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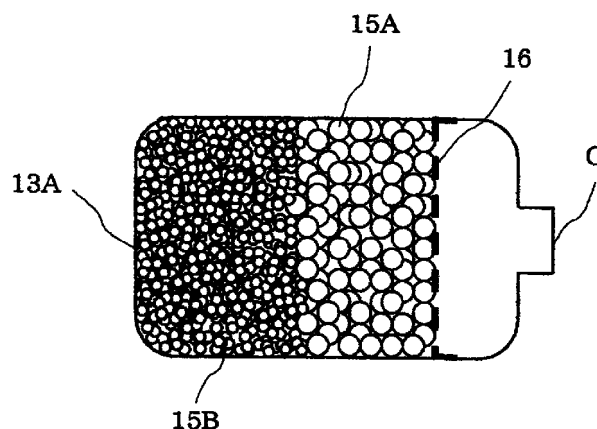
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(54) **Method for installing air conditioner**

(57) An object of the invention is to provided an easy method for installing an air conditioner taking an influence on environment into consideration. In the method for installing an air conditioner, an outdoor unit includes a compressor and an outdoor unit heat exchanger into both of which refrigerant gas is charged, an indoor unit includes an indoor unit heat exchanger which is opened into atmosphere, the outdoor unit and the indoor unit are connected through a connecting pipe opened to atmosphere, air in the indoor unit heat exchanger and the connecting pipe is replaced by carbon dioxide and then, the carbon dioxide is collected by a trap apparatus having zeolite or calcium hydroxide, after the carbon dioxide is collected, the refrigerant gas in the outdoor unit is charged into the indoor unit heat exchanger or the connecting pipe, wherein when the air in the indoor unit heat exchanger and the connecting pipe is replaced by the carbon dioxide, pressure in the indoor unit heat exchanger and the connecting pipe is brought into a positive pressure state.

FIG.3



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Description

Background of the Invention

(1) Field of the Invention

[0001] The present invention relates to a method for installing an air conditioner and particularly for connecting an indoor unit and an outdoor unit using connecting pipes.

(2) Description of the Prior Art

[0002] Conventionally, an air conditioner is installed in such a manner that more than prescribed amount of refrigerant gas is charged into an outdoor unit for purging air; the air in the connecting pipes and an indoor unit is purged by the refrigerant gas introduced from a liquid-side two-way valve, and the refrigerant gas is discharged into the atmosphere from a valve called a service port of a gas-side three-way valve.

[0003] Further, conventionally, the air conditioner is installed in such a manner that after the connecting pipes and the indoor unit are brought into a sufficiently evacuated state using a vacuum pump from the valve called the service port of the gas-side three-way valve, the refrigerant gas is introduced into the connecting pipes and the indoor unit from the liquid-side two-way valve.

[0004] However, environmental regulations against destruction of the ozone layer, global warming and the like are becoming strict in recent years; and discharging refrigerant gas having high ozone layer destroying coefficient or high global warming coefficient into the atmosphere when the air conditioner is installed is becoming a problem.

[0005] An installing method using a vacuum pump is recommended as an installing method which does not discharge the refrigerant gas. However, it is difficult to use the vacuum pump in the installing places having bad installation conditions such as on a roof.

[0006] Further, the installing method using the vacuum pump takes more time to install the air conditioner as compared with a method using the conventional purging method using refrigerant gas of the outdoor unit and discharging the refrigerant gas into the atmosphere.

[0007] The present invention has been accomplished in view of the problems that conventional methods had; and it is an object of the invention to provide an easy method for installing an air conditioner while taking an influence on environment into consideration.

Disclosure of the Invention

[0008] To achieve the above and other objectives, according to the present invention, there is provided a method for installing an air conditioner which is com-

prised of an outdoor unit including a compressor and an outdoor unit heat exchanger into which refrigerant gas is charged, an indoor unit including an indoor unit heat exchanger which is opened to atmosphere, and a connecting pipe connecting said outdoor unit and said indoor unit which is also opened to atmosphere; and the method is comprised of: air in said indoor unit heat exchanger and said connecting pipe is replaced by carbon dioxide; said carbon dioxide is collected by a trap apparatus having zeolite; and after said carbon dioxide is collected, the refrigerant gas in the outdoor unit is charged into said indoor unit heat exchanger and said connecting pipe, wherein when said air in said indoor unit heat exchanger and said connecting pipe is replaced by said carbon dioxide, pressure in said indoor unit heat exchanger and said connecting pipe is brought into a positive pressure state. According to this mode, the inside pressure is held at positive pressure when air is replaced by carbon dioxide. Therefore, when the inside pressure is brought into communication with the trap apparatus next, the positive pressure state of the inside becomes a trigger of convection of gas, the carbon dioxide is swiftly absorbed by the zeolite in the trap apparatus, and the carbon dioxide can be collected swiftly.

[0009] Further, according to the invention, there is provided a method for installing an air conditioner which is comprised of an outdoor unit including a compressor and an outdoor unit heat exchanger into which refrigerant gas is charged, an indoor unit including an indoor unit heat exchanger which is opened to atmosphere, and a connecting pipe connecting said outdoor unit and said indoor unit which is opened to atmosphere; and the method is comprised of: air in said indoor unit heat exchanger and said connecting pipe is replaced by carbon dioxide; said carbon dioxide is collected by a trap apparatus having zeolite; and after said carbon dioxide is collected, the refrigerant gas in the outdoor unit is charged into said indoor unit heat exchanger and said connecting pipe, wherein when said air in said indoor unit heat exchanger and said connecting pipe is replaced by said carbon dioxide, pressure in said indoor unit heat exchanger or said connecting pipe is brought into pressure higher than that in said trap apparatus. According to this mode, the inside pressure is held at a higher pressure than that of the trap apparatus when air is replaced by carbon dioxide. Therefore, when the inside pressure is brought into communication with the trap apparatus next, the higher pressure state of the inside becomes a trigger of convection of gas, the carbon dioxide is swiftly absorbed by the zeolite in the trap apparatus, and the carbon dioxide can be collected swiftly.

[0010] Further, according to the present invention, in the above method for installing an air conditioner, wherein said trap apparatus includes therein a structure body constructed with carriers which are coated with a layer mainly made of zeolite. With this mode, since zeo-

lite exists on the surface of the structure body, it is possible to increase the contact area with the carbon dioxide, and to swiftly collect the carbon dioxide.

[0011] Further, according to the present invention, in the above method for installing an air conditioner, wherein said trap apparatus includes 60g or greater zeolite per one liter of a volume of a pipe of said indoor unit and said connecting pipe. With this mode, if the weight of zeolite is set taking the volume of the pipe of the indoor unit and the connection pipes into consideration, it is possible to collect the carbon dioxide with sufficient speed.

[0012] Further, according to the present invention of trap apparatus for installing an air conditioner, the trap apparatus is comprised of a structure body constructed with carriers which are coated with a layer mainly made of zeolite. With this mode, since zeolite exists on the surface of the structure body, it is possible to increase the contact area with the carbon dioxide.

[0013] Further, according to the present invention, in the above trap apparatus for installing an air conditioner, the structure body is a honeycomb structure body or a corrugated structure body. With this mode, it is possible to increase the contact area with the carbon dioxide, and to speed up the collection of the carbon dioxide.

[0014] Further, according to the present invention, there is provided a trap apparatus for installing an air conditioner wherein zeolite is charged such that a flow path space is larger on the inlet side than that of the bottom side. With this mode, by forming the flow path space which is greater on the side of the inlet than that of the bottom side, it is possible to smoothly diffuse the carbon dioxide in the trap apparatus and collect it swiftly.

[0015] Further, according to the present invention, there is provided a trap apparatus for installing an air conditioner wherein a hollow cylindrical zeolite is used. With this mode, by using a hollow cylindrical zeolite, the flow path necessary for diffusing carbon dioxide can sufficiently be ensured, and it is possible to speed up the trap of carbon dioxide.

[0016] Further, according to the present invention, there is provided a trap apparatus for installing an air conditioner wherein zeolite having surface area greater than that of zeolite disposed closer to a bottom of the trap apparatus is disposed closer to an inlet of the trap apparatus. With this mode, since zeolite having greater surface area is charged in the trap apparatus closer to its inlet than its bottom, it is possible to smoothly diffuse the carbon dioxide in the trap apparatus and to collect it swiftly.

[0017] Further, according to the present invention, there is provided a trap apparatus for installing an air conditioner wherein spherical or columnar zeolite is used, and zeolite having diameter or length greater than that of zeolite disposed closer to a bottom of the trap apparatus is disposed closer to an inlet of the trap apparatus. With this mode, by using the spherical or colum-

nar zeolite, a flow path necessary for diffusing the carbon dioxide can sufficiently be secured, and by charging zeolite having greater surface area into the trap apparatus closer to its inlet than its bottom, it is possible to smoothly diffuse the carbon dioxide in the trap apparatus and thereby to collect swiftly.

[0018] Further, according to the present invention, in the trap apparatus for installing an air conditioner, pressure in the trap apparatus is brought into a negative state equal to or lower than 1 mmHg. With this mode, when the air is replaced by carbon dioxide, since the inside of the trap apparatus is in the negative pressure state, this negative pressure state becomes a trigger of convection of gas, the carbon dioxide is swiftly absorbed by the zeolite in the trap apparatus, and the carbon dioxide can be collected swiftly.

[0019] Further, according to the present invention, there is provided a method for installing an air conditioner, wherein carbon dioxide replacing air in an indoor unit heat exchanger and a connecting pipe is collected using the trap apparatus constructed in accordance with this invention. With this mode, the carbon dioxide can swiftly be collected, and the installing operation can be carried out easily.

[0020] Further, according to the present invention, there is provided a method for installing an air conditioner which is comprised of an outdoor unit including a compressor and an outdoor unit heat exchanger into which refrigerant gas is charged, an indoor unit including an indoor unit heat exchanger which is opened to atmosphere, and a connecting pipe connecting said outdoor unit and said indoor unit which is opened to atmosphere; and the method is comprised of: air in said indoor unit heat exchanger and said connecting pipe is replaced by carbon dioxide; said carbon dioxide is collected by a trap apparatus having calcium hydroxide; and after said carbon dioxide is collected, the refrigerant gas in the outdoor unit is charged into said indoor unit heat exchanger and said connecting pipe, wherein when said air in said indoor unit heat exchanger and said connecting pipe is replaced by said carbon dioxide, pressure in said indoor unit heat exchanger and said connecting pipe is brought into a positive pressure state. According to this mode, the inside pressure is held at positive pressure when air is replaced by carbon dioxide. Therefore, when the inside pressure is brought into communication with the trap apparatus next, the positive pressure state of the inside becomes a trigger of convection of gas, the chemical reaction with calcium hydroxide in the trap apparatus is swiftly caused, and the carbon dioxide can be collected swiftly.

[0021] Further, according to the present invention, there is provided a method for installing an air conditioner which is comprised of an outdoor unit including a compressor and an outdoor unit heat exchanger into which refrigerant gas is charged, an indoor unit including an indoor unit heat exchanger which is opened to atmosphere, and a connecting pipe connecting said

outdoor unit and said indoor unit which is opened to atmosphere; and the method is comprised of: air in said indoor unit heat exchanger and said connecting pipe is replaced by carbon dioxide; said carbon dioxide is collected by a trap apparatus having calcium hydroxide; and after said carbon dioxide is collected, the refrigerant gas in the outdoor unit is charged into said indoor unit heat exchanger and said connecting pipe, wherein when said air in said indoor unit heat exchanger and said connecting pipe is replaced by said carbon dioxide, pressure in said indoor unit heat exchanger and said connecting pipe is brought into pressure higher than that in said trap apparatus. According to this mode, the inside pressure is held at a higher pressure than that of the trap apparatus when air is replaced by carbon dioxide. Therefore, when the inside pressure is brought into communication with the trap apparatus next, the higher pressure state of the inside becomes a trigger of convection of gas, the chemical reaction with calcium hydroxide in the trap apparatus is swiftly caused, and the carbon dioxide can be collected swiftly.

[0022] Further, according to the present invention, in the above method for installing an air conditioner, the trap apparatus includes therein a structure body constructed with carriers which are coated with a layer mainly made of calcium hydroxide. With this mode, since calcium hydroxide exists on the surface of the structure body, it is possible to increase the contact area with the carbon dioxide, and to swiftly collect the carbon dioxide.

[0023] Further, according to the present invention, in the above method for installing an air conditioner, the trap apparatus includes 6.6g or greater calcium hydroxide per one liter of a volume of a pipe of the indoor unit and the connecting pipe. With this mode, by using two times or greater trap material of stoichiometry weight with respect to the volume in the connecting pipes and the indoor unit, it is possible to collect the carbon dioxide with sufficient speed.

[0024] Further, according to the present invention, there is provided a trap apparatus for installing an air conditioner comprising a structure body constructed with carriers which are coated with a layer mainly made of calcium hydroxide. With this mode, since calcium hydroxide exists on the surface of the structure body, it is possible to increase the contact area for the chemical reaction with carbon dioxide.

[0025] Further, according to the present invention, in the above trap apparatus for installing an air conditioner, the structure body is a honeycomb structure body or a corrugated structure body. With this mode, it is possible to increase the contact area for the chemical reaction with carbon dioxide, and to prevent the flow path from being impaired by volume expansion at the time of the chemical reaction.

[0026] Further, according to the present invention, in the above trap apparatus for installing an air conditioner, water in the amount of 0.1 to 10 wt% of calcium

hydroxide is included. With this mode, by adding a small amount of water to calcium hydroxide, this becomes a catalytic trigger, and the chemical reaction speed from the calcium hydroxide to calcium carbonate can be accelerated, thereby, collection speed will be increased.

[0027] Further, according to the present invention, in the above trap apparatus for installing an air conditioner, the calcium hydroxide is mixed with at least one of zeolite, activated alumina and silica gel to form the coating layer. With this mode, it is possible to hold water by zeolite, activated alumina or silica gel, and this water becomes a catalytic trigger, and the chemical reaction speed from the calcium hydroxide to calcium carbonate can be accelerated, thereby, collection speed will be increased.

[0028] Further, according to the present invention, in the above trap apparatus for installing an air conditioner, a heat radiating portion or a cooling portion is provided outside the trap apparatus. With this mode, reaction heat generated by the abrupt chemical reaction can efficiently be transmitted and diffused outside, and it is possible to prevent the reaction speed from being lowered.

Brief Description of the Drawings

[0029]

Fig.1 is a block diagram of a refrigeration cycle of an air conditioner used in an embodiment of the present invention to which a carbon dioxide cylinder is connected;

Fig.2 is a block diagram of the refrigeration cycle of the air conditioner used in an embodiment of the present invention to which a trap apparatus is connected;

Fig.3 is a schematic view of a trap apparatus according to a first embodiment;

Fig.4 is a schematic view of a trap apparatus according to a second embodiment;

Fig.5 is a schematic view of a trap apparatus according to a third embodiment;

Fig.6 is a sectional view taken along the line A-A in Fig.5;

Fig.7 is an enlarged sectional view of an essential portion of an inside structure body in Fig.6;

Fig.8 is a schematic view of a trap apparatus according to a fourth embodiment;

Fig.9 is a sectional view taken along the line A-A in Fig.8;

Fig.10 is an enlarged sectional view of an essential portion of an inside structure body in Fig.8; and

Fig.11 is a graph showing the relation between weight of zeolite charged in the trap apparatus and pressure after ten minutes.

Description of the Preferred Embodiments

[0030] Embodiments of the present invention will be explained with reference to the drawings below.

[0031] Figs.1 and 2 are block diagrams of a refrigeration cycle of an air conditioner used in the embodiment. Fig.1 shows a state where a carbon dioxide cylinder is connected, and Fig.2 shows a state where a trap apparatus is connected.

[0032] First, the entire structure of the refrigeration cycle constituting the air conditioner will be explained using Figs.1 and 2.

[0033] The refrigeration cycle comprises a compressor 1, a four-way valve 2, an outdoor unit heat exchanger 3, an expansion device 4, a dryer 5 and an indoor unit heat exchanger 6. The compressor 1, the four-way valve 2, the outdoor unit heat exchanger 3, the expansion device 4 and the dryer 5 are disposed in an outdoor unit A, and the indoor unit heat exchanger 6 is disposed in an indoor unit B.

[0034] The outdoor unit A is provided with a liquid-side two-way valve 7 and a gas-side three-way valve 8. The outdoor unit A and the indoor unit B are connected to each other through connection pipes 9 and 10 using the liquid-side two-way valve 7 and the gas-side three-way valve 8. The liquid-side two-way valve 7 includes a screw portion 7a, and a pipe on the side of the outdoor unit A and a connecting pipe 9 are brought into communication with each other by opening the screw portion 7a. The gas-side three-way valve 8 includes a screw portion 8a and a service port 8b, and a pipe on the side of the outdoor unit A and a connecting pipe 10 are brought into communication with each other by opening this screw portion 8a.

[0035] As shown in Fig.1, a carbon dioxide cylinder 11 can be connected to the service port 8b using a connecting device 12, or as shown in Fig.2, a trap apparatus 13 can be connected to the service port 8b using a connecting device 14. The carbon dioxide cylinder 11 or the trap apparatus 13 can be brought into communication with a connecting pipe 10 through the connecting device 12 or 14.

[0036] Next, an embodiment of the trap apparatus which can be used in the present invention will be explained using Figs.3 to 7.

[0037] Fig.3 is a schematic view of the trap apparatus according to the first embodiment.

[0038] Spherical shape zeolite particles 15A and 15B are charged in the trap apparatus 13A. The zeolite particles 15A have 6 to 8 mesh diameter, and the zeolite particles 15B have 4 to 6 mesh diameter. The trap apparatus 13A is provided therein with a baffle 16 for separating an inlet C and the zeolite particles 15A so that the zeolite particles 15A and 15B are securely held. This baffle 16 has holes of such diameters that the zeolite particles 15A and 15B cannot pass through. In the present embodiment, an opening ratio is set to 60%.

[0039] As shown in Fig.3, in the trap apparatus 13A

of the present embodiment, the zeolite particles 15A having greater diameter are charged closer to the inlet C, and the zeolite particles 15B having smaller diameter is charged in the deep side of the trap apparatus 13A. With this layout, it is possible to form a flow path space which is greater on the side of the inlet C than that of the bottom side. In the present embodiment, 100g of zeolite particles 15A and 15B in total were charged.

[0040] Fig.4 is a schematic view of the trap apparatus according to the second embodiment.

[0041] Hollow cylindrical zeolite particles 15C are charged in the trap apparatus 13B. The zeolite particles 15C has size of $\phi 5 \times 7$ mm, and thickness of 2mm. The trap apparatus 13B is provided therein with the baffle 16 for separating the inlet C and the zeolite particles 15C so that the zeolite particles 15C is securely held. In the present embodiment also, the opening ratio is set to 60%.

[0042] As shown in Fig.4, the hollow cylindrical zeolite particles 15C are charged in the trap apparatus 13B. Therefore, the flow path space can be enlarged, and the contact area can be increased. In the present embodiment, 100g of zeolite particles 15C were charged in total.

[0043] Figs.5 to 7 show a trap apparatus according to the third embodiment. Fig.5 is a schematic view of the trap apparatus used in the third embodiment, Fig.6 is a sectional view taken along the line A-A in Fig.5, and Fig.7 is an enlarged sectional view of an essential portion of an inside structure body in Fig.6.

[0044] A trap apparatus 13C is provided therein with a honeycomb structure body 17. The honeycomb structure body 17 has 400 cells/inch² (see Fig.6), and volume of $70\phi \times 90$ mm; and is coated on its surface with a coating layer 15D that is mainly made of zeolite in the amount of 100g in total.

[0045] Figs.8 to 10 show the fourth embodiment. Fig.8 is a schematic view of a trap apparatus according to the fourth embodiment, Fig.9 is a sectional view taken along the line A-A in Fig.8, and Fig.10 is an enlarged sectional view of an essential portion of an inside structure body in Fig.8.

[0046] A trap apparatus 13D is provided therein with a honeycomb structure body 18. An outer periphery of a body of the trap apparatus 13D is provided with radiating fins 19. The honeycomb structure body 18 has 200 cells/inch² (see Fig.9), and volume of $50\phi \times 65$ mm.

[0047] The honeycomb structure body 18 is coated on its surface with a coating layer 18A which is mainly made of calcium hydroxide in the amount of 10g in total. More specifically, the coating layer 18A is made of 90 wt% of calcium hydroxide, and 10 wt% of A-type zeolite. The A-type zeolite which easily absorbs water is allowed to hold 10 wt% of water.

[0048] Chemical reaction from calcium hydroxide to calcium carbonate occurs very rapidly, and a small amount of water is required as a catalytic trigger at that time. In order to allow water to effectively act as the trig-

ger, it is preferable to mix the calcium hydroxide with a material which easily holds water, and the A-type zeolite is used in the present embodiment.

[0049] During the chemical reaction from calcium hydroxide to calcium carbonate, since high reaction heat is generated, it is necessary to diffuse this heat to the outside, and the radiating fins 19 are provided in the present embodiment.

[0050] As in the present embodiment, since the zeolite is mixed in the coating layer 18A, the water held by the zeolite is less prone to be disassociated even if abrupt reaction heat is generated, and therefore, it acts effectively as a catalytic trigger.

[0051] Next, a method for installing the air conditioner will be explained in reference to figs. 1 and 2.

[0052] Before the air conditioner is installed, refrigerant gas is charged in the outdoor unit A including in the compressor 1 as well as in the outdoor heat exchange unit 3. At that time, in addition to the refrigerant gas which is necessary for operation, the refrigerant gas to be used for purge operation is also charged in the outdoor unit A. On the other hand, pipes in the indoor unit such as those in the indoor heat exchanger 6 and the connecting pipes 9 and 10 are not hermetically sealed but are opened to the atmosphere.

[0053] First, as shown Fig. 1, the outdoor unit A and the indoor unit B are connected through the connecting pipes 9 and 10. At that time, a screw portion 7a of a liquid-side two-way valve 7 and a screw portion 8a of a gas-side three-way valve 8 are closed. The carbon dioxide cylinder 11 is mounted to the service port 8b of the gas-side three-way valve 8 using the connecting device 12.

[0054] After the carbon dioxide cylinder 11 is mounted to the service port 8b, a flare portion of the liquid-side two-way valve 7 is slightly loosened. Then, the carbon dioxide cylinder 11 is pushed against the connecting device 12 while being rotated, thereby introducing the carbon dioxide contained in the carbon dioxide cylinder 11 into the connecting pipe 10 and the indoor unit B and the connecting pipe 9. Air in the connecting pipes 9 and 10 and the indoor unit B is discharged out into the atmosphere from the loosened portion of flare portion of the liquid-side two-way valve 7 together with the introduced carbon dioxide.

[0055] Thereafter, the flare portion of the liquid-side two-way valve 7 is tightly closed keeping the pressure in the connecting pipes 9 and 10 and the indoor unit B at positive pressure (about 0.1 kgf/cm²).

[0056] Next, the connecting device 12 is removed from the service port 8b together with the carbon dioxide cylinder 11.

[0057] Then, as shown in Fig.2, the trap apparatus 13 is mounted to the service port 8b using the connecting device 14.

[0058] The trap apparatus 13 is mounted to the connection device 14 by being pushed to the connection device 14 while being rotated. By this mounting operation,

the interior of the trap apparatus 13 is brought into communication with the connecting pipe 10.

[0059] By bringing the trap apparatus 13 into communication with the connecting pipe 10, the carbon dioxide in the connecting pipes 9 and 10 and the indoor unit B is introduced into the trap apparatus 13 through the service port 8b.

[0060] In the embodiments of the first to the third, the introduced carbon dioxide is physically absorbed and collected by the zeolite in the trap apparatus 13, whereas in the fourth embodiment, the introduced carbon dioxide becomes calcium carbonate by chemical reaction with calcium hydroxide, and thereby, is collected.

[0061] After the carbon dioxide is collected, the screw portion 7a of the liquid-side two-way valve 7 is slightly loosened, the refrigerant gas in the outdoor unit A is introduced, thereby bringing the pressure in the connecting pipes 9 and 10 and the pipes in the indoor units B into positive pressure (about 0.2 kgf/cm²).

[0062] Thereafter, the connecting device 14 is removed from the service port 8b together with the trap apparatus 13, and the screw portion 7a of the liquid-side two-way valve 7 is completely opened.

[0063] Lastly, the screw portion 8a of the gas-side three-way valve 8 is also completely opened, and the installation of the air conditioner is completed.

[0064] In the above embodiments, the volume of the pipe of the indoor unit B including the indoor unit heat exchanger 6 and the connecting pipes 9 and 10 was 1.5 liters.

[0065] Using the trap apparatus 13A of the first embodiment shown in Fig.3, the above installing operation was carried out.

[0066] As a result, the pressure in the pipe of the indoor unit B including the indoor unit heat exchanger 6 and the connecting pipes 9 and 10 reached sufficient negative atmosphere (10 mmHg or less) in four minutes.

[0067] Next, using the trap apparatus 13B of the second embodiment shown in Fig.4, the above installing operation was carried out.

[0068] As a result, the pressure in the pipe of the indoor unit B including the indoor unit heat exchanger 6 and the connecting pipes 9 and 10 reached sufficient negative atmosphere (10 mmHg or less) in three minutes.

[0069] Next, using the trap apparatus 13C of the third embodiment shown in Figs.5 to 7, the above installing operation was carried out.

[0070] As a result, the pressure in the pipe of the indoor unit B including the indoor unit heat exchanger 6 and the connecting pipes 9 and 10 reached sufficient negative atmosphere (10 mmHg or less) in two minutes.

[0071] Next, using the trap apparatus 13D of the fourth embodiment shown in Figs.8 to 10, the above installing operation was carried out. As a result, the pressure in the connecting pipes 9 and 10 and the pipe

of the indoor unit B reached a sufficient negative atmosphere (50 mmHg or less) in three minutes.

[0072] When the above embodiments are compared, the honeycomb structure body coated with zeolite, the third embodiment, reached the sufficient negative pressure fastest.

[0073] However, in the third embodiment, a trap apparatus body container required for accommodating 100g of zeolite is adversely increased in size as compared with those of the first and second embodiments. The trap apparatus directly accommodating the spherical zeolite particles as in the first embodiment was most compact. Therefore, it is preferable to select a suitable trap apparatus while taking time required for installing operation and a size of tool required for the operation into consideration.

[0074] In each of the embodiments, after the inside air was replaced by carbon dioxide, next operation was carried out in a state where the pressure in each of the connecting pipes 9, 10 and the pipe of the indoor unit B was kept at about 0.1 kgf/cm². The level of the positive pressure required at that time should be slightly positive as compared with the atmospheric pressure, and it is preferable that this pressure is 0.3kgf/cm² or lower. With this pressure level, when the pipes are brought into communication with the inside of the trap apparatus 13D, convection of gas is generated and carbon dioxide can swiftly be collected. Further, even if the pressure is lower than the atmospheric pressure, if the pressure is higher than a pressure in the trap apparatus 13, the same effect can be obtained. To achieve the same effect, the pressure in the trap apparatus 13 can be set to negative pressure (e.g., 1 mmHg or lower) so that the convection of gas from the connecting pipes 9, 10 and the pipe of the indoor unit B to the trap apparatus 13 can be obtained.

[0075] Although the spherical zeolite particles were used in the first embodiment, the shape of the zeolite particles may be oval spherical shape, and if the zeolite particles are formed with bumps and dips so as to increase its surface area, higher effect can be obtained. Further, although the spherical zeolite particles having different size were used in the first embodiment, zeolite particles having different shape may be used. In this case, it is preferable to dispose zeolite particles having greater surface area at the place closer to the inlet.

[0076] In the third embodiment, a honeycomb structure body was used. The same effect can be obtained if a corrugated structure body is used. A structure body which can be used for the present invention should not be limited to the above embodiments, such structure body is appropriate if it has sufficient communication holes from the inlet to the bottom of the trap apparatus and zeolite can be supported on the surface or inside of such structure body so as to have sufficiently great contact area. Further, by employing the structure body such as honeycomb structure body or corrugated structure body, the trap apparatus can be conveniently trans-

ported because even if an impact is applied to the trap apparatus, the zeolite attached to the structure body is less prone to be crushed into powder.

[0077] In the fourth embodiment, a honeycomb structure body was used. Here again, the same effect can be obtained if a corrugated structure body is used. A structure body which can be used for the present invention should not be limited to the above embodiments, such structure body is appropriate if it has sufficient communication holes from the inlet to the bottom of the trap apparatus and calcium hydroxide can be supported on the surface or inside of such structure body so as to have sufficiently great contact area for effective chemical reactions. Further, the structure body useable in this embodiment should have such structure which does not cause gas passage impairment even when the volume of the structure body is expanded due to the chemical reaction. Further, in this embodiment, the radiation fins 19 are provided to the trap apparatus 13D. However, it is also effective if the inside heat generation is suppressed by cooling from the outside. Affirmative cooling, for example, dipping the trap apparatus partially in a water tank and blowing the air against the radiation fins 19, is effective.

[0078] In the first to third embodiments, although 100g of zeolite was used when the total volume of the pipe of the indoor unit B and the connecting pipes 9 and 10 was 1.5 liters, the weight of zeolite with which the effect of these embodiments was achieved was 60g or greater per one liter of the total volume of the pipe of the indoor unit B and the connecting pipes 9 and 10. With this weight of zeolite, carbon dioxide was trapped in two to five minutes and the negative pressure state of 10 to 30 mmHg was obtained. Although there is no problem even if the amount of zeolite exceeds the above value, if the zeolite is excessively increased, it is not preferable because the container for accommodating the trap material becomes bulk. If the amount of zeolite is less than 60g, the speed with which a pressure reaches the sufficient negative pressure becomes slow, and one of the objects of the present invention may be sacrificed.

[0079] Fig.11 is a graph showing the relation between the weight of zeolite charged in the trap apparatus and the pressure reached after ten minutes. In the experiment shown in Fig.11, the pressure was measured when the volume of the pipe of the indoor unit B and the connecting pipes 9 and 10 was 1.5 liters. Therefore, if the volume is 1 liter, sufficient effect should be obtained even with 60g or less of zeolite, but since collection of carbon dioxide is hindered if water is absorbed, it is conceived that 60 to 100g of zeolite per liter is practically preferable.

[0080] In the fourth embodiment, although 9g of calcium hydroxide was used when the volume of the pipe of the indoor unit B and the connecting pipes 9 and 10 was 1.5 liters, the weight of calcium hydroxide which could obtain the sufficient effect of the embodiment was 6.6 to 16.5g. Stoichiometry weight necessary for cal-

cium hydroxide to trap 1.5 liters of carbon dioxide is 4.95g at 25°C. Therefore, the weight of calcium hydroxide per 1 liter of the volume of the pipe of the indoor unit B and the connecting pipes 9 and 10 is 3.30g. However, in the present invention, two to five times of calcium hydroxide is necessary to collect the carbon dioxide swiftly. By using two to five times of calcium hydroxide, the carbon dioxide was able to be collected in two to five minutes and the negative pressure state of 10 to 50 mmHg level was obtained.

[0081] In the embodiment, the amount of water with respect to the calcium hydroxide was 1 wt%, but the amount of water applicable to the present invention was 0.1 to 10 wt%. If the amount was less than 0.1 wt%, the amount of water is too small to effectuate catalytic reaction trigger, and it took time to collect carbon dioxide. Further, if the amount of water exceeds 10 wt%, water vapor was generated by chemical reaction; and the vapor entered the connecting pipes, and it was not preferable in terms of reliability. For purpose of holding water, zeolite was used in the present embodiment. Similarly, as materials which can hold water and do not desorb water, activated alumina, silica gel and the like was found applicable. As a factor of the applicable materials, specific surface of 100m²/g was preferable.

[0082] Although in connection with the explanation of the method for installing, the outdoor unit having the normal two-way valve and three-way valve was used in the present embodiments, the present invention can also be applied to an outdoor unit having a three-way valve and another three-way valve. Further, although the installation was carried out using two kinds connecting devices for the two-way valve, the connecting device may have T-bifurcation shape; and carbon dioxide may be supplied from one of the connecting portions, and the carbon dioxide can be collected from the other connecting portion. It is preferable to commonly use the same connecting device.

[0083] In each of the above embodiments, a dryer 5 is disposed in the outdoor unit A. According to an installing method using a vacuum pump, water existing in the indoor unit A and the connecting pipes 9 and 10 can also be eliminated by increasing the operation time of the vacuum pump, but it is difficult to sufficiently eliminate the water by a purge method using refrigerant gas as in the present invention. Therefore, by providing the dryer 5 in the refrigeration cycle, it is possible to ensure the long term reliability of the air conditioner.

[0084] As apparent from the above embodiments, according to the present invention, since the physical absorption or chemical reaction is used without using a power supply, it is possible to complete the installing operation within a short time. Further, since carbon dioxide is discharged into the atmosphere instead of refrigerant gas having environmental problem, the influence on global warming is extremely small.

[0085] Further, according to the present invention, the inside pressure is held positive after air has been

replaced by carbon dioxide. Therefore, when the inside pressure is brought into communication with the trap apparatus next, the positive pressure state of the inside becomes a trigger of convection of gas so that the carbon dioxide is swiftly absorbed by the zeolite (or collected as a result of calcium chemical reaction from calcium hydroxide to calcium carbonate) in the trap apparatus.

[0086] Further, according to the present invention, the inside pressure is held at higher pressure than that of the trap apparatus after air has been replaced by carbon dioxide. Therefore, when the inside pressure is brought into communication with the trap apparatus next, the higher pressure state of the inside becomes a trigger of convection of gas so that the carbon dioxide is swiftly absorbed by the zeolite (or collected as a result of calcium chemical reaction from calcium hydroxide to calcium carbonate) in the trap apparatus.

[0087] Furthermore, according to the present invention, when the structure body is utilized, since zeolite exists on the surface of the structure body, it is possible to increase the contact area with the carbon dioxide, and to swiftly collect the carbon dioxide.

[0088] Furthermore, according to the present invention, the trap apparatus having 60g or more zeolite per one liter of volume of the pipe of the indoor unit and the connection pipes is used. Therefore, if the weight of zeolite is set while taking the volume of the pipe of the indoor unit and the connection pipes into consideration, it is possible to collect the carbon dioxide with sufficient speed.

[0089] Furthermore, according to the present invention, the structure body comprising carriers with the coated layer mainly made of zeolite is included inside. By this structure, since zeolite exists on the surface of the structure body, it is possible to increase the contact area with the carbon dioxide.

[0090] Furthermore, according to the present invention, by employing the honeycomb structure body or the corrugated structure body, it is possible to increase the contact area with the carbon dioxide, and to speed up the collection of the carbon dioxide.

[0091] Furthermore, according to the present invention, by forming the flow path space which is greater on the side of the inlet than the bottom side, it is possible to smoothly diffuse the carbon dioxide in the trap apparatus.

[0092] Furthermore, according to the present invention, by using a hollow cylindrical zeolite particles, the flow path necessary for diffusing carbon dioxide can sufficiently be ensured, and it is possible to speed up the trap of carbon dioxide.

[0093] Furthermore, according to the present invention, zeolite particles having greater surface area is charged in the trap apparatus closer to its inlet than its bottom, it is possible to smoothly diffuse the carbon dioxide in the trap apparatus.

[0094] Furthermore, according to the present inven-

tion, by using the spherical or columnar zeolite particles, a flow path necessary for diffusing the carbon dioxide can sufficiently be secured, and by charging zeolite particles having greater surface area into the trap apparatus closer to its inlet than its bottom, it is possible to smoothly diffuse the carbon dioxide in the trap apparatus.

[0095] Further, according to the present invention, since in the trap apparatus, a trap material exists on the structure body having communication ports, it is possible to increase the contact area for the diffusion reaction between the trap material and carbon dioxide, and to prevent the flow path from being closed by volume expansion at the time of the chemical reaction.

[0096] Further, according to the present invention, a heat radiating portion or a cooling portion is provided outside the trap apparatus, reaction heat generated by the abrupt chemical reaction can efficiently be transmitted and diffused outside, and a pressure in the connecting pipes and the indoor unit can be brought into a negative state, i.e., 50 mmHg or less.

[0097] Further, according to the present invention, by using the amount of trap material which is two to five times of stoichiometry weight with respect to the volume in the connecting pipes and the indoor unit, a pressure in the connecting pipes and the indoor unit can be brought into a negative state, i.e., 50 mmHg or less at a sufficient speed.

[0098] Further, according to the present invention, by adding a small amount of water to calcium hydroxide, this becomes a catalytic trigger, the chemical reaction speed from the calcium hydroxide to calcium carbonate is accelerated.

[0099] Further, according to the present invention, by collecting carbon dioxide replacing air in the indoor unit heat exchanger and the connection pipes using the above-described installation trap apparatus, the carbon dioxide can swiftly be collected, and the installation operation can conveniently be carried out.

Claims

1. A method for installing an air conditioner which is comprised of (a) an outdoor unit including a compressor and an outdoor unit heat exchanger into which refrigerant gas is charged, (b) an indoor unit including an indoor unit heat exchanger which is opened to atmosphere, and (c) a connecting pipe connecting said outdoor unit and said indoor unit which is opened to atmosphere, comprising:

air in said indoor unit heat exchanger and said connecting pipe is replaced by carbon dioxide; said carbon dioxide is collected by a trap apparatus having zeolite; and
after said carbon dioxide is collected, the refrigerant gas in the outdoor unit is charged into said indoor unit heat exchanger and said con-

necting pipe, wherein when said air in said indoor unit heat exchanger and said connecting pipe is replaced by said carbon dioxide, pressure in said indoor unit heat exchanger and said connecting pipe is brought into a positive pressure state.

2. A method for installing an air conditioner which is comprised of (a) an outdoor unit including a compressor and an outdoor unit heat exchanger into which refrigerant gas is charged, (b) an indoor unit including an indoor unit heat exchanger which is opened to atmosphere, and (c) a connecting pipe connecting said outdoor unit and said indoor unit which is opened to atmosphere, comprising:

air in said indoor unit heat exchanger and said connecting pipe is replaced by carbon dioxide; said carbon dioxide is collected by a trap apparatus having zeolite; and

after said carbon dioxide is collected, the refrigerant gas in the outdoor unit is charged into said indoor unit heat exchanger and said connecting pipe, wherein when said air in said indoor unit heat exchanger and said connecting pipe is replaced by said carbon dioxide, pressure in said indoor unit heat exchanger or said connecting pipe is brought into pressure higher than that in said trap apparatus.

3. A method for installing an air conditioner according to claim 1 or 2, wherein said trap apparatus includes therein a structure body constructed with carriers which are coated with a layer mainly made of zeolite.
4. A method for installing an air conditioner according to claim 1 or 2, wherein said trap apparatus includes 60g or greater zeolite per one liter of a volume of a pipe of said indoor unit and said connecting pipe.
5. A trap apparatus for installing an air conditioner comprising a structure body constructed with carriers which are coated with a layer mainly made of zeolite.
6. A trap apparatus for installing an air conditioner according to claim 5, wherein said structure body is a honeycomb structure body or a corrugated structure body.
7. A trap apparatus for installing an air conditioner wherein zeolite is charged such that a flow path space is larger on the inlet side than that of the bottom side.
8. A trap apparatus for installing an air conditioner

wherein a hollow cylindrical zeolite particle is used.

9. A trap apparatus for installing an air conditioner wherein zeolite particles having surface area greater than that of zeolite particles disposed closer to a bottom of said trap apparatus is disposed closer to an inlet of said trap apparatus. 5
10. A trap apparatus for installing an air conditioner wherein spherical or columnar zeolite particles is used, and zeolite particles having diameter or length greater than that of zeolite particles disposed closer to a bottom of said trap apparatus is disposed closer to an inlet of said trap apparatus. 10
11. A trap apparatus for installing an air conditioner according to any one of claims 5 to 10, wherein pressure in said trap apparatus is brought into a negative state equal to or lower than 1 mmHg. 15
12. A method for installing an air conditioner, wherein carbon dioxide that has replaced air in an indoor unit heat exchanger or a connecting pipe is collected using the trap apparatus described in any one of claims 5 to 10. 20
13. A method for installing an air conditioner which is comprised of (a) an outdoor unit including a compressor and an outdoor unit heat exchanger into which refrigerant gas is charged, (b) an indoor unit including an indoor unit heat exchanger which is opened to atmosphere, and (c) a connecting pipe connecting said outdoor unit and said indoor unit which is opened to atmosphere, comprising: 25

air in said indoor unit heat exchanger and said connecting pipe is replaced by carbon dioxide; said carbon dioxide is collected by a trap apparatus having calcium hydroxide; and after said carbon dioxide is collected, the refrigerant gas in the outdoor unit is charged into said indoor unit heat exchanger and said connecting pipe, wherein when said air in said indoor unit heat exchanger and said connecting pipe is replaced by said carbon dioxide, pressure in said indoor unit heat exchanger and said connecting pipe is brought into a positive pressure state. 30
14. A method for installing an air conditioner which is comprised of (a) an outdoor unit including a compressor and an outdoor unit heat exchanger into which refrigerant gas is charged, (b) an indoor unit including an indoor unit heat exchanger which is opened to atmosphere, and (c) a connecting pipe connecting said outdoor unit and said indoor unit which is opened to atmosphere, comprising: 35

air in said indoor unit heat exchanger and said connecting pipe is replaced by carbon dioxide; said carbon dioxide is collected by a trap apparatus having calcium hydroxide; and after said carbon dioxide is collected, the refrigerant gas in the outdoor unit is charged into said indoor unit heat exchanger and said connecting pipe, wherein when said air in said indoor unit heat exchanger and said connecting pipe is replaced by said carbon dioxide, pressure in said indoor unit heat exchanger and said connecting pipe is brought into a positive pressure state. 40

air in said indoor unit heat exchanger and said connecting pipe is replaced by carbon dioxide; said carbon dioxide is collected by a trap apparatus having calcium hydroxide; and after said carbon dioxide is collected, the refrigerant gas in the outdoor unit is charged into said indoor unit heat exchanger and said connecting pipe, wherein when said air in said indoor unit heat exchanger and said connecting pipe is replaced by said carbon dioxide, pressure in said indoor unit heat exchanger and said connecting pipe is brought into pressure higher than that in said trap apparatus.

15. A method for installing an air conditioner according to claim 13 or 14, wherein said trap apparatus includes therein a structure body constructed with carriers which are coated with a layer mainly made of calcium hydroxide. 15
16. A method for installing an air conditioner according to claim 13 or 14, wherein said trap apparatus includes 6.6g or greater calcium hydroxide per one liter of a volume of a pipe of said indoor unit and said connecting pipe. 20
17. A trap apparatus for installing an air conditioner comprising a structure body constructed with carriers which are coated with a layer mainly made of calcium hydroxide. 25
18. A trap apparatus for installing an air conditioner according to claim 17, wherein said structure body is a honeycomb structure body or a corrugated structure body. 30
19. A trap apparatus for installing an air conditioner according to claim 17, wherein water in an amount of 0.1 to 10 wt% of calcium hydroxide is included. 35
20. A trap apparatus for installing an air conditioner according to claim 17, wherein said calcium hydroxide is mixed with at least one of zeolite, activated alumina and silica gel to form said coating layer. 40
21. A trap apparatus for installing an air conditioner according to claim 17, wherein a heat radiating portion or a cooling portion is provided outside said trap apparatus. 45
22. A method for installing an air conditioner, wherein carbon dioxide that has replaced air in an indoor unit heat exchanger and a connecting pipe is collected using the trap apparatus described in any one of claims 17 to 21. 50

FIG. 1

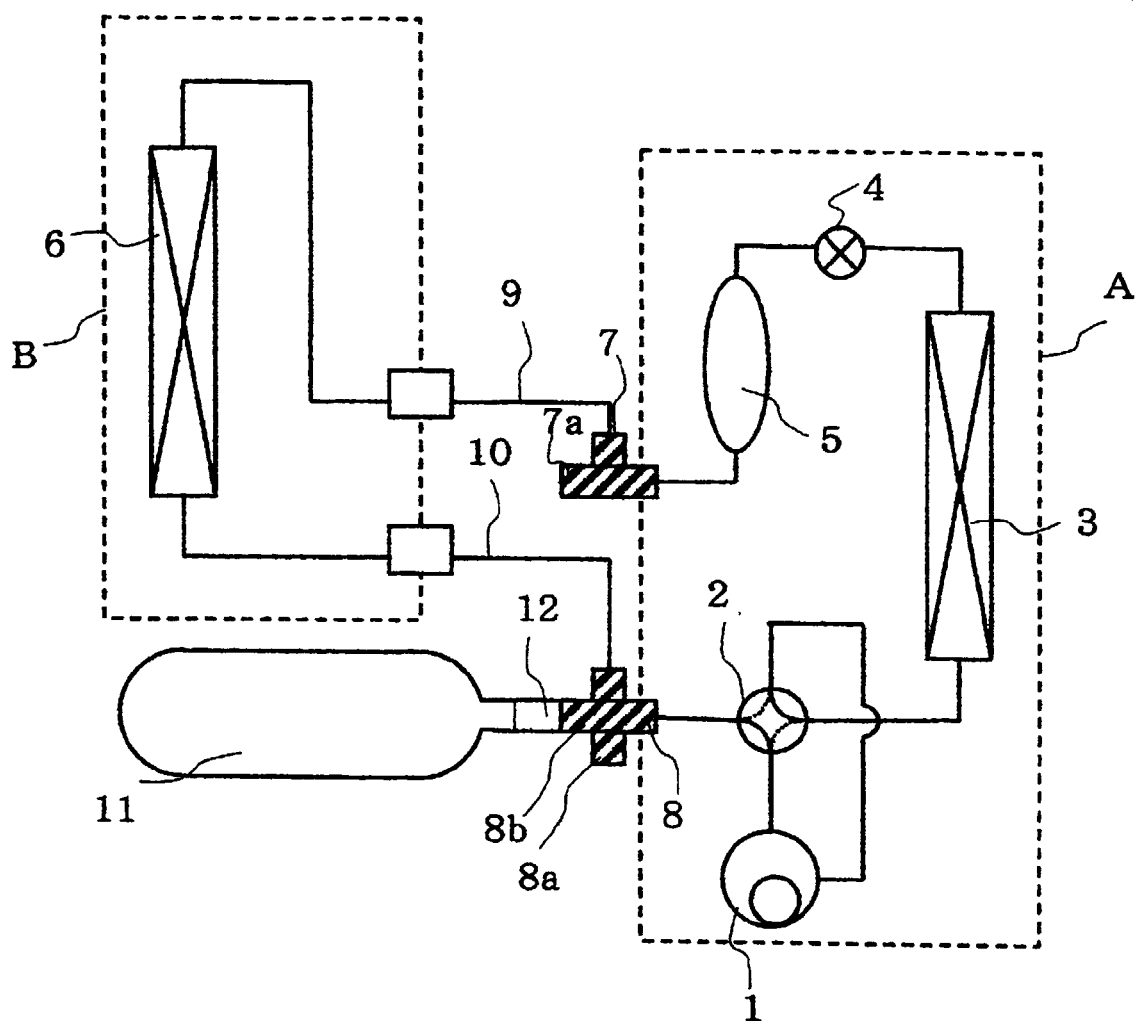


FIG.2

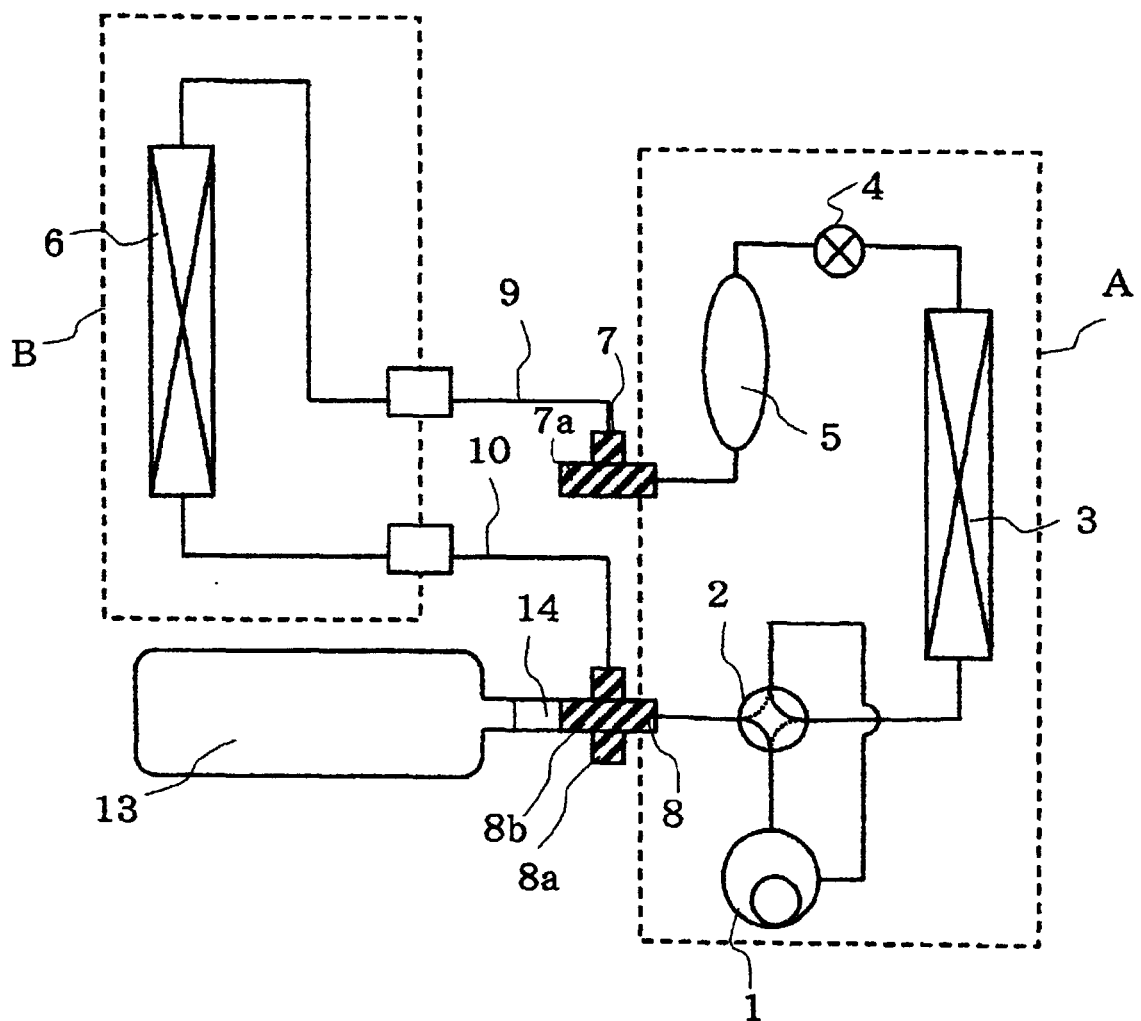


FIG.3

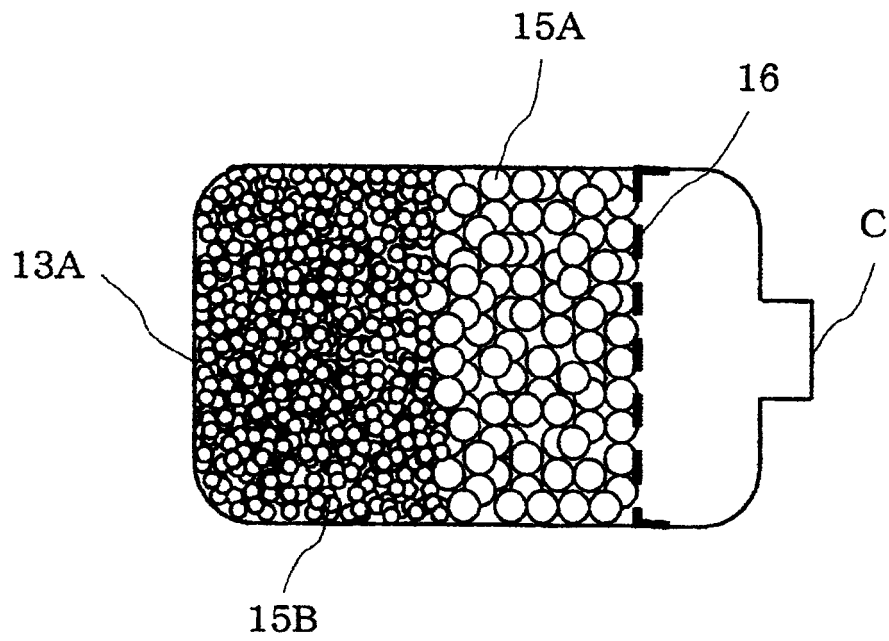


FIG.4

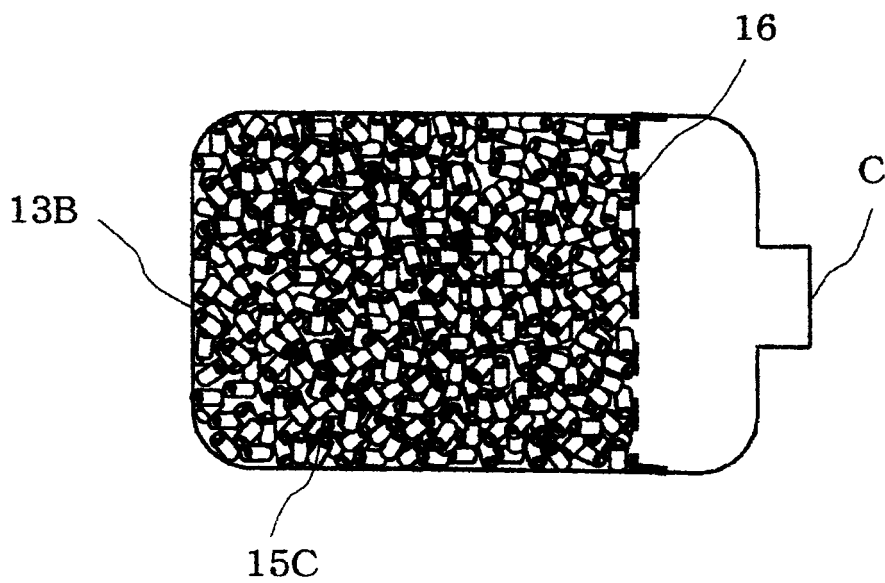


FIG.5

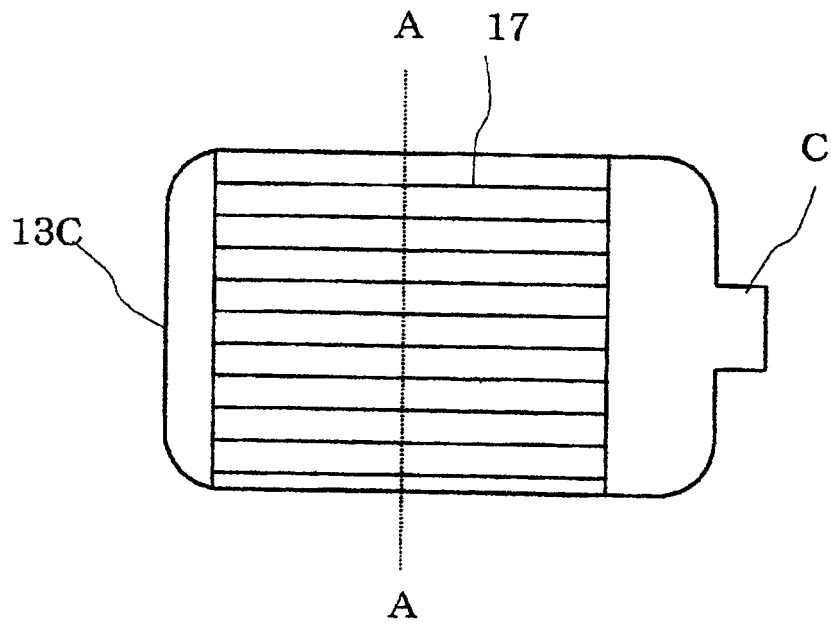


FIG.6

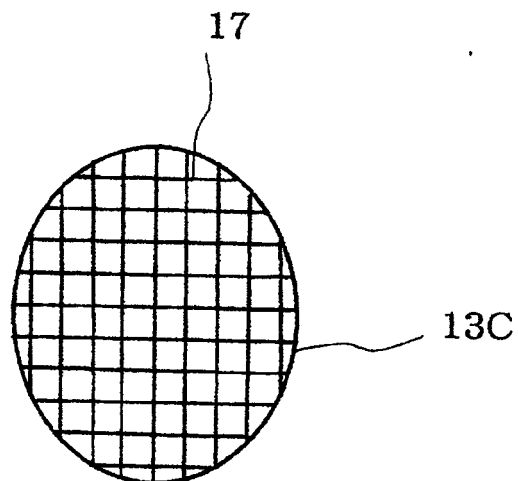


FIG. 7

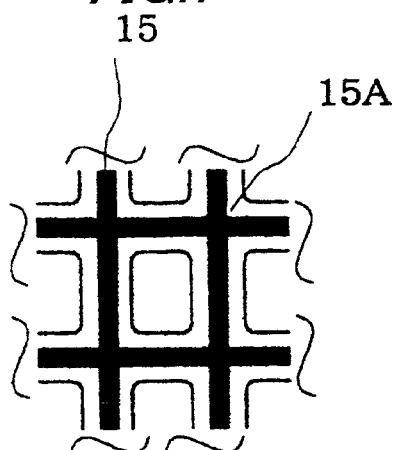


FIG. 8

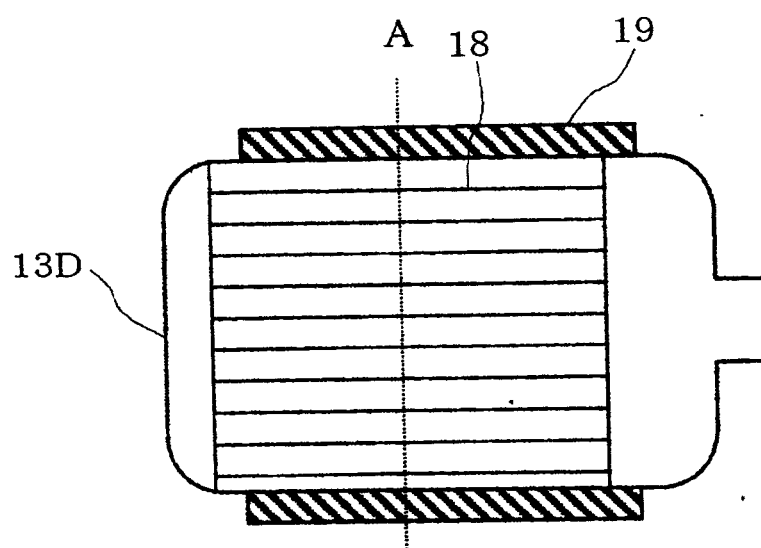


FIG. 9

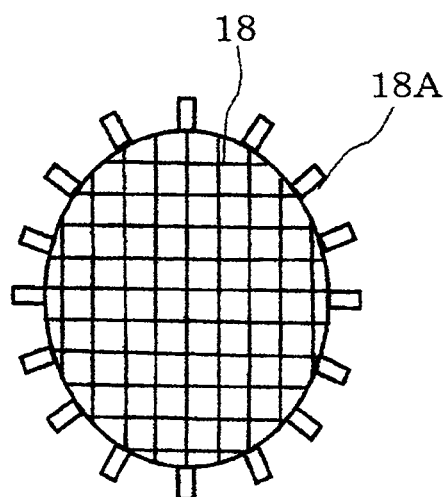


FIG. 10

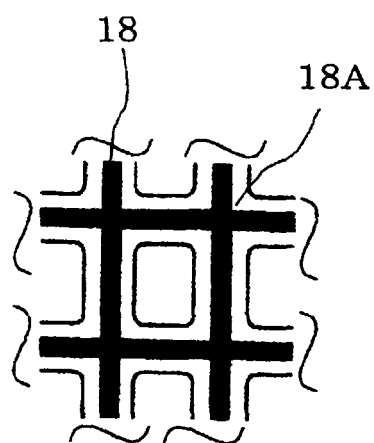


FIG. 11

