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(54) REFRIGERANT RECOVERY SYSTEM AND REFRIGERANT RECOVERY METHOD

(57) Provided is a refrigerant recovery system (10) for recovering an air conditioning refrigerant from a refrigerant circuit (30) of a refrigeration air conditioner (12). The refrigerant recovery system (10) comprises: a refrigerant recovery device (14) which generates a compressed and condensed refrigerant by compressing and condensing an air conditioning refrigerant in the refrigerant circuit (30); a recovery cylinder (16) which recovers the compressed and condensed refrigerant generated by the refrigerant recovery device (14); a gas separation module (68) which separates the air conditioning refrigerant from the inside of the recovery cylinder (16) that has recovered the compressed and condensed refrigerant; and refeed piping (58) which refeeds the air conditioning refrigerant separated by the gas separation module (68) back to the refrigerant recovery device (14).

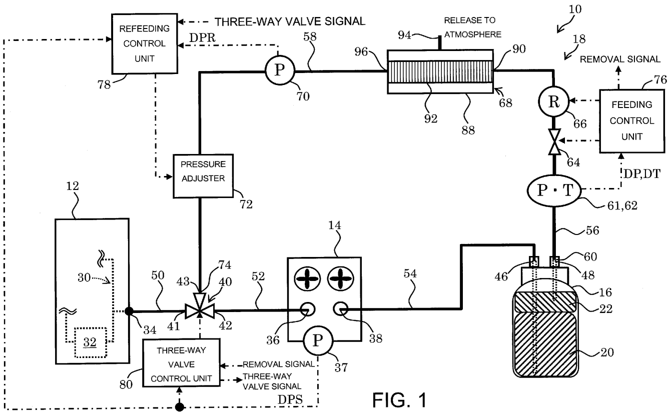

FIG. 1

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Description

TECHNICAL FIELD

[0001] The present invention generally relates to a refrigerant recovery system and a method for recovering refrigerant.

BACKGROUND

[0002] In refrigerating and air conditioning equipment (refrigerant-using equipment), such as a refrigerating machine or an air conditioner, a refrigerant circulation path through which thermal energy is delivered is provided with an air conditioning compressor, an air conditioning condenser, an expansion valve, a refrigerant recovery condenser, and an accumulator. The air conditioning compressor compresses gaseous refrigerant, being vaporized refrigerant, to increase the temperature and the pressure of the gaseous refrigerant to a high temperature and a high pressure. The air conditioning condenser cools the gaseous refrigerant, which is increased in temperature and pressure to a high temperature and a high pressure by the air conditioning compressor, by outside air or the like to liquefy the gaseous refrigerant. The expansion valve expands the refrigerant (liquid refrigerant), which is liquefied by the air conditioning condenser, to vaporize the refrigerant. The refrigerant recovery condenser liquefies the refrigerant (gaseous refrigerant), which is vaporized by the expansion valve. The accumulator accumulates the refrigerant (liquid refrigerant), which is liquefied by the refrigerant recovery condenser. Refrigerant plays a role of transferring thermal energy. While the refrigerant releases heat to the outside at the air conditioning condenser, the refrigerant receives heat from outside air or the like after passing through the expansion valve.

[0003] Various refrigerants used in the refrigerating and air conditioning equipment have a large global warming potential and a large ozone depletion potential and hence, there is a restriction on discharge of refrigerant into the atmosphere. Accordingly, particularly when refrigerant is replaced or when refrigerating and air conditioning equipment is discarded, it is mandatory to recover refrigerant filled in the refrigerating and air conditioning equipment while suppressing leakage of the refrigerant to the atmosphere as much as possible. Simultaneously, conversion to refrigerant with a low environmental load is promoted. In recent years, it is mainstream to use HFCs (hydrofluorocarbons) or the like as alternatives to chlorofluorocarbons. Examples of HFCs as a single refrigerant include R134a and R32. Examples of HFCs as a mixed refrigerant include R410A and R407C.

[0004] For recovery of refrigerant, a refrigerant recovery device is used. In the refrigerant recovery device, refrigerant in the accumulator of the refrigerating and air conditioning equipment is vaporized and, thereafter, gaseous refrigerant is suctioned and adiabatically compressed by a compressor disposed in the refrigerant recovery device. The adiabatically compressed gaseous refrigerant is liquefied by a condenser disposed in the refrigerant recovery device, and is filled and recovered into a recovery cylinder as liquid refrigerant. The amount of the recovered refrigerant is measured by a weight scale.

[0005] In Patent Document 1, it is pointed out that, at the time of recovering refrigerant in refrigerant-using equipment into a recovery container (recovery cylinder) with a refrigerant recovery device, when non-condensable gas, such as air, enters a recovery system, the non-condensable gas is also recovered into the recovery container (see paragraph 0056 in Patent Document 1). Non-condensable gas is not condensed in the recovery container, and is present as compressed gas. Accordingly, with a reduction in the volume of the gaseous phase due to an increase in the amount of liquid refrigerant in the recovery container, the pressure and the temperature in the recovery container rise. To cope with such a problem, Patent Document 1 discloses the following technique. At a stage in which the temperature in the recovery container reaches a predetermined value, the coupling of the recovery container with the refrigerant recovery device and the refrigerant-using equipment is released, and a gas separation apparatus is connected to the recovery container to remove non-condensable gas in the recovery container by the gas separation apparatus.

[0006] Specifically, mixed gas of gaseous refrigerant and non-condensable gas in the recovery container is sent to the gas separation apparatus to separate the non-condensable gas from the gaseous refrigerant, and the non-condensable gas is discharged to the atmosphere and the gaseous refrigerant is returned into the recovery container. After the non-condensable gas in the recovery container is removed, the refrigerant recovery device and the refrigerant-using equipment are connected to the recovery container again, and an operation of recovering refrigerant into the recovery container is restarted.

CITATION LIST

PATENT LITERATURE

[0007] Patent Document 1 : JP 2010- 159 952 A

SUMMARY

TECHNICAL PROBLEM

[0008] As described above, in the recovery of refrigerant from the refrigerant circuit of the refrigerating and air conditioning equipment, refrigerant is vaporized by the refrigerant recovery device and, thereafter, is adiabatically compressed, and is then liquefied and recovered. During such recovery, when non-condensable gas containing air, such as nitrogen (N_2) and oxygen (O_2), as a main component is mixed into refrigerant, the non-condensable gas is not condensed by the refrigerant recovery device, and is filled into the recovery cylinder while remaining in a gaseous state.

[0009] As a result, the internal pressure of the recovery cylinder rises, so that it becomes difficult for liquid refrigerant to be filled into the recovery cylinder, leading to a lowering of the rate of recovery of refrigerant into the recovery cylinder. For this reason, it takes a large amount of time to recover all refrigerant.

[0010] To cope with such a problem, in Patent Document 1, non-condensable gas in the recovery container is removed by the gas separation apparatus. However, in the course of the recovery of refrigerant, it is necessary to release the coupling of the recovery container (recovery cylinder) with the refrigerant recovery device and the refrigerant-using equipment and to connect the recovery container to the gas separation apparatus. Further, when the process of removing non-condensable gas is completed, it is necessary to again connect the recovery container to the refrigerant recovery device and the refrigerant-using equipment, thus requiring a large amount of labor.

[0011] Further, refrigerant is returned to (injected into) the recovery container from the gas separation apparatus in a state of gaseous refrigerant (in the gaseous phase) and hence, there is also a problem that the amount of refrigerant filled into the recovery container is lowered as compared with the case in which refrigerant is injected into the recovery container after being liquefied.

[0012] There is demand for an improved technique in which non-condensable gas in the recovery cylinder can be reduced while connection among the recovery cylinder, the refrigerant recovery device, and the refrigerating and air conditioning equipment is maintained. It is an object of the present invention to reduce, at the time of recovering refrigerant from the refrigerating and air conditioning equipment, non-condensable gas in the recovery cylinder while connection among the recovery cylinder, the refrigerant recovery device, and the refrigerating and air conditioning equipment is maintained.

SOLUTION TO THE PROBLEM

[0013] A refrigerant recovery system of the present invention is a refrigerant recovery system that recovers air conditioning refrigerant from a refrigerant circuit of refrigerating and air conditioning equipment, and the refrigerant recovery system is characterized by including: a refrigerant recovery device configured to generate compressed and condensed refrigerant by compressing and condensing the air conditioning refrigerant; a recovery cylinder configured to recover the compressed and condensed refrigerant generated by the refrigerant recovery device; a gas separation module configured to separate the air conditioning refrigerant from an inside of the recovery cylinder into which the compressed and condensed refrigerant is recovered; and a refeeding pipe configured to refeed the air conditioning refrigerant, separated by the gas separation module, to the refrigerant recovery device.

[0014] A method for recovering refrigerant of the present invention is a method for recovering refrigerant, air conditioning refrigerant being recovered from a refrigerant circuit of refrigerating and air conditioning equipment by the method, and the method is characterized by including: a generation step of generating compressed and condensed refrigerant by compressing and condensing the air conditioning refrigerant by using a refrigerant recovery device; a recovery step of recovering the compressed and condensed refrigerant, generated by the refrigerant recovery device, into a recovery cylinder; a separation step of separating, by using a gas separation module, the air conditioning refrigerant from a gas component contained inside the recovery cylinder into which the compressed and condensed refrigerant is recovered; and a refeeding step of refeeding the air conditioning refrigerant, separated by the gas separation module, to the refrigerant recovery device.

ADVANTAGEOUS EFFECTS OF INVENTION

[0015] According to the present invention, at the time of recovering refrigerant from the refrigerating and air conditioning equipment, it is possible to reduce non-condensable gas in the recovery cylinder while connection among the recovery cylinder, the refrigerant recovery device, and the refrigerating and air conditioning equipment is maintained.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016]

FIG. 1 is a schematic view of a refrigerant recovery system according to an embodiment of the present invention.

FIG. 2 is a block diagram of a feeding control unit.

FIG. 3 is a diagram showing characteristics of saturated vapor pressures (pressure characteristics) with respect to temperatures of various refrigerants.

FIG. 4 is a block diagram of a three-way valve control unit.

FIG. 5 is a diagram for describing separation of gas by an inorganic separation membrane.

FIG. 6 is a diagram for describing separation of gas by an organic separation membrane.

FIG. 7 is a flowchart of a method for recovering refrigerant according to the embodiment of the present invention.

FIG. 8 is a flowchart of a first three-way valve control.

FIG. 9 is a flowchart of a second three-way valve control.

FIG. 10 is a schematic view of a refrigerant recovery system according to another embodiment of the present invention.

DESCRIPTION OF EMBODIMENTS

[0017] Hereinafter, embodiments according to the present invention will be described in detail with reference to attached drawings. Configurations described below are for illustrative purposes only, and may be suitably changed according to the specifications of a system, an apparatus, or the like. In the case in which a plurality of embodiments or a plurality of modifications are included in the following description, it is anticipated from the beginning that features of such embodiments or modifications are used in suitable combination. In all drawings, identical elements are assigned the same reference symbols, and repeated description will be omitted.

[0018] FIG. 1 is a schematic view of a refrigerant recovery system 10 according to an embodiment of the present invention. In the drawing, thick solid lines indicate pipes through which a fluid flows, and chain lines indicate control lines through which signals are inputted to or outputted from respective control units. The refrigerant recovery system 10 is a system that recovers air conditioning refrigerant from refrigerating and air conditioning equipment, and that fills the air conditioning refrigerant into a recovery cylinder 16.

[0019] Hereinafter, the description will be made for an example in which air conditioning refrigerant is recovered from an air conditioner 12 serving as the refrigerating and air conditioning equipment. However, the refrigerant recovery system 10 is applicable to recovery of refrigerant from equipment in general that uses refrigerant. Note that air conditioning refrigerant is refrigerant that transfers thermal energy and changes phase between the liquid phase and the gaseous phase during operation of the refrigerating and air conditioning equipment, thus achieving at least either one of an air cooling function and an air heating function of the refrigerating and air conditioning equipment.

[0020] The refrigerant recovery system 10 includes a refrigerant recovery device 14, the recovery cylinder 16, a gas separation module 68, a refeeding pipe 58, and a three-way valve 40. The refrigerant recovery device 14 suctions air conditioning refrigerant from a refrigerant circuit 30 of the air conditioner 12, adiabatically compresses the air conditioning refrigerant, and condenses and liquefies the compressed refrigerant, thus generating compressed and condensed refrigerant.

[0021] The recovery cylinder 16 recovers the compressed and condensed refrigerant generated by the refrigerant recovery device 14. The gas separation module 68 separates air conditioning refrigerant from a gas component 22 contained inside the recovery cylinder 16 into which the compressed and condensed refrigerant is recovered. The air conditioning refrigerant separated by the gas separation module 68 is refed to the refrigerant recovery device 14 through the refeeding pipe 58. The three-way valve 40 is disposed between the refrigerant circuit 30 and the refrigerant recovery device 14. As will be described below, a separation apparatus 18 is configured to include the gas separation module 68 and the refeeding pipe 58. The air conditioner 12 includes a service port 34 communicating with the refrigerant circuit 30, and the refrigerant circuit 30 includes an accumulator 32 in which liquid refrigerant is accumulated. The refrigerant recovery device 14 suctions, through the service port 34, gaseous refrigerant being vaporized liquid refrigerant in the accumulator 32.

[0022] For the refrigerant recovery device 14, it is possible to use a widely commercially available chlorofluorocarbon recovery device that includes a compressor and a condenser. The refrigerant recovery device 14 includes an inlet 36 (intake port), an outlet 38, and a pressure detector 37, with air conditioning refrigerant from the refrigerant circuit 30 being taken into the refrigerant recovery device 14 through the inlet 36, compressed and condensed refrigerant being discharged through the outlet 38, and the pressure detector 37 detecting the pressure of air conditioning refrigerant at the inlet 36.

[0023] The recovery cylinder 16 includes a liquid inlet/outlet 46 and a gas inlet/outlet 48, the compressed and condensed refrigerant from the refrigerant recovery device 14 being taken into the recovery cylinder 16 through the liquid inlet/outlet 46, and the gas component 22 in the recovery cylinder 16 being discharged through the gas inlet/outlet 48.

[0024] The three-way valve 40 includes first, second, and third ports 41, 42, 43. The service port 34 of the air conditioner 12 and the first port 41 of the three-way valve 40 are connected to each other by a connection pipe 50. The second port 42 of the three-way valve 40 and the inlet 36 of the refrigerant recovery device 14 are connected to each other by an upstream pipe 52.

[0025] The third port 43 of the three-way valve 40 and the refeeding pipe 58 are connected to each other. The outlet 38 of the refrigerant recovery device 14 and the liquid inlet/outlet 46 of the recovery cylinder 16 are connected to each other by a downstream pipe 54. In performing general recovery of refrigerant, the first port 41 and the second port 42 of the three-way valve 40 are brought into a communicating state (normal mode).

[0026] Due to a defect of the valve, corrosion of the pipe or the like, decomposition of refrigerant, intrusion of air at the time of repair, for example, a non-condensable gas that contains air (nitrogen, oxygen and the like) as a main component may be mixed into air conditioning refrigerant (hereinafter also simply referred to as "refrigerant") of the air conditioner 12. In performing recovery of refrigerant, when a non-condensable gas is suctioned into the refrigerant recovery device 14 together with refrigerant, the non-condensable gas is not condensed in the refrigerant recovery device 14 and is filled into the recovery cylinder 16 while remaining in a gaseous state.

[0027] As a result, the internal pressure of the recovery cylinder 16 rises, so that it becomes difficult for liquid refrigerant to be filled into the recovery cylinder 16, leading to a lowering of the rate of recovery of refrigerant into the recovery cylinder 16. To cope with such a problem, the refrigerant recovery system 10 includes the separation apparatus 18 that removes non-condensable gas in the recovery cylinder 16. In the recovery cylinder 16, gaseous refrigerant, being a portion of revaporized liquid refrigerant 20, is mixed with a non-condensable gas, thus generating a mixed gas 22 (the gas component 22).

[0028] The separation apparatus 18 includes a gas inflow port 60, a feeding pipe 56, the gas separation module 68, and the refeeding pipe 58. The gas inflow port 60 is connected to the gas inlet/outlet 48 of the recovery cylinder 16. The mixed gas 22 taken into the feeding pipe 56 through the gas inflow port 60 flows through the feeding pipe 56. The mixed gas 22 in the feeding pipe 56 is fed to the gas separation module 68, the gas separation module 68 separating the mixed gas 22 into gaseous refrigerant and non-condensable gas.

[0029] The refeeding pipe 58 is connected to the gas separation module 68. The gas separation module 68 includes an inlet 90, a separation membrane 92, a release port 94, and an outlet 96. The mixed gas 22 is taken into the gas separation module 68 through the inlet 90. The separation membrane 92 separates gas. Non-condensable gas separated by the separation membrane 92 is released to the atmosphere through the release port 94. A refed gaseous refrigerant (air conditioning refrigerant) is discharged through the outlet 96, the refed gaseous refrigerant being a gas component containing less non-condensable gas than the mixed gas 22 due to the separation membrane 92.

[0030] One end of the feeding pipe 56 serves as the gas inflow port 60, and the other end of the feeding pipe 56 is connected to the inlet 90 of the gas separation module 68. One end of the refeeding pipe 58 is connected to the outlet 96 of the gas separation module 68, and the other end of the refeeding pipe 58 serves as a gas outflow port 74 and is connected to the third port 43 of the three-way valve 40.

[0031] As will be described hereinafter, a detector, a valve, and the like are disposed on the feeding pipe 56 and the refeeding pipe 58. However, it is also possible to form a refrigerant recovery system without including some of such components. A basic method for recovering refrigerant by a refrigerant recovery system including such a configuration includes the following steps (1) to (4).

(1) A generation step in which the first and second ports 41, 42 of the three-way valve 40 are brought into a communicating state (hereinafter referred to as "normal mode") to introduce air conditioning refrigerant in the refrigerant circuit 30 into the refrigerant recovery device 14 through the connection pipe 50 and the upstream pipe 52, and the air conditioning refrigerant is compressed and condensed by using the refrigerant recovery device 14 to generate compressed and condensed refrigerant.

(2) A recovery step in which the compressed and condensed refrigerant generated by the refrigerant recovery device 14 is recovered into the recovery cylinder 16 through the downstream pipe 54.

(3) A separation step in which the gas component 22 contained inside the recovery cylinder 16 is introduced into the gas separation module 68 through the feeding pipe 56, and the gas component 22 is separated into non-condensable gas and refed gaseous refrigerant (air conditioning refrigerant) by using the gas separation module 68.

(4) A refeeding step in which the second and third ports 42, 43 of the three-way valve 40 are brought into a communicating state (hereinafter referred to as "circulation mode"), and the refed gaseous refrigerant separated by the gas separation module 68 is refed to the refrigerant recovery device 14 through the refeeding pipe 58 and the upstream pipe 52.

[0032] The description of the refrigerant recovery system 10 shown in FIG. 1 is continued. The separation apparatus 18 further includes a pressure detector 61, a temperature detector 62, a control valve 64, and a pressure reducing valve 66, a pressure detector 70, a pressure adjuster 72, a feeding control unit 76, a refeeding control unit 78, and a three-way valve control unit 80, the pressure detector 61, the temperature detector 62, the control valve 64, and the pressure reducing valve 66 being disposed on the feeding pipe 56, and the pressure detector 70 and the pressure adjuster 72 being disposed on the refeeding pipe 58.

[0033] The pressure detector 61 and the temperature detector 62 on the feeding pipe 56 are located at positions closer to the recovery cylinder 16 than is the control valve 64, and detect the pressure and the temperature in the recovery cylinder 16. The pressure detector 70 on the refeeding pipe 58 detects the pressure in the refeeding pipe 58 at a position on the upstream side of (at a position closer to the gas separation module 68 than) the pressure adjuster 72. The pressure adjuster 72 adjusts the pressure in a portion of the refeeding pipe 58 on the downstream side (on the gas outflow port 74 side) of the pressure adjuster 72.

[0034] Each of the feeding control unit 76, the refeeding control unit 78, and the three-way valve control unit 80 is a controller, and is a microcomputer including a CPU, a ROM, a RAM, a flash memory, an input/output port and the like, for example. These control units may be achieved by one common microcomputer. These control units may include an ASIC (Application Specific Integrated Circuit) and the like in place of or in combination with a microcomputer.

[0035] Based on a detected value DP from the pressure detector 61 and a detected value DT from the temperature detector 62, the feeding control unit 76 determines whether it is necessary to remove non-condensable gas from the inside of the recovery cylinder 16. When the feeding control unit 76 determines that it is necessary to remove non-condensable gas, the feeding control unit 76 brings the control valve 64 into an open state. When the feeding control unit 76 determines that it is not necessary to remove non-condensable gas, the feeding control unit 76 brings the control valve 64 into a closed state. In the case in which the control valve 64 is in a closed state, the three-way valve control unit 80 brings the first port 41 and the second port 42 into a communicating state (normal mode) by controlling the three-way valve 40.

[0036] In the case in which the control valve 64 is in an open state, the three-way valve control unit 80 brings the second port 42 and the third port 43 into a communicating state (circulation mode) or brings the first port 41 and the third port 43 into a communicating state (hereinafter referred to as "vaporization promotion mode") by controlling the three-way valve 40. As described above, in the embodiment shown in FIG. 1, the vaporization promotion mode is added to the basic method for recovering refrigerant.

[0037] The normal mode is a mode in which refrigerant is recovered into the recovery cylinder 16 from the air conditioner 12. The circulation mode is a mode in which a circulation loop of the separation apparatus 18, the refrigerant recovery device 14, and the recovery cylinder 16 is formed, and mixed gas 22 in the recovery cylinder 16 is repeatedly fed into the gas separation module 68 to remove non-condensable gas in the recovery cylinder 16.

[0038] The vaporization promotion mode is a mode in which when there is a possibility of refrigerant in the refrigerant circuit 30 of the air conditioner 12 being condensed at a low temperature, a portion of the mixed gas 22 in the recovery cylinder 16 is fed into the refrigerant circuit 30 from the separation apparatus 18 to raise the temperature of the refrigerant in the refrigerant circuit 30, thus promoting vaporization of the refrigerant. The gaseous refrigerant that passes through the refrigerant recovery device 14 is adiabatically compressed, thus having a temperature higher than the temperature at the time of flowing into the refrigerant circuit 30; that is, into the refrigerant recovery device 14. Therefore, the refrigerant that enters the recovery cylinder 16 from the refrigerant recovery device 14 has an increased temperature.

[0039] FIG. 2 is a block diagram of the feeding control unit 76. The feeding control unit 76 includes a reference pressure acquisition unit 104, a pressure reducing valve control unit 106, and a determination unit 108. The separation apparatus 18 includes an input unit 100, such as a keypad or a barcode reader, and a storage unit 102, such as a flash memory. The input unit 100 and the storage unit 102 are electrically connected to the feeding control unit 76. A memory disposed in the feeding control unit 76 may be used as the storage unit 102.

[0040] Before refrigerant is recovered, recovery refrigerant information 110, indicating the kind of refrigerant to be recovered (hereinafter also referred to as "recovery refrigerant"), is inputted from the input unit 100 and is stored in the storage unit 102. For example, when a barcode that is applied to the surface of the housing of the air conditioner 12 and that indicates the kind of refrigerant used in the air conditioner 12 is read by a barcode reader, serving as the input unit 100, the recovery refrigerant information 110 is stored in the storage unit 102. Further, characteristics of saturated vapor pressures with respect to temperatures (hereinafter referred to as "pressure characteristics 112") are stored in advance in the storage unit 102 for each of a plurality of kinds of refrigerant. FIG. 3 shows pressure characteristics of respective refrigerants A, B, C, and D.

[0041] A detected temperature DT (the temperature in the recovery cylinder 16) from the temperature detector 62 on the feeding pipe 56 is inputted to the reference pressure acquisition unit 104. The reference pressure acquisition unit 104 reads, from the storage unit 102, the pressure characteristics 112 that correspond to recovery refrigerant indicated by the recovery refrigerant information 110, and acquires, as a reference pressure RP, the saturated vapor pressure of the recovery refrigerant (refrigerant A in the example in FIG. 3) at the detected temperature DT (the temperature in the recovery cylinder 16) as shown in FIG. 3. Then, the reference pressure acquisition unit 104 outputs the reference pressure RP to the determination unit 108.

[0042] The reference pressure RP and a detected pressure DP (the pressure in the recovery cylinder 16) from the pressure detector 61 on the feeding pipe 56 are inputted to the determination unit 108. In the case in which the detected pressure DP is higher than the reference pressure RP (the saturated vapor pressure of recovery refrigerant) as shown in FIG. 3, it is indicated that non-condensable gas is in the recovery cylinder 16. When the detected pressure DP is higher than the reference pressure RP (hereinafter also referred to as "high pressure state"), the determination unit 108 controls the control valve 64 to an open state to send the mixed gas 22 in the recovery cylinder 16 to the gas separation module 68.

[0043] In contrast, when the detected pressure DP is not in a high pressure state, the determination unit 108 maintains the control valve 64 in a closed state. The determination unit 108 also outputs a removal signal indicating whether non-condensable gas is being removed. A removal signal is a signal that is low when the control valve 64 is in a closed state, and that is high when the control valve 64 is in an open state.

[0044] The detected pressure DP (the pressure in the recovery cylinder 16) from the pressure detector 61 on the feeding pipe 56 is inputted to the pressure reducing valve control unit 106. Based on the detected pressure DP, the pressure reducing valve control unit 106 controls the pressure reducing valve 66 such that when the control valve 64 is brought into an open state and the mixed gas 22 in the recovery cylinder 16 is fed into the gas separation module 68, the separation membrane 92 of the gas separation module 68 is prevented from being damaged by the pressure in the recovery cylinder 16. By controlling the pressure reducing valve 66, the pressure in a portion of the pipe on the downstream side (on the gas separation module 68 side) of the pressure reducing valve 66 is adjusted.

[0045] FIG. 4 is a block diagram of the three-way valve control unit 80. The three-way valve control unit 80 includes a determination unit 118. The input unit 100, such as a keypad, and the storage unit 102, such as a flash memory, are electrically connected to the three-way valve control unit 80. A memory in the three-way valve control unit 80 may be used as the storage unit 102.

[0046] Before refrigerant is recovered, a pressure threshold 120, being the condition for which the mode transitions to the vaporization promotion mode, and duration 122 of the vaporization promotion mode are inputted from the input unit 100 and are stored in the storage unit 102. A removal signal, a detected pressure DPS (the pressure at the inlet 36 of the refrigerant recovery device 14) from the pressure detector 37 of the refrigerant recovery device 14, and the pressure threshold 120 and the duration 122, which are stored in the storage unit 102, are inputted to the determination unit 118. In this embodiment, the detected pressure DPS indicates the pressure in the refrigerant circuit 30 of the air conditioner 12 in the normal mode.

[0047] In the case in which a removal signal is low, the determination unit 118 controls the three-way valve 40 in such a way as to cause the first port 41 and the second port 42 of the three-way valve 40 to be in a communicating state (normal mode). When the removal signal is changed from low to high, based on the comparison result between the detected pressure DPS (the pressure in the refrigerant circuit 30) and the pressure threshold 120, the determination unit 118 decides whether the three-way valve 40 is controlled to either one of the circulation mode and the vaporization promotion mode.

[0048] Specifically, when the detected pressure DPS is higher than the pressure threshold 120, the determination unit 118 estimates that there is a low possibility of refrigerant in the refrigerant circuit 30 being condensed at a low temperature, and controls the three-way valve 40 in such a way as to cause the second port 42 and the third port 43 of the three-way valve 40 to be in a communicating state (circulation mode). In contrast, when the detected pressure DPS is equal to or less than the pressure threshold 120, the determination unit 118 estimates that there is a possibility of refrigerant in the refrigerant circuit 30 being condensed at a low temperature, and controls the three-way valve 40 in such a way as to cause the first port 41 and the third port 43 of the three-way valve 40 to be in a communicating state (vaporization promotion mode).

[0049] Further, when a time of the duration 122 has elapsed from the transition to the vaporization promotion mode, the determination unit 118 controls the three-way valve 40 from the vaporization promotion mode to the circulation mode. The determination unit 118 also outputs a three-way valve signal indicating that the three-way valve is currently in any one of the normal mode, the circulation mode, and the vaporization promotion mode.

[0050] As shown in FIG. 1, a three-way valve signal, a detected pressure DPR (the pressure in the refeeding pipe 58) from the pressure detector 70 on the refeeding pipe 58, and the detected pressure DPS (the pressure at the inlet 36 of the refrigerant recovery device 14) from the pressure detector 37 of the refrigerant recovery device 14 are inputted to the refeeding control unit 78. When a three-way valve signal indicates the circulation mode, based on the detected pressures DPR, DPS, the refeeding control unit 78 controls the pressure adjuster 72 in such a way as to cause the pressure in the portion of the refeeding pipe 58 on the downstream side (on the gas outflow port 74 side) of the pressure adjuster 72 to be higher than the pressure at the inlet 36 of the refrigerant recovery device 14. With such an operation, it is possible to prevent refrigerant from flowing back from the upstream pipe 52 toward the refeeding pipe 58. When a three-way valve signal indicates the vaporization promotion mode, the refeeding control unit 78 controls the pressure adjuster 72 in such a way as to cause the pressure in the portion of the refeeding pipe 58 on the downstream side (on the gas outflow port 74 side) of the pressure adjuster 72 to be a predetermined pressure at which gas can be fed into the refrigerant circuit 30 of the air conditioner 12.

[0051] Next, the gas separation module 68 will be described. As shown in FIG. 1, the gas separation module 68 includes a cylindrical housing 88 and the cylindrical separation membrane 92 disposed in the housing 88. The housing 88 includes the inlet 90, the outlet 96, and the release port 94, the mixed gas 22 being taken into the housing 88 through the inlet 90, the outlet 96 being disposed in such a way as to face the inlet 90, refed gaseous refrigerant being discharged through the outlet 96, and non-condensable gas being released to the atmosphere through the release port 94.

[0052] One end of the separation membrane 92 is connected to the inlet 90 of the housing 88, and the other end of the separation membrane 92 is connected to the outlet 96 of the housing 88. The mixed gas 22 enters the separation membrane 92 from the inlet 90, and proceeds toward the outlet 96. When the mixed gas 22 proceeds toward the outlet 96, non-condensable gas containing air as a main component permeates through the separation membrane 92 and flows to the outside of the separation membrane 92, and is eventually released to the atmosphere from the release port 94 of the housing 88. Refed gaseous refrigerant containing less non-condensable gas than the mixed gas 22 is discharged into the refeeding pipe 58 from the outlet 96 of the housing 88.

[0053] For the separation membrane 92, for example, a membrane made of an inorganic material (hereinafter referred to as "inorganic separation membrane") or a membrane made of an organic material (hereinafter referred to as "organic separation membrane") may be used. FIG. 5 is a diagram schematically showing the state of separation of gas by the inorganic separation membrane. FIG. 6 is a diagram schematically showing the state of separation of gas by the organic separation membrane.

[0054] As shown in FIG. 5, the inorganic separation membrane separates gas by making use of a difference in molecular diameter. Air 26 and water 28 having a smaller molecular diameter than gaseous refrigerant 24 flow to the outside of the membrane through the pores of the separation membrane 92. In contrast, the gaseous refrigerant 24 remains on the inner side of the membrane. As a material used for forming the inorganic separation membrane, ceramic, zeolite, or the like may be used.

[0055] As shown in FIG. 6, the organic separation membrane separates gas by making use of a difference in rate of permeation of molecules through the membrane. Air 26 and water 28 having a higher permeation rate than the gaseous refrigerant 24 permeate through the separation membrane 92 and flow to the outside of the membrane. In contrast, the gaseous refrigerant 24 remains on the inner side of the membrane. For a material used for forming the organic separation membrane, a polyimide resin or the like may be used.

[0056] Next, a specific method for recovering refrigerant by using the refrigerant recovery system 10 will be described. FIG. 7 is a flowchart showing the specific method for recovering refrigerant by using the refrigerant recovery system 10. In FIG. 7, S 100 to S104, S126, and S128 are steps performed by an operator, and other steps are steps automatically performed by the refrigerant recovery system 10.

[0057] First, in S 100, the operator prepares the refrigerant recovery device 14, the recovery cylinder 16, and the separation apparatus 18. Then, in S102, the operator cuts off the power supply of the air conditioner 12 and, thereafter, connects the air conditioner 12, the refrigerant recovery device 14, the recovery cylinder 16, and the separation apparatus 18 to each other as shown in FIG. 1.

[0058] Next, in S 103, the operator turns on the power supply of the separation apparatus 18. Thereafter, the operator inputs the recovery refrigerant information 110 (see FIG. 2), and the pressure threshold 120 and the duration 122 (see FIG. 4) relating to the vaporization promotion mode through the input unit 100. When the power supply of the separation apparatus 18 is turned on, the three-way valve control unit 80 controls the three-way valve 40 to the normal mode, in which the first port 41 and the second port 42 communicate with each other. In S104, the operator drives the refrigerant recovery device 14. With such operations, recovery of refrigerant from the air conditioner 12 is started.

[0059] S106 to S122 are automatically controlled by the refrigerant recovery system 10. In S106, based on pressure characteristics of recovery refrigerant indicated by the recovery refrigerant information 110 (see FIG. 3), the reference pressure acquisition unit 104 of the feeding control unit 76 acquires, as the reference pressure RP, the saturated vapor pressure of the recovery refrigerant at the detected temperature DT (the temperature in the recovery cylinder 16) from the temperature detector 62.

[0060] Then, the determination unit 108 of the feeding control unit 76 checks whether the detected pressure DP (the pressure in the recovery cylinder) from the pressure detector 61 is higher than the reference pressure RP. As shown in S106 in FIG. 7, the determination unit 108 may check whether the detected pressure DP (the pressure in the recovery cylinder) is higher than a pressure obtained by adding a predetermined pressure α to the reference pressure RP (RP + α, hereinafter referred to as "criterion pressure").

[0061] When the detected pressure DP is equal to or less than the criterion pressure (RP + α) (S106: NO), the determination unit 108 determines that the removal of non-condensable gas in the recovery cylinder 16 is unnecessary, and the recovery of refrigerant is continued (S108).

[0062] In contrast, when the detected pressure DP is higher than the criterion pressure (RP + α) (S106: YES), the determination unit 108 determines that the removal of non-condensable gas in the recovery cylinder 16 is necessary, the removal signal is changed from low to high and, thereafter, the process advances to S 110. When the determination is performed by using a criterion pressure as described above, it is possible to start removal of non-condensable gas after non-condensable gas is accumulated in the recovery cylinder 16 to some extent.

[0063] In S110, with the reception of the removal signal changing from low to high, the three-way valve control unit 80 performs a first three-way valve control. FIG. 8 is a flowchart showing the first three-way valve control. In S200 shown in FIG. 8, the determination unit 118 of the three-way valve control unit 80 checks whether the detected pressure DPS (the pressure in the refrigerant circuit 30) from the pressure detector 37 of the refrigerant recovery device 14 is equal to or less than the pressure threshold 120 stored in the storage unit 102. The pressure threshold 120 may be approximately 0.1 MPa, for example.

[0064] When the determination in S200 is NO, the determination unit 118 estimates that there is a low possibility of refrigerant in the refrigerant circuit 30 of the air conditioner 12 being condensed at a low temperature, controls the three-way valve 40 to the circulation mode, in which the second port 42 and the third port 43 communicate with each other (S206), and turns off a vaporization promotion flag (S208) to finish the first three-way valve control.

[0065] In contrast, when the determination in S200 is YES, the determination unit 118 estimates that there is a high possibility of refrigerant in the refrigerant circuit 30 of the air conditioner 12 being condensed at a low temperature, controls the three-way valve 40 to the vaporization promotion mode, in which the first port 41 and the third port 43 communicate with each other (S202), and turns on the vaporization promotion flag (S204) to finish the first three-way valve control.

[0066] Returning to FIG. 7, after S110, in S112 the determination unit 108 of the feeding control unit 76 opens the control valve 64 on the feeding pipe 56. The timing at which the removal signal is changed from low to high is substantially simultaneous with the timing at which S110 (first three-way valve control) is performed and with the timing at which S112 is performed (the control valve 64 is opened). Before the control valve 64 is opened, the pressure reducing valve 66 is adjusted by the pressure reducing valve control unit 106. By opening the control valve 64, the mixed gas 22 in the recovery cylinder 16 is sent to the gas separation module 68.

[0067] In the case of the circulation mode, the circulation loop of the separation apparatus 18, the refrigerant recovery device 14, and the recovery cylinder 16 is formed, and the mixed gas 22 in the recovery cylinder 16 is repeatedly fed into the gas separation module 68. Non-condensable gas is released to the atmosphere, and refed gaseous refrigerant is fed into the upstream pipe 52 disposed on the upstream of the refrigerant recovery device 14, passes through the refrigerant recovery device 14, and returns to the recovery cylinder 16 in a state of being liquefied. With such a configuration, non-condensable gas in the recovery cylinder 16 is gradually removed, and the pressure in the recovery cylinder 16 is lowered.

[0068] In the case of the vaporization promotion mode, refed gaseous refrigerant, being a portion of the mixed gas 22 in the recovery cylinder 16, is fed into the refrigerant circuit 30 of the air conditioner 12 to raise the temperature of refrigerant in the refrigerant circuit 30. With such an operation, vaporization of the refrigerant is promoted and hence, it is possible to increase the rate of recovery of refrigerant when the recovery of refrigerant is restarted.

[0069] The refeeding control unit 78 controls the pressure adjuster 72 in the circulation mode and the vaporization promotion mode to adjust the pressure in the portion of the refeeding pipe 58 on the downstream side (the gas outflow port 74 side) of the pressure adjuster 72.

[0070] In S114, the determination unit 108 of the feeding control unit 76 checks whether the detected pressure DP (the pressure in the recovery cylinder 16) from the pressure detector 61 is equal to or less than the reference pressure RP. When the determination in S114 is NO, the removal of non-condensable gas is continued (S116), and the process advances to S118.

[0071] In S118, the three-way valve control unit 80 performs a second three-way valve control. FIG. 9 is a flowchart showing the second three-way valve control. In S300 shown in FIG. 9, the determination unit 118 of the three-way valve control unit 80 checks whether the vaporization promotion flag is ON. When the determination in S300 is NO (in the case of the circulation mode), the determination unit 118 finishes the second three-way valve control. In contrast, when the determination in S300 is YES (in the case of the vaporization promotion mode), the process advances to S302.

[0072] In S302, the determination unit 118 checks whether a time of the duration 122 has elapsed from the transition to the vaporization promotion mode, the duration 122 being stored in the storage unit 102 (see FIG. 4). When the determination in S302 is NO, the determination unit 118 determines that it is necessary to continue the vaporization promotion mode, and the determination unit 118 finishes the second three-way valve control. In contrast, when the determination in S302 is YES, the determination unit 118 determines that the vaporization promotion mode is allowed to be finished, and the determination unit 118 controls the three-way valve 40 to the circulation mode, in which the second port 42 and the third port 43 communicate with each other (S304), and turns off the vaporization promotion flag (S306) to finish the second three-way valve control.

[0073] Returning to FIG. 7, in S114, when the detected pressure DP (the pressure in the recovery cylinder 16) from the pressure detector 61 is equal to or less than the reference pressure RP (S 114: YES), the determination unit 108 of the feeding control unit 76 determines that the removal of non-condensable gas in the recovery cylinder 16 is completed, and the process advances to S120.

[0074] In S120, the determination unit 108 of the feeding control unit 76 closes the control valve 64 on the feeding pipe 56, and changes a removal signal from high to low. With the reception of the removal signal changing from high to low, the determination unit 118 of the three-way valve control unit 80 controls the three-way valve 40 to the normal mode, in which the first port 41 and the second port 42 communicate with each other. The pressure reducing valve control unit 106 of the feeding control unit 76 finishes the control of the pressure reducing valve 66, and the refeeding control unit 78 finishes the control of the pressure adjuster 72.

[0075] Next, in S122, the refrigerant recovery device 14 checks whether the detected pressure DPS (the pressure in the refrigerant circuit 30) from the pressure detector 37 is a negative pressure. When the determination in S122 is NO, the refrigerant recovery device 14 continues the recovery of refrigerant (S124). When the determination in S 122 is YES, the refrigerant recovery device 14 notifies the operator of the finish of the recovery of refrigerant by a lamp, a sound, or the like.

[0076] In S 126, the operator stops the refrigerant recovery device 14. Then, in S 128, the operator turns off the power supply of the separation apparatus 18. The flow of the recovery of refrigerant is as described above.

[0077] Next, the manner of operation and advantageous effects of the above-described refrigerant recovery system 10 will be described. In the refrigerant recovery system 10, the mixed gas 22 in the recovery cylinder 16 is sent to the gas separation module 68, so that non-condensable gas is separated from the mixed gas 22 and is discharged to the atmosphere, and refed gaseous refrigerant containing less non-condensable gas than the mixed gas 22 is discharged from the outlet 96 of the gas separation module 68 and is sent into the pipe between the refrigerant circuit 30 of the air conditioner 12 and the refrigerant recovery device 14. Further, the refed gaseous refrigerant passes through the refrigerant recovery device 14 again, and returns to the recovery cylinder 16 in a state of being liquefied.

[0078] As described above, it is possible to reduce non-condensable gas in the recovery cylinder 16 while connection among the recovery cylinder 16, the refrigerant recovery device 14, and the air conditioner 12 is maintained. A rise of the internal pressure of the recovery cylinder 16 can be suppressed and hence, the rate of recovery of refrigerant into the recovery cylinder 16 can be increased and it is possible to increase the amount of refrigerant filled into the recovery cylinder 16.

[0079] Further, the refed gaseous refrigerant is returned to the recovery cylinder 16 in a state of being liquefied (in a reduced volume state) and hence, it is possible to further increase the amount of refrigerant filled into the recovery cylinder 16. The mixed gas 22 in the recovery cylinder 16 is sent to the gas separation module 68 and hence, the arrangement of the recovery cylinder 16, the gas separation module 68, and the refrigerant recovery device 14 in this order has important significance.

[0080] The gas separation module 68 is attached above the recovery cylinder 16. Therefore, liquid components, such as liquid refrigerant and water mixed into the liquid refrigerant, stay at the bottom portion of the recovery cylinder 16. Accordingly, there is no possibility of liquid refrigerant or a large amount of water entering the separation membrane 92 of the gas separation module 68 and hence, it is possible to suppress a lowering of the gas separation effect of the separation membrane 92. Further, air conditioning refrigerant is adiabatically compressed by the refrigerant recovery device 14, and is filled into the recovery cylinder 16 in a state of being liquefied.

[0081] Therefore, only refrigerant is vaporized by an amount corresponding to the saturated vapor pressure for the volume of the space portion in the recovery cylinder 16, and most of refrigerant is in a liquid state in the recovery cylinder 16. The proportion of vaporized refrigerant (gaseous refrigerant) is low and hence, it is possible to reduce the amount of gaseous refrigerant sent to the gas separation module 68. Accordingly, it is also possible to reduce a risk of leakage of refrigerant in the gas separation module 68.

[0082] The circulation loop of the separation apparatus 18, the refrigerant recovery device 14, and the recovery cylinder 16 is formed and non-condensable gas is repeatedly separated by the gas separation module 68 and hence, it is possible to effectively remove non-condensable gas in the recovery cylinder 16. That is, it is possible to increase separation efficiency as compared with a configuration in which the mixed gas 22 passes through the gas separation module 68 only one time.

[0083] Further, only in the case in which non-condensable gas is in the recovery cylinder 16, the control valve 64 is brought into an open state to remove non-condensable gas by the gas separation module 68. Accordingly, it is possible to avoid unnecessary use of the gas separation module 68 when there is no non-condensable gas or when there is a small amount of non-condensable gas in the recovery cylinder 16.

[0084] The pressure characteristics 112 of a plurality of kinds of refrigerant are stored in the storage unit 102 of the separation apparatus 18 and hence, it is possible to use the common separation apparatus 18 for the recovery of refrigerants of different kinds.

[0085] When the gas separation module 68 is used (when the control valve 64 is in an open state) and when the pressure in the refrigerant circuit 30 is higher than the predetermined pressure, it is possible to accurately feed refed gaseous refrigerant from the refeeding pipe 58 to the refrigerant recovery device 14. Further, when the gas separation module 68 is used (when the control valve 64 is in an open state) and when the pressure in the refrigerant circuit 30 is equal to or less than the predetermined pressure, it is possible to feed refed gaseous refrigerant (having a temperature higher than the temperature in the refrigerant circuit 30) to the refrigerant circuit 30, the refed gaseous refrigerant being a portion of gaseous refrigerant in the recovery cylinder 16 into which refrigerant is taken that is adiabatically compressed by the refrigerant recovery device 14, thus having a temperature higher than the temperature at the time of flowing into the refrigerant recovery device 14. With such a configuration, it is possible to promote gasification of refrigerant by raising the temperature of the refrigerant in the refrigerant circuit 30 and hence, the rate of recovery of refrigerant can be increased when the recovery of refrigerant is restarted.

[0086] Next, a refrigerant recovery system according to another embodiment of the present invention will be described. FIG. 10 is a schematic view of a refrigerant recovery system 10A according to another embodiment of the present invention. The refrigerant recovery system 10A is obtained by omitting the three-way valve 40 and the three-way valve control unit 80 from the above-described refrigerant recovery system 10, and by adding a control valve 150 onto the refeeding pipe 58. A gas outflow port 74 of a separation apparatus 18A is connected to a pipe between the refrigerant circuit 30 of the air conditioner 12 and the refrigerant recovery device 14, thus forming a connection portion 152.

[0087] Control of the respective components performed by the feeding control unit 76 and a removal signal are substantially identical to the corresponding control of the respective components and the corresponding removal signal in the above-described refrigerant recovery system 10. A removal signal is inputted to the refeeding control unit 78 in place of a three-way valve signal, and the refeeding control unit 78 controls the control valve 150 on the refeeding pipe 58 based on low/high of the removal signal.

[0088] Specifically, when a removal signal is low (the control valve 64 on the feeding pipe 56 is in a closed state), the control valve 150 on the refeeding pipe 58 is also brought into a closed state. When a removal signal is high (the control valve 64 on the feeding pipe 56 is in an open state), the control valve 150 on the refeeding pipe 58 is also brought into an open state. When a removal signal is high, based on detected pressures DPR, DPS, the refeeding control unit 78 controls the pressure adjuster 72 in such a way as to cause the pressure in the portion of the refeeding pipe 58 on the downstream side (the gas outflow port 74 side) of the pressure adjuster 72 to be higher than the pressure at the inlet 36 of the refrigerant recovery device 14.

[0089] According to this embodiment, by bringing the control valves 64, 150 into a closed state, it is possible to perform general recovery of refrigerant into the recovery cylinder 16 from the air conditioner 12. Further, by bringing the control valves 64, 150 into an open state, the circulation loop of the separation apparatus 18A, the refrigerant recovery device 14, and the recovery cylinder 16 is formed and hence, it is possible to remove non-condensable gas from the inside of the recovery cylinder 16. The three-way valve and the three-way valve control unit are omitted and hence, the configuration of the refrigerant recovery system 10A can be simplified.

[0090] Next, a modification will be described. In the method for recovering refrigerant shown in FIG. 7, the three-way valve 40 is changed to the circulation mode only one time in the process of recovering refrigerant. However, the three-way valve 40 may be changed to the circulation mode a plurality of times. That is, in the case in which the three-way valve 40 is changed to the circulation mode and, thereafter, is changed to the normal mode to restart the recovery of refrigerant, when the pressure in the recovery cylinder 16 increases again, the three-way valve 40 may be changed to the circulation mode again.

[0091] In the method for recovering refrigerant shown in FIG. 7, the vaporization promotion mode is performed. However, the vaporization promotion mode may be omitted, and it may be the case that only the normal mode and the circulation mode are performed. With such a configuration, the method for recovering refrigerant can be simplified.

[0092] In the respective embodiments described above, each control unit controls each unit. However, the operator may visually check detected values from the respective detectors, and may manually operate at least one of the control valves 64, 150, the pressure reducing valve 66, the three-way valve 40, and the pressure adjuster 72.

[0093] In the respective embodiments described above, the pressure and the temperature in the recovery cylinder 16 are detected by the pressure detector 61 and the temperature detector 62 disposed on the feeding pipe 56 of the separation apparatus 18. However, the pressure and the temperature at the outlet 38 of the refrigerant recovery device 14 may be detected as the pressure and the temperature in the recovery cylinder 16, and may be inputted to the feeding control unit 76 to perform control. Alternatively, the pressure and the temperature detected by the pressure detector and the temperature detector provided to the recovery cylinder 16 may be inputted to the feeding control unit 76 as the pressure and the temperature in the recovery cylinder 16 to perform control.

LIST OF REFERENCE SIGNS

[0094]

10, 10A	refrigerant recovery system
12	air conditioner (refrigerating and air conditioning equipment)
14	refrigerant recovery device
16	recovery cylinder
18	separation apparatus
18A	separation apparatus
20	liquid refrigerant
22	mixed gas (gas component)
24	gaseous refrigerant
26	air
28	water
30	refrigerant circuit
32	accumulator
34	service port
36	inlet
37	pressure detector
38	outlet
40	three-way valve
41	first port
42	second port
43	third port
461	iquid inlet/outlet
48	gas inlet/outlet
50	connection pipe
52	upstream pipe
54	downstream pipe
56	feeding pipe
58	refeeding pipe
60	gas inflow port
61	pressure detector
62	temperature detector
64	control valve
66	pressure reducing valve
68	gas separation module
70	pressure detector
72	pressure adjuster
74	gas outflow port
76	feeding control unit
78	refeeding control unit
80	three-way valve control unit
88	housing
90	inlet
92	separation membrane
94	release port

96	outlet
100	input unit
102	storage unit
104	reference pressure acquisition unit
106	pressure reducing valve control unit
108	determination unit
110	recovery refrigerant information
112	pressure characteristics
118	determination unit
120	pressure threshold
122	duration
150	control valve
152	connection portion.

Claims

1. A refrigerant recovery system that recovers air conditioning refrigerant from a refrigerant circuit of refrigerating and air conditioning equipment, the refrigerant recovery system comprising:

a refrigerant recovery device configured to generate compressed and condensed refrigerant by compressing and condensing the air conditioning refrigerant;
a recovery cylinder configured to recover the compressed and condensed refrigerant generated by the refrigerant recovery device;
a gas separation module configured to separate the air conditioning refrigerant from an inside of the recovery cylinder into which the compressed and condensed refrigerant is recovered; and
a refeeding pipe configured to refeed the air conditioning refrigerant, separated by the gas separation module, to the refrigerant recovery device.

2. The refrigerant recovery system according to claim 1, comprising:

a pressure adjuster configured to adjust a pressure in the refeeding pipe; and
a refeeding control unit configured to control the pressure adjuster in such a way as to cause the pressure in the refeeding pipe to be higher than a pressure at an intake port of the refrigerant recovery device, the air conditioning refrigerant being taken into the refrigerant recovery device through the intake port.

3. The refrigerant recovery system according to claim 1 or 2, wherein

the recovery cylinder includes a gas inlet/outlet through which a gas component is taken out,
the refrigerant recovery system includes a feeding pipe connected to the gas inlet/outlet, the gas component entering the feeding pipe from the recovery cylinder,
the feeding pipe is connected to the gas separation module, the gas component enters the gas separation module from the feeding pipe, and the gas separation module separates the gas component into non-condensable gas and the air conditioning refrigerant, and
the gas separation module is connected to the refeeding pipe, refed gaseous refrigerant, being the air conditioning refrigerant separated by the gas separation module, enters the refeeding pipe, and the refeeding pipe sends the refed gaseous refrigerant into a pipe between the refrigerant circuit and the refrigerant recovery device.

4. The refrigerant recovery system according to claim 3, comprising:

a control valve configured to open and close between the gas inlet/outlet of the feeding pipe and the gas separation module;
a feeding control unit configured to control the control valve;
a temperature detector and a pressure detector, the temperature detector being configured to detect a temperature in the recovery cylinder, the pressure detector being configured to detect a pressure in the recovery cylinder; and
a storage unit configured to store a pressure characteristic of a saturated vapor pressure with respect to a temperature of recovery refrigerant, the recovery refrigerant being refrigerant recovered into the recovery cylinder, wherein
the feeding control unit acquires the saturated vapor pressure of the recovery refrigerant at a detected temperature from the temperature detector based on the pressure characteristic, and in a case of a high pressure state where the detected pressure from the pressure detector is higher than the saturated vapor pressure acquired, the feeding control unit controls the control valve to an open state, and when not in the high pressure state, the feeding control unit controls the control valve to a closed state.

5. The refrigerant recovery system according to claim 4, comprising

an input unit configured to input a kind of the recovery refrigerant, wherein
the pressure characteristic of each of a plurality of kinds of refrigerant is stored in the storage unit, and
the feeding control unit controls an open/closed state of the control valve based on the pressure characteristic that corresponds to a kind of the

recovery refrigerant inputted from the input unit and that is stored in the storage unit.

6. The refrigerant recovery system according to claim 4 or 5, comprising:

a three-way valve disposed between the refrigerant circuit and the refrigerant recovery device; and
a three-way valve control unit configured to control the three-way valve, wherein
the three-way valve includes a first port, a second port, and a third port,
the first port of the three-way valve is connected to the refrigerant circuit, the second port of the three-way valve is connected to the refrigerant recovery device, and the third port of the three-way valve is connected to the refeeding pipe,
in a case in which the control valve on the feeding pipe is in a closed state, the three-way valve control unit controls the three-way valve in such a way as to cause the first port and the second port of the three-way valve to be in a communicating state, and
in a case in which the control valve on the feeding pipe is in an open state, the three-way valve control unit controls the three-way valve in such a way as to cause the second port and the third port of the three-way valve to be in a communicating state.

7. The refrigerant recovery system according to claim 4 or 5, comprising:

a three-way valve disposed between the refrigerant circuit and the refrigerant recovery device; and
a three-way valve control unit configured to control the three-way valve; and
another pressure detector configured to detect a pressure in the refrigerant circuit, wherein
the three-way valve includes a first port, a second port, and a third port,
the first port of the three-way valve is connected to the refrigerant circuit, the second port of the three-way valve is connected to the refrigerant recovery device, and the third port of the three-way valve is connected to the refeeding pipe,
in a case in which the control valve on the feeding pipe is in a closed state, the three-way valve control unit controls the three-way valve in such a way as to cause the first port and the second port of the three-way valve to be in a communicating state,
in a case in which the control valve on the feeding pipe is in an open state and a detected pressure from the other pressure detector is higher than a predetermined pressure, the three-way valve control unit controls the three-way valve in such a way as to cause the second port and the third port of the three-way valve to be in a communicating state, and
in a case in which the control valve on the feeding pipe is in an open state and a detected pressure from the other pressure detector is equal to or less than the predetermined pressure, the three-way valve control unit controls the three-way valve in such a way as to cause the first port and the third port of the three-way valve to be in a communicating state.

8. A method for recovering refrigerant, air conditioning refrigerant being recovered from a refrigerant circuit of refrigerating and air conditioning equipment by the method, the method comprising:

a generation step of generating compressed and condensed refrigerant by compressing and condensing the air conditioning refrigerant by using a refrigerant recovery device;
a recovery step of recovering the compressed and condensed refrigerant, generated by the refrigerant recovery device, into a recovery cylinder;
a separation step of separating, by using a gas separation module, the air conditioning refrigerant from a gas component contained inside the recovery cylinder into which the compressed and condensed refrigerant is recovered; and
a refeeding step of refeeding the air conditioning refrigerant, separated by the gas separation module, to the refrigerant recovery device.

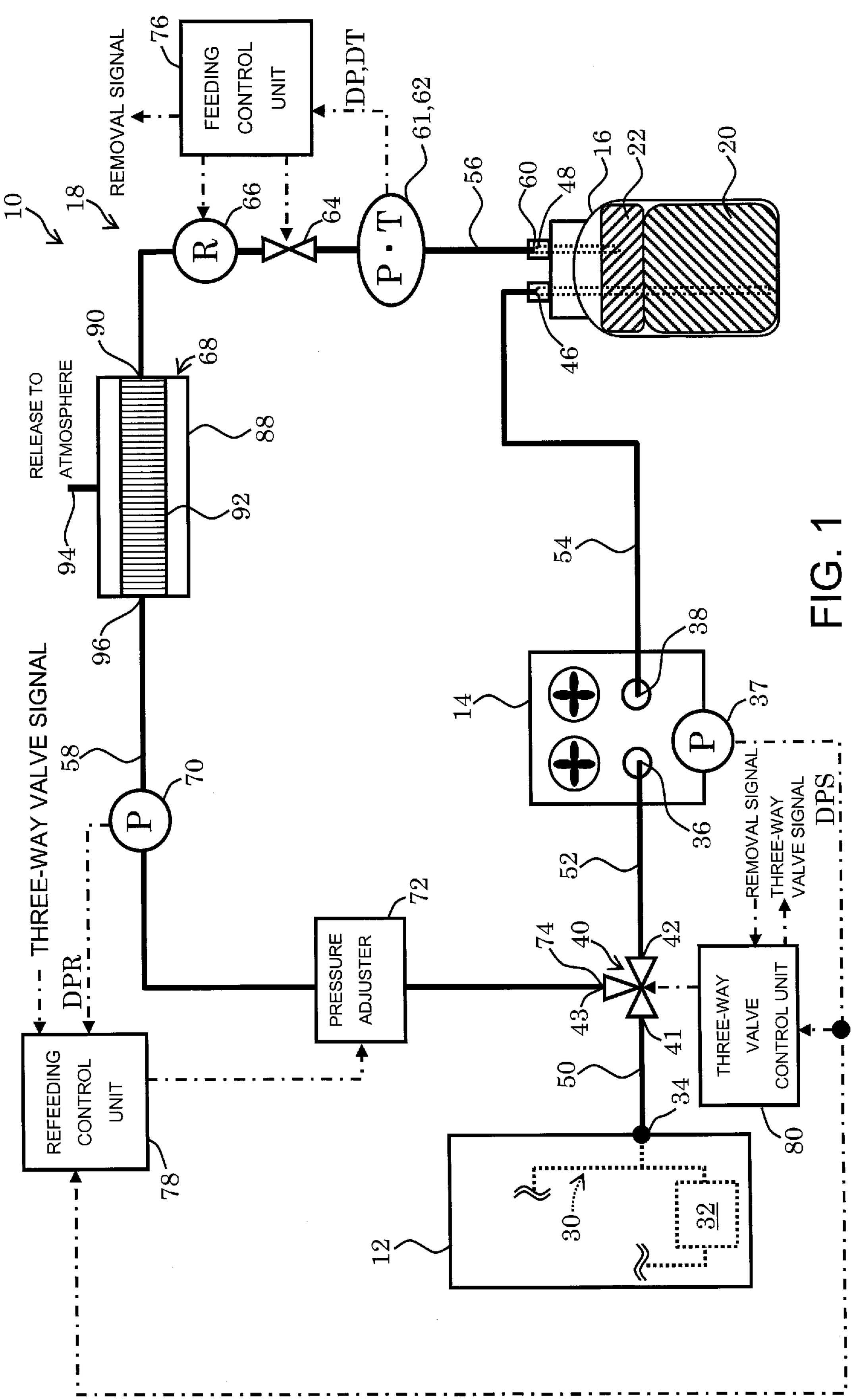
10
18
REMOVAL SIGNAL
76
FEEDING
CONTROL
UNIT
DP,DT
61,62
66
R
64
P・T
56
60
48
16
22
20
46
RELEASE TO
ATMOSPHERE
94
90
68
88
92
96
THREE-WAY VALVE SIGNAL
58
P
70
DPR
REFEEDING
CONTROL
UNIT
78
PRESSURE
ADJUSTER
72
54
14
38
37
P
36
52
REMOVAL SIGNAL
THREE-WAY
VALVE SIGNAL
DPS
74
40
42
43
41
THREE-WAY
VALVE
CONTROL UNIT
80
50
34
12
30
32

FIG. 1

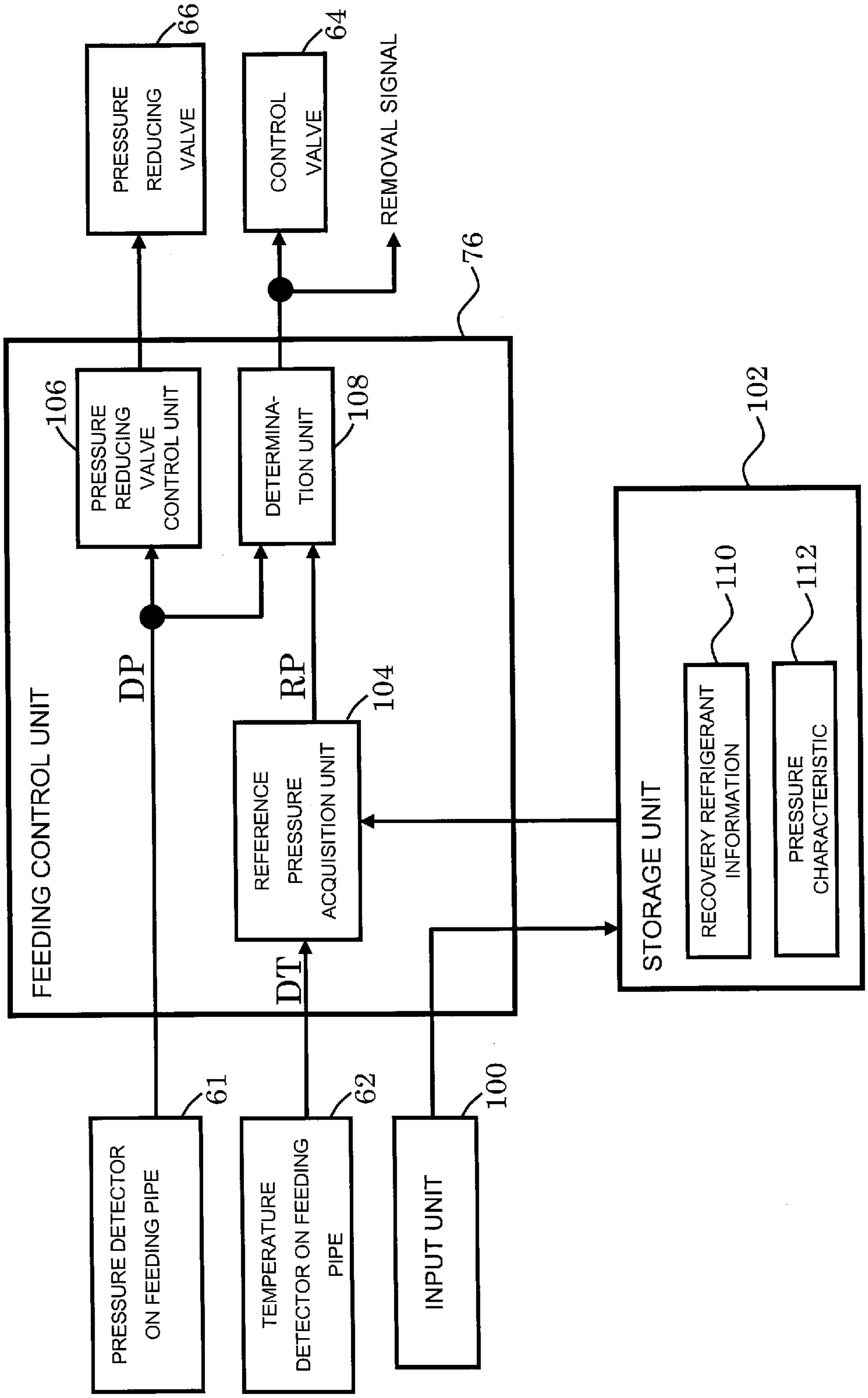
PRESSURE DETECTOR ON FEEDING PIPE
61
TEMPERATURE DETECTOR ON FEEDING PIPE
62
INPUT UNIT
100
FEEDING CONTROL UNIT
76
DP
DT
RP
REFERENCE PRESSURE ACQUISITION UNIT
104
PRESSURE REDUCING VALVE CONTROL UNIT
106
DETERMINATION UNIT
108
PRESSURE REDUCING VALVE
66
CONTROL VALVE
64
REMOVAL SIGNAL
STORAGE UNIT
102
RECOVERY REFRIGERANT INFORMATION
110
PRESSURE CHARACTERISTIC
112

FIG. 2

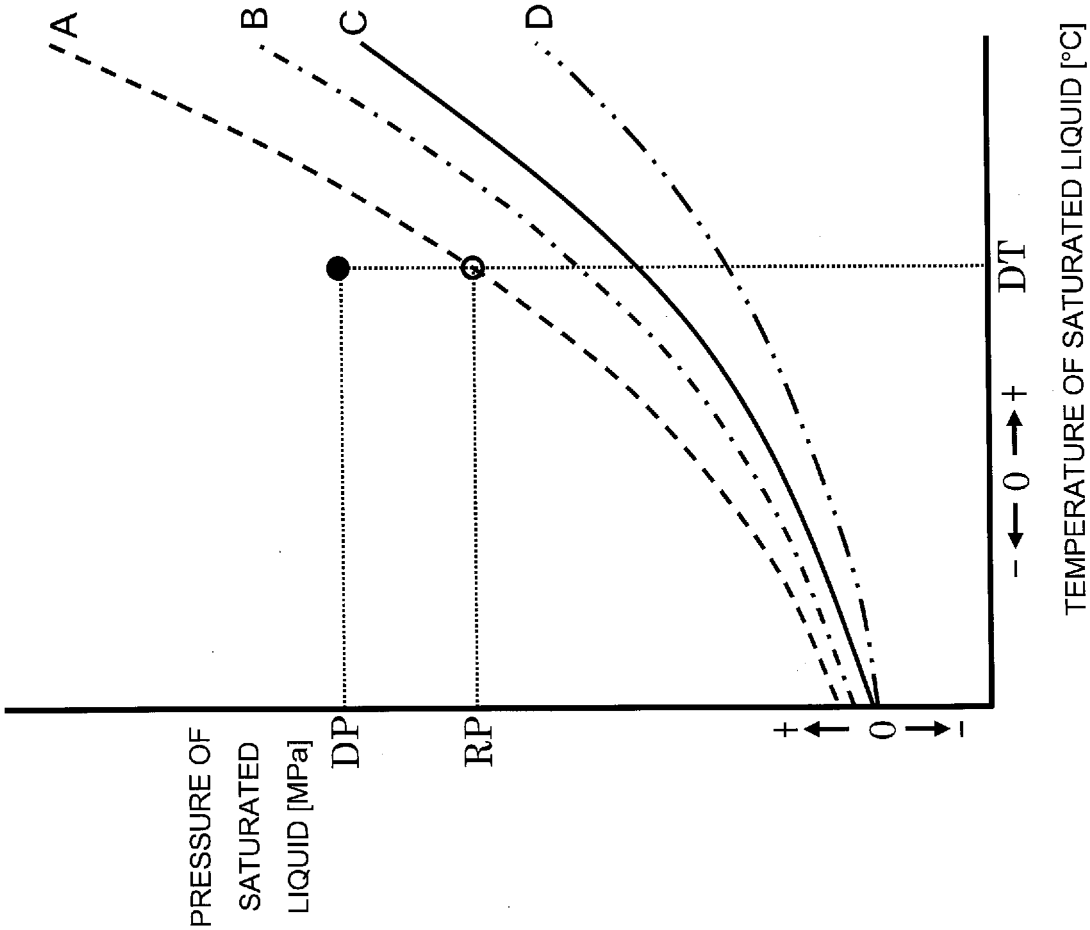
A
B
C
D
PRESSURE OF SATURATED LIQUID [MPa]
DP
RP
+
0
−
DT
− 0 +
TEMPERATURE OF SATURATED LIQUID [°C]

FIG. 3

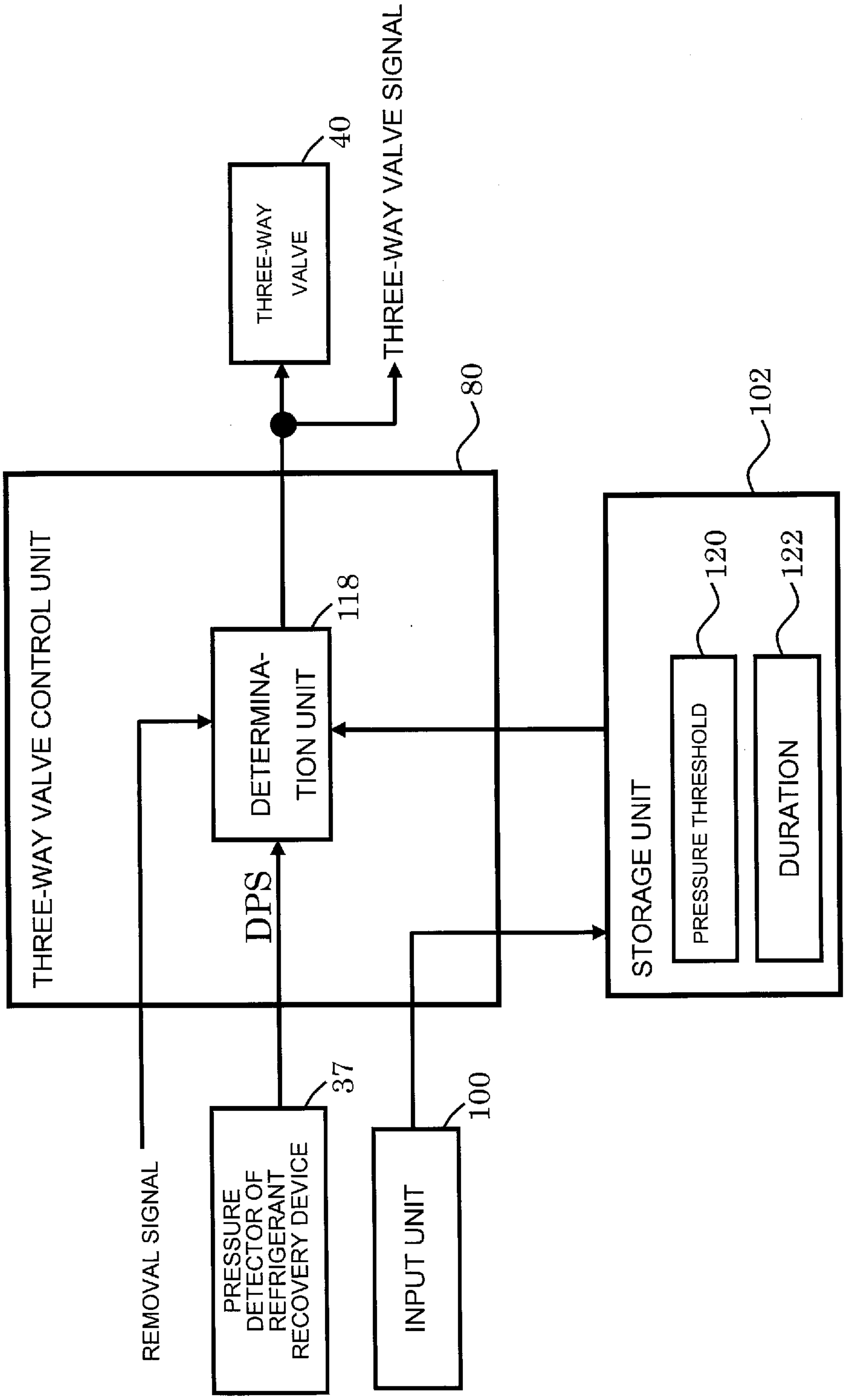
THREE-WAY VALVE SIGNAL
40
THREE-WAY VALVE
80
102
THREE-WAY VALVE CONTROL UNIT
118
DETERMINA-TION UNIT
DPS
STORAGE UNIT
120
PRESSURE THRESHOLD
122
DURATION
REMOVAL SIGNAL
37
PRESSURE DETECTOR OF REFRIGERANT RECOVERY DEVICE
100
INPUT UNIT

FIG. 4

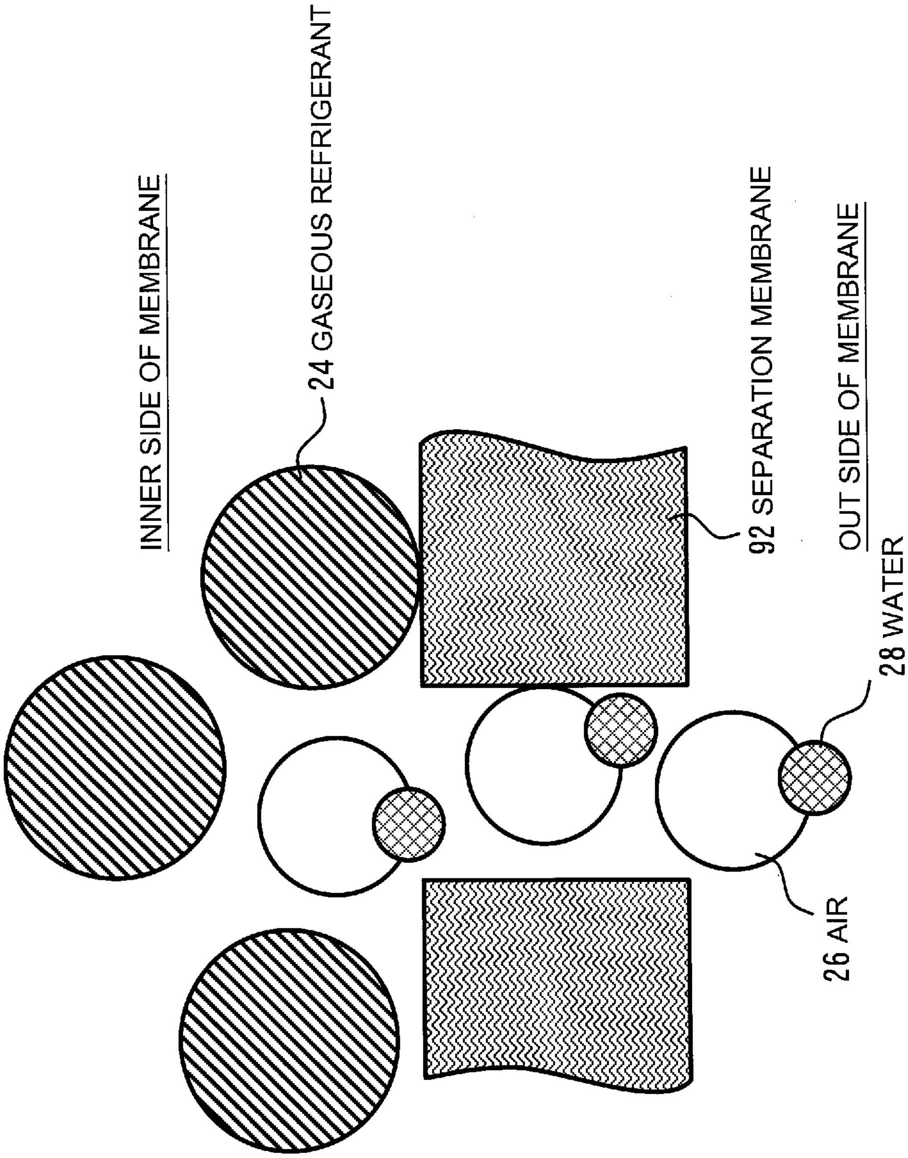
INNER SIDE OF MEMBRANE
24 GASEOUS REFRIGERANT
92 SEPARATION MEMBRANE
OUT SIDE OF MEMBRANE
28 WATER
26 AIR

FIG. 5

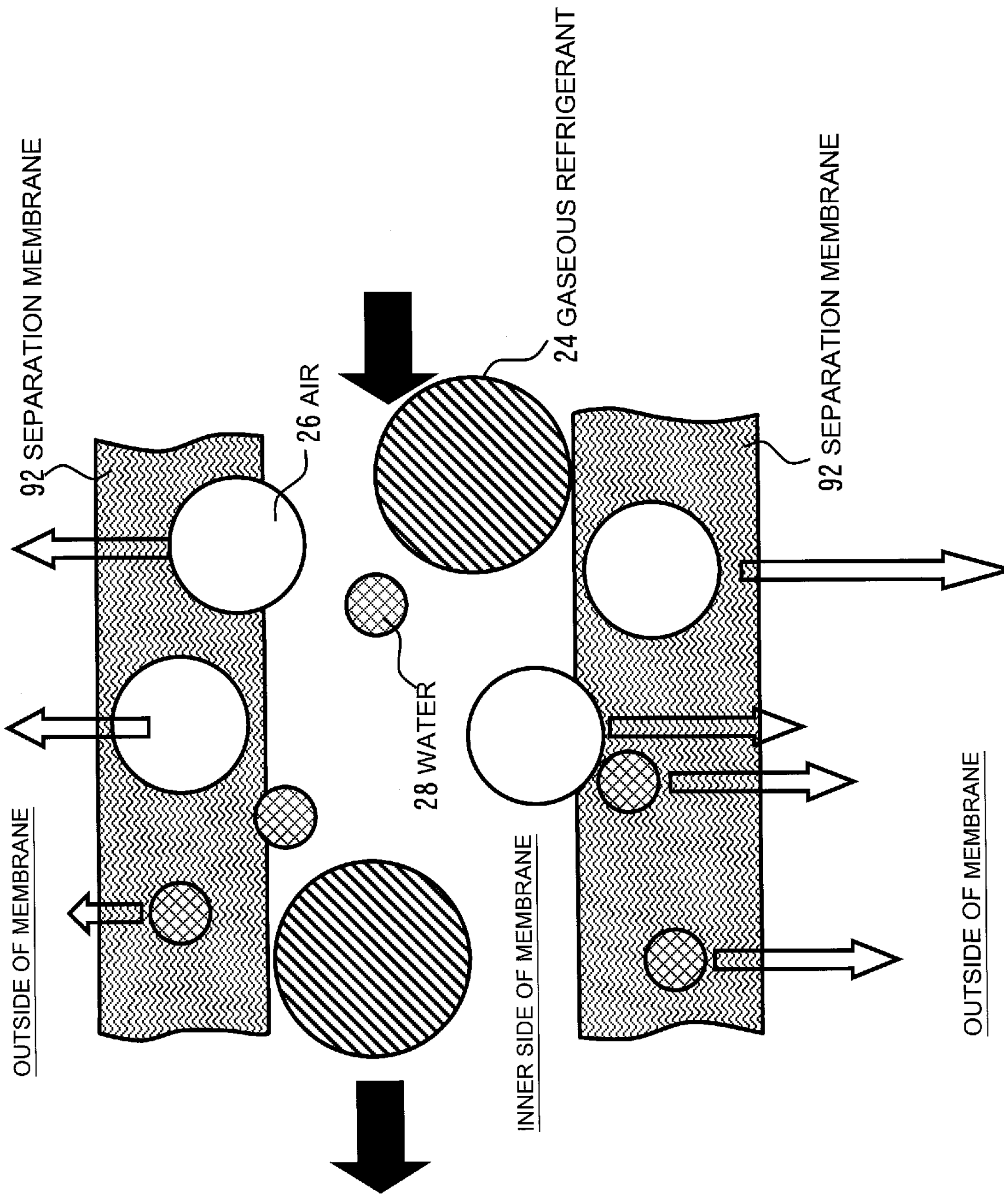
92 SEPARATION MEMBRANE
26 AIR
24 GASEOUS REFRIGERANT
92 SEPARATION MEMBRANE
28 WATER
OUTSIDE OF MEMBRANE
INNER SIDE OF MEMBRANE
OUTSIDE OF MEMBRANE

FIG. 6

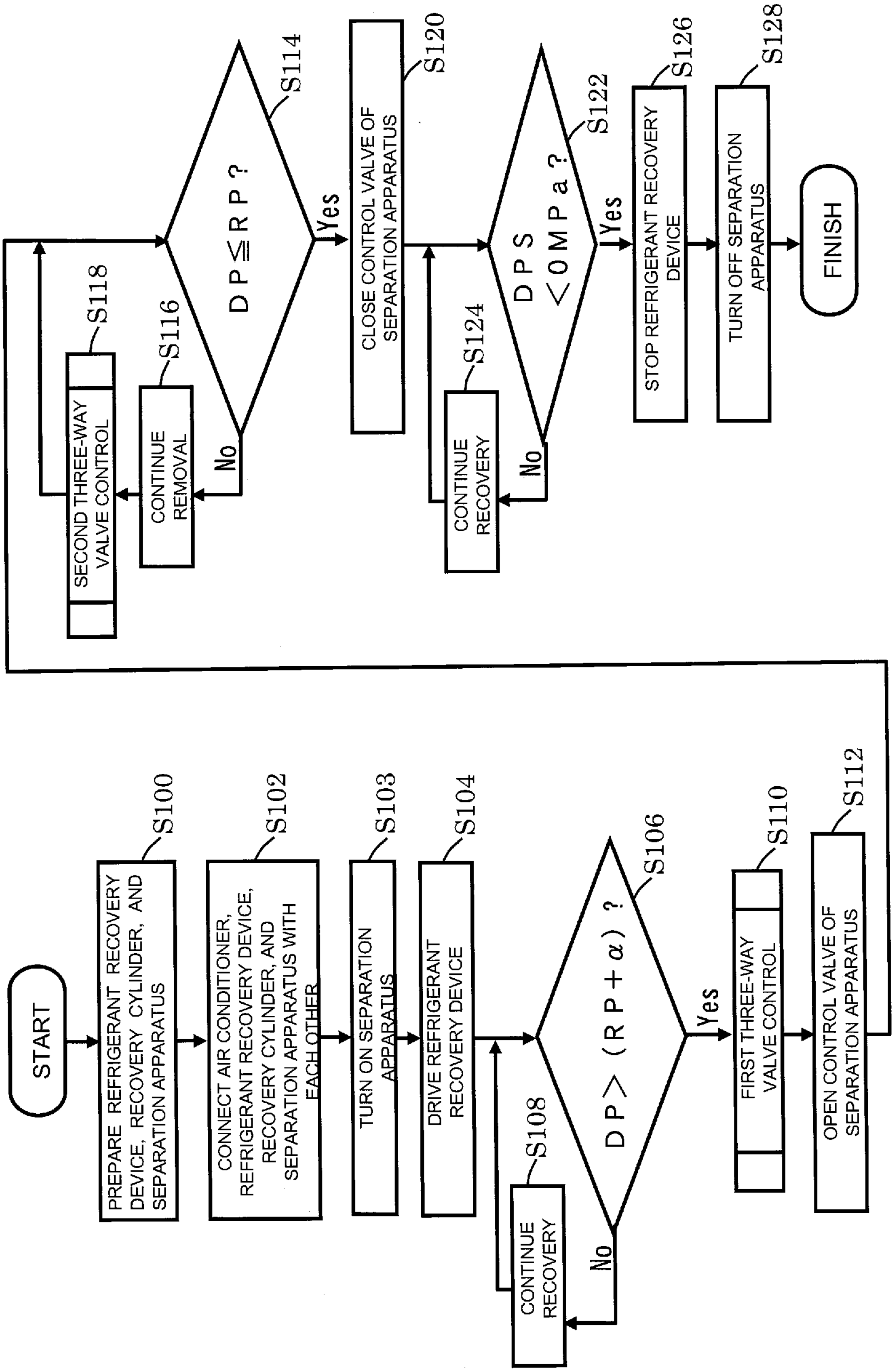
START
PREPARE REFRIGERANT RECOVERY DEVICE, RECOVERY CYLINDER, AND SEPARATION APPARATUS
S100
CONNECT AIR CONDITIONER, REFRIGERANT RECOVERY DEVICE, RECOVERY CYLINDER, AND SEPARATION APPARATUS WITH EACH OTHER
S102
TURN ON SEPARATION APPARATUS
S103
DRIVE REFRIGERANT RECOVERY DEVICE
S104
DP > (RP + α) ?
S106
No
CONTINUE RECOVERY
S108
Yes
FIRST THREE-WAY VALVE CONTROL
S110
OPEN CONTROL VALVE OF SEPARATION APPARATUS
S112
DP ≦ RP ?
S114
No
CONTINUE REMOVAL
S116
SECOND THREE-WAY VALVE CONTROL
S118
Yes
CLOSE CONTROL VALVE OF SEPARATION APPARATUS
S120
DPS <0MPa ?
S122
No
CONTINUE RECOVERY
S124
Yes
STOP REFRIGERANT RECOVERY DEVICE
S126
TURN OFF SEPARATION APPARATUS
S128
FINISH

FIG. 7

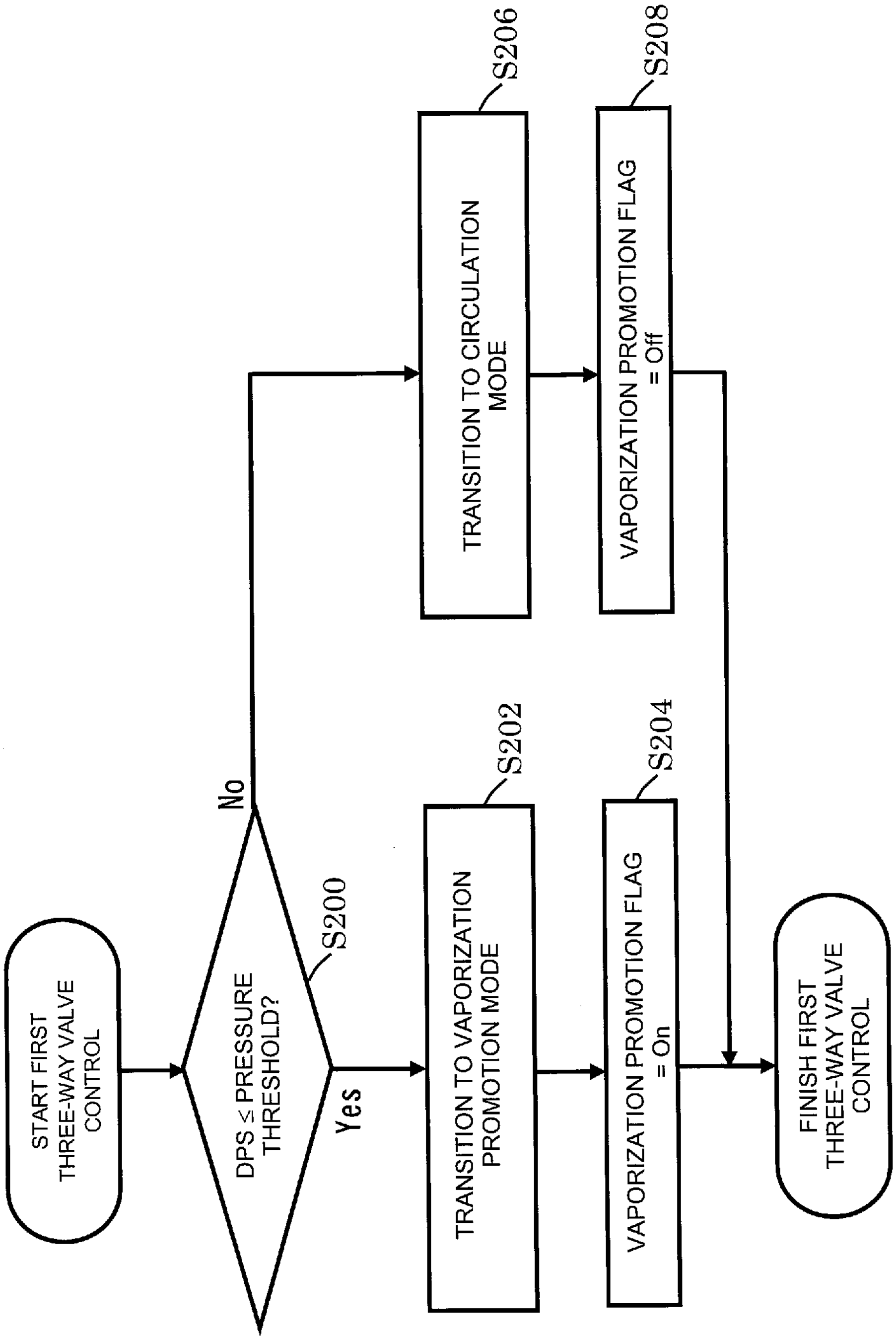
START FIRST THREE-WAY VALVE CONTROL
DPS ≤ PRESSURE THRESHOLD?
S200
Yes
No
TRANSITION TO VAPORIZATION PROMOTION MODE
S202
VAPORIZATION PROMOTION FLAG = On
S204
TRANSITION TO CIRCULATION MODE
S206
VAPORIZATION PROMOTION FLAG = Off
S208
FINISH FIRST THREE-WAY VALVE CONTROL

FIG. 8

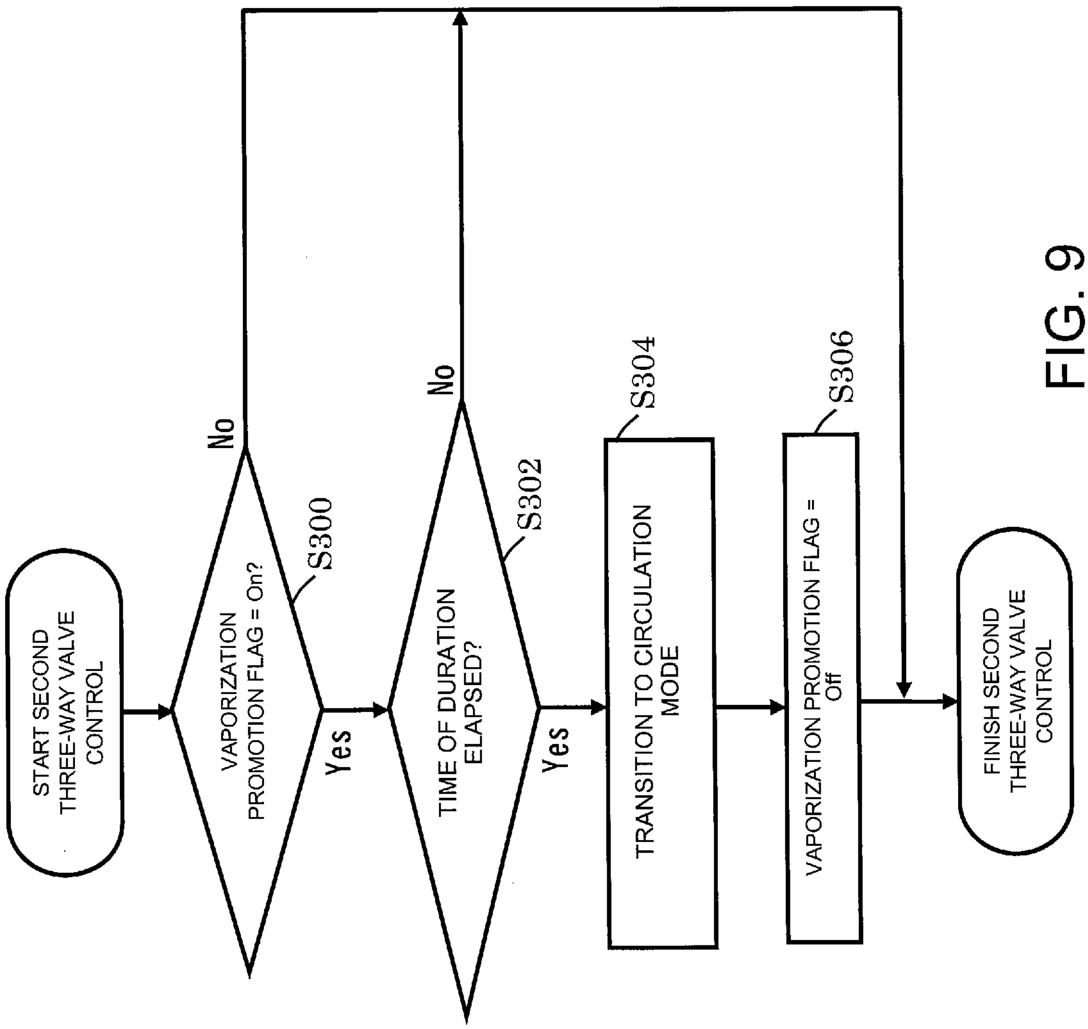
START SECOND THREE-WAY VALVE CONTROL
VAPORIZATION PROMOTION FLAG = On?
S300
No
Yes
TIME OF DURATION ELAPSED?
S302
No
Yes
TRANSITION TO CIRCULATION MODE
S304
VAPORIZATION PROMOTION FLAG = Off
S306
FINISH SECOND THREE-WAY VALVE CONTROL

FIG. 9

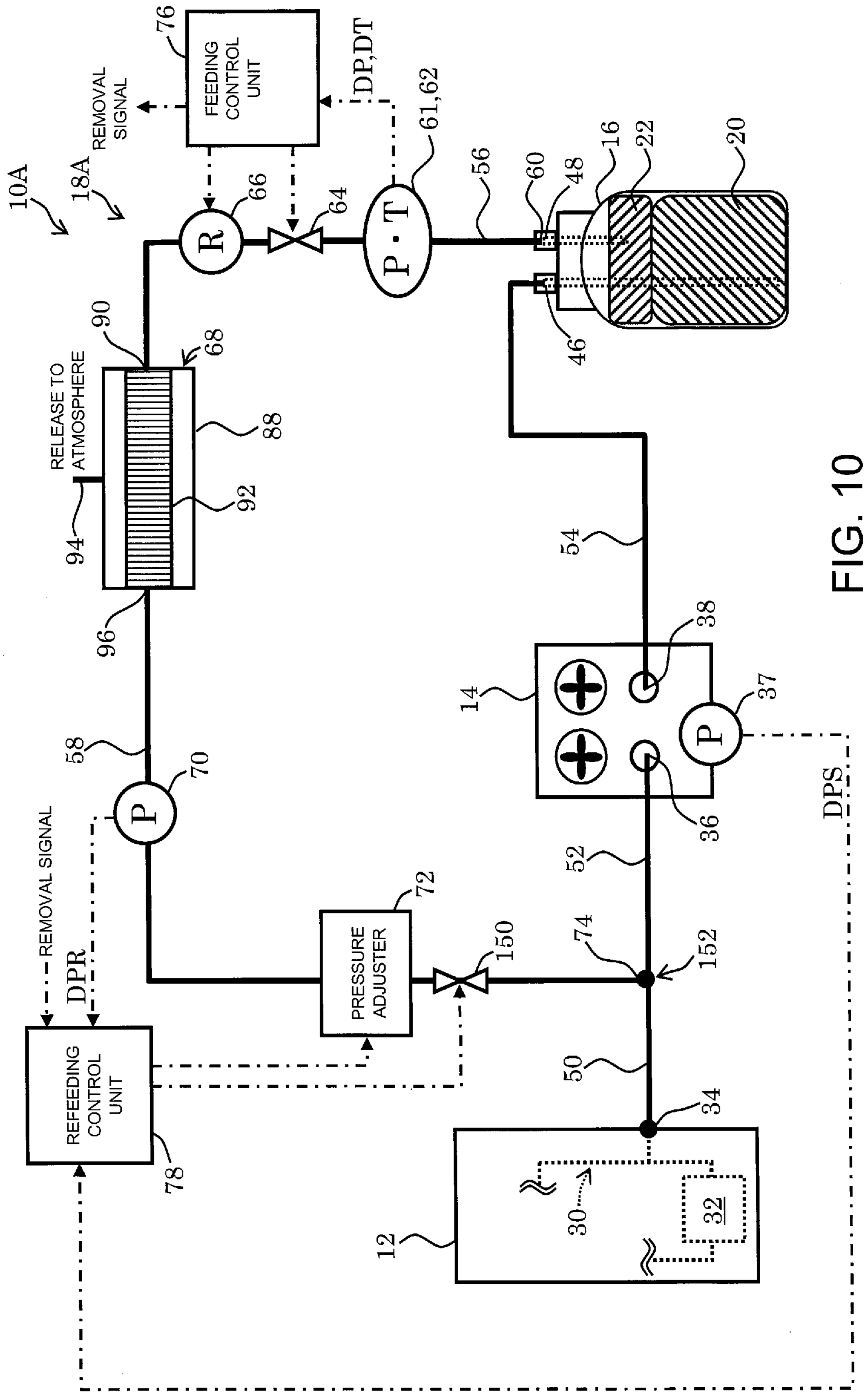
FEEDING CONTROL UNIT
REMOVAL SIGNAL
DP,DT
RELEASE TO ATMOSPHERE
REMOVAL SIGNAL
DPR
REFEEDING CONTROL UNIT
PRESSURE ADJUSTER
DPS

FIG. 10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2020/036533

A. CLASSIFICATION OF SUBJECT MATTER
F25B 45/00(2006.01)i
FI: F25B45/00 A

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F25B45/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2020
Registered utility model specifications of Japan	1996-2020
Published registered utility model applications of Japan	1994-2020

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2009-229028 A (HARA TECH CORPORATION) 08 October 2009 (2009-10-08) paragraphs [0001], [0007]-[0021], fig. 1	1-6, 8
A	paragraphs [0001], [0007]-[0021], fig. 1	7
Y	US 5598714 A (RTI TECHNOLOGIES, INC.) 04 February 1997 (1997-02-04) specification, column 1, lines 20-54, column 4, line 33 to column 6, line 39, fig. 1, 4-5	1-6, 8
A	specification, column 1, lines 20-54, column 4, line 33 to column 6, line 39, fig. 1, 4-5	7
Y	JP 2010-159952 A (KANKYO SOKEN KK) 22 July 2010 (2010-07-22) paragraphs [0054]-[0058], fig. 5	1-6, 8
Y	JP 04-165273 A (TATSUNO CO., LTD.) 11 June 1992 (1992-06-11) page 2, lower right column, line 5 to page 3, lower right column, line 1, fig. 1	4-6

☒ Further documents are listed in the continuation of Box C.　☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 November 2020 (13.11.2020)	01 December 2020 (01.12.2020)

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2020/036533

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2017-072284 A (MITSUBISHI ELECTRIC BUILDING TECHNO-SERVICE CO., LTD.) 13 April 2017 (2017-04-13) paragraphs [0001], [0061]-[0062], fig. 4	5
A	JP 2005-127564 A (DAIKIN INDUSTRIES, LTD.) 19 May 2005 (2005-05-19) entire text, all drawings	1-8
A	JP 06-323698 A (DENGEN CO., LTD.) 25 November 1994 (1994-11-25) entire text, all drawings	1-8
A	JP 03-028676 A (DAIKIN INDUSTRIES, LTD.) 06 February 1991 (1991-02-06) entire text, all drawings	1-8

Form PCT/ISA/210 (continuation of second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2020/036533

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
JP 2009-229028 A	08 Oct. 2009	(Family: none)	
US 5598714 A	04 Feb. 1997	US 5570590 A WO 1997/011324 A1	
JP 2010-159952 A	22 Jul. 2010	(Family: none)	
JP 4-165273 A	11 Jun. 1992	(Family: none)	
JP 2017-072284 A	13 Apr. 2017	(Family: none)	
JP 2005-127564 A	19 May 2005	(Family: none)	
JP 06-323698 A	25 Nov. 1994	(Family: none)	
JP 03-028676 A	06 Feb. 1991	(Family: none)	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2010 A **[0007]**
- JP 159952 A **[0007]**