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(54) HEAT PUMP SYSTEM

(57) The present invention discloses a heat pump system including a casing defining an air inlet, a refrigerant circuit disposed in the casing and having an evaporator heat exchanger for vaporizing refrigerant, a fan associated with the evaporator heat exchanger adapted for being operable to introduce air into the casing via the air inlet and further passes through the evaporator heat exchanger, and an internal air directing means. The air directing means is disposed between the air inlet and the evaporator heat exchanger. In this way, the air flow introduced into the casing can reach the evaporator heat exchanger without contacting components within the space where the air directing means is positioned, thereby reducing the possibility of explosion caused by electrostatic charges and/or heat losses.

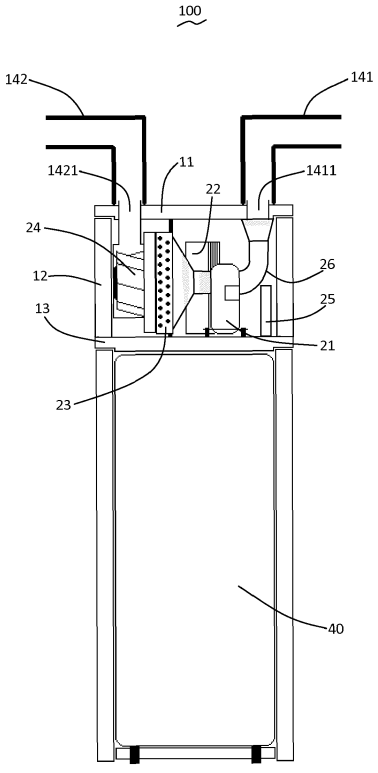

Fig. 1

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to a heat pump system having a refrigerant circuit employing ducted air as exchange medium.

BACKGROUND OF THE INVENTION

[0002] Refrigerants used in home heating, ventilating and air conditioning (HVAC) units include hydrofluorocarbons (HFCs), chlorofluorocarbons (CFCs) and perfluorocarbons (PFCs). Since there are evidences showing that all these substances contribute very significantly to the global warming, and additionally that CFCs destroy the Earth's ozone layer, there have been attempts to replace them with environment-friendly refrigerants, such as hydrocarbons (HCs) or HFCs with low warming potential. However, these alternative environment-friendly refrigerants are often flammable. If there occurs a refrigerant leakage inside an appliance, the leaked flammable substance can accumulate and reach a concentration value that could cause an explosion.

[0003] Fig. 3 discloses a conventional heat pump type water heater system. The system has a casing enclosing a refrigerant circuit and a water tank 97 disposed below the casing. The refrigerant circuit includes a compressor 91 compressing refrigerant to obtain refrigerant of high temperature and high pressure, a condenser heat exchanger 92 condensing the refrigerant of high temperature and high pressure to release heat from the refrigerant to the water to be entering the water tank 97, an expansion valve (now shown) depressurizing the high-pressure refrigerant that is condensed by the condenser heat exchanger 92, and an evaporator heat exchanger 93 evaporating the refrigerant that is depressurized by the expansion valve to absorb heat from air that is supplied via a fan 94. An electronic board 95 is also enclosed in the casing. An air inlet duct 961 and an air outlet duct 962 are connected with the casing to respectively introduce and discharge the air driven the fan 94.

[0004] As air is introduced into the casing and passing over the heat pump system components, electrostatic charge may be generated in the casing as a result of friction between the air flow and system components. Spark discharge can occur as soon as the system components become charged. If there occurs a flammable refrigerant leakage inside the casing and a potentially explosive atmosphere is formed at the same time, the leaking refrigerant can be ignited and result in an explosion. In addition, the air flow can take away heat released by the condenser heat exchanger thereby causing heat losses and leading to degradation of the heat exchanging performance.

SUMMARY OF THE INVENTION

[0005] It is an object of present invention to provide a heat pump system that employs an internal air directing means to reduce the possibility of explosion caused by electrostatic charges and/or heat losses.

[0006] According to the present invention there is provided a heat pump system including a casing defining an air inlet, a refrigerant circuit disposed in the casing and having an evaporator heat exchanger for vaporizing refrigerant, a fan associated with the evaporator heat exchanger adapted for being operable to introduce air into the casing via the air inlet and further passes through the evaporator heat exchanger, and an internal air directing means. The air directing means is disposed between the air inlet and the evaporator heat exchanger. In this way, the air flow introduced into the casing can reach the evaporator heat exchanger without contacting components within the space where the air directing means is positioned, thereby reducing the possibility of explosion caused by electrostatic charges and/or heat losses.

[0007] In one embodiment, the air directing means includes a nozzle defining an air passageway therein to direct air flow from the air inlet to the evaporator heat exchanger without contacting other components.

[0008] Preferably, the nozzle has an incoming portion with an incoming surface facing the air inlet, an outgoing portion with an outgoing surface facing the evaporator heat exchanger, and an intermediate portion connected between the incoming portion and the outgoing portion. Wherein, the intermediate portion has a cross-sectional size that is smaller than a size of the outgoing surface to adapt it to be contained in a compact space within the casing.

[0009] Preferably, the cross-sectional size of the intermediate portion is smaller than a size of the incoming surface.

[0010] Preferably, the intermediate portion is bended so as to prevent it from interfering with other components.

[0011] In a prefered embodiment, the casing defines an air outlet; and wherein the evaporator heat exchanger and the fan are both encased between the air directing means and the air outlet, so that air flow can pass through the evaporator heat exchanger and the fan and be discharged outside of the casing without contacting other components.

[0012] In a preferred embodiment, the refrigerant circuit is charged with a flammable refrigerant or combined refrigerants containing a flammable refrigerant.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] For a more complete understanding of the present invention, and the advantages thereof, reference is now made to the following descriptions taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a diagram showing the configuration of a

heat pump system in accordance with one embodiment of present invention;

Fig. 2 is a diagram of the heat pump system shown in Fig. 1, wherein some components, such as a compressor, a condenser heat exchanger, and an electronic board are removed in order to show an internal air directing means explicitly;

Fig. 3 is a diagram showing the configuration of a heat pump system in the state of art.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0014] Reference will now be made to the drawing figures to describe the preferred embodiments of the present invention in detail. However, the embodiments can not be used to restrict the present invention. Changes such as structure, method and function obviously made to those of ordinary skill in the art are also protected by the present invention.

[0015] Referring to Fig. 1, in one embodiment of present invention, a heat pump system 100 takes form of a domestic hot water tank integrated with a heat pump for preparing domestic hot water. The heat pump system 100 can stand on the floor with a water tank 40 located at a lower portion thereof and a refrigerant circuit located at an upper portion thereof. The water tank is enclosed by top, bottom, and side insulations to avoid a heat loss of hot water inside the tank 40.

[0016] The refrigerant circuit is enclosed by a casing composed by top, side, and bottom insulated walls 11, 12, 13 for reducing heat loss on operation of the refrigerant circuit. An air inlet duct 141 and an air outlet duct 142 are connected with the casing to define an air inlet 1411 and an air outlet 1421 respectively. The air inlet 1411 and the air outlet 1421 can be disposed in the same wall, like the top wall 11, or respectively in two different walls, like the top wall 11 and the side wall 12.

[0017] The refrigerant circuit typically has a compressor 21, a condenser heat exchanger 22, an expansion device (now shown), and an evaporator heat exchanger 23. These components are generally serially connected via conduits and are well known in the art. During operation of the refrigerant circuit, the compressor 21 acts on relatively cool gaseous refrigerant to raise the temperature and pressure of the refrigerant. From the compressor 21, the high temperature, high pressure gaseous refrigerant flows into the condenser heat exchanger 22 where it is cooled and exits the condenser heat exchanger 22 as a high pressure liquid refrigerant. The condenser heat exchanger 22 can be a plate type heat exchanger, and it performs as a heat source for the water tank 40. Water extracted from the water tank 40 passes through the condenser heat exchanger 22 to be heated by the refrigerant in a non-contact way, and then the heated water flows back and is stored within the tank 40.

[0018] The high pressure liquid refrigerant then flows to an expansion device (now shown), which controls the amount of refrigerant entering into the evaporator heat exchanger 23. In this embodiment, the evaporator heat exchanger 23 takes form of a finned tube heat exchanger. With reference to Fig. 2, the finned tube heat exchanger typically has copper tube coils 233 that are accompanied by aluminum fins for purpose of maximizing heat transfer between the refrigerant and air mediums. In a preferred embodiment, the heat exchanger 23 is encased in a shell with a front face 231 and a rear face 232. A centrifugal fan 24 is disposed adjacent to the evaporator heat exchanger 23 for being operable to generate forced air passing through tube coils and fins of the evaporator heat exchanger 23. The fan 24 is preferably housed in a housing 241 with one opening connected to the rear face 232 of the evaporator heat exchanger 23 and the other opening connected to the air outlet 1421 of the casing.

[0019] In the evaporator heat exchanger 23, the low temperature refrigerant absorbs heat from air blown over the tube coils 233 and the fins, and exits the appliance via the air outlet duct 142. The suction of the compressor 21 then draws the gaseous refrigerant back to the compressor where the cycle begins again. In addition, an electronic board 25 is contained in the casing and connected with related components, such as the compressor 21 and the fan 24 to control the operation of the refrigerant circuit.

[0020] In this embodiment, the refrigerant circuit is charged with a flammable refrigerant or combined refrigerants containing a flammable refrigerant. The flammable refrigerant can be HFC or HC substance such as R32, R152a, R290, R600 and the like.

[0021] Referring to Fig. 1 in conjunction with Fig. 2, an air directing means 26 is disposed in the casing and located between the air inlet 1411 and the evaporator heat exchanger 23. The air directing means 26 can take form of a nozzle that defines an air passageway therein to direct air flow from the air inlet 1411 to the evaporator heat exchanger 23 without contacting other components, thereby reducing the possibility of explosion caused by electrostatic charges and heat losses.

[0022] In this embodiment, the nozzle has an incoming portion 261 with an incoming surface facing the air inlet 1411, an outgoing portion 263 with an outgoing surface facing the front face 231 of the evaporator heat exchanger 23, and an intermediate portion 262 connected between the incoming portion 261 and the outgoing portion 263. Since the outgoing surface of the outgoing portion 263 is generally has a large size for covering nearly the entire front face 231 of the evaporator heat exchanger 23, and the components inside the casing are crowed, the intermediate portion 22 is so configured to have a cross-sectional size that is much smaller than the size of the outgoing surface. In some cases, the cross-sectional size of the intermediate portion 22 is even smaller than the size of the incoming surface of the incoming portion 261. Moreover, the intermediate portion 262 can be

bended so as to prevent it from interfering with other components.

[0023] As the nozzle 26 is disposed between the air inlet 1411 and the evaporator heat exchanger 23, the air flow introduced into the casing can reach the evaporator heat exchanger 23 without contacting components within the space where the nozzle 26 is positioned, thereby reducing the possibility of explosion caused by electrostatic charges and heat losses. Preferably, the evaporator heat exchanger 23 and the fan 24 are both encased between the nozzle 26 and the air outlet 1421, as a result, the forced air can pass through the evaporator heat exchanger 23 and the fan 24 and be discharged outside of the casing without contacting other components within the casing, therefore, explosion risks caused by electrostatic charges can be completely avoided.

[0024] It would be apparent to those skilled in the art that, the internal air directing means used in aforementioned ducted heat pumps can also be used in ducted air conditioners or ducted air heat recovery appliances. Furthermore, the air directing means can also be used to appliances including the refrigerant circuit charged with nonflammable refrigerant to avoid heat losses.

[0025] It is to be understood, however, that even though numerous, characteristics and advantages of the present invention have been set forth in the foregoing description, together with details of the structure and function of the invention, the disclosed is illustrative only, and changes may be made in detail, especially in matters of number, shape, size, and arrangement of parts within the principles of the invention to the full extent indicated by the broadest general meaning of the terms in which the appended claims are expressed.

Claims

1. A heat pump system comprising:

   a casing defining an air inlet;
   a refrigerant circuit disposed in the casing, said refrigerant circuit comprising an evaporator heat exchanger for vaporizing refrigerant;
   a fan associated with the evaporator heat exchanger; said fan being operable to introduce air into the casing via the air inlet and further passes through the evaporator heat exchanger;
   characterized by comprising
   an air directing means disposed between the air inlet and the evaporator heat exchanger.

2. A heat pump system according to claim 1, wherein said air directing means comprises a nozzle, and said nozzle defines an air passageway therein to direct air flow from the air inlet to the evaporator heat exchanger without contacting other components.

3. A heat pump system according to claim 2, wherein said nozzle has an incoming portion with an incoming surface facing the air inlet, an outgoing portion with an outgoing surface facing the evaporator heat exchanger, and an intermediate portion connected between the incoming portion and the outgoing portion; wherein said intermediate portion has a cross-sectional size that is smaller than a size of the outgoing surface.

4. A heat pump system according to claim 3, wherein said cross-sectional size of the intermediate portion is smaller than a size of the incoming surface.

5. A heat pump system according to claim 3, wherein said intermediate portion is bended.

6. A heat pump system according to claim 1, wherein the casing defines an air outlet; and wherein the evaporator heat exchanger and the fan are both encased between the air directing means and the air outlet, so that air flow can pass through the evaporator heat exchanger and the fan and be discharged outside of the casing without contacting other components.

7. A heat pump system according to claim 1, wherein the refrigerant circuit is charged with a flammable refrigerant or combined refrigerants containing a flammable refrigerant.

8. A heat pump system according to claim 1, further comprising a water tank disposed below the casing.

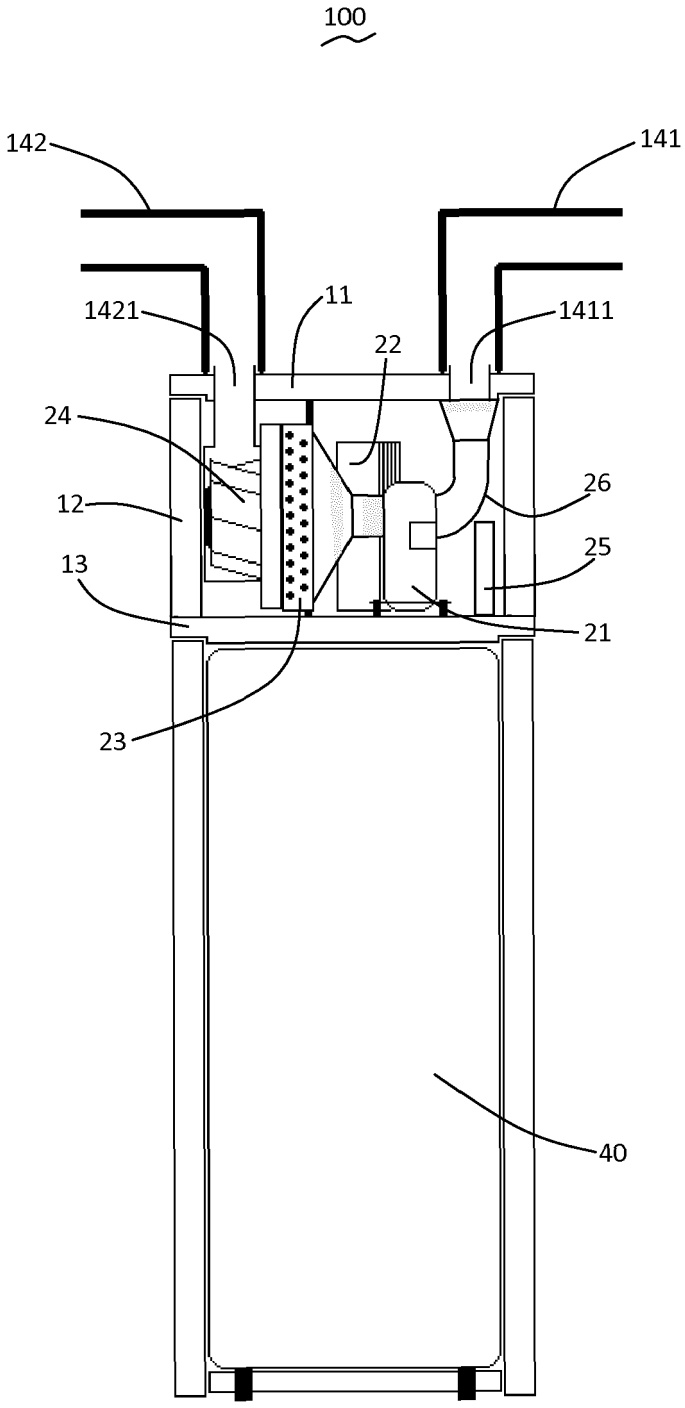

Fig. 1

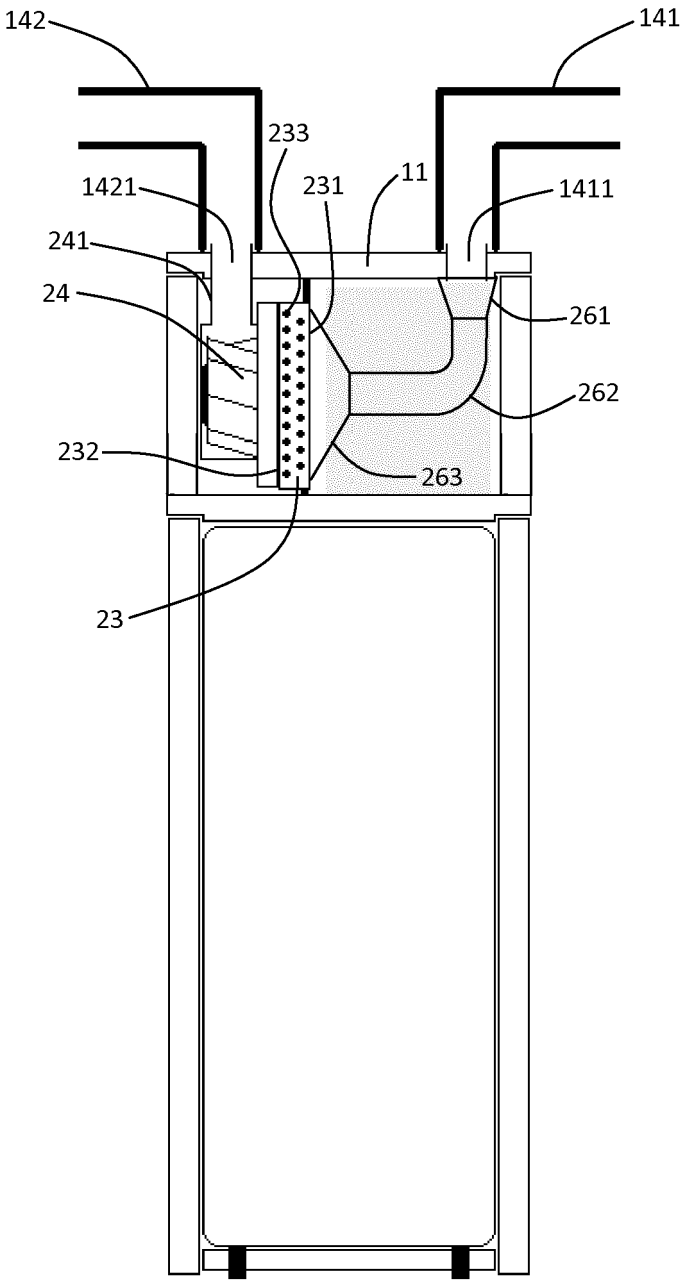

Fig. 2

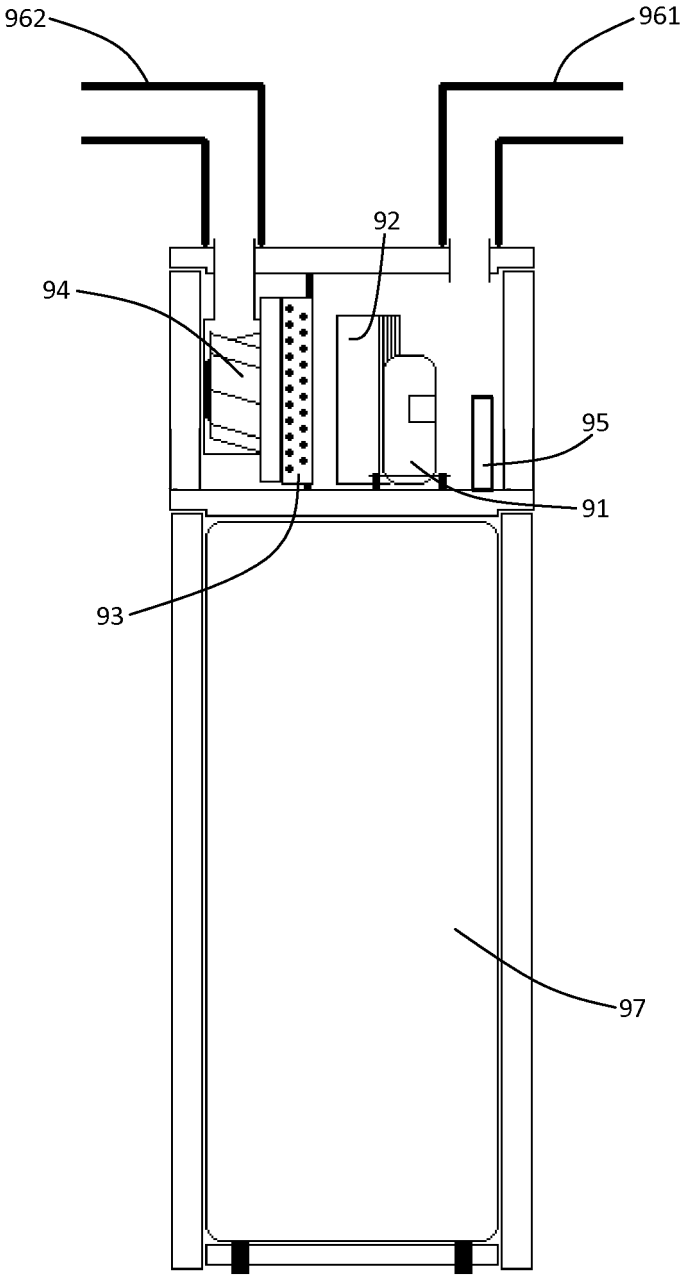

Fig. 3 (state of art)

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EUROPEAN SEARCH REPORT

Application Number
EP 15 18 0162

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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A	* paragraphs [0003], [0007], [0015] - [0022], [0058] - [0079]; figures 2-4 *	2-6,8	TECHNICAL FIELDS SEARCHED (IPC) F24H F24F F25B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	25 January 2016	von Mittelstaedt, A

CATEGORY OF CITED DOCUMENTS

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