehicle.

[0177] In addition, since the heat stored in the heat storage material **24** in the heat storage unit **190** is not absorbed by the first heat medium, the heat from the heat recovery circuit **30** can be stored in the heat storage material **24**.

[0178] In addition, a latent heat storage material capable of supercooling is used as the heat storage material **24** and, when the latent heat storage material is in a supercooled state, supercooling is released by the nucleation unit **300** after it has been determined that the temperature of the compressor **11** (T_{comp}) is lower than the predetermined lower limit (T_{comp_min}). Accordingly, the heat stored in the heat storage material **24** can be absorbed by the compressor **11**.

[0179] When the temperature of the compressor **11** is low, there is a risk in which the heat may escape from the gas of the compressed, high-temperature first heat medium to the compressor **11**, resulting in a reduced heating performance.

[0180] Therefore, for example, when it is determined that the temperature of the compressor **11** (T_{comp}) is lower than the predetermined lower limit (T_{comp_min}), heat is provided from the heat storage tank **190** to the compressor **11**, and thus escape of heat from the compressor **11** is suppressed.

[0181] In contrast, for example, when the temperature of the compressor (T_{comp}) is not less than the predetermined lower limit (T_{comp_min}), the temperature of the evaporator **18** (T_{ev2}) is measured by the temperature measuring unit **18***a* (steps S**34** and S**35**).

[0182] When, for example, the temperature of the evaporator **18** (T_{ev2}) is not less than the predetermined lower limit (T_{min}), inflow of the first heat medium into the heat storage unit **190** side is blocked by the switching valve **20** (steps S**36** and S**37**).

[0183] In this case, by driving the compressor **11** (step S**39**), the first heat medium is caused to circulate through a predetermined path in the heating side circuit **10***d*. That is, the first heat medium is caused to circulate in the compressor **11**, the switching valve **14**, the condenser **13**, the expansion valve **16**, the switching valve **20**, and the evaporator **18**.

[0184] For example, when the temperature of the compressor **11** (T_{comp}) is not less than the predetermined lower limit (T_{comp_min}) and the temperature of the evaporator **18** (T_{ev2}) is not less than the predetermined lower limit (T_{min}), heat from the compressor **11** and heat from the heat recovery circuit **30** are stored in the heat storage material **24**. In this case, since inflow of the first heat medium into the heat storage unit **190** side is blocked by the switching valve **20**, the heat stored in the heat storage material **24** is not absorbed by the first heat medium.

[0185] In contrast to this, for example, when the temperature of the evaporator **18** (T_{ev2}) is lower than the predetermined lower limit (T_{min}), inflow of the first heat medium into the heat storage unit **190** side is caused by the switching valve **20** (steps S**36** and S**38**).

[0186] In this case, by driving the compressor **11** (step S**39**), the first heat medium is caused to circulate through a predetermined path in the heating side circuit **10***d*. That is, the first heat medium is caused to circulate in the compressor **11**, the switching valve **14**, the condenser **13**, the expansion valve **16**, the switching valve **20**, the heat storage unit **190**, and the evaporator **18**.

[0187] For example, when the temperature of the compressor **11** (T_{comp}) is not less than the predetermined lower limit (T_{comp_min}) and the temperature of the evaporator **18** (T_{ev2}) is lower than the predetermined lower limit (T_{min}), inflow of the first heat medium into the heat storage unit **190** side is caused by the switching valve **20**. The first heat medium having flown into the flow path **128** of the heat storage unit **190** absorbs the heat from the heat storage material **24**. Accordingly, load on the evaporator **18** is reduced, and thus the amount of sticking frost can be reduced. A heater may be provided in the evaporator **18**.

[0188] In addition, a latent heat storage material capable of supercooling is used as the heat storage material **24** and, when the latent heat storage material is in a supercooled state, supercooling is released by the nucleation unit **300** after it has been determined that the temperature of the compressor **11** (T_{comp}) is not less than the predetermined lower limit (T_{comp_min}) and the temperature of the evaporator **18** (T_{ev2}) is lower than the predetermined lower limit (T_{min}). Accordingly, even when the period from storing heat in the heat storage material **24** to releasing the heat is long, heat at the melting point can be released from the heat storage material **24**, and thus the first heat medium can absorb sufficient heat.

[0189] In the embodiment, when the temperature of the compressor **11** and the temperature of the second heat medium are higher than the temperature of the heat storage material **24**, the heat storage material **24** absorbs heat from the compressor **11** and the second heat medium.

[0190] In contrast to this, when the temperature of the compressor **11** or the temperature of the first heat medium is low, the compressor **11** or the first heat medium absorbs heat from the heat storage material **24**.

[0191] Therefore, in an electric vehicle or a fuel-cell vehicle, since heat can be used more efficiently inside the vehicle, power consumption when operating the air conditioning system can be further suppressed.

[0192] According to the embodiment illustrated above, an air conditioning system capable of reducing power consumption can be realized.

[0193] While certain embodiments have been described, these embodiments have been presented by way of example only, and are not intended to limit the scope of the inventions. Indeed, the novel embodiments described herein may be embodied in a variety of other forms; furthermore, various omissions, substitutions and changes in the form of the embodiments described herein may be made without departing from the spirit of the inventions. The accompanying claims and their equivalents are intended to cover such forms or modifications as would fall within the scope and spirit of the invention. Moreover, above-mentioned embodiments can be combined mutually and can be carried out.

What is claimed is:

1. An air conditioning system comprising:

a compressor which compresses and discharges a first heat medium taken therein;

a condenser provided on a discharge side of the compressor;

an expansion valve provided on the outflow side of the condenser;

a switching valve which is provided on the outflow side of the expansion valve and which performs switching so that the first heat medium flows through either a first flow path or a second flow path;

an evaporator provided downstream of confluence position of the first flow path and the second flow path, on the intake side of the compressor;

a pump which supplies a second heat medium to the heat source;

a radiator which releases heat of the second heat medium supplied to the heat source; and

a heat storage unit having a heat storage material, wherein

the heat storage unit has

a first heat exchange region in which heat is exchanged between the first heat medium flowing through the first flow path and the heat storage material, and

a second heat exchange region which is provided upstream of the radiator and in which heat is exchanged between the second heat medium supplied to the heat source and the heat storage material.

2. The system according to claim **1**, wherein the first flow path connects one outflow side of the switching valve and the evaporator via the heat storage unit, and the second flow path connects the other outflow side of the switching valve and the evaporator.

3. The system according to claim **1**, wherein the second heat exchange region is provided closer to a center of the heat storage unit than the first heat exchange region.

4. The system according to claim **1**, wherein the heat storage unit has a cylindrical shape, the first heat exchange region is provided on a side of an inner wall of the cylindrical heat storage unit, and the second heat exchange region is provided on a side of a center of the cylindrical heat storage unit.

5. The system according to claim **1** further comprising a first temperature measuring unit which measures temperature of the evaporator, wherein the switching valve performs switching, based on the measured temperature of the evaporator, so that the first heat medium flows through either the first flow path or the second flow path.

6. The system according to claim **1**, wherein

the switching valve performs switching so that the first heat medium flows through the second flow path when the measured temperature of the evaporator is higher than a predetermined value, and

the switching valve performs switching so that the first heat medium flows through the first flow path when the measured temperature of the evaporator is lower than a predetermined value.

7. The system according to claim **1**, wherein the compressor is thermally connected to the heat storage unit.

8. The system according to claim **7**, further comprising a second temperature measuring unit which measures temperature of the compressor, wherein the switching valve performs switching, based on the measured temperature of the compressor, so that the first heat medium flows through either the first flow path or the second flow path.

9. The system according to claim **8**, wherein the switching valve performs switching so that the first heat medium flows through the second flow path when the measured temperature of the compressor is lower than a predetermined value.

10. The system according to claim **1**, further comprising a nucleation unit which is provided inside the heat storage unit and causes the heat storage material to nucleate.

11. The system according to claim **1**, wherein the heat storage material is a latent heat storage material.

12. The system according to claim **11**, wherein the latent heat storage material includes at least one type selected from the group consisting of sodium acetate hydrate, sodium sulphate hydrate, paraffin, erythritol, and sodium acetate trihydrate.

13. The system according to claim **9**, further comprising a first temperature measuring unit which measures temperature of the evaporator, wherein

the heat storage material is a latent heat storage material capable of supercooling, and

when the heat storage material is in a supercooled state, and the measured temperature of the evaporator is lower than a predetermined value,

the nucleation unit releases the supercooled state of the heat storage material.

14. The system according to claim **9**, wherein the nucleation unit is an electrode which applies a voltage to the heat storage material.

15. The system according to claim **9**, wherein the nucleation unit causes the heat storage material to nucleate at a fixed time interval.

16. The system according to claim **10**, wherein

the nucleation unit is provided downward in the gravity direction inside the casing.

17. The system according to claim **1**, further comprising a heating unit which heats the heat storage material.

18. An air conditioning system comprising:

a compressor which compresses and discharges a first heat medium taken therein;

a condenser provided on a discharge side of a discharge side of the compressor;

an expansion valve provided on the outflow side of the condenser;

an evaporator provided on the outflow side of the expansion valve, and also on the intake side of the compressor;

a pump which supplies a second heat medium to the heat source;

a radiator which releases heat of the second heat medium supplied to the heat source; and

a heat storage unit having a heat storage material, wherein the heat storage unit has

a first heat exchange region which is provided upstream of the evaporator and in which heat is exchanged between the first heat medium and the heat storage material, and

a second heat exchange region which is provided upstream of the radiator and in which heat is exchanged between the second heat medium supplied to the heat source and the heat storage material.

19. The system according to claim **18**, wherein the second heat exchange region is provided closer to the center of the heat storage unit than the first heat exchange region.

20. The system according to claim **18**, wherein the heat second exchange region is provided adjacent to the first heat exchange region.

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