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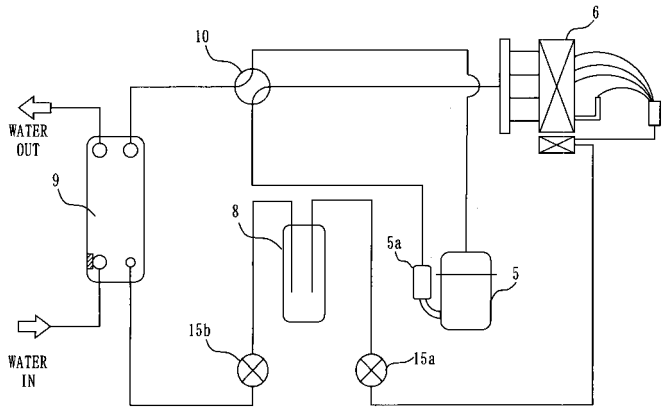
(54) Air/water heat exchange apparatus

(57) An object is to provide a cost saving and energy efficient air/water heat exchange apparatus by utilizing parts of an outdoor unit designed for a separate type air conditioner, and thus utilizing existing plant and equipment. The air/water heat exchange apparatus includes the outdoor unit that is separated by the separator into the fan room and the machine room. The fan room includes an air-refrigerant heat exchanger that exchanges heat between air and the refrigerant, and the fan that sends the air to the air-refrigerant heat exchanger. The machine room includes the compressor that compresses the refrigerant, the plate heat exchanger that exchanges heat between the refrigerant and water, the electronic expansion valves, and the accumulator that accumulates the refrigerant. The outdoor unit contains the closed refrigerant circuit, which includes the compressor, the plate heat exchanger, the electronic valves, the air-refrigerant heat exchanger, and the accumulator.

Fig. 4



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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to an air/water heat exchange apparatus that heats or cools water by using a refrigeration cycle.

Description of the Related Art

[0002] A plate type subcool heat exchanger to be installed in a machine room of an outdoor unit of refrigeration cycle equipment has been introduced (See e.g. Patent Document 1). The plate type subcool heat exchanger is formed to include five plate materials, i.e., a first end plate, a first flow channel plate, a partition plate, a second flow channel plate, and a second end plate. The first end plate is an aluminum plate, and formed to include a first inlet pipe for letting a main refrigerant A flow in and a second outlet pipe for letting a bypassed refrigerant B at low temperature flow out. The first flow channel plate, with an aluminum core material, is made from a brazing sheet with cladding of aluminum, as a brazing material, on both sides. The first flow channel plate is formed to include a flow channel for letting the main refrigerant A pass through, and a hole for letting the low-temperature bypassed refrigerant B pass through. The partition plate is an aluminum plate, and formed to include a hole for letting the main refrigerant A pass through and a hole for letting the bypassed refrigerant B pass through. The second flow channel plate is made from a brazing sheet, and formed to include a flow channel for letting the bypassed refrigerant B pass through, and a hole for letting the main refrigerant A pass through. The second end plate is formed to include a first outlet pipe to let the main refrigerant A flow out, and a second inlet pipe to let the low-temperature bypassed refrigerant flow in. These five plate materials are combined and then heated together in an atmosphere furnace to be joined.

[0003] A neat and space saving heat pump air conditioner and water heater, which can be installed without wasted space, has been introduced (See e.g. Patent Document 2). The heat pump air conditioner and water heater is formed to include a hot water storage tank on one side of a frame body. On the other side are an outdoor heat exchanger and a fan provided at the upper portion, and a compressor, a water-refrigerant heat exchanger and a water circulation pump provided at the lower portion. On both or either of a top surface and a side surface facing the outdoor heat exchanger are suction openings provided. On a front surface is a discharge opening provided. Therefore, the hot water storing tank, the outdoor heat exchanger, the fan, etc. may be stored neatly within a single frame body. The outdoor heat exchanger can exchange heat normally with fresh air sucked from the top surface or the side surface of the frame body. Therefore, the outdoor heat exchanger can be installed close to wall of a house without gap.

[0004] In Europe, however, it is expected according to their energy policies that energy sources will be switched from oil to electricity very quickly. They used to have radiator heating, but their mainstream heating is currently radiant heating such as floor heating. Radiant heating mainly uses petroleum products as the heat source. Therefore, there has been a growing demand for replacing the petroleum products by a highly energy efficient heat pump heating system. An inverter heat pump heater can achieve low running costs by the use of R410A as a refrigerant.

[0005] In the Southern European market, air/water heat exchange devices are dominant due to the housing and power source conditions. The air/water heat exchange devices are compact and produce hot water and cold water using a small amount of air. There is a large demand for these air/water heat exchange devices not only for heating water but also for other purposes by the connection to the local applications such as fan coil units. The fan coil unit is an assembly of a heat exchanger (a coil), a fan motor unit, and an air filter. The fan coil unit is used mainly for regulating room temperature while the required amount of fresh air is conditioned by an air conditioner.

[0006] A method of installing a plate heat exchanger has been introduced (See e.g. Patent Document 3). According to this method, mounting hardware with screw holes is mounted on the back of the plate heat exchanger. The mounting hardware is screwed, for example, on a sheet metal base for the plate heat exchanger mounted on a hot water storage tank by spot welding.

[0007] With a plate heat exchanger that is used as a subcool heat exchanger described in the Patent Document 1, it is an outdoor unit of an air conditioner that exchanges heat between refrigerants. On-site refrigerant pipework is therefore required for connecting the outdoor unit to an indoor unit.

[0008] With the heat pump water heater described in the Patent Document 2, CO_2 refrigerant and water are used for heat exchange. This poses a problem: it is hardly acceptable under European energy policies and measures for reducing emissions that CO_2 is used as a refrigerant.

[0009] With the method of installing a plate heat exchanger described in the Patent Document 3, a plate heat exchanger is fastened by screws and bolts and secured firmly to a heavy object such as a hot water storage tank and a pump. This poses a problem: vibration transmitted from vibrating equipment, such as a compressor, a pump, etc., may be absorbed by transforming connection pipes for fluid circulation. Accordingly, stress on the connection pipes for fluid circulation is increased, and thereby the damage probability is increased.

[0010] Another problem has been posed by a different type of a plate heat exchanger from that of the Patent Document 3, which is covered with thermal insulating

materials, and mounted to support pillars on a housing etc. by bounding together by means of a thin resin band. The plate heat exchanger is not held firmly enough to stand against vibration during transportation or vibration transmitted from vibrating equipment, such as a compressor, a pump, etc., in operation. Accordingly, the arrangement of the plate heat exchanger cannot be stable in position. This results in applying stress to connection pipes for fluid circulation connected to the plate heat exchanger.

[Patent Document 1] JP 8-270984
[Patent Document 2] JP 2005-83712
[Patent Document 3] JP 2005-147583

SUMMARY OF THE INVENTION

[0011] Embodiments of this invention are designed to solve problems as described above. It is an object to provide a cost saving and energy efficient air/water heat exchange apparatus by utilizing parts of an outdoor unit designed for a separate type air conditioner, and thus utilizing existing plant and equipment.

[0012] It is another object to provide an air/water heat exchange apparatus that may hold a plate heat exchanger with constant strength, and absorb and distribute undue vibration transmitted from vibrating equipment, such as a compressor, a pump, etc. This may result in the effect of reducing stress on connection pipes for fluid circulation, and also facilitating assembly work.

[0013] These and other objects of the embodiments of the present invention are accomplished by the present invention as hereinafter described in further detail.

[0014] According to one aspect of the present invention, an air/water heat exchange apparatus may include the outdoor unit that may be separated by the separator into the fan room and the machine room. The fan room may include an air-refrigerant heat exchanger that exchanges heat between air and the refrigerant, and the fan that sends the air to the air-refrigerant heat exchanger. The machine room may include the compressor that compresses the refrigerant, the plate heat exchanger that exchanges heat between the refrigerant and water, the electronic expansion valves, and the accumulator that accumulates the refrigerant. The outdoor unit contains the closed refrigerant circuit, which includes the compressor, the plate heat exchanger, the electronic valves, the air-refrigerant heat exchanger, and the accumulator.

[0015] According to another aspect of the present invention, an air/water heat exchange apparatus may include the outdoor unit that may be separated by the separator into the fan room and the machine room. The fan room may include an air-refrigerant heat exchanger that exchanges heat between air and the refrigerant, and the fan that sends the air to the air-refrigerant heat exchanger. The machine room may include the compressor that compresses the refrigerant, the plate heat exchanger that exchanges heat between the refrigerant and water, the electronic expansion valves, and the accumulator that accumulates the refrigerant. The outdoor unit contains the closed refrigerant circuit, which includes the compressor, the plate heat exchanger, the electronic valves, the air-refrigerant heat exchanger, and the accumulator. Then, the plate heat exchanger is covered with the resilient thermal insulating material. The air/water heat exchange apparatus may further include a cover case that encases the plate heat exchanger with the thermal insulating material under compression.

[0016] An air/water heat exchange apparatus, according to one embodiment of the present invention, is allowed to utilize most parts of an outdoor unit designed for a separate type air conditioner, and thus utilize existing plant and equipment. This may result in providing the market with cost saving and energy efficient air/water heat exchange apparatuses. Another market attraction of the air/water heat exchange apparatus is that the refrigerant circuit is a closed circuit, and therefore on-site refrigerant pipework is not needed.

[0017] Further scope of applicability of the present invention will become apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] The present invention will become more fully understood from the detailed description given hereinafter and the accompanying drawings which are given by way of illustration only, and thus are not limitative of the present invention, and wherein:

Fig. 1 shows an outline view of an outdoor unit 1 according to a first embodiment;
Fig. 2 shows a perspective view of an internal structure of the outdoor unit 1 according to the first embodiment;
Fig. 3 shows a top view of an internal structure of the outdoor unit 1 according to the first embodiment;
Fig. 4 shows a refrigerant circuit according to the first embodiment;
Fig. 5 shows an exploded perspective view of a plate heat exchanger 9 according to the first embodiment;
Fig. 6 shows a perspective view of an internal structure of the outdoor unit 1 according to the first embodiment;
Fig. 7 shows a perspective view of an internal structure of the outdoor unit 1 according to a second embodiment;
Fig. 8 shows an enlarged view of a part of a stay 11 according to the second embodiment;
Fig. 9 shows an exploded perspective view of a main part of an internal structure of the outdoor unit 1 il-

lustrating a method of installing the plate heat exchanger 9 according to a third embodiment;
Fig. 10 shows a perspective view of a main part of an internal structure of the outdoor unit 1 according to the third embodiment;
Fig. 11 shows a cross sectional view illustrating an arrangement of an auxiliary support member 104, a cover case 103a, and the plate heat exchanger 9 according to a fourth embodiment;
Fig. 12 shows a perspective view of the auxiliary support member 104 according to the fourth embodiment; and
Fig. 13 shows a cross sectional view illustrating an arrangement of the auxiliary support member 104, the cover case part 103a, and the plate heat exchanger 9 according to a fifth embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0019] Reference will now be made in detail to the present preferred embodiments of the invention, examples of which are illustrated in the accompanying drawings, wherein like reference numerals indicate like devices through out the several views.

Embodiment 1.

[0020] A first embodiment will be discussed with reference to Fig. 1 to Fig. 6. Fig. 1 shows an outline view of an outdoor unit 1. Fig. 2 shows a perspective view of an internal structure of the outdoor unit 1. Fig. 3 shows a top view of an internal structure of the outdoor unit 1. Fig. 4 shows a refrigerant circuit. Fig. 5 shows an exploded perspective view of a plate heat exchanger 9. Fig. 6 shows a perspective view of an internal structure of the outdoor unit 1.

[0021] As shown in Fig. 1, then outdoor unit 1 looks very similar to an outdoor unit for a separate type air conditioner. The outdoor unit 1 has a front grill 1a on the font side, through which air is blown out. The outdoor unit 1 produces hot water by heating water and cold water by cooling water, for example, in a refrigeration cycle. Thus, the outdoor unit 1 is an air/water heat exchange apparatus as a type of refrigeration and air conditioning equipment. The outdoor unit 1 is characterized by containing a closed refrigerant circuit. On site, therefore, installation requires nothing but water pipework. The outdoor unit 1 is also characterized in that an existing outdoor unit for an air conditioner may be utilized.

[0022] With reference to Fig. 2 and Fig. 3, the outdoor unit 1 contains a fan room 2 and a machine room 4, which are separated by a separator 7. The fan room 2 contains an air-refrigerant heat exchanger 6 that exchanges heat between air and a refrigerant, a fan 3 that sends air to the air-refrigerant exchanger 6, etc. The outdoor unit 1 also has a box placed over the machine room 4 for storing electrical parts, which does not appear in the figures.

[0023] The machine room 4 contains a compressor 5 that compress a refrigerant, an accumulator 8 that is placed on a suction side of the compressor 5 to hold the refrigerant, a four-way valve 10 that switches the flow of the refrigerant, a plate heat exchanger 9 that exchanges heat between the refrigerant and water, electronic expansion valves 15a and 15b that decompress the refrigerant, etc. The compressor 5 is equipped with a suction muffler 5a on a suction side. According to this embodiment, R410A is used for the refrigerant, and the compressor 5 is inverter-driven and operated by heat pumping. This may contribute to energy saving and CO_2 reduction.

[0024] The plate heat exchanger 9 is formed to have a refrigerant pipe connecting port 9a on the front surface, and a water pipe connecting port 9b on the back surface thereof. The plate heat exchanger 9 is encased with a cover case, which does not appear in Fig. 2 and Fig. 3.

[0025] Fig. 4 shows a block diagram of the refrigerant circuit. Fig. 4 shows a case of supplying a high-pressure and high-temperature gas refrigerant from the compressor 5 to plate heat exchanger 9 to heat water that enters a water circuit of the plate heat exchanger 9. The compressor 5 compresses the refrigerant (e.g., R410A) to the high-pressure and high-temperature gas refrigerant, which is then supplied to the plate heat exchanger 9 via the four-way valve 10. The plate heat exchanger 9 exchanges heat between the refrigerant and water, which flow in opposite directions there, to heat the water. A liquid refrigerant flowing out of the plate heat exchanger 9 is subcooled by the electronic expansion valve 15b, and enters the accumulator 8. The liquid refrigerant is reduced in pressure by the electronic expansion valve 15a to become a two-phase refrigerant. The two-phase refrigerant is evaporated in the air-refrigerant heat exchanger 6 to become a low pressure gas refrigerant. The low pressure gas refrigerant returns to the compressor 5 through the suction muffler 5a via the four-way valve 10. High-temperature water heated by the plate heat exchanger 9 is supplied to a hot water tank, a fan coil unit, etc., which do not appear in the figures.

[0026] In a case of cooling water in the plate heat exchanger 9, the flow direction of the refrigerant is opposite to that described above. The compressor 5 cools a refrigerant (e.g., R410A) to produce a high-pressure and high-temperature gas refrigerant, which is supplied to the air-refrigerant heat exchanger 6 via the four-way valve 10. A liquid refrigerant from the air-refrigerant heat exchanger 6 is subcooled by the electronic expansion valve 15a and enters the accumulator 8. The liquid refrigerant is reduced in pressure by the electronic expansion valve 15b to become a two-phase refrigerant. The two-phase refrigerant is evaporated in the plate heat exchanger 9 to become a low pressure gas refrigerant. The plate heat exchanger 9 exchanges heat between the refrigerant and water, which flow in parallel there, to cool the water. The low pressure gas refrigerant from the plate heat exchanger 9 returns to the compressor 5 through the suction muf-

fler 5a via the four-way valve 10. Water cooled in the plate heat exchanger 9 is supplied to a fan coil unit, for example, to be used for air conditioning, etc.

[0027] As mentioned earlier, water pipework is performed on site to connect water pipes to the water pipe connecting port 9b formed on the back surface of the plate heat exchanger 9.

[0028] The use of R410A for the refrigerant may meet CO_2 emission reduction measures under European energy policies.

[0029] A further description will be give of a layout of parts in the machine room 4 with reference to Fig. 3. The compressor 5, the heaviest part in the machine room 4, is placed on the separator 7 side, while the suction muffler 5a, with a relatively large surface area, is placed near the center of the machine room 4. This may allow for effective use of space in the machine room 4.

[0030] The accumulator 8 is placed next to the compressor 5 at an end of the outdoor unit 1 in the longitudinal direction (in a corner at the front side of the outdoor unit 1). The compressor 5 and the accumulator 8 are placed at the front side of the outdoor unit 1 (at the lower side in the case of Fig. 2). The plate heat exchanger 9 is placed at the back side of the accumulator 8 and the compressor 5 (in a corner at the back side of the outdoor unit 1). The plate heat exchanger 9 is formed to have the refrigerant pipe connecting port 9a at the front side and the water pipe connecting port 9b at the back side (See Fig. 3).

[0031] The machine room 4, thus containing the compressor 5, the accumulator 8, and the plate heat exchanger 9, may have neat connections of refrigerant pipes within the machine room 4. This may achieve well balanced weight distribution.

[0032] The plate heat exchanger 9 is of an ordinary existing type, and therefore will not be discussed about the structure here in detail. Fig. 5 shows a brief description of an internal structure of the plate heat exchanger 9. The plate heat exchanger 9 of Fig. 5 is shown without a cylindrical body of a cover that encases the plate heat exchanger 9. The plate heat exchanger 9 has the refrigerant pipe connecting ports 9a formed on one of end plates 9d and the water pipe connecting ports 9b formed on the other end plate 9d. There is a plurality of corrugated heat exchange plates 9c placed adjacent to each other between the both end plates 9d. A refrigerant flow channels 9e and a water flow channels 9f are arranged alternately in gaps between the heat transfer plates 9c through the plurality of heat transfer plates 9c. The heat transfer plates 9c are formed to include refrigerant communicating holes 9g, respectively, to connect the refrigerant flow channels 9e with the refrigerant pipe connecting ports 9a, respectively. The heat transfer plates 9c are also formed to include the water communicating holes 9h, respectively, to connect the water flow channels 9f with the water pipe connecting ports 9b, respectively.

[0033] Alternatively, as shown in Fig. 6, the water pipe connecting ports 9b of the plate heat exchanger 9 may be formed on the side of the outdoor unit 1.

[0034] The air/water heat exchange apparatus, thus configured, is allowed to utilize most parts of an outdoor unit designed for a separate type air conditioner. This may result in providing the market with a cost saving and energy efficient air/water heat exchange apparatus by the utilization of existing plant and equipment.

[0035] The outdoor unit 1 looks very similar, designwise, from an anterior view to an outdoor unit of an air conditioner. Therefore, when the water pipe connecting ports 9b are provided at the back or side of the outdoor unit 1, water pipework is allowed to be done in a similar manner to that of connecting an outdoor unit and an indoor unit of an air conditioner via refrigerant pipes.

Embodiment 2.

[0036] A second embodiment will be discussed with reference to Fig. 7 and Fig. 8. Fig. 7 shows a perspective view of an internal structure of the outdoor unit 1. Fig. 8 shows an enlarged view of a part of a stay 11.

[0037] As shown in Fig. 7, a stay 11 (an example of a strengthening member) is screwed to the separator 7 and a side panel 12 of the outdoor unit 1 to increase the strength of the structure of the outdoor unit 1.

[0038] The stay 11, as shown in Fig. 8, includes a U-shaped cut 11a or a notch 11b. The U-shaped cut 11a or the notch 11b may be used, for convenience sake, to hold a pressure meter 13 (See Fig. 7) for checking the pressure of the refrigerant temporarily at a regular check of the outdoor unit 1, for example.

[0039] The stay 11 also includes a band 14, and therefore has a function to fix a cable for power supply or for communication.

[0040] The use of the stay 11 as the strengthening member inside the outdoor unit 1, of this embodiment, may improve the strength of the structure of the outdoor unit 1. The use of a cutout, such as the U-shaped cut 11a or the notch 11b, may provide a temporary and steady place for necessary tools, such as a pressure meter, etc at a regular check.

[0041] According to this embodiment, the four-way valve 10 is provided to switch the flow of refrigerant to heat and cool water. Alternatively, however, the four-way valve may be eliminated in the case of either heating or cooling water.

[0042] Thus, the air/water heat exchange apparatus of one embodiment of the present invention may include the outdoor unit that may be separated by the separator into the fan room and the machine room. The fan room may include an air-refrigerant heat exchanger that exchanges heat between air and the refrigerant and the fan that sends the air to the air-refrigerant heat exchanger. The machine room may include the compressor that compresses the refrigerant, the plate heat exchanger that exchanges heat between the refrigerant and water, the electronic expansion valves, and the accumulator that accumulates the refrigerant. The outdoor unit contains the closed refrigerant circuit, which includes the com-

pressor, the plate heat exchanger, the electronic valves, the air-refrigerant heat exchanger, and the accumulator. Therefore, the air/water heat exchange apparatus is allowed to utilize most parts of an outdoor unit designed for a separate type air conditioner. This may allow for providing the market with a cost saving and energy efficient air/water heat exchange apparatus, such as a water heater, of a refrigerant cycle type by the utilization of existing plant and equipment. Another market attraction of the air/water heat exchange apparatus is that the refrigerant circuit is a closed circuit contained in a product, which may eliminate on-site refrigerant pipework.

[0043] According to the air/water heat exchange apparatus of one embodiment of the present invention, the accumulator may be placed on the side of the compressor in the longitudinal direction of the outdoor unit in the machine room, and the plate heat exchanger may be placed at the back of the compressor and the accumulator in the machine room. The plate heat exchanger may be formed to include the connecting port to the water circuit, which is located on the back or side surface of the outdoor unit. This may achieve neat and space-saving refrigerant pipe connection in the machine room with well balanced weight distribution.

[0044] According to the air/water heat exchange apparatus of one embodiment of the present invention, the outdoor unit may be formed to include the side panel as part of the housing of the outdoor unit. The separator and the side panel may be secured to the outdoor unit by means of the strengthening member. This may improve the strength of the structure of the outdoor unit.

[0045] The air/water heat exchange apparatus, according to one embodiment of the present invention, may use R410A for the refrigerant. This may contribute to CO_2 emission reduction.

[0046] The air/water heat exchange apparatus, according to one embodiment of the present invention, may include a four-way valve in the refrigerant circuit to switch the flow of the refrigerant. This may allow for both heating and cooling water.

Embodiment 3.

[0047] A third embodiment will be discussed with reference to Fig. 9 and Fig. 10. Fig. 9 shows an exploded perspective view of a main part of an internal structure of the outdoor unit 1 illustrating a method of installing the plate heat exchanger 9. Fig. 10 shows a perspective view of a main part of an internal structure of the outdoor unit 1.

[0048] The plate heat exchanger 9 shown in Fig. 5 has the refrigerant pipe connecting ports 9a at the front side and the water pipe connecting ports 9b at the back side. The plate heat exchanger 9 is encased with a cover case, which does not appear in Fig. 5.

[0049] With reference to Fig. 9 and Fig. 10, the plate heat exchanger 9 is covered all over, except for the refrigerant pipe connecting ports 9a and the water pipe connecting ports 9b, with a resilient thermal insulating material 102. The plate heat exchanger 9 is encased with a cover case part 103a (a first cover case part) and a cover case part 103b (a second cover case part) together. The cover case part 103a and the cover case part 103b are each formed to include three sides. The cover case parts 103a and 103b are a little smaller in shape than the outline of the plate heat exchanger 9 when covered with the resilient thermal insulating material 102. The cover case parts 103a and 103b are strong enough against the restoring force of the thermal insulating material 102 to keep their shape. The cover case parts 103a and 103b together encase the plate heat exchanger 9 covered with the resilient thermal insulating material 102 under compression. The cover case part 103a and the cover case part 103b are screwed to assemble a plate heat exchanger assembly 103.

[0050] The plate heat exchanger assembly 103 is fixed temporarily to ease mounting work by sliding the cover case part 103a down until a claw 103c meets a fitting hole105b. The fitting hole 105b is formed on a base platform 105a that is fixed to a base board 105 by spot welding. The claw 103c is formed at the bottom portion of the cover case part 103a. The plate heat exchanger assembly 103 is finally screwed to the base platform 105a. The plate heat exchanger 9 is connected with refrigerant pipes 108 for refrigerant to circulate by the compressor 5, and water pipes 107a for water to circulate by a pump 107.

[0051] The thermal insulating material 102 according to this embodiment is a felt flat sheet, for example. The plate heat exchanger 9 is an approximate rectangular solid with six outer sides. The plate heat exchanger 9 is applied with six divided sheets of the thermal insulating material 102 for the respective six sides of the approximate hexahedron. The thermal insulating material 102 is approximately 20mm thick. The compression rate of the thermal insulating material 102 is approximately 60%. The thermal insulating material 102, thus divided into six flat sheets, may achieve accuracy of assembly, and also facilitate the efficiency of assembly.

[0052] The cover case part 103a consists of a front wall, a top wall, and a side wall (a first side wall). The front wall includes two U shaped cuts 103d formed in upper and lower portions, respectively, for letting the refrigerant pipes 108 pass through. The U shaped cuts 103d are formed to have openings facing an assembly direction (the right direction in the case of Fig. 9). This may allow for the assembly of the cover case part 103a even after the refrigerant pipes 108 are welded and connected to the plate heat exchanger 9.

[0053] The cover case part 103b consists of a back wall, bottom wall, and a side wall (a second side wall). The back wall of the cover case part 103b has two circular holes 103e in upper and lower portions thereof, respectively, to let the water pipe connecting ports 9b pass through.

[0054] The plate heat exchanger 9 may have vibration transmitted from the compressor 5 or the pump 107 in

operation, via the refrigerant pipes 108 and the water pipes 107a. The impact of water hammer caused by switching of operations may be transmitted as vibration to the plate heat exchanger 9 via the pipes. In such cases, the resilient thermal insulating material 102 that covers the plate heat exchanger 9 may absorb vibration, and reduce stress on the refrigerant pipes 108 and the water pipes 107a.

[0055] The resilient thermal insulating material 102 may support the plate heat exchanger 9 by surface pressure in case of a fall or drop, during transportation, etc., of the outdoor unit 1 that is manufactured by using the method of installing the plate heat exchanger 9 discussed above. This will not cause a major displacement in arrangement inside the place heat exchanger 9. This may result in an effect of reducing piping stress on the refrigerant pipes 108 and the water pipes 107a.

[0056] A refrigerant circuit of the outdoor unit 1 discussed in the third embodiment is similar to that of the outdoor unit 1 shown in Fig. 5 discussed in the first embodiment, and therefore will not be described here in detail.

[0057] Like the case of the fist embodiment, R410A is used for the refrigerant, which meets CO_2 emission reduction measures under European energy policies.

[0058] The plate heat exchanger 9 is of an existing type described in the first embodiment, and therefore will not be discussed about the structure here in detail.

Embodiment 4.

[0059] A fourth embodiment will be discussed with reference to Fig. 11 and Fig. 12. Fig. 11 shows a cross sectional view illustrating an arrangement of an auxiliary support member 104, the cover case part 103a, and the plate heat exchanger 9. Fig. 12 shows a perspective view of the auxiliary support member 104.

[0060] As shown in Fig. 11, the thermal insulating material 102 is cut to create a space where the auxiliary member 104 is placed. The auxiliary support member 104 is placed to touch the inner wall of the cover case part 103a. The height (a horizontal length in the case of Fig. 11) of the auxiliary support member 104 is narrower than the thickness of the compressed thermal insulating material 102 in the plate heat exchanger assembly 103. A gap A is provided between the auxiliary support member 104 and the plate heat exchanger 9. The auxiliary support member 104 may hold and support the plate heat exchanger 9 when the thermal insulating material 102 is compressed by excessive force applied to reach the height of the auxiliary support member 104.

[0061] The gap A between the plate heat exchanger 9 and the auxiliary support member 104 may be approximately 1mm to 4mm. When the gap A is 1mm or less, irregularity in size may cause interference between the plate heat exchanger 9 and the auxiliary support member 104. When the gap is 4mm or more, the auxiliary support member 104 does not function properly. (The auxiliary support member 104 cannot hold or support the plate heat exchanger 9 when the thermal insulating material 102 is compressed by excessive force up to the height of the auxiliary support member 104.)

[0062] With the example of Fig. 11, the auxiliary support member 104 is placed in the space created by cutting a part of the thermal insulating material 102 between the plate heat exchanger 9 and the cover case part 103a. The auxiliary support member 104 may also be placed in a space created by cutting a part of the thermal insulating material 102 between the plate heat exchanger 9 and the cover case part 103b, as well.

[0063] The auxiliary support member 104 is a crank-shaped sheet metal part, as shown in Fig. 12. The auxiliary support member 104 may be formed to create a cutout 104a on a surface on the plate heat exchanger 9 side.

[0064] Thus, it is allowed for the plate heat exchanger 9 to touch the auxiliary support member 104 in case of a fall or drop of the outdoor unit 1 during transportation, etc. The amount of displacement in the plate heat exchanger 9 is thereby limited to a certain degree, regardless of the size of impact. This may result in an effect of limiting the amount of displacement of pipe connections.

Embodiment 5.

[0065] A fifth embodiment will be discussed with reference to Fig. 13. Fig. 13 shows a cross sectional view illustrating an arrangement of the auxiliary support member 104, the cover case 103a, and the plate heat exchanger 9.

[0066] Fig. 13 shows that the thermal insulating material 102 is compressed and inserted between the inner walls of the auxiliary support member 104 and the cover case part 103a. This allows the thermal insulating material 102 to be held by the cover case part 103a, thereby improving efficiencies of manufacturing and assembly work and regular maintenance work of the plate heat exchanger assembly 103. The auxiliary support member 104 is formed to have the cutout 104a on the surface of the plate heat exchanger 9 side, as shown in Fig. 12. This may facilitate the efficiency of compressing and inserting the thermal insulating material 102 between the inner walls of the auxiliary support member 104 and the cover case part 103a.

[0067] According to the example of Fig. 13, the thermal insulating material 102 is compressed and inserted between the inner walls of the auxiliary support member 104 and the cover case part 103a. The thermal insulating material 102 may also be compressed and inserted in between the inner walls of the auxiliary support member 104 and the cover case part 103b, as well.

[0068] The resilient thermal insulating material 102, thus sandwiched and held between the plate heat exchanger 9 and the cover case parts 103a and 103b, may remove the need of attaching the resilient thermal insulating material 102 to the plate heat exchanger 9 or the

cover case parts 103a and 103b. This may have an effect of facilitating the efficiency of assembly work.

Embodiment 6.

[0069] The cover case parts 103a and 103b may be made of sheet metal. In this case, flammable materials, such as the thermal insulating material 102, fitted around the plate heat exchanger 9, may be kept away from flames during the work of brazing the refrigerant pipes 108 to the refrigerant pipe connecting port 9a, or the water pipes 107a to the water pipe connecting port 9b of the plate heat exchanger 9. This may restrict fire spread to flammable materials, thereby improving efficiencies of manufacturing products and regular maintenance work.

[0070] With reference to the examples discussed in the aforementioned embodiments, the four-way valve 10 is provided to switch the flow of the refrigerant in order to both heat and cool water. The four-way valve 10, however, may be eliminated in the case of either heating or cooling water.

[0071] The material, degree of thickness, and compression rate of the thermal insulating material 102 introduced in the aforementioned embodiments are only examples that are considered to be preferable. Other materials, etc. may also be applied to the aforementioned embodiments.

[0072] Thus, according to the air/water heat exchange apparatus of one embodiment of the present invention, the outdoor unit that is separated by the separator into the fan room and the machine room. The fan room may include an air-refrigerant heat exchanger that exchanges heat between air and the refrigerant, and the fan that sends the air to the air-refrigerant heat exchanger. The machine room may include the compressor that compresses the refrigerant, the plate heat exchanger that exchanges heat between the refrigerant and water, the electronic expansion valves, and the accumulator that accumulates the refrigerant. The outdoor unit has the closed refrigerant circuit, which includes the compressor, the plate heat exchanger, the electronic valves, the air-refrigerant heat exchanger, and the accumulator. The plate heat exchanger is covered with the resilient thermal insulating material. The air/water heat exchange apparatus may further include a cover case that encases the plate heat exchanger with the thermal insulating material under compression. Therefore, the thermal heat material, as a cushioning material, may absorb and distribute vibration generated by the compressor, pump, etc. in operation, which is transmitted to the plate heat exchanger via pipes for fluid circulation connected to the plate heat exchanger. This has an effect of reducing stress applied to the pipes for fluid circulation, thereby avoiding damage on the pipes, and also reducing resonantly generated abnormal sounds. Another effect may be based on the stable arrangement of the plate heat exchanger. The plate heat exchanger is formed to be held in a certain position against impact in case of a fall of the outdoor unit during transportation, and therefore a major displacement will not be caused in the plate heat exchanger. This allows for reducing stress applied to pipes connected to the plate heat exchanger, thereby thus avoiding damage on the pipes.

[0073] According to the air/water heat exchange apparatus of one embodiment of the present invention, the plate heat exchanger is formed to include the water pipe connecting port. The cover case is formed to include the first cover case part and the second cover case part. The first cover case part is formed to include the front wall, the top wall, and the first side wall, where the front wall is formed to include the U shaped cuts to let refrigerant pipes get out of the refrigerant circuit. The second cover case part that is formed to include the back wall, the bottom wall, and the second side wall, where the back wall is formed to include the circular holes to let the water pipe connecting port pass through. This may facilitate assembly of the cover case.

[0074] According to the air/water heat exchange apparatus of one embodiment of the present invention, the U shaped cut is formed to have the opening in the assembly direction. This may make the assemble work of the cover case possible even after the plate heat exchanger and the refrigerant pipes are welded.

[0075] According to the air/water heat exchange apparatus of one embodiment of the present invention, the plate heat exchanger is the approximate rectangular solid with six outer sides, and the six outer sides of the plate heat exchanger are covered, respectively, with the divided six sheets of the thermal insulating material. This may achieve accuracy of assembly with the divided sheets of the thermal insulating material, and also facilitate assembly.

[0076] According to the air/water heat exchange apparatus of one embodiment of the present invention, the auxiliary support member that is inserted between the plate heat exchanger and the cover case to provide complementarily support to the plate heat exchanger when the thermal insulating material is compressed excessively with excessive force applied by the plate heat exchanger. This may allow the plate heat exchanger to be supported by the auxiliary support member in case of a fall of the outdoor unit during transportation. Therefore, the amount of displacement in the plate heat exchanger may be limited to a certain degree, regardless of the size of impact. This therefore has an effect on limiting the amount of displacement of pipe connections.

[0077] According to the air/water heat exchange apparatus of one embodiment of the present invention, the thermal insulating material is compressed and inserted between the auxiliary support member and either the first cover case part or the second cover case part. This may hold the thermal insulating material within the cover case, thereby improving efficiencies of manufacturing and assembly work and regular maintenance work of the plate heat exchanger assembly.

[0078] According to the air/water heat exchange ap-

paratus of one embodiment of the present invention, the cover case may be made of sheet metal. This may keep flammable materials, such as the thermal insulating material, fitted around the plate heat exchanger away from flames during the work of brazing the refrigerant pipes to the refrigerant pipe connecting port or the water pipes to the water pipe connecting port of the late heat exchanger. This may therefore restrict fire spread to flammable materials, thereby improving efficiencies of manufacturing products and regular maintenance work.

[0079] According to the air/water heat exchange apparatus of one embodiment of the present invention, R410A may be used for the refrigerant. This may contribute to CO_2 emission reduction.

[0080] According to the air/water heat exchange apparatus of one embodiment of the present invention, the four-way valve may be included in the refrigerant circuit to switch the flow of the refrigerant. This may allow for both heating and cooling water.

[0081] The invention being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.

Claims

1. An air/water heat exchange apparatus comprising:

an outdoor unit that is separated by a separator (7) into a fan room (2) and a machine room (4), the fan room including an air-refrigerant heat exchanger (6) that exchanges heat between air and a refrigerant, and a fan (3) that sends the air to the air-refrigerant heat exchanger, and
the machine room including a compressor (5) that compresses the refrigerant, a plate heat exchanger (9) that exchanges heat between the refrigerant and water, electronic expansion valves (15a, 15b), and an accumulator (8) that accumulates the refrigerant,
wherein the outdoor unit has a closed refrigerant circuit, which includes the compressor, the plate heat exchanger, the electronic valves, the air-refrigerant heat exchanger, and the accumulator.

2. The air/water heat exchange apparatus according to claim 1,
wherein the accumulator is placed on a side of the compressor in a longitudinal direction of the outdoor unit in the machine room,
wherein the plate heat exchanger is placed at a back of the compressor and the accumulator in the machine room, and
wherein the plate heat exchanger is formed to include a connecting port to a water circuit located on one of a back surface and a side surface of the outdoor unit.

3. The air/water heat exchange apparatus according to claim 1 or 2,
wherein the outdoor unit is formed to include a side panel (12) as part of a housing of the outdoor unit, and
wherein the side panel and the separator are secured to the outdoor unit by means of a strengthening member.

4. The air/water heat exchange apparatus according to claim 1,
wherein the plate heat exchanger is covered with a resilient thermal insulating material (102),
the air/water heat exchange apparatus further comprising:

a cover case that encases the plate heat exchanger covered with the thermal insulating material under compression.

5. The air/water heat exchange apparatus according to claim 4,
wherein the plate heat exchanger is formed to include a water pipe connecting port (9b), and
wherein the cover case is formed to include:

a first cover case part (103a) that is formed to include a front wall, a top wall, and a first side wall, the front wall being formed to include a U shaped cut (103d) to let refrigerant pipes (108) get out of the refrigerant circuit; and
a second cover case part (103b) that is formed to include a back wall, a bottom wall, and a second side wall, the back wall being formed to include a circular hole (103e) to let the water pipe connecting port pass through.

6. The air/water heat exchange apparatus according to claim 5, wherein the U shaped cut is formed to have an opening in an assembly direction.

7. The air/water heat exchange apparatus according to any one of claims 4 to 6,
wherein the plate heat exchanger is an approximate rectangular solid with six outer sides, and
wherein the six outer sides of the plate heat exchanger are covered, respectively, with divided six sheets of the thermal insulating material.

8. The air/water heat exchange apparatus according to any one of claims 4 to 7 further comprising:

an auxiliary support member that is inserted be-

tween the plate heat exchanger and the cover case to provide complementarily support to the plate heat exchanger when the thermal insulating material is compressed excessively with excessive force applied by the plate heat exchanger.

9. The air/water heat exchange apparatus according to claim 8, wherein the thermal insulating material is compressed and inserted between the auxiliary support member and one of the first cover case part and the second cover case part.

10. The air/water heat exchange apparatus according to any one of claims 4 to 9, wherein the cover case is made of sheet metal.

11. The air/water heat exchange apparatus according to any one of claims 4 to 10, wherein R410A is used for the refrigerant.

12. The air/water heat exchange apparatus according to any one of claims 1 to 11, wherein the refrigerant circuit includes a four-way valve (10) to switch a flow of the refrigerant.

Fig. 1

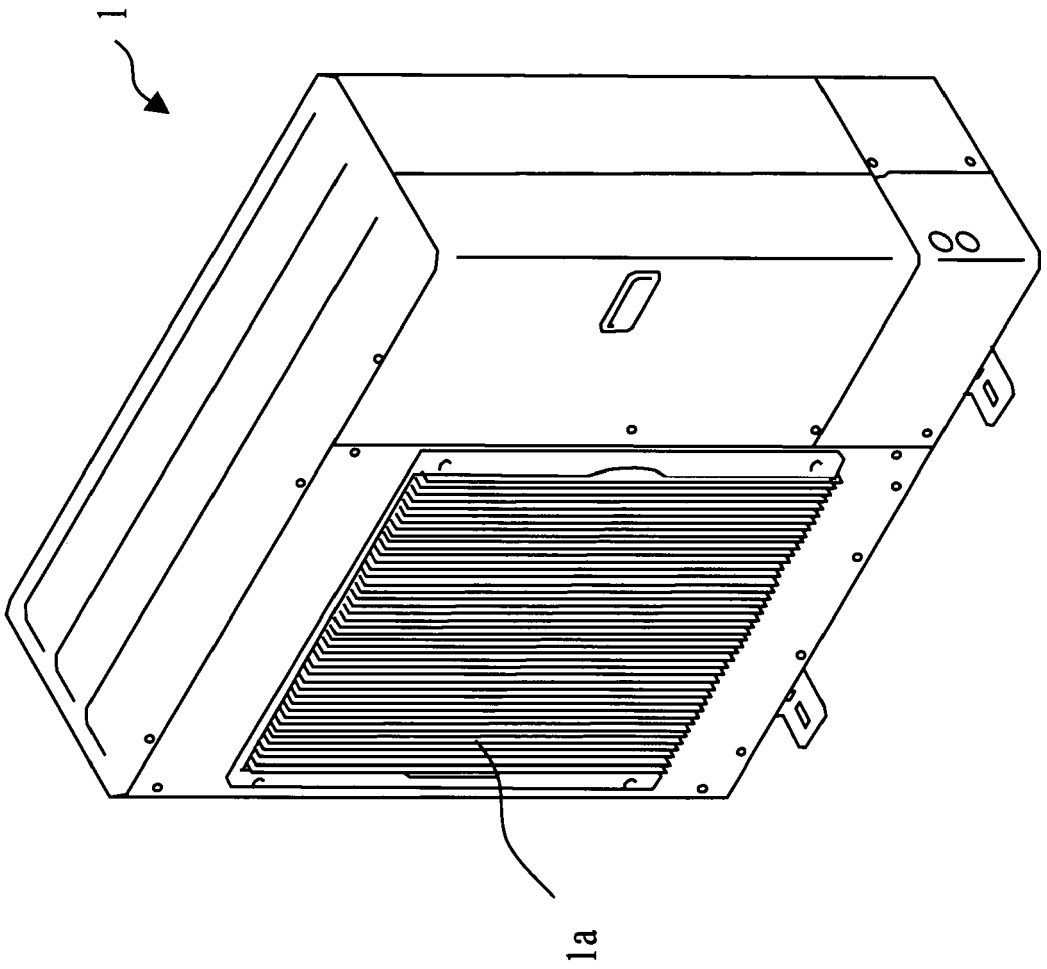


Fig. 2

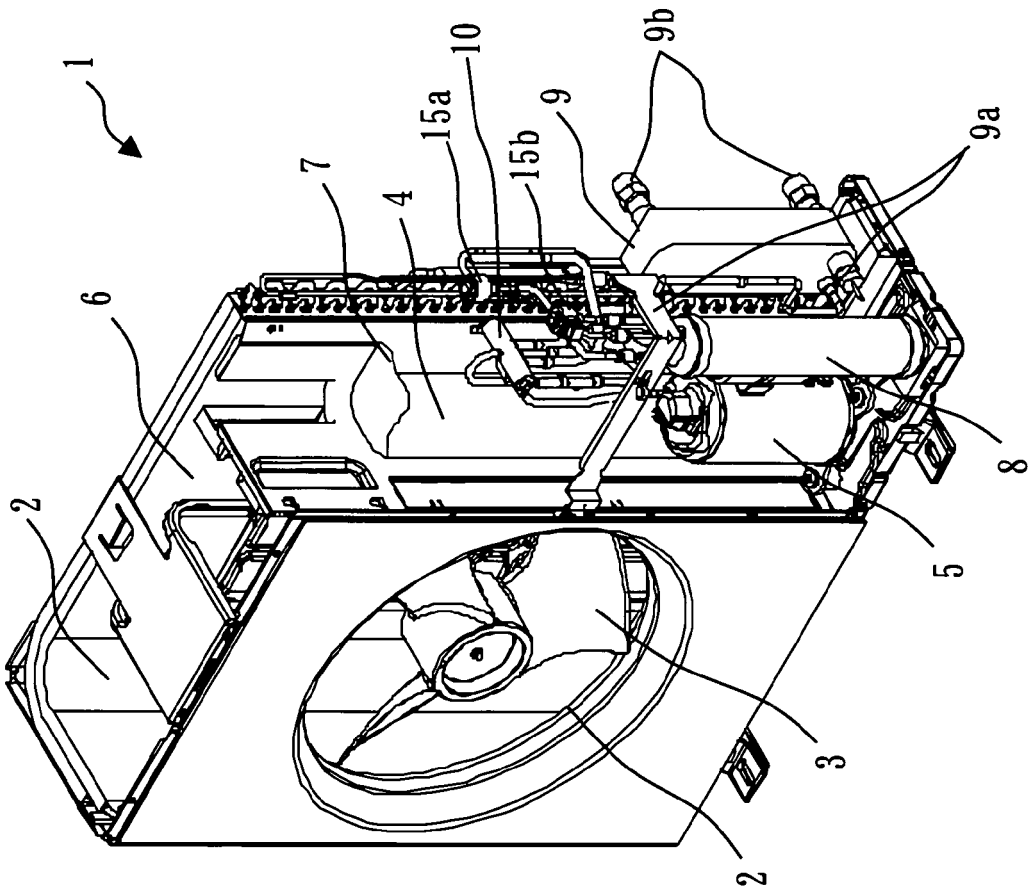


Fig. 3

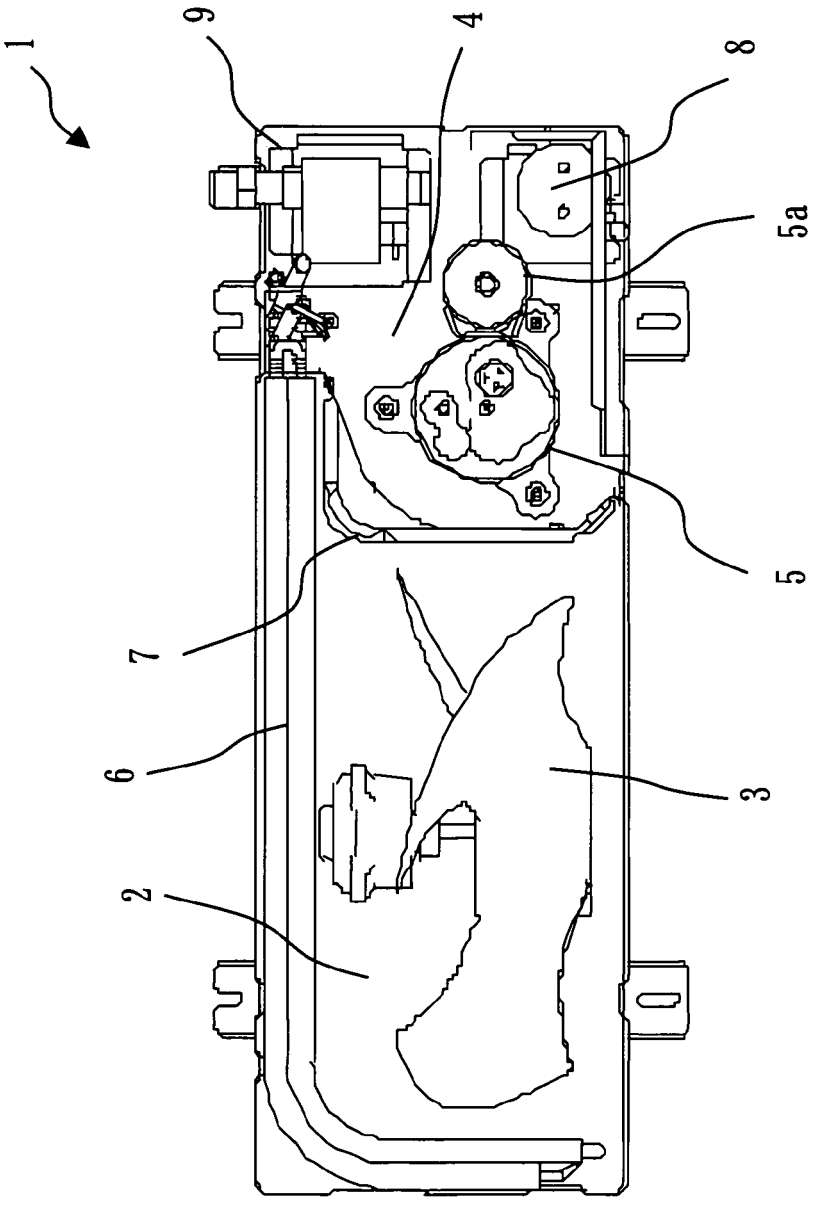


Fig. 4

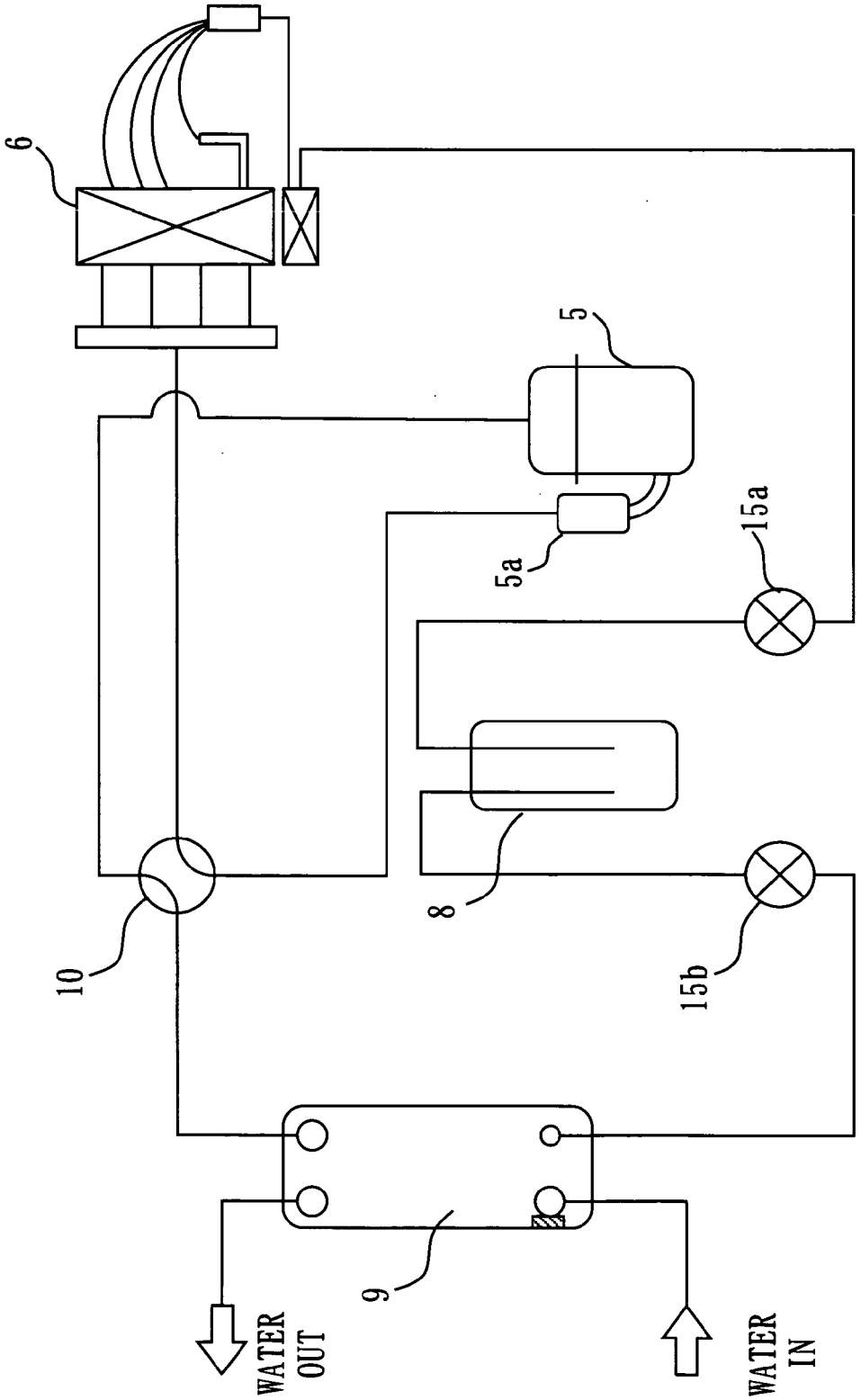


Fig. 5

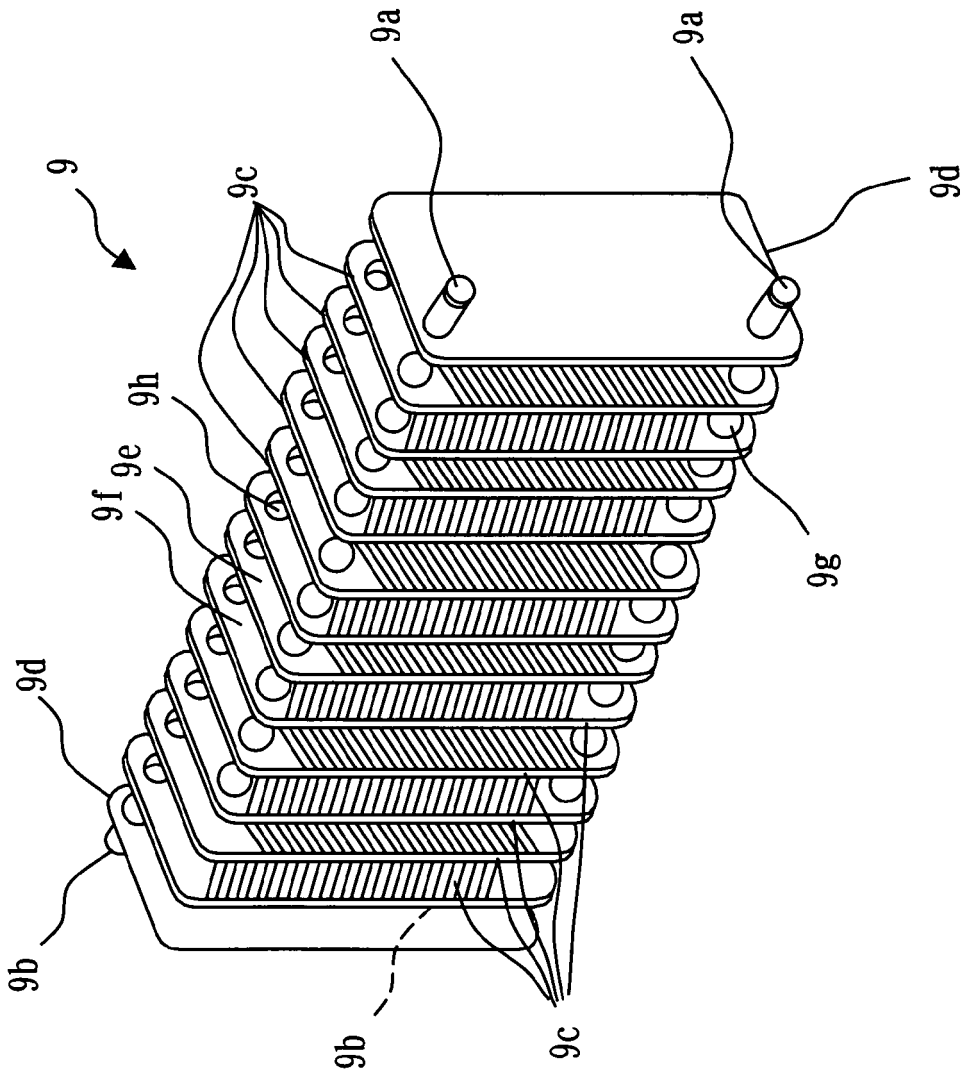


Fig. 6

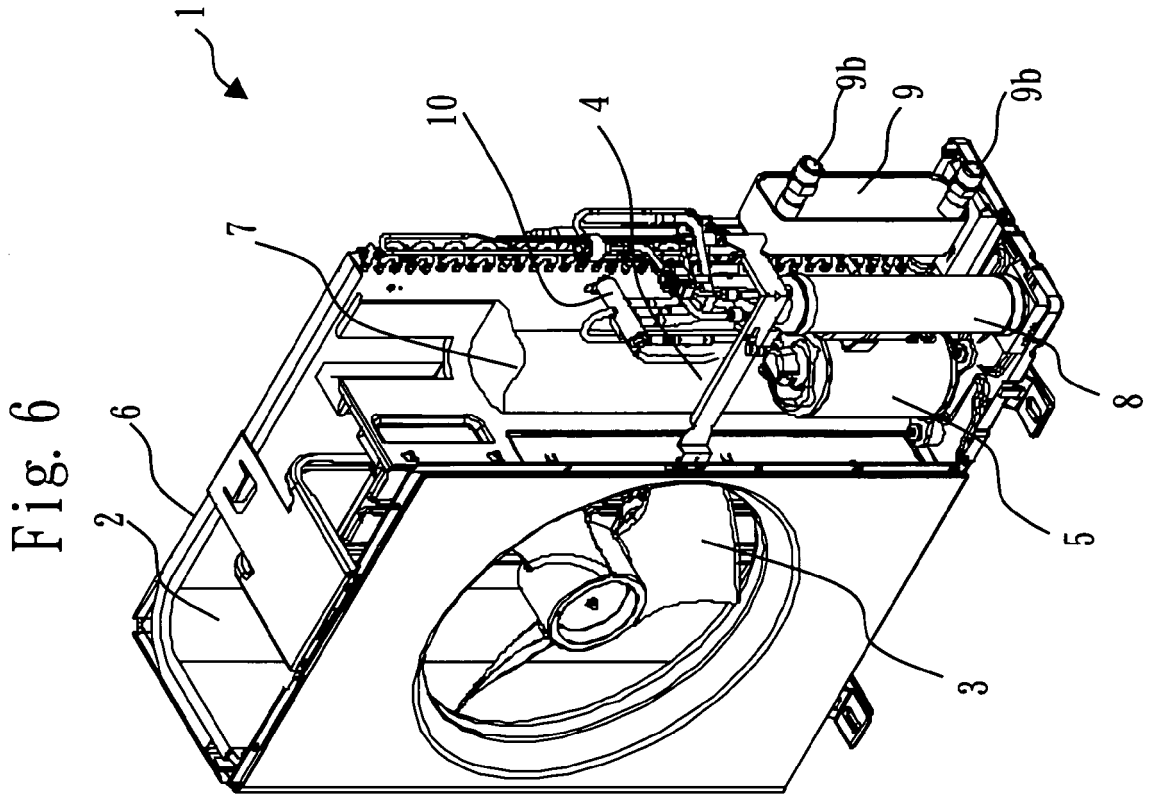


Fig. 7

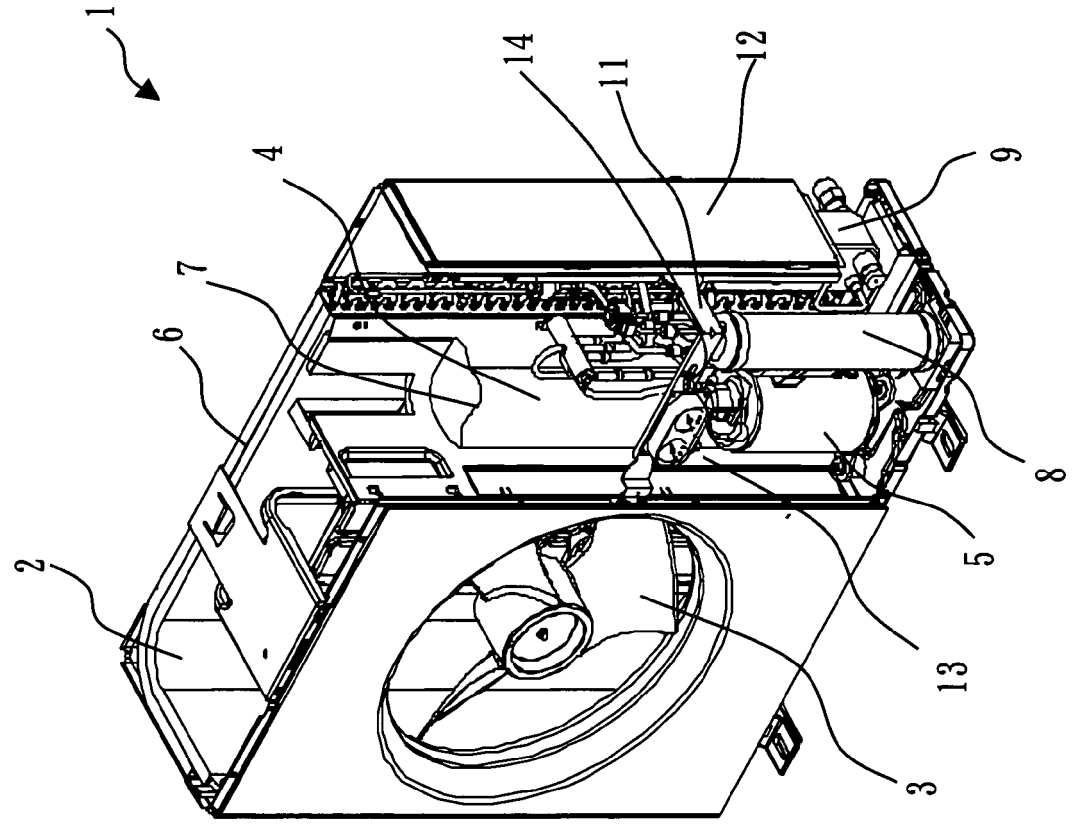


Fig. 8

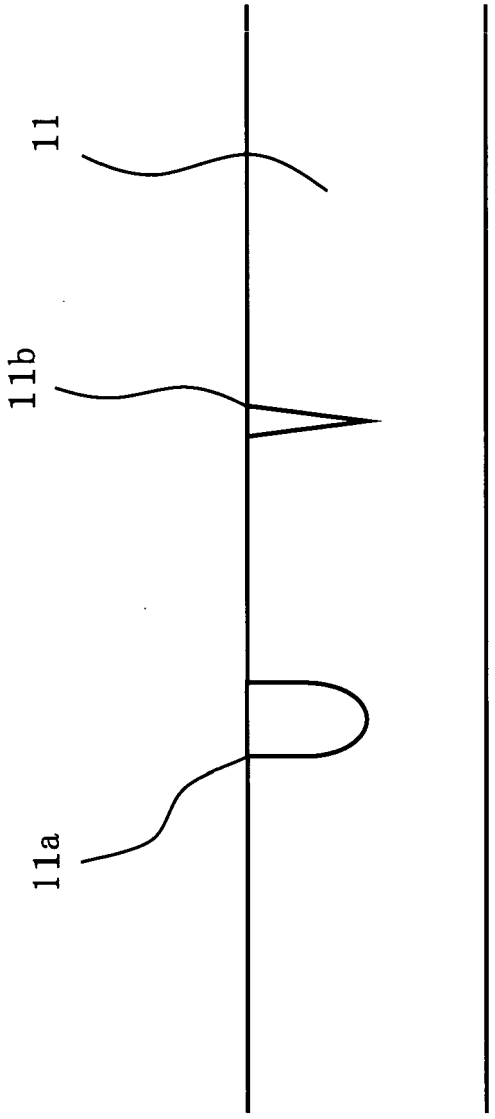


Fig. 9

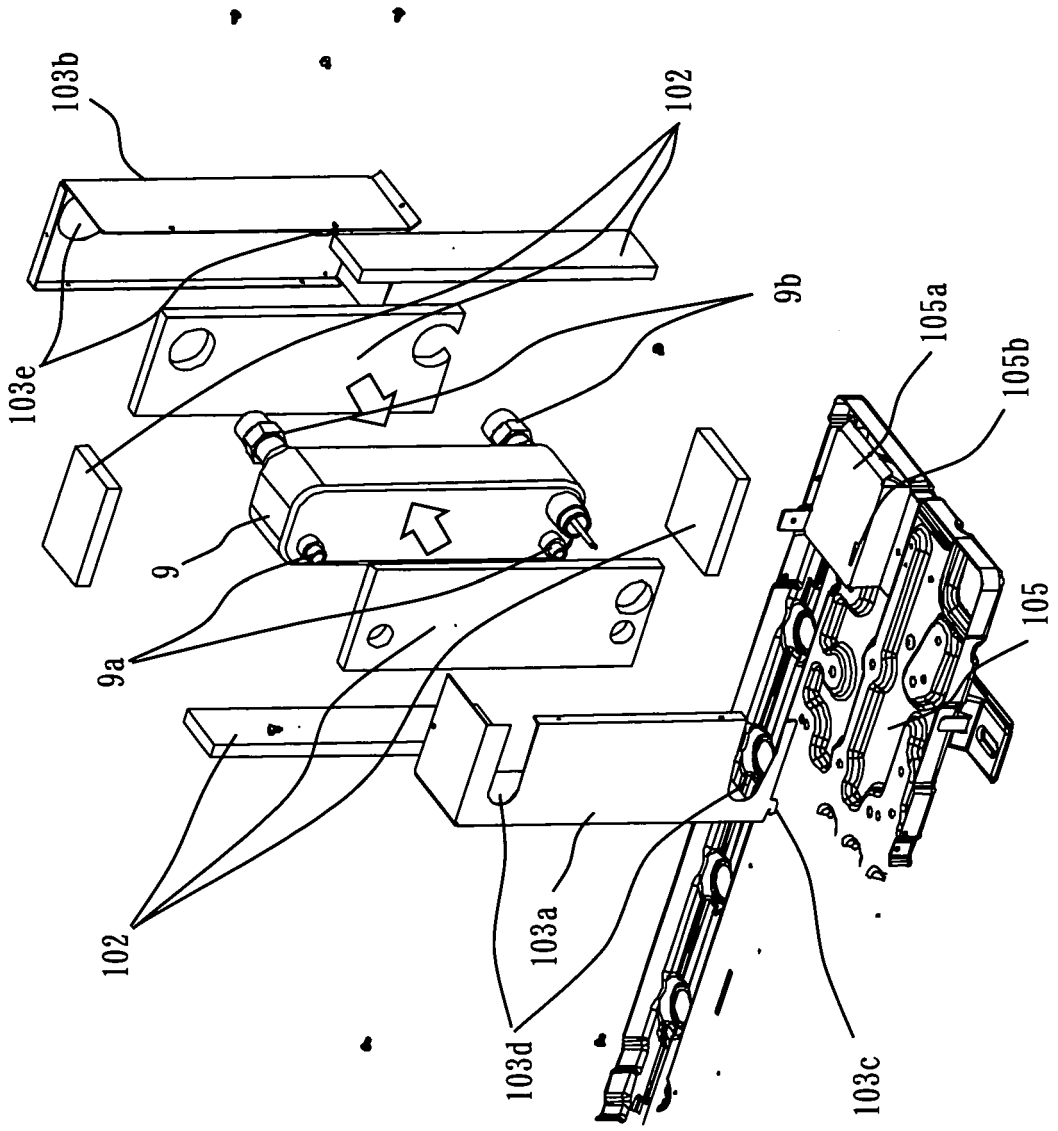


Fig. 10

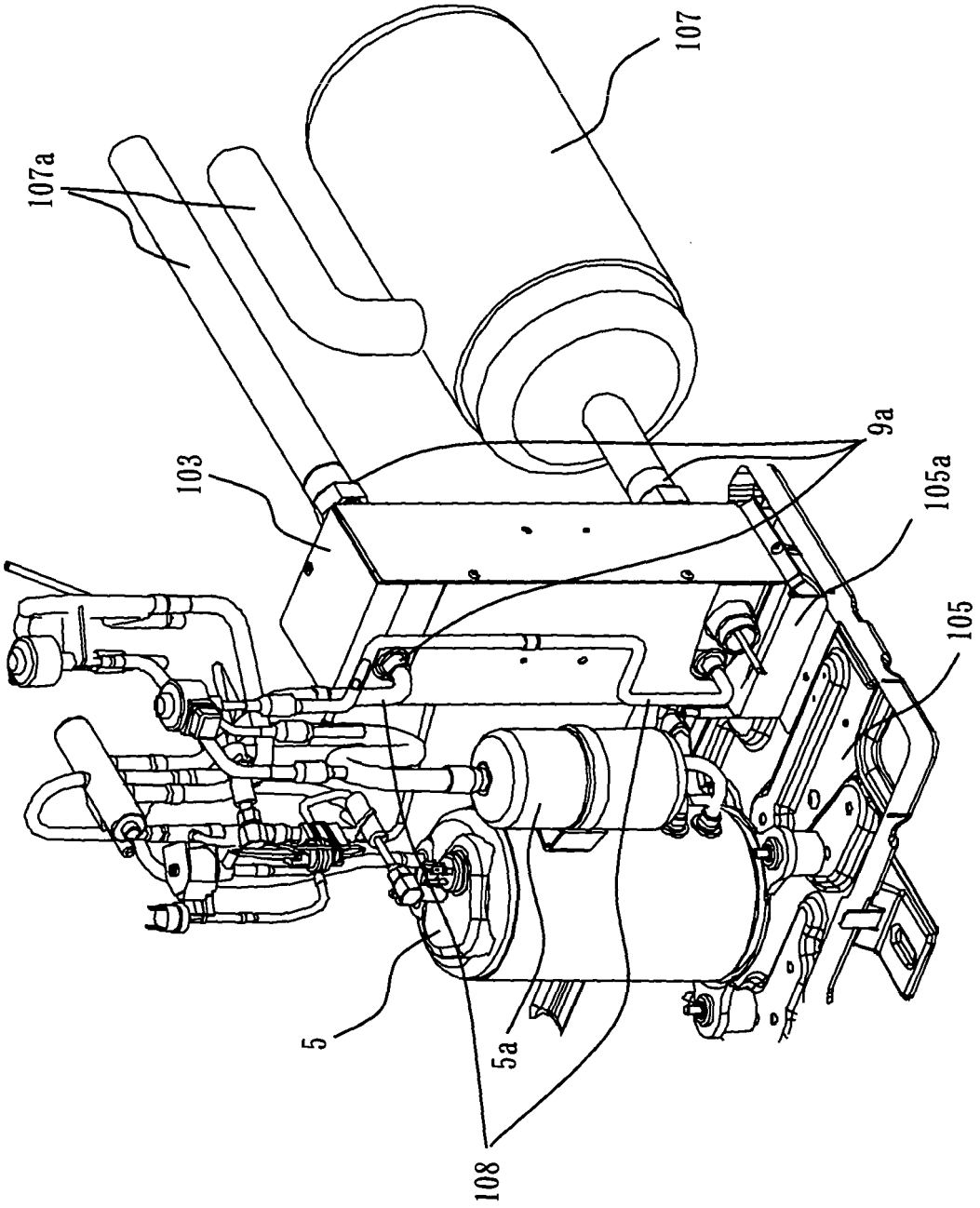


Fig. 11

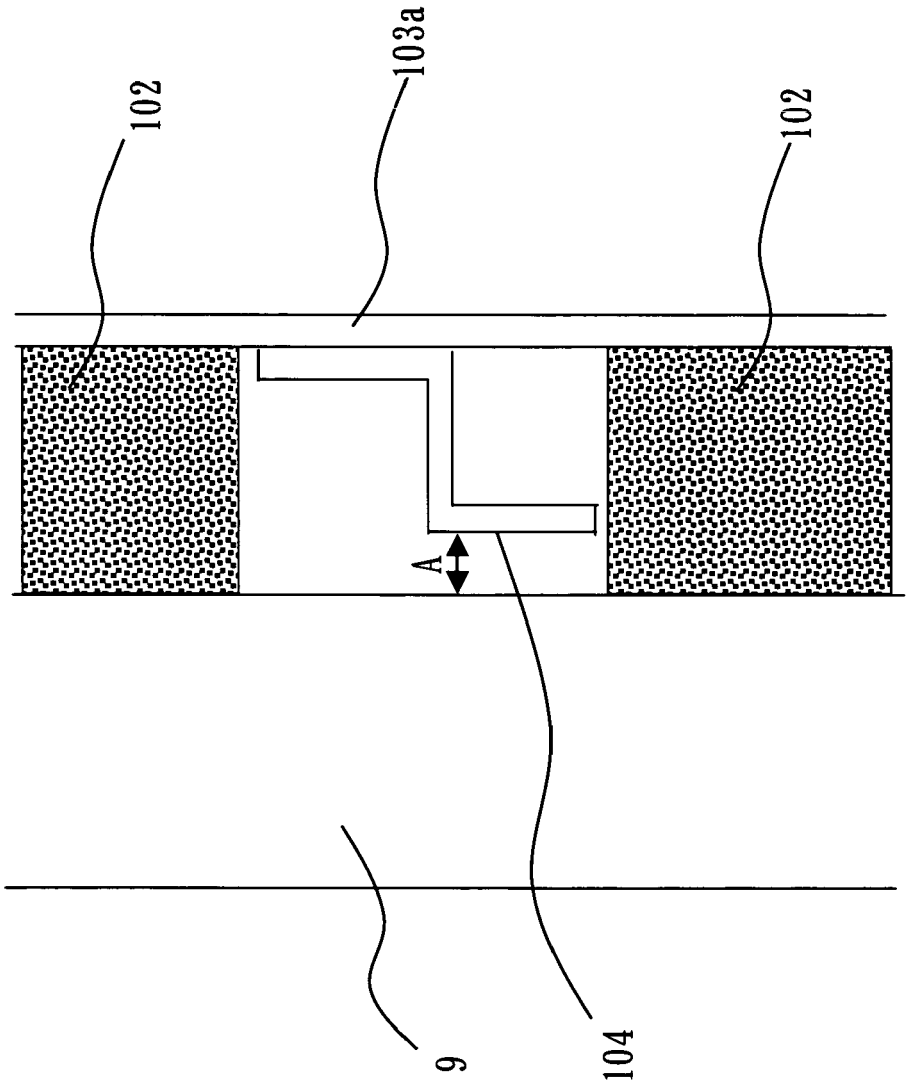


Fig. 12

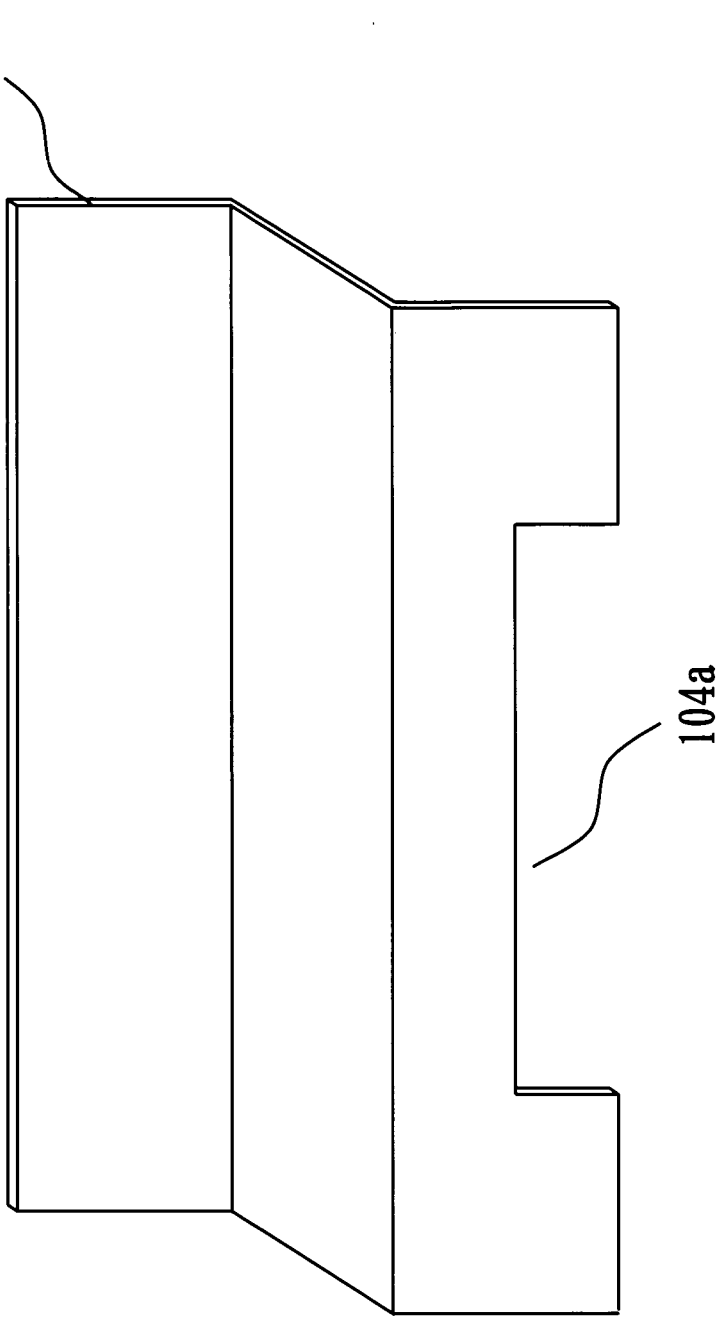
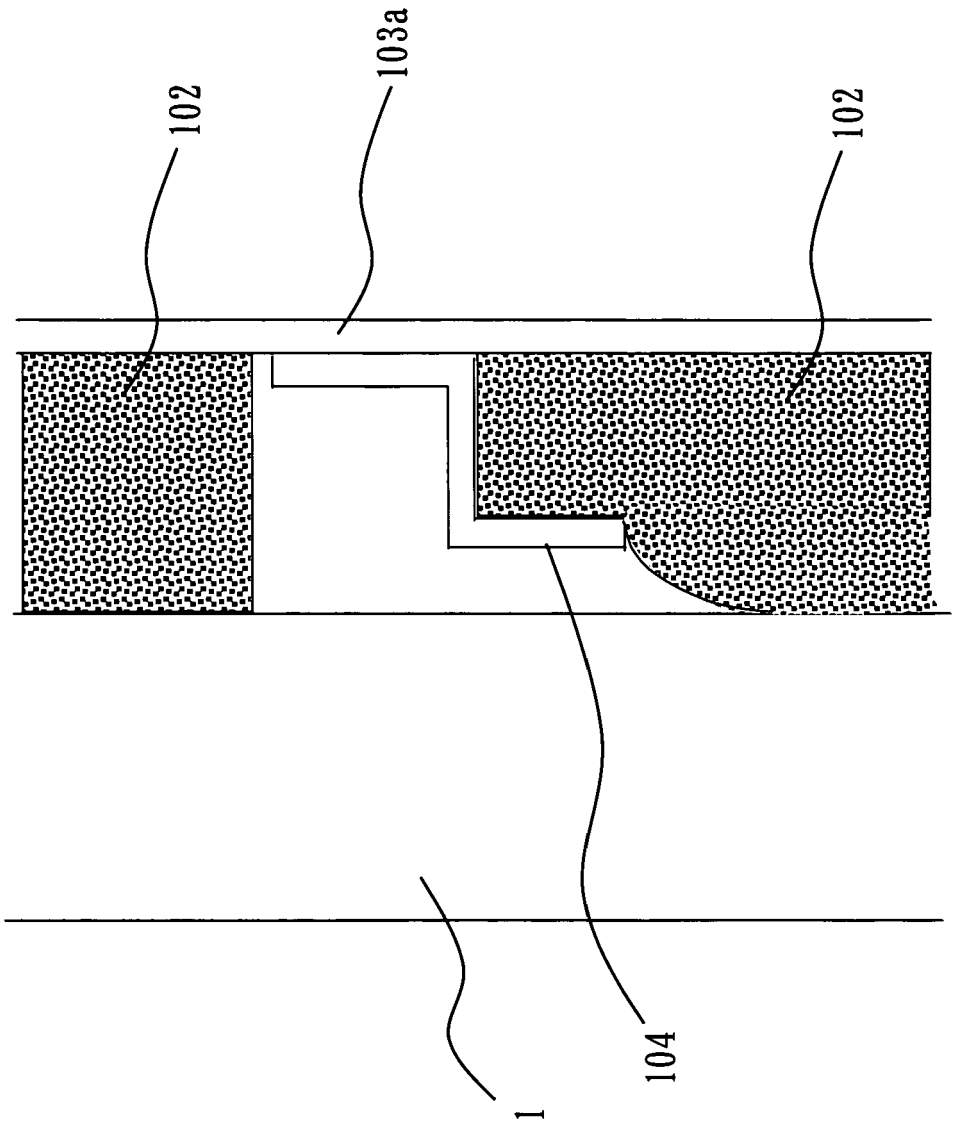


Fig. 13



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EUROPEAN SEARCH REPORT

Application Number
EP 08 00 0874

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