



EUROPEAN PATENT APPLICATION

(43) Date of publication:
01.09.2021 Bulletin 2021/35

(51) Int Cl.:
F25B 49/00 (2006.01) F25B 49/02 (2006.01)

(21) Application number: **21158549.2**

(22) Date of filing: **22.02.2021**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(72) Inventors:
• **SHIGETA, Akihiro**
Osaka-shi, Osaka 540-6207 (JP)
• **HASHIMOTO, Shunichi**
Osaka-shi, Osaka 540-6207 (JP)
• **MAEKAWA, Naoki**
Osaka-shi, Osaka 540-6207 (JP)

(30) Priority: **25.02.2020 JP 2020029489**

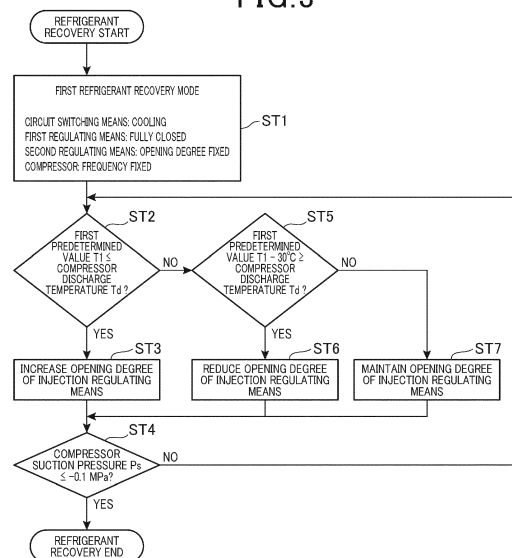
(71) Applicant: **Panasonic Intellectual Property Management Co., Ltd.**
Osaka-shi, Osaka 540-6207 (JP)

(74) Representative: **Eisenführ Speiser**
Patentanwälte Rechtsanwälte PartGmbB
Postfach 31 02 60
80102 München (DE)

(54) **AIR CONDITIONING APPARATUS**

(57) To provide an air conditioning apparatus capable of reliably performing refrigerant recovery even when the outside temperature is high. An air conditioning apparatus 1 includes an injection pipe 30 connecting an injection port 31 of a compressor 11 and a refrigerant pipe between a first regulating valve 14 and an indoor heat exchanger 21, and an injection regulating valve 32 disposed on the injection pipe 30. A control unit 40 executes a first refrigerant recovery operation including: controlling a four-way valve 12 so that an outdoor heat exchanger 13 serves as a radiator and the indoor heat exchanger 21 serves as an evaporator; operating the compressor 11; fully closing the first regulating valve 14; and controlling the opening degree of the injection regulating valve 32.

FIG.3



Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to an air conditioning apparatus, and more particularly, to an air conditioning apparatus that performs a refrigerant recovery operation.

Description of the Related Art

[0002] A conventional technique that recovers a refrigerant from a use-side circuit to a heat-source-side circuit while preventing, for example, damage to a compressor and reliably reduces the amount of refrigerant leaking from the use-side circuit when refrigerant leakage occurs is disclosed (e.g., refer to Japanese Patent Laid-Open No. 2019-074222). In the technique, an outdoor expansion valve is disposed on a liquid-side pipe of an outdoor circuit, and the outdoor circuit is provided with a liquid-side bypass pipe for allowing the liquid-side pipe to communicate with a suction side of the compressor. When receiving a signal indicating leakage of the refrigerant from an indoor circuit, an outdoor controller executes a refrigerant recovery control operation of operating the compressor with a liquid-side control valve closed and executes a valve control operation of opening a liquid-side bypass valve of the liquid-side bypass pipe in the refrigerant recovery control operation, which prevents an excessive rise in the discharge temperature of the compressor in the refrigerant recovery control operation.

[0003] In order to prevent damage to the compressor, it is necessary to suck the gasified refrigerant into the compressor. However, in the conventional technique, when refrigerant recovery is performed under high outside temperature (e.g., 40°C), the discharge temperature cannot be sufficiently reduced up to a temperature that enables prevention of damage to the compressor in a system using, for example, R32 refrigerant having relatively high discharge temperature, which may result in insufficient refrigerant recovery.

[0004] The low pressure gradually decreases by performing the refrigerant recovery operation (pump down). Thus, the evaporation temperature decreases, the temperature difference from indoor air increases, and the superheat degree thus increases at an outlet of an indoor heat exchanger. Along with this, the temperature of the refrigerant discharged from the compressor also increases.

[0005] In particular, under a high outside temperature condition (e.g., 35°C), the temperature of the refrigerant discharged from the compressor reaches the vicinity of an upper limit (e.g., 100°C) even in the cooling operation.

[0006] When the refrigerant recovery operation is performed in this state, the pressure further increases, and the discharge temperature also further increases. Thus,

the compressor comes to a stop before the refrigerant recovery is completed.

[0007] The present invention has been made in view of the points described above, and an object thereof is to provide an air conditioning apparatus capable of reliably performing refrigerant recovery even when the outside temperature is high.

SUMMARY OF THE INVENTION

[0008] In order to achieve the above object, the present invention provides an air conditioning apparatus including: an outdoor unit including a compressor and an outdoor heat exchanger; an indoor unit including an indoor heat exchanger; a refrigerant pipe connecting the outdoor unit and the indoor unit and including a liquid-side pipe and a gas-side pipe; circuit switching means disposed on the refrigerant pipe; a first regulating valve disposed on the refrigerant pipe; and a control unit; the air conditioning apparatus further including: an injection pipe connecting an injection port of the compressor and the refrigerant pipe between the first regulating valve and the indoor heat exchanger; and an injection regulating valve disposed on the injection pipe. The control unit executes a first refrigerant recovery operation including: controlling the circuit switching means so that the outdoor heat exchanger serves as a radiator and the indoor heat exchanger serves as an evaporator; operating the compressor; fully closing the first regulating valve; and controlling an opening degree of the injection regulating valve.

[0009] With this configuration, allowing the intermediate-pressure refrigerant to flow to the low-pressure pipe from the compressor during the refrigerant recovery operation makes it possible to prevent reduction in the refrigerant pressure in the liquid-side pipe on the downstream side relative to the first regulating valve, increase the evaporation temperature to prevent increase in the temperature difference from indoor air, and reduce the discharge temperature from the compressor.

[0010] According to the present invention, it is possible to prevent reduction in the refrigerant pressure in the liquid-side pipe on the downstream side relative to the first regulating valve, increase the evaporation temperature to prevent increase in the temperature difference from indoor air, reduce the discharge temperature from the compressor, and thus reliably perform refrigerant recovery even when the outside temperature is high.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011]

Fig. 1 is a refrigerant circuit diagram showing a first embodiment of an air conditioning apparatus according to the present invention;

Fig. 2 is a block diagram showing a control configuration of the first embodiment;

Fig. 3 is a flowchart showing a refrigerant recovery operation of the first embodiment;

Fig. 4 is a refrigerant circuit diagram showing a second embodiment of the present invention;

Fig. 5 is a flowchart showing a refrigerant recovery operation of the second embodiment;

Fig. 6 is a refrigerant circuit diagram showing a third embodiment;

Fig. 7 is a block diagram showing a control configuration of the third embodiment; and

Fig. 8 is a flowchart showing a refrigerant recovery operation of the third embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0012] A first invention provides an air conditioning apparatus including: an outdoor unit including a compressor and an outdoor heat exchanger; an indoor unit including an indoor heat exchanger; a refrigerant pipe connecting the outdoor unit and the indoor unit and including a liquid-side pipe and a gas-side pipe; circuit switching means disposed on the refrigerant pipe; a first regulating valve disposed on the refrigerant pipe; and a control unit; the air conditioning apparatus further including: an injection pipe connecting an injection port of the compressor and the refrigerant pipe between the first regulating valve and the indoor heat exchanger; and an injection regulating valve disposed on the injection pipe. The control unit executes a first refrigerant recovery operation including: controlling the circuit switching means so that the outdoor heat exchanger serves as a radiator and the indoor heat exchanger serves as an evaporator; operating the compressor; fully closing the first regulating valve; and controlling an opening degree of the injection regulating valve.

[0013] With this configuration, allowing the intermediate-pressure refrigerant to flow to the low-pressure pipe from the compressor during the refrigerant recovery operation makes it possible to prevent reduction in the refrigerant pressure in the liquid-side pipe on the downstream side relative to the first regulating valve, increase the evaporation temperature to prevent increase in the temperature difference from indoor air, reduce the discharge temperature from the compressor, and thus reliably perform refrigerant recovery even when the outside temperature is high.

[0014] In a second invention, in the first refrigerant recovery operation, the control unit controls the opening degree of the injection regulating valve so that a refrigerant discharge temperature of a refrigerant discharged from the compressor becomes equal to or lower than a first predetermined temperature.

[0015] With this configuration, allowing the intermediate-pressure refrigerant to flow to the low-pressure pipe from the compressor during the refrigerant recovery operation makes it possible to prevent reduction in the refrigerant pressure in the liquid-side pipe on the down-

stream side relative to the first regulating valve, increase the evaporation temperature to prevent increase in the temperature difference from indoor air, reduce the discharge temperature from the compressor, and thus reliably perform refrigerant recovery even when the outside temperature is high.

[0016] In a third invention, the air conditioning apparatus further includes a second regulating valve disposed on the refrigerant pipe between a connection point of the injection pipe and the indoor heat exchanger, and the control unit executes, when a refrigerant discharge pressure of a refrigerant discharged from the compressor becomes equal to or higher than a first predetermined pressure, a second refrigerant recovery operation including: closing the second regulating valve; and opening the first regulating valve.

[0017] With this configuration, allowing the refrigerant with low superheat degree to flow into the intermediate-pressure refrigerant in the middle of compression in the compressor makes it possible to reduce, up to the vicinity of the saturation temperature, the refrigerant temperature that has risen once, and thus reduce the discharge temperature of the compressor. As a result, even when the refrigerant recovery is performed under the high outside temperature condition, and the high pressure rises, it is possible to reduce the temperature of the refrigerant discharged from the compressor and reliably recover the refrigerant in the indoor heat exchanger into the outdoor heat exchanger.

[0018] In a fourth invention, the air conditioning apparatus further includes an injection heat exchanger configured to exchange heat between the refrigerant flowing between the first regulating valve and the connection point of the injection pipe and the refrigerant flowing between the injection port and the injection regulating valve.

[0019] With this configuration, it is possible to reduce the temperature of the refrigerant flowing out of the outdoor heat exchanger and improve the refrigerant concentration (liquefaction) by exchanging heat between the refrigerant flowing between an injection branch point and the first refrigerant amount regulating means and the refrigerant flowing between the injection regulating means and the injection port. Thus, even in the case of overload where the temperature of air discharged from the heat source side becomes high (e.g., 50°C), it is possible to reduce the temperature of the recovered refrigerant to improve the refrigerant concentration, thereby reducing the high pressure. As a result, even when the refrigerant recovery is performed in the case of overload, it is possible to improve the refrigerant concentration to reduce the high pressure and reduce the temperature of the refrigerant discharged from the compressor, thereby reliably recovering the refrigerant in the indoor heat exchanger into the outdoor heat exchanger.

[0020] In a fifth invention, the air conditioning apparatus further includes: a bypass pipe having one end connected to the refrigerant pipe between the outdoor heat exchanger and the second regulating valve and the other

end connected to the refrigerant pipe between the circuit switching means and a suction side of the compressor; a bypass regulating valve disposed on the bypass pipe; and a refrigerant storage unit disposed between the other end of the bypass pipe and the compressor. The control unit executes, when the refrigerant discharge pressure of the refrigerant discharged from the compressor is equal to or higher than a second predetermined pressure, a third refrigerant recovery operation including opening the bypass regulating valve.

[0021] With this configuration, when the refrigerant is fully stored in the outdoor heat exchanger, and the high pressure rises, the refrigerant stored in the outdoor heat exchanger can be stored into the refrigerant storage unit through the bypass pipe, which reduces the high pressure. As a result, even when a large amount of refrigerant is enclosed inside the refrigerant circuit, it is possible to prevent rise in the temperature of the refrigerant discharged from the compressor, the temperature rise being caused by the high pressure rise, reduce the high pressure to reduce the temperature of the refrigerant discharged from the compressor, and reliably recover the refrigerant in the indoor heat exchanger into the outdoor heat exchanger.

[0022] Hereinbelow, embodiments of the present invention will be described with reference to the drawings.

[0023] Fig. 1 is a refrigerant circuit diagram showing a first embodiment of an air conditioning apparatus according to the present invention.

[0024] As shown in Fig. 1, an air conditioning apparatus 1 in the present embodiment includes an outdoor unit 10 and an indoor unit 20.

[0025] The outdoor unit 10 includes a compressor 11, a four-way valve 12 as the circuit switching means, an outdoor heat exchanger 13, a first regulating valve 14, and a gas-side pipe 15 and a liquid-side pipe 16 which connect these components to each other. An outdoor fan 17 is disposed near the outdoor heat exchanger 13 to send outside air to the outdoor heat exchanger 13.

[0026] The indoor unit 20 includes an indoor heat exchanger 21, and the indoor unit 20 and the outdoor unit 10 are connected with each other by the gas-side pipe 15 and the liquid-side pipe 16. An indoor fan 22 is disposed near the indoor heat exchanger 21 to send indoor air to the indoor heat exchanger 21.

[0027] The compressor 11 is configured to compress a gas refrigerant sucked through the gas-side pipe 15 to a predetermined pressure and discharge the compressed gas refrigerant, and the compressed gas refrigerant is fed to the outdoor heat exchanger 13 through the four-way valve 12 in a cooling operation.

[0028] The outdoor heat exchanger 13 exchanges heat between outside air and the refrigerant by driving the outdoor fan 17, and is configured to function as a condenser in the cooling operation and function as an evaporator in a heating operation.

[0029] The first regulating valve 14 is disposed on the liquid-side pipe 16, and decompresses and expands the

refrigerant flowing into the indoor heat exchanger 21 in the cooling operation.

[0030] The indoor heat exchanger 21 performs heat exchange of indoor air by driving the indoor fan 22, and is configured to function as an evaporator in the cooling operation and function as a condenser in the heating operation.

[0031] In the present embodiment, an injection pipe 30 is connected, at one end thereof, between the first regulating valve 14 and the indoor heat exchanger 21, and the other end of the injection pipe 30 is connected to an injection port 31 at an intermediate pressure in a compression space of the compressor 11.

[0032] An injection regulating valve 32 is disposed midway of the injection pipe 30.

[0033] A second regulating valve 33 is disposed between the first regulating valve 14 and the indoor heat exchanger 21 at a position closer to the indoor heat exchanger 21 than the connection point of the injection pipe 30 is.

[0034] Note that each of the first regulating valve 14, the injection regulating valve 32, and the second regulating valve 33 includes a motor-operated valve having an opening degree adjustable in any manner.

[0035] A discharge temperature sensor 35 which detects a refrigerant discharge temperature and a discharge pressure sensor 36 which detects a refrigerant discharge pressure are disposed at a refrigerant discharge side of the compressor 11.

[0036] A suction pressure sensor 37 which detects a refrigerant suction pressure is disposed at a refrigerant suction side of the compressor 11.

[0037] Next, a control configuration of the first embodiment will be described.

[0038] Fig. 2 is a block diagram showing the control configuration of the first embodiment.

[0039] As shown in Fig. 2, the air conditioning apparatus 1 of the present embodiment includes a control unit 40. The control unit 40 includes, for example, a processor, such as a CPU or an MPU, and a memory device, such as a ROM or a RAM, and controls each part of the air conditioning apparatus 1.

[0040] The discharge temperature sensor 35, the discharge pressure sensor 36, and the suction pressure sensor 37 are connected to the control unit 40.

[0041] The control unit 40 is configured to control, based on detection values of the discharge temperature sensor 35, the discharge pressure sensor 36, and the suction pressure sensor 37, driving of the compressor 11, the outdoor fan 17, and the indoor fan 22, the opening degrees of the first regulating valve 14, the second regulating valve 33, and the injection regulating valve 32, and switching of the four-way valve 12.

[0042] Next, a refrigerant recovery operation in the present embodiment will be described.

[0043] Fig. 3 is a flowchart showing the refrigerant recovery operation in the present embodiment.

[0044] As shown in Fig. 3, when starting the refrigerant

recovery operation, the control unit 40 performs a first refrigerant recovery operation (ST1).

[0045] The first refrigerant recovery operation includes: switching the four-way valve 12 to the cooling operation; fully closing the first regulating valve 14; fixing the second regulating valve 33 at a predetermined opening degree; and fixing the operation frequency of the compressor 11.

[0046] Then, the control unit 40 acquires a refrigerant discharge temperature T_d of the compressor 11 detected by the discharge temperature sensor 35 and determines whether the refrigerant discharge temperature T_d is equal to or higher than a first predetermined temperature T_1 (ST2).

[0047] When the refrigerant discharge temperature T_d is equal to or higher than the first predetermined temperature T_1 (ST2: YES), the control unit 40 performs control to increase the opening degree of the injection regulating valve 32 (ST3).

[0048] Typically, the pressure of the low-pressure refrigerant on the upstream side of the indoor heat exchanger 21 gradually decreases by performing the refrigerant recovery operation. Thus, the evaporation temperature in the indoor heat exchanger 21 decreases, the temperature difference from indoor air increases, and the superheat degree thus increases at an outlet of the indoor heat exchanger 21. Along with this, the temperature of the refrigerant discharged from the compressor 11 also increases.

[0049] In particular, under a high outside temperature condition (e.g., 35°C), the temperature of the refrigerant discharged from the compressor 11 reaches the vicinity of an upper limit (e.g., 100°C) even in the cooling operation.

[0050] When the refrigerant recovery operation is performed in this state, the temperature of the refrigerant discharged from the compressor 11 further increases. Thus, the compressor 11 comes to a stop before the refrigerant recovery is completed.

[0051] In the present embodiment, allowing the intermediate-pressure refrigerant in the compressor 11 to flow to the liquid-side pipe 16 from the compressor 11 through the injection pipe 30 makes it possible to prevent reduction in the refrigerant pressure in the liquid-side pipe 16 on the downstream side relative to the first regulating valve 14, increase the evaporation temperature in the indoor heat exchanger 21 to prevent increase in the temperature difference from indoor air, and largely reduce the discharge temperature from the compressor 11.

[0052] Then, the control unit 40 acquires a suction pressure P_s of the compressor 11 detected by the suction pressure sensor 37 and determines whether the refrigerant suction pressure P_s is equal to or lower than -0.1 Mpa (ST4).

[0053] When it is determined that the suction pressure P_s is equal to or lower than -0.1 Mpa (ST4: YES), the control unit 40 ends the refrigerant recovery operation.

[0054] When it is determined that the suction pressure

P_s is not equal to or lower than -0.1 Mpa (ST4: NO), the control unit 40 returns to step 2 to determine whether the refrigerant discharge temperature T_d is equal to or higher than the first predetermined temperature T_1 (ST2).

[0055] On the other hand, when the refrigerant discharge temperature T_d is not equal to or higher than the first predetermined temperature T_1 (ST2: NO), the control unit 40 determines whether the refrigerant discharge temperature T_d is equal to or lower than the first predetermined temperature T_1 - 30°C (ST5).

[0056] When it is determined that the refrigerant discharge temperature T_d is equal to or lower than the first predetermined temperature T_1 - 30°C (ST5: YES), the control unit 40 performs control to reduce the opening degree of the injection regulating valve 32 (ST6).

[0057] When it is determined that the refrigerant discharge temperature T_d is not equal to or lower than the first predetermined temperature T_1 - 30°C (ST5: NO), the control unit 40 performs control to maintain the opening degree of the injection regulating valve 32 (ST7).

[0058] After controlling the opening degree of the injection regulating valve 32, the control unit 40 shifts to step 4 to determine whether the refrigerant suction pressure P_s is equal to or lower than -0.1 Mpa (ST4).

[0059] As described above, in the present embodiment, the air conditioning apparatus 1 further includes the injection pipe 30 connecting the injection port 31 of the compressor 11 and the refrigerant pipe between the first regulating valve 14 and the indoor heat exchanger 21, and the injection regulating valve 32 disposed on the injection pipe 30. The control unit 40 executes the first refrigerant recovery operation including: controlling the four-way valve 12 (circuit switching means) so that the outdoor heat exchanger 13 serves as a radiator and the indoor heat exchanger 21 serves as an evaporator; operating the compressor 11; fully closing the first regulating valve 14; and controlling the opening degree of the injection regulating valve 32.

[0060] With this configuration, allowing the intermediate-pressure refrigerant to flow to the low-pressure pipe from the compressor 11 during the refrigerant recovery operation makes it possible to prevent reduction in the refrigerant pressure in the liquid-side pipe 16 on the downstream relative to the first regulating valve 14, increase the evaporation temperature to prevent increase in the temperature difference from indoor air, reduce the discharge temperature from the compressor 11, and thus perform refrigerant recovery even when the outside temperature is high.

[0061] Next, a second embodiment of the present invention will be described.

[0062] Fig. 4 is a refrigerant circuit diagram showing the second embodiment of the present invention.

[0063] As shown in Fig. 4, an air conditioning apparatus 1 includes an injection heat exchanger 34 which exchanges heat between the refrigerant flowing between a first regulating valve 14 and a connection point of an injection pipe 30 and the refrigerant flowing between an

injection port 31 and an injection regulating valve 32.

[0064] Since the other configurations are similar to those of the first embodiment shown in Fig. 1, identical reference signs designate identical parts to omit description thereof.

[0065] Next, a refrigerant recovery operation in the second embodiment will be described.

[0066] Fig. 5 is a flowchart showing the refrigerant recovery operation of the present embodiment.

[0067] Since a control configuration in the second embodiment is similar to the control configuration of the first embodiment shown in Fig. 2, the second embodiment will be described with reference to Fig. 2.

[0068] As shown in Fig. 5, when starting the refrigerant recovery operation, the control unit 40 performs a first refrigerant recovery operation. In this case, the first refrigerant recovery operation is similar to the operations from step (ST1) to step (ST7) of the flowchart shown in Fig. 3. Thus, identical step numbers designate identical steps to omit description thereof.

[0069] When it is determined that the suction pressure Ps is not equal to or lower than -0.1 Mpa in the first refrigerant recovery operation (ST4: NO), the control unit 40 determines whether a refrigerant discharge pressure Pd is equal to or higher than a first predetermined pressure Pd1 (ST8).

[0070] Then, when it is determined that the refrigerant discharge pressure Pd is equal to or higher than the first predetermined pressure Pd1 (ST8: YES), the control unit 40 performs a second refrigerant recovery operation (ST9).

[0071] The second refrigerant recovery operation includes: switching the four-way valve 12 to the cooling operation; fixing the first regulating valve 14 to a predetermined opening degree; fully closing the second regulating valve 33; and fixing the operation frequency of the compressor 11.

[0072] Then, the control unit 40 acquires a refrigerant discharge temperature Td of the compressor 11 detected by the discharge temperature sensor 35 and determines whether the refrigerant discharge temperature Td is equal to or higher than a second predetermined temperature T2 (ST10).

[0073] When the refrigerant discharge temperature Td is equal to or higher than the second predetermined temperature T2 (ST10: YES), the control unit 40 performs control to increase the opening degree of the injection regulating valve 32 (ST11).

[0074] Then, when it is determined that the refrigerant discharge temperature Td is not equal to or higher than the second predetermined temperature T2 (ST10: NO), the control unit 40 determines whether the refrigerant discharge temperature Td is equal to or lower than the first predetermined temperature T1 - 30°C (ST12).

[0075] When it is determined that the refrigerant discharge temperature Td is equal to or lower than the first predetermined temperature T1 - 30°C (ST12: YES), the control unit 40 performs control to reduce the opening

degree of the injection regulating valve 32 (ST13).

[0076] When it is determined that the refrigerant discharge temperature Td is not equal to or lower than the first predetermined temperature T1 - 30°C (ST12: NO), the control unit 40 performs control to maintain the opening degree of the injection regulating valve 32 (ST14).

[0077] After controlling the opening degree of the injection regulating valve 32, the control unit 40 shifts to step 4 to determine whether the refrigerant suction pressure Ps is equal to or lower than -0.1 Mpa (ST4).

[0078] Note that although the second embodiment has been described with reference to a refrigeration cycle circuit shown in Fig. 4, similar actions and effects can also be obtained in a refrigeration cycle circuit that does not use the injection heat exchanger 34, such as the refrigeration cycle circuit shown in Fig. 1, by performing similar control.

[0079] As described above, in the present embodiment, the air conditioning apparatus 1 includes the second regulating valve 33 disposed on the refrigerant pipe between the connection point of the injection pipe 30 and the indoor heat exchanger 21. When the refrigerant discharge pressure of the refrigerant discharged from the compressor 11 becomes equal to or higher than the first predetermined pressure, the control unit 40 executes the second refrigerant recovery operation including: closing the second regulating valve 33; and opening the first regulating valve 14.

[0080] With this configuration, allowing the refrigerant with low superheat degree to flow into the intermediate-pressure refrigerant in the middle of compression in the compressor 11 makes it possible to reduce, up to the vicinity of the saturation temperature, the refrigerant temperature that has risen once, and thus reduce the discharge temperature of the compressor 11. As a result, even when the refrigerant recovery is performed under the high outside temperature condition, and the high pressure rises, it is possible to reduce the temperature of the refrigerant discharged from the compressor 11 and reliably recover the refrigerant in the indoor heat exchanger 21 into the outdoor heat exchanger 13.

[0081] In the present embodiment, the air conditioning apparatus 1 includes the injection heat exchanger 34 which exchanges heat between the refrigerant flowing between the first regulating valve 14 and the connection point of the injection pipe 30 and the refrigerant flowing between the injection port 31 and the injection regulating valve 32.

[0082] With this configuration, it is possible to reduce the temperature of the refrigerant flowing out of the outdoor heat exchanger 13 and improve the refrigerant concentration (liquefaction) by exchanging heat between the refrigerant flowing between the injection branch point and the first refrigerant amount regulating means and the refrigerant flowing between the injection regulating means and the injection port 31. Thus, even in the case of overload where the temperature of air discharged from the heat source side becomes high (e.g., 50°C), it is possible

to reduce the temperature of the recovered refrigerant to improve the refrigerant concentration, thereby reducing the high pressure. As a result, even when the refrigerant recovery is performed in the case of overload, it is possible to improve the refrigerant concentration to reduce the high pressure and reduce the temperature of the refrigerant discharged from the compressor 11, thereby reliably recovering the refrigerant in the indoor heat exchanger 21 into the outdoor heat exchanger 13.

[0083] Next, a third embodiment of the present invention will be described.

[0084] Fig. 6 is a refrigerant circuit diagram showing the third embodiment of the present invention.

[0085] As shown in Fig. 6, in the third embodiment, a bypass pipe 50 is provided. One end of the bypass pipe 50 is connected to a refrigerant pipe between an outdoor heat exchanger 13 and a second regulating valve 33, and the other end thereof is connected to the refrigerant pipe between a four-way valve 12 and a suction side of a compressor 11.

[0086] A bypass regulating valve 51 is disposed midway of the bypass pipe 50. A refrigerant storage unit 52 is disposed on the bypass pipe 50 between a connection point of a gas-side pipe 15 and the compressor 11.

[0087] Fig. 7 is a block diagram showing a control configuration of the third embodiment.

[0088] As shown in Fig. 7, a control unit 40 is configured to control, based on detection values of a discharge temperature sensor 35, a discharge pressure sensor 36, and a suction pressure sensor 37, driving of the compressor 11, an outdoor fan 17, and an indoor fan 22, the opening degrees of a first regulating valve 14, a second regulating valve 33, an injection regulating valve 32, and the bypass regulating valve 51, and switching of the four-way valve 12.

[0089] In Figs. 6 and 7, since the other configurations are similar to those of the second embodiment, identical reference signs designate identical parts to omit description thereof.

[0090] Next, a refrigerant recovery operation in the third embodiment will be described.

[0091] Fig. 8 is a flowchart showing the refrigerant recovery operation of the present embodiment.

[0092] As shown in Fig. 8, when starting the refrigerant recovery operation, the control unit 40 performs a first refrigerant recovery operation. In this case, the first refrigerant recovery operation is similar to the operations from step (ST1) to step (ST14) of the flowchart shown in Fig. 5. Thus, identical step numbers designate identical steps to omit description thereof.

[0093] When it is determined that the refrigerant discharge pressure Pd is equal to or higher than the first predetermined pressure Pd1 (ST8: YES), the control unit 40 determines whether the refrigerant discharge pressure Pd of the compressor 11 is equal to or higher than a second predetermined pressure Pd2 (ST15).

[0094] Then, when it is determined that the refrigerant discharge pressure Pd is not equal to or higher than the

second predetermined pressure Pd2 (ST15: NO), the control unit 40 performs a second refrigerant recovery operation (ST9). The second refrigerant recovery operation is similar to that of the second embodiment.

5 **[0095]** On the other hand, when it is determined that the refrigerant discharge pressure Pd is equal to or higher than the second predetermined pressure Pd2 (ST15: YES), the control unit 40 performs a third refrigerant recovery operation (ST16).

10 **[0096]** The third refrigerant recovery operation includes: switching the four-way valve 12 to the cooling operation: fixing the first regulating valve 14 to a predetermined opening degree; fully closing the second regulating valve 33; increasing the opening degree of the bypass regulating valve 51; and fixing the operation frequency of the compressor 11.

15 **[0097]** Then, the control unit 40 determines whether the refrigerant discharge pressure Pd of the compressor 11 is equal to or higher than the second predetermined pressure Pd2 + 0.1 Mpa (ST17) and ends the refrigerant recovery operation when it is determined that the refrigerant discharge pressure Pd of the compressor 11 is equal to or higher than the second predetermined pressure Pd2 + 0.1 Mpa (ST17: YES).

20 **[0098]** When it is determined that the refrigerant discharge pressure Pd of the compressor 11 is not equal to or higher than the second predetermined pressure Pd2 + 0.1 Mpa (ST17: NO), the control unit 40 returns to step 4 (ST4).

25 **[0099]** As described above, in the present embodiment, the air conditioning apparatus 1 includes the bypass pipe 50 having one end connected to the refrigerant pipe between the outdoor heat exchanger 13 and the second regulating valve 33 and the other end connected to the refrigerant pipe between the four-way valve 12 and the suction side of the compressor 11, the bypass regulating valve 51 disposed on the bypass pipe 50, and the refrigerant storage unit 52 disposed between the other end of the bypass pipe 50 and the compressor 11. When the discharge pressure of the refrigerant discharged from the compressor 11 is equal to or higher than the second predetermined pressure, the control unit 40 executes the third refrigerant recovery operation including opening the bypass regulating valve 51.

30 **[0100]** With this configuration, when the refrigerant is fully stored in the outdoor heat exchanger 13, and the high pressure rises, the refrigerant stored in the outdoor heat exchanger 13 can be stored into the refrigerant storage unit 52 through the bypass pipe 50, which reduces the high pressure. As a result, even when a large amount of refrigerant is enclosed inside the refrigerant circuit, it is possible to prevent rise in the temperature of the refrigerant discharged from the compressor 11, the temperature rise being caused by the high pressure rise, reduce the high pressure to reduce the temperature of the refrigerant discharged from the compressor 11, and reliably recover the refrigerant in the indoor heat exchanger 21 into the outdoor heat exchanger 13.

[0101] Note that the present invention is not limited to the embodiments described above, and various modifications and applications can be made without departing from the gist of the present invention.

[0102] As described above, the air conditioning apparatus according to the present invention is suitably usable as an air conditioning apparatus capable of reliably performing refrigerant recovery even when the outside temperature is high.

Reference Signs List

[0103]

1 air conditioning apparatus

10 outdoor unit

11 compressor

12 four-way valve

13 outdoor heat exchanger

14 first regulating valve

15 gas-side pipe

16 liquid-side pipe

17 outdoor fan

20 indoor unit

21 indoor heat exchanger

22 indoor fan

30 injection pipe

31 injection port

32 injection regulating valve

33 second regulating valve

34 injection heat exchanger

35 discharge temperature sensor

36 discharge pressure sensor

37 suction pressure sensor

40 control unit

50 bypass pipe

51 bypass regulating valve

52 refrigerant storage unit

Claims

1. An air conditioning apparatus comprising:

an outdoor unit (10) including a compressor (11) and an outdoor heat exchanger (13);

an indoor unit (20) including an indoor heat exchanger (21);

a refrigerant pipe connecting the outdoor unit and the indoor unit and including a liquid-side pipe (15) and a gas-side pipe (15);

circuit switching means disposed on the refrigerant pipe;

a first regulating valve (14) disposed on the refrigerant pipe;

a control unit (40), **characterized by** comprising:

an injection pipe (30) connecting an injection port (31) of the compressor and the refrigerant pipe between the first regulating valve and the indoor heat exchanger; and an injection regulating valve (32) disposed on the injection pipe, wherein the control unit executes a first refrigerant recovery operation including: controlling the circuit switching means so that the outdoor heat exchanger serves as a radiator and the indoor heat exchanger serves as an evaporator; operating the compressor; fully closing the first regulating valve; and controlling an opening degree of the injection regulating valve.

2. The air conditioning apparatus according to claim 1, wherein, in the first refrigerant recovery operation, the control unit controls the opening degree of the injection regulating valve so that a refrigerant discharge temperature of a refrigerant discharged from the compressor becomes equal to or lower than a first predetermined temperature.

3. The air conditioning apparatus according to claim 1, further comprising a second regulating valve (33) disposed on the refrigerant pipe between a connection point of the injection pipe and the indoor heat exchanger, wherein the control unit executes, when a refrigerant discharge pressure of a refrigerant discharged from the compressor becomes equal to or higher than a first predetermined pressure, a second refrigerant recovery operation including: closing the second regulating valve; and opening the first regulating valve.

4. The air conditioning apparatus according to claim 3, further comprising an injection heat exchanger (34) configured to exchange heat between the refrigerant flowing between the first regulating valve and the connection point of the injection pipe and the refrigerant flowing between the injection port and the injection regulating valve.

5. The air conditioning apparatus according to claim 3, further comprising:

a bypass pipe (50) having one end connected to the refrigerant pipe between the outdoor heat exchanger and the second regulating valve and the other end connected to the refrigerant pipe between the circuit switching means and a suction side of the compressor; a bypass regulating valve (51) disposed on the bypass pipe; and a refrigerant storage unit (52) disposed between the other end of the bypass pipe and the compressor, wherein

the control unit executes, when the refrigerant discharge pressure of the refrigerant discharged from the compressor is equal to or higher than a second predetermined pressure, a third refrigerant recovery operation including opening the bypass regulating valve. 5

10

15

20

25

30

35

40

45

50

55

FIG. 1

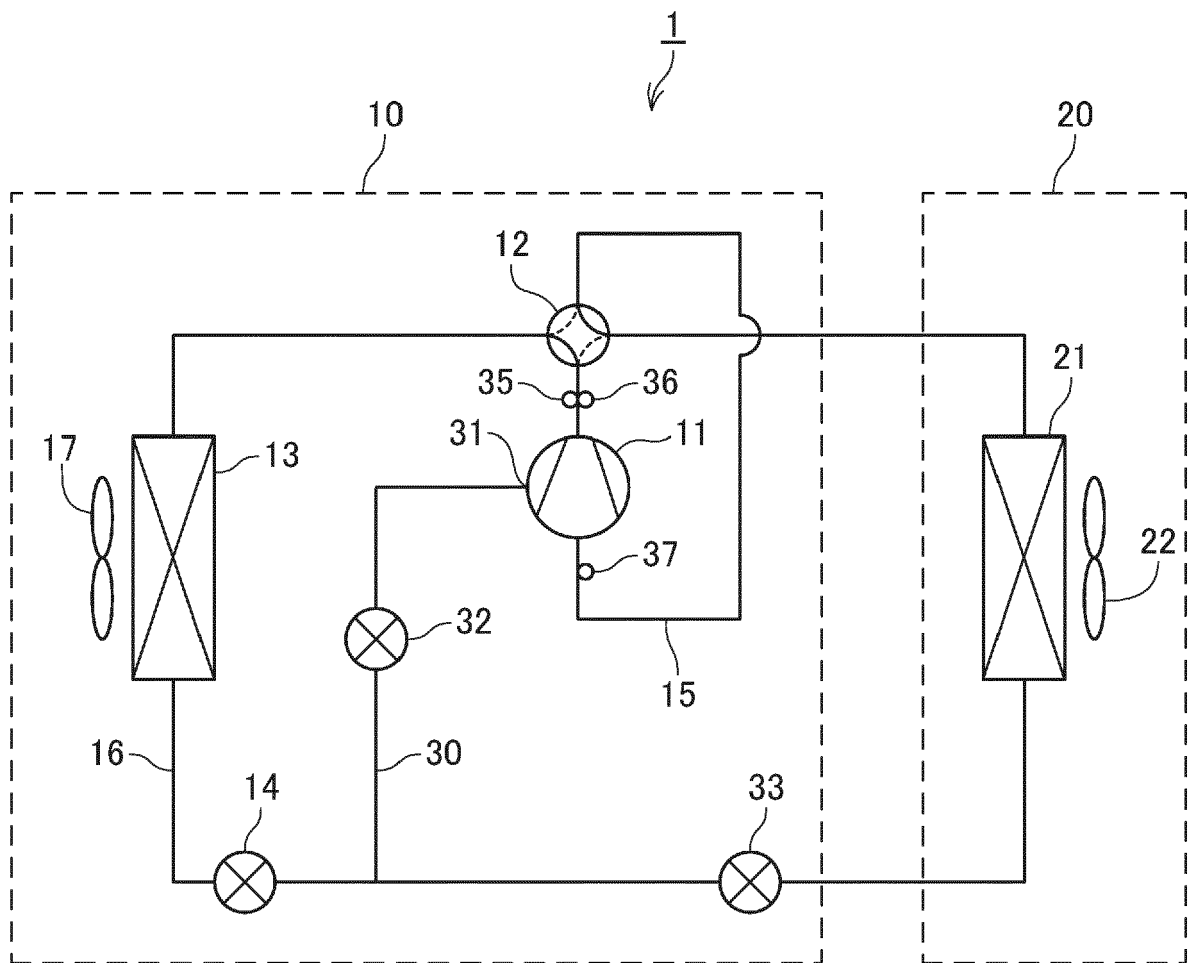


FIG.2

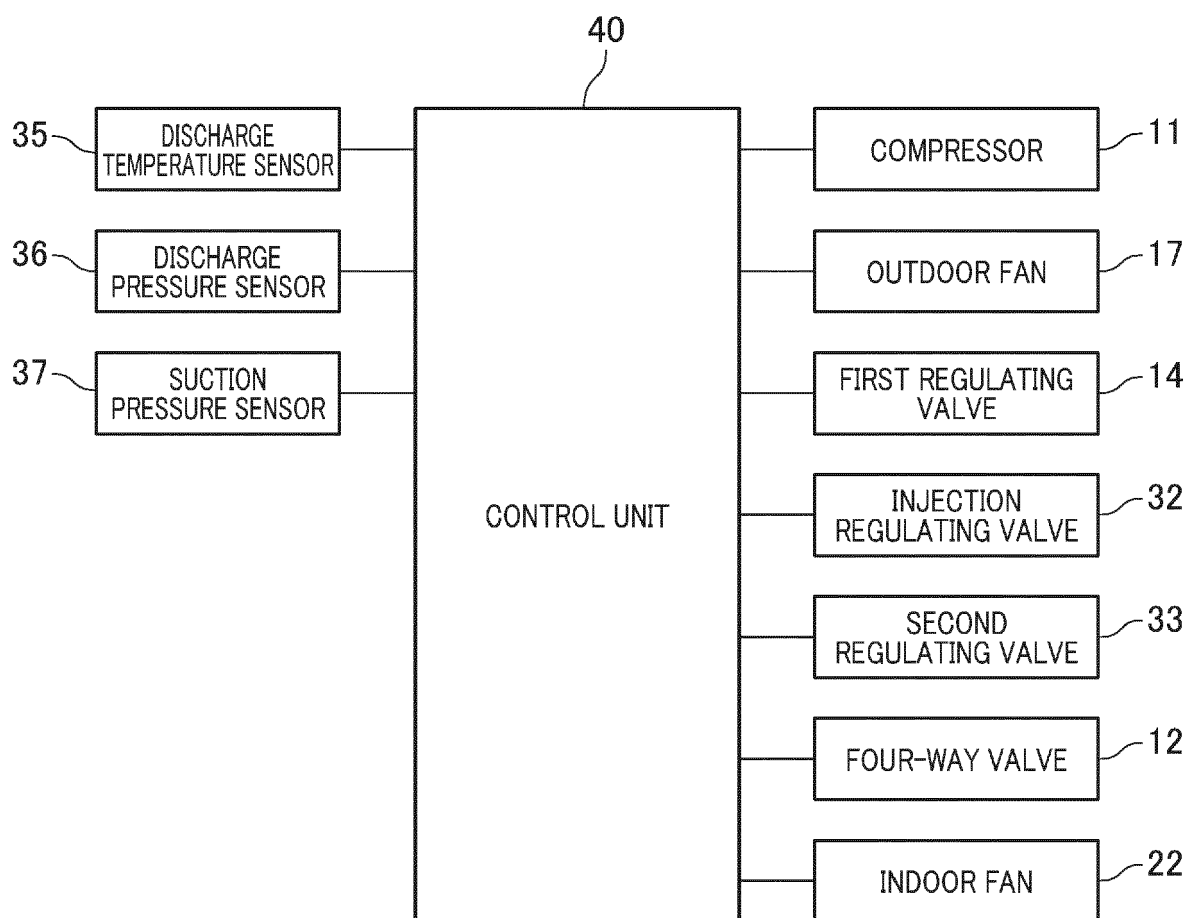


FIG. 3

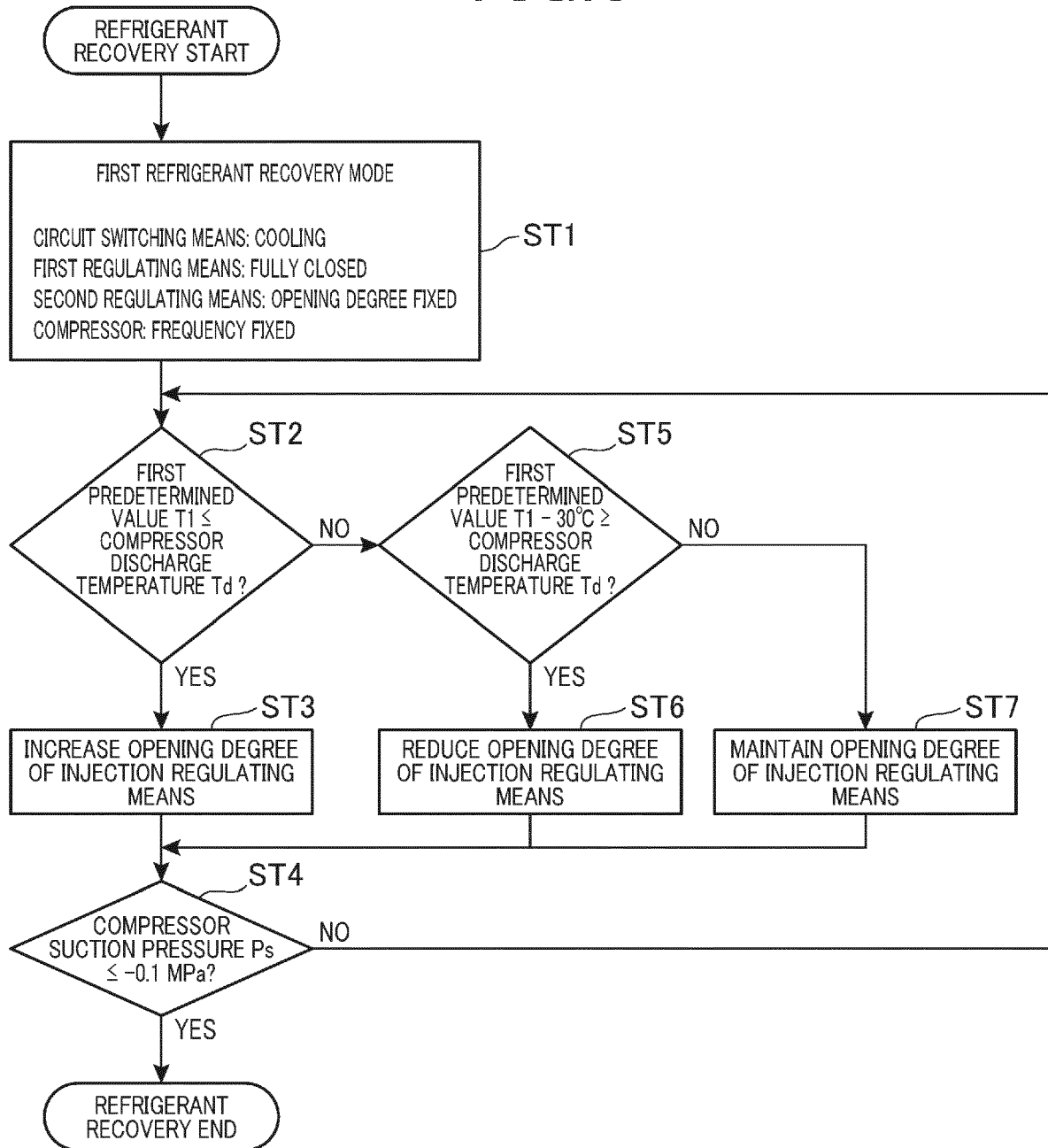


FIG. 4

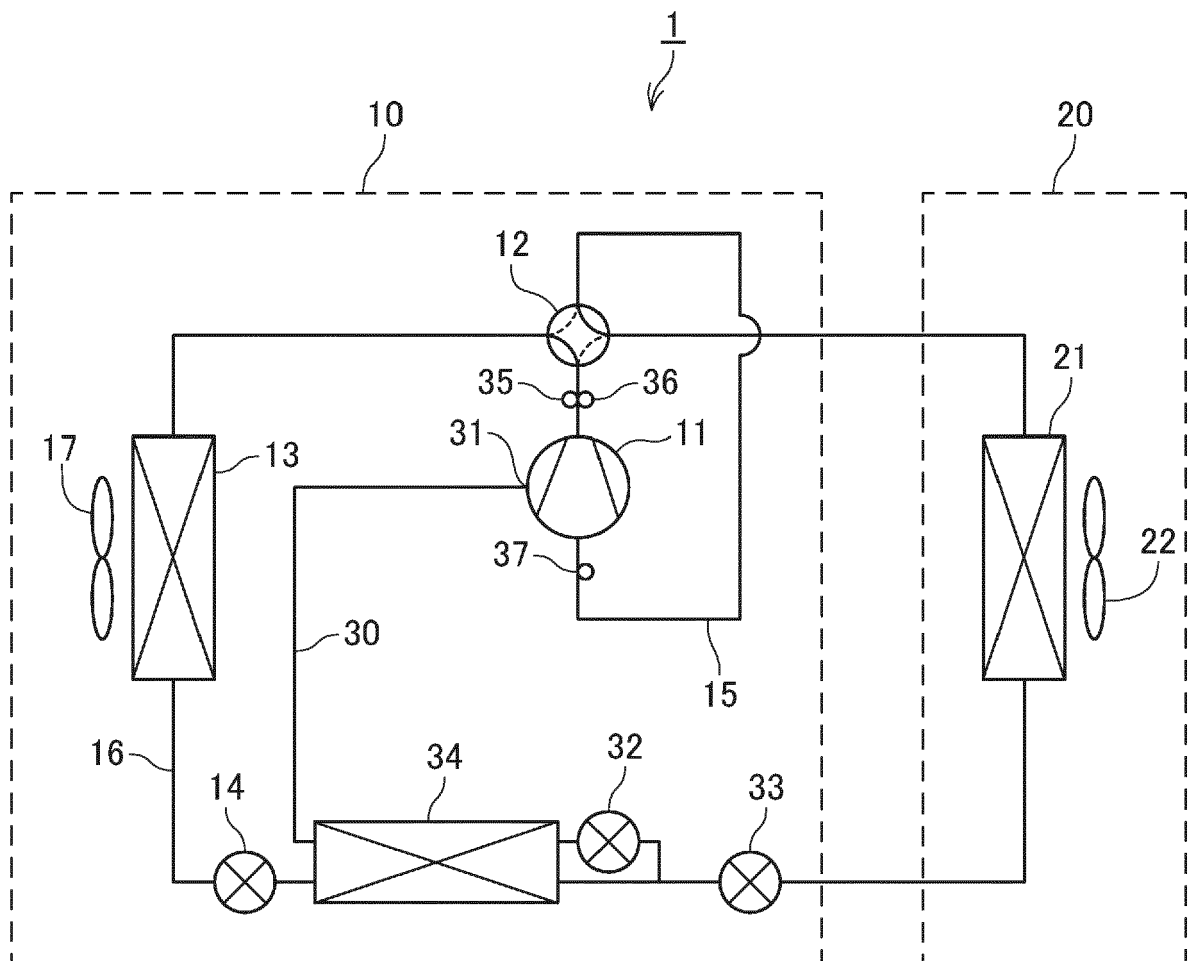


FIG.5

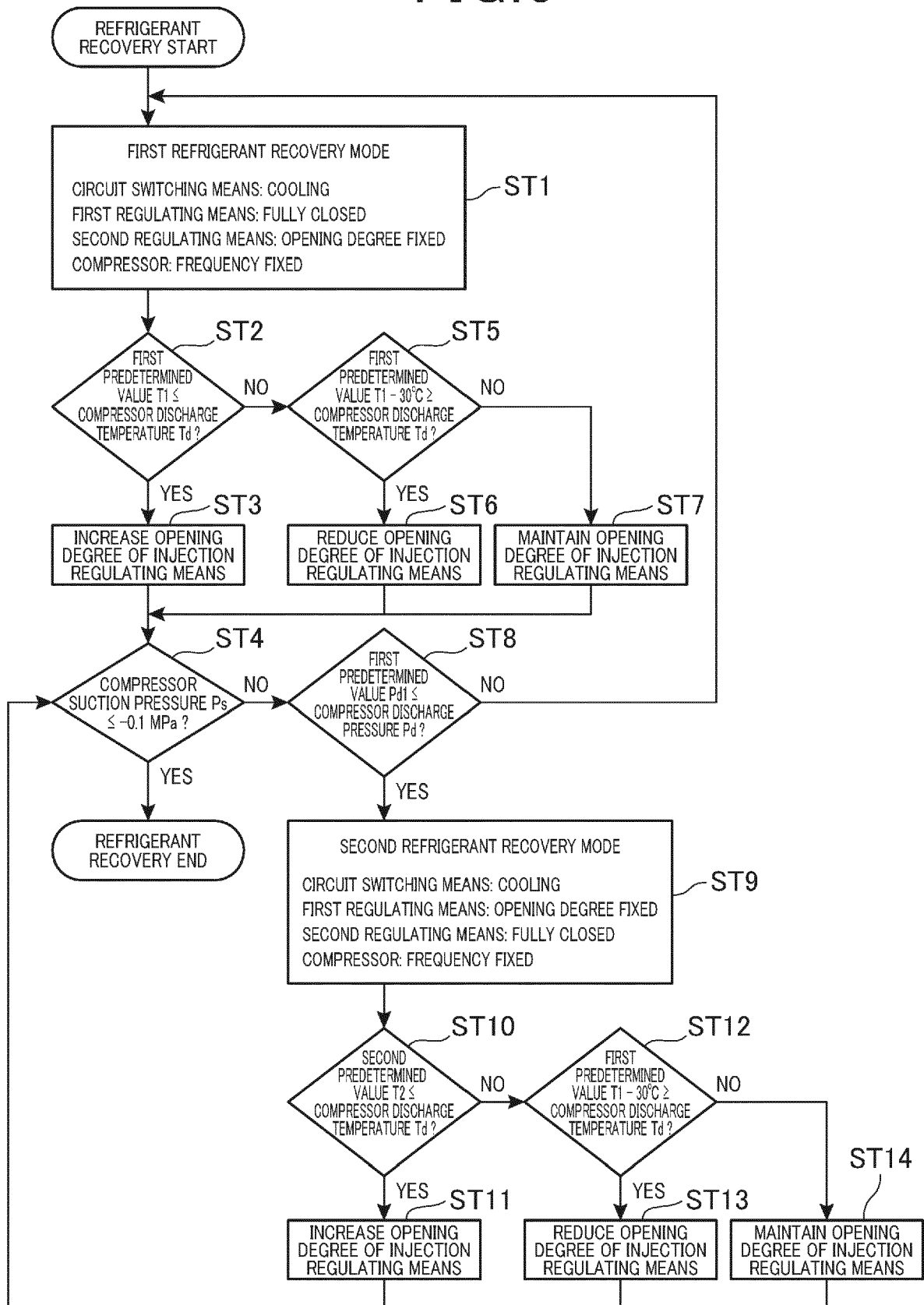


FIG. 6

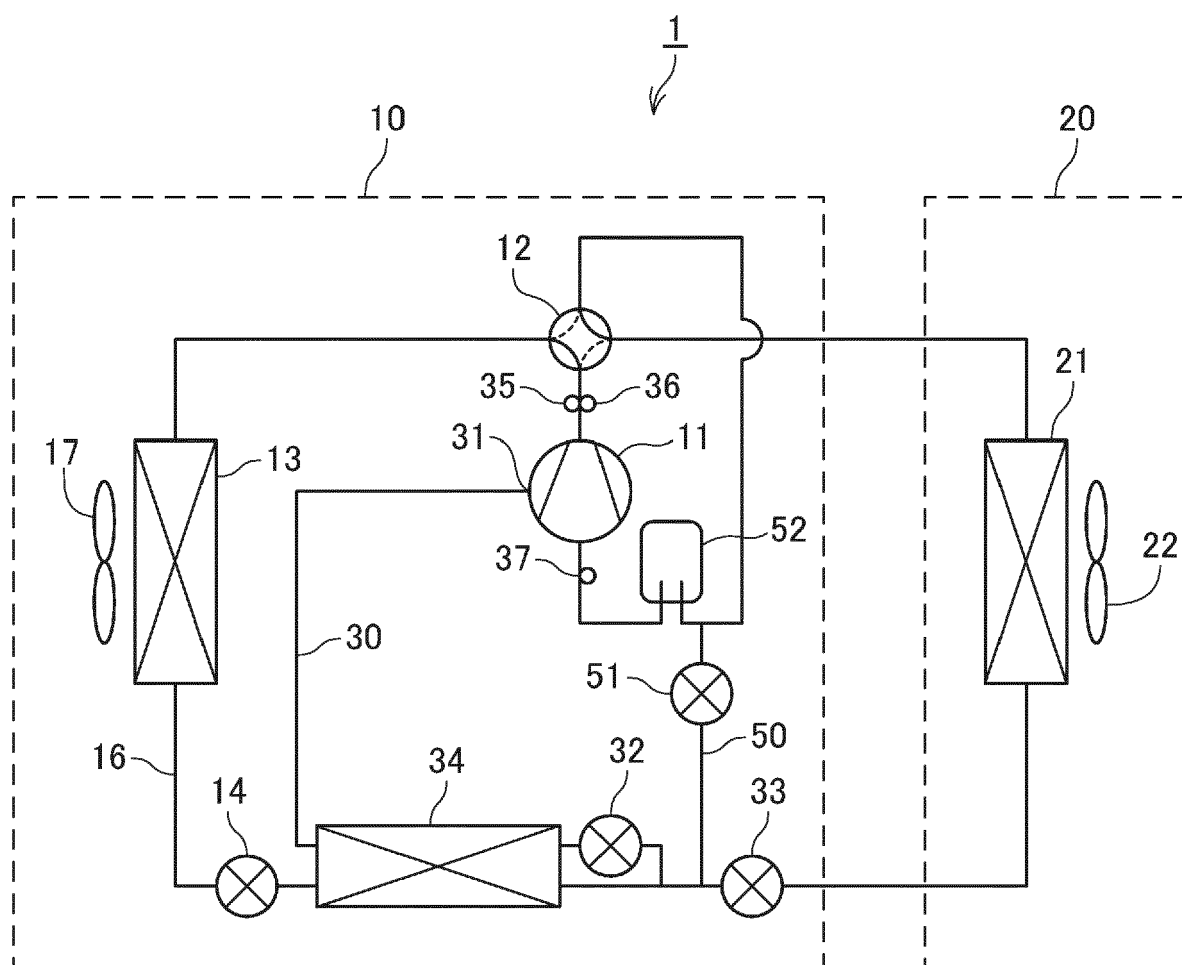


FIG. 7

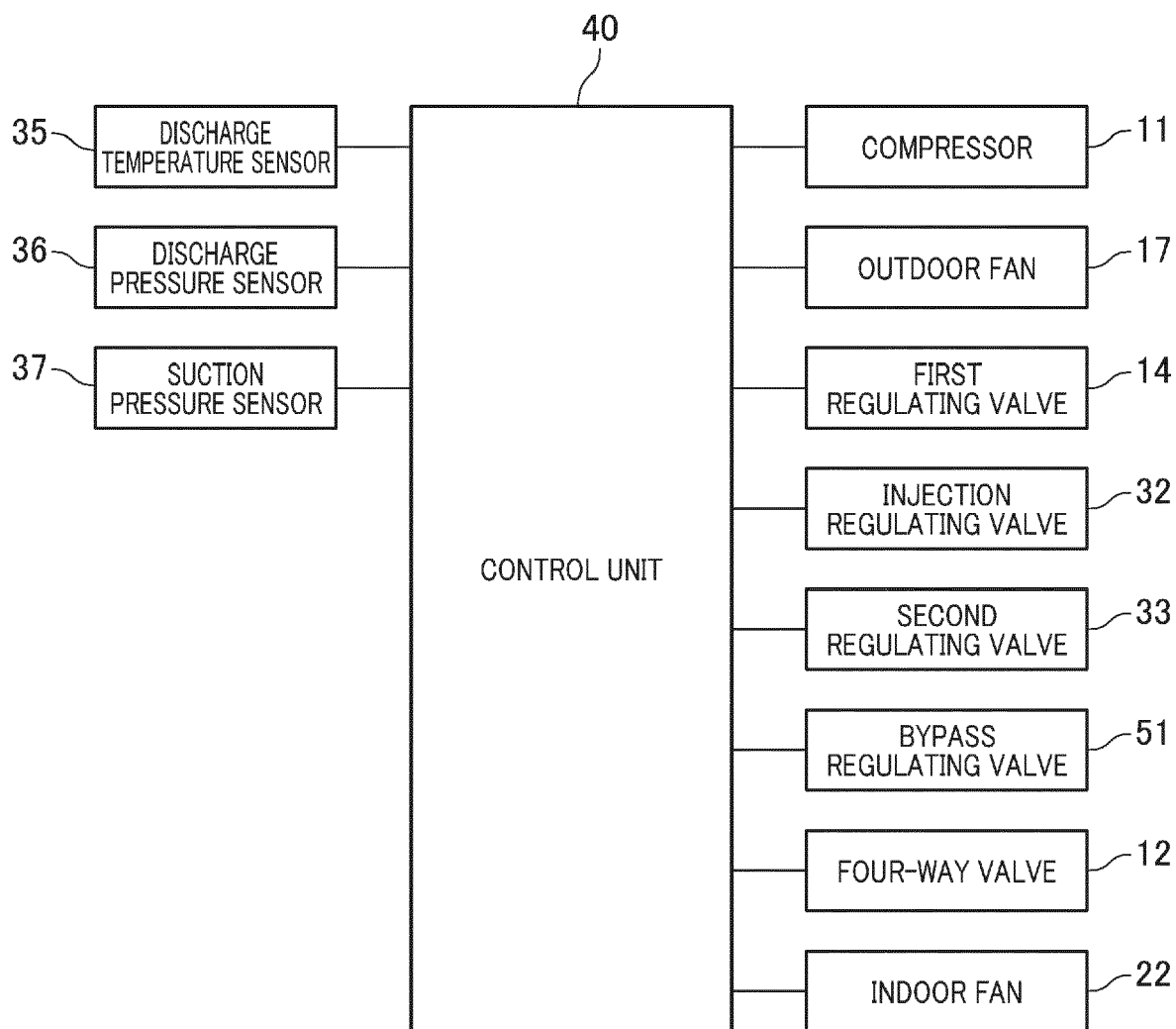
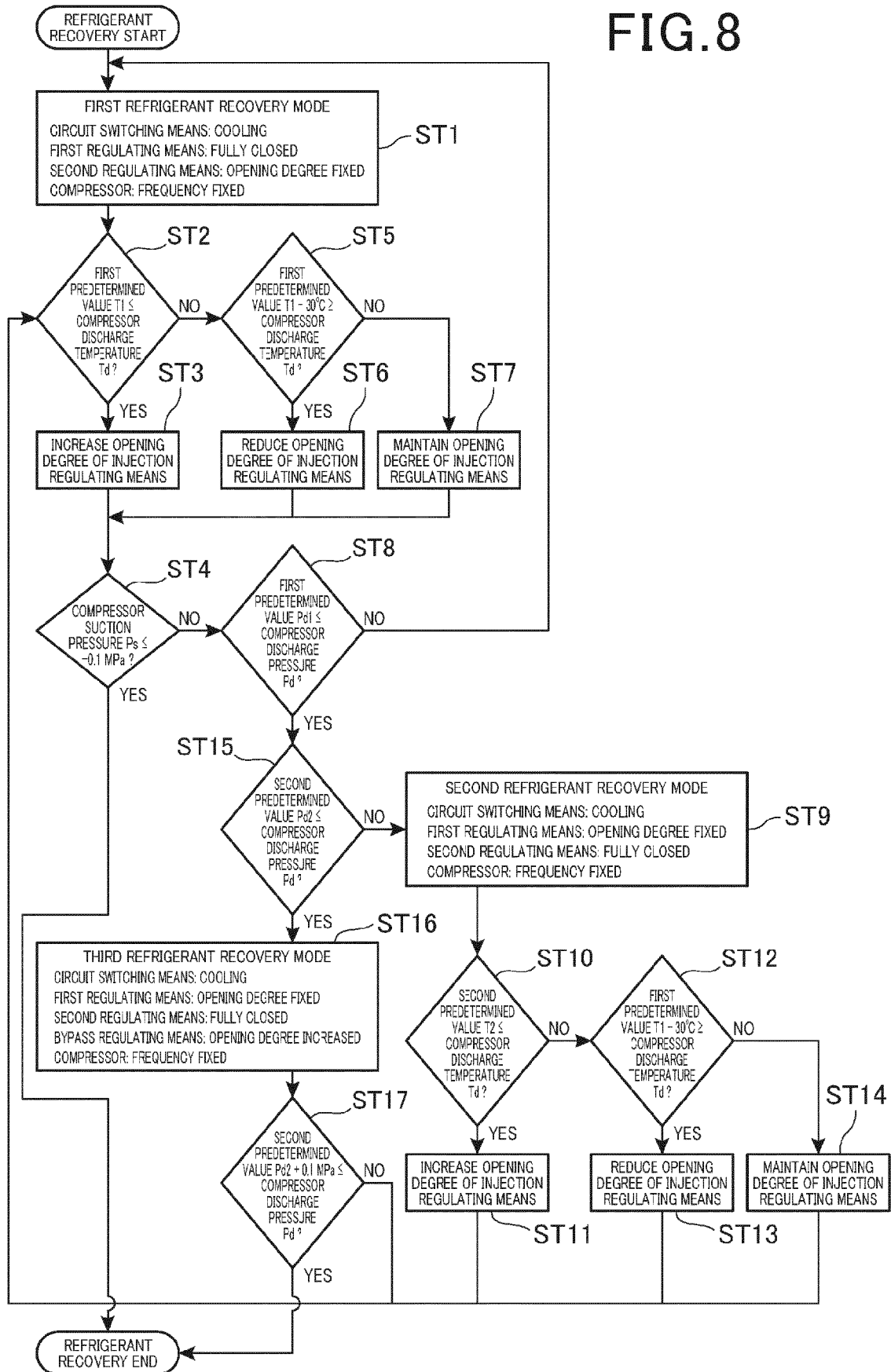


FIG.8





EUROPEAN SEARCH REPORT

Application Number
EP 21 15 8549

5

10

15

20

25

30

35

40

45

50

55

2

EPO FORM 1503 03.82 (P04C01)

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 3 279 580 A1 (MITSUBISHI ELECTRIC CORP [JP]) 7 February 2018 (2018-02-07)	1,2	INV.
A	* paragraphs [0013] - [0024], [0043] - [0045]; figures 2, 4, 5 *	3-5	F25B49/00 F25B49/02
A	EP 3 418 655 A1 (DAIKIN IND LTD [JP]) 26 December 2018 (2018-12-26) * paragraphs [0041] - [0126]; figures 1-3 *	1-5	
A	EP 2 808 621 A1 (MITSUBISHI ELECTRIC CORP [JP]) 3 December 2014 (2014-12-03) * paragraphs [0016] - [0169]; figures 1, 11, 12 *	1-5	
			TECHNICAL FIELDS SEARCHED (IPC)
			F25B
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 28 June 2021	Examiner Amous, Moez
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 21 15 8549

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

28-06-2021

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 3279580 A1	07-02-2018	EP 3279580 A1	07-02-2018
		JP 6479162 B2	06-03-2019
		JP W02016157519 A1	02-11-2017
		WO 2016157519 A1	06-10-2016

EP 3418655 A1	26-12-2018	EP 3418655 A1	26-12-2018
		JP 6156528 B1	05-07-2017
		JP 2017145998 A	24-08-2017
		WO 2017141899 A1	24-08-2017

EP 2808621 A1	03-12-2014	CN 104053959 A	17-09-2014
		EP 2808621 A1	03-12-2014
		JP 5871959 B2	01-03-2016
		JP W02013111176 A1	11-05-2015
		US 2014360218 A1	11-12-2014
		WO 2013111176 A1	01-08-2013

FORM P0459

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2019074222 A [0002]