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VEHICLE AIR CONDITIONING DEVICE

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Field of the Invention

The present invention relates to a vehicle air conditioning device having an evaporator unit, attached to a ceiling of a vehicle such as a bus, for cooling and discharging air.

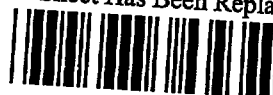
This application is based on Japanese Patent Application No. Hei 10-14508, the contents of which are incorporated herein by reference.

Background Art

Referring to Fig. 6, reference numeral 1 denotes an evaporator unit for a vehicle air conditioning device attached to a ceiling 3 of a vehicle 2 such as a bus. The evaporator unit 1 is disposed in a space enclosed by a roof cover 5 on a roof 4 of the vehicle 2, and is supported by a frame 6 surrounding the evaporator unit 1.

The evaporator unit 1 comprises an evaporator 7 with an evaporator coil for performing heat exchange, and a plurality of fan motors 8 for drawing the air into the evaporator 7, drawing the air cooled by the evaporator 7 from inlet openings 8a, and discharging the air through outlet openings 8b. The air introduced into the evaporator 7 (as indicated by the arrows FA in the figure) is cooled while passing through the evaporator 7 (as indicated by the arrows FB), is led through a channel 11 enclosed by upper and lower covers 9a and 9b and side walls 10, is drawn into the fan motors 8 (as indicated by the arrows FC), is blown from the outlet openings 8a of the fan motors 8 into ducts 12 located along the corners of the ceiling 3 of the vehicle 2, and is distributed to the front and the rear of the vehicle 2.

This Sheet Has Been Replaced



Reference numeral 13 denotes a drain pan for storing drain water which is dew produced when the air is cooled by the evaporator 7.

The evaporator unit 1 protrudes from the roof 4 of the vehicle 2, increasing the height of the vehicle.

The evaporator 7, the upper and lower covers 9a and 9b, the side walls 10, the drain pan 13, and the fan motors 8 in the evaporator unit 1 are supported by the frame 6 in the roof cover 5, and this complicates the assembly of the device and increases the number of the parts, the weight of the device, and the manufacturing cost.

The cooled air blown from the fan motors 8 hits the walls of the duct 12 and then the flow is turned, increasing air resistance, lowering efficiency, and producing noise.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a low noise type advanced vehicle air conditioning device which makes assembly of the device easier, reduces the number of parts, and reduces the size, weight and the manufacturing cost of the device.

In order to accomplish the above object, a vehicle air conditioning device of the present invention comprises: an evaporator unit, attached to a ceiling of a vehicle, for discharging cooled air into a duct extending from the front to the rear of the vehicle along an upper corner of the vehicle; a compressor for compressing a refrigerant, the compressor being driven by an engine; and a condenser for cooling and liquefying the refrigerant compressed by the compressor and sending the refrigerant to the evaporator unit, wherein the evaporator unit comprises: an evaporator for absorbing heat by

vaporizing the refrigerant sent from the condenser and by returning the refrigerant to the compressor; a duct case attached to a side wall of the evaporator; and a plurality of fan motors, attached to a bottom plate of the duct case, for drawing the air through the evaporator into the duct case to cool the air and discharging the cooled air into the duct, the evaporator unit being arranged inside the duct, the fan motors being arranged so that outlet openings of the fan motors are directed in the direction of extension of the duct and so that the cooled air discharged from the outlet openings is prevented from interfering with the fan motors located downstream.

According to the present invention, the evaporator unit which includes the evaporator, the duct case, and the fan motors is arranged inside the duct on the ceiling of the vehicle, thereby eliminating a protrusion on the roof of the vehicle and reducing the height of the vehicle. Compared with the prior structure which includes a protrusion on the roof of the vehicle, a roof cover for covering the evaporator unit and a frame for supporting the parts of the evaporator unit inside the roof cover are unnecessary, thereby reducing the number of the parts, making the assembly of the device simpler and easier, and reducing the size, the weight and the manufacturing cost of the device.

Because the fan motors are arranged so that the outlet openings of the fan motors are directed in the direction of extension of the ducts and so that the cooled air discharged from the outlet openings is prevented from interfering with the fan motors located downstream, the air blown from the fan motors is led smoothly through the duct. This prevents pressure loss and occurrence of noise due to the interference of the air blown from the fan motors with the fan motors 8 located downstream and with the walls of the duct.

In another aspect of the present invention, the duct case is attached to an upper

portion of the side wall of an evaporator case of the evaporator in communication with an opening in the upper portion of the side wall of the evaporator case. The fan motors are positioned adjacent to the lower portion of the side wall of the evaporator case, and the lower portion of the side wall of the evaporator case to which the duct case is attached is a dew shield plate for preventing dew produced during cooling the air from entering the duct case.

Because the duct case is attached to the upper portion of the side wall of the evaporator case of the evaporator, and because the space for the fan motors, which are secured on the lower cover of the duct case, is located adjacent to the lower portion of the side wall of the evaporator case, the evaporator unit can be reduced in size. The lower portion of the side wall of the evaporator case is the dew shield plate 23a, which prevents the dew, produced during cooling the air, from entering the duct case.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view of an evaporator unit in a vehicle air conditioning device according to the present invention.

Fig. 2 is a top view of the vehicle showing the arrangement of the evaporator unit in the vehicle air conditioning device according to the present invention.

Fig. 3 is a cross-sectional view of the vehicle showing the arrangement of the evaporator unit in the vehicle air conditioning device according to the present invention.

Fig. 4 is a front view of the evaporator unit in the vehicle air conditioning device according to the present invention.

Fig. 5 is a top view of the evaporator unit in the vehicle air conditioning device according to the present invention

Fig. 6 is a perspective view of an evaporator unit in a vehicle air conditioning device of the background art.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A vehicle air conditioning device, according to an embodiment of the present invention, will be explained with reference to figures.

Referring to Fig. 1, reference numeral 21 denotes an evaporator unit for the vehicle air conditioning device of the embodiment of the present invention. The evaporator units 21, as shown in Figs. 2 and 3, are disposed along both side corners in a front of a vehicle 2 and are attached to a ceiling 3 of the vehicle 2. The vehicle 2 has a compressor (not shown), which is driven by an engine, for compressing a refrigerant, and a condenser (not shown) for cooling and liquefying the refrigerant compressed by the compressor, wherein the refrigerant is sent from the condenser through an expansion valve to the evaporator unit 21. The refrigerant is vaporized with the evaporator 7 in the evaporator unit 21 and is returned to the compressor, while the evaporator 7 absorbs heat by vaporization of the refrigerant. The compressor, the condenser, and the evaporator unit 21 compose the vehicle air conditioning device.

Ducts 22 extend from the front to the rear of the vehicle 2 along both sides of the ceiling 3 in the vehicle 2, and accommodate the evaporator units 21. Air inlet openings 22a for drawing the air in the vehicle are formed in the ducts 22, facing the center of the vehicle 2. Cooled air outlet openings 22b for discharging the cooled air from the duct 22 into the vehicle are formed in the underside of the ducts 22.

The structure of the evaporator unit 21, for example, at the left side of the vehicle 2, will be explained.

In the evaporator 7 of the evaporator unit 21 shown in Fig. 4, a evaporator case 23 includes an evaporator coil 24, which cools the air passing through the evaporator 7.

A duct case 25 is integrally formed with an upper portion of a side wall of the evaporator case 23. The duct case 25 comprises upper and lower covers 26a and 26b and side walls 27, defining an inside channel for the air flowing from the evaporator 7, and communicates with an opening 28 at a side wall of the evaporator case 23.

A lower portion of the side wall of the evaporator case 23 defines a configuration space S, where a plurality of the fan motors 8 are provided. The fan motors 8 are attached to the lower cover 26b, which is a bottom plate of the duct case 25, so as to make the rotational axes of the inside fans vertical. Inlet openings 8a of the fan motors 8 communicate with openings 26b' with diameters identical to those of the inlet openings 8a, so that the cooled air in the duct case 25 is drawn through the openings 26b' into the inlet openings 8a of the fan motors 8. Rubber air tight seals 27 cover the connection between the lower cover 26b and the fan motors 8 to prevent leakage of air from the connection. Centrifugal multiblade blowers may be employed as the fan motors 8.

The lower portion of the side wall of the evaporator case 23, to which the duct case 25 is connected, forms dew shield plate 23a which prevents dew, produced when the air is cooled by the evaporator coils 24, from entering the duct case 25. The dew hitting the dew shield plate 23a falls into the drain pan 13 located under the evaporator case 23. The height H from the bottom of the evaporator coil 24 in the evaporator 7 to the top of the dew shield plate 23a is approximately $0.3h$ to $0.4h$, where h represents the height of the evaporator coil 24.

A corner connecting the top of the dew shield plate 23a and the lower cover 26b

of the duct case 25 is formed into a comparatively large curved portion 29 which smoothly leads the cooled air through the evaporator coil 24 into the channel in the duct case 25.

An evaporator inlet opening 30 for drawing the air into the evaporator 7 is provided with a filter, not shown, in a side wall of the evaporator case 23 opposite to the duct case 25.

In the evaporator unit 21, the air is drawn by the fan motors 8 from the evaporator inlet opening 30 of the evaporator case 23 (as indicated by the arrows FA' in Fig. 1), is cooled while passing through the evaporator 7 (as indicated by the arrows FB'), is led through the duct case 25, is drawn into the fan motors 8 (as indicated by the arrows FC'), is blown through the outlet openings 8b into the duct 22 (as indicated by the arrows FD'), and is distributed to the front and the rear of the vehicle 2.

The arrangement of the fan motors 8 in the evaporator unit 21 will be explained with reference to Fig. 5.

The fan motors 8 are hereinafter referred to as 8A, 8B, 8C, and 8D from the rear to the front of the vehicle 2.

1) The position of the fan motor 8A

The outlet opening 8b of the fan motor 8A is directed to the rear of the vehicle, while the blow angle is α with respect to the direction of extension of the duct 22 toward the center of the vehicle 2, providing a main flow X of air passing through the duct 22.

2) The position of the fan motor 8B

The outlet opening 8b of the fan motor 8B is directed to the rear of the vehicle, the fan motor 8B is shifted with respect to the fan motor 8A in the vehicle-width direction toward the outside by a distance A, and the blow angle is β toward the outside

of the vehicle 2, providing a main flow Y of the air passing through the duct 22. Thus, the air blown from the fan motor 8B softly hits the back side of the fan motor 8A, and passes between the fan motor 8A and the side wall of the duct 22.

3) The position of the fan motor 8C

The outlet opening 8b of the fan motor 8C is directed to the rear of the vehicle, the fan motor 8C is shifted with respect to the fan motor 8A in the vehicle-width direction toward the outside by a distance B, where $B > A$, and the blow angle is β toward the outside of the vehicle 2, providing a main flow Z of the air passing through the duct 22. Thus, the air blown from the fan motor 8C softly hits the back side of the fan motor 8B, and passes between the fan motor 8B and the side wall of the duct 22.

4) The position of the fan motor 8D

The outlet opening 8b of the fan motor 8D is directed to the front of the vehicle so as to make a blow angle parallel to the duct 22.

Thus, the fan motors 8A to 8D are arranged on the lower cover 26b of the duct case 25 according to their functions.

The evaporator unit 21 in which the parts such as the evaporator 7, the duct case 25, and the fan motors 8 are integrated is arranged inside the duct 22 on the ceiling 3 of the vehicle 2, thereby eliminating the need for a protrusion on the roof 4 of the vehicle 2 and reducing the height of the vehicle. As compared with the prior structure which includes a protrusion on the roof 4 of the vehicle 2, the roof cover 5 which covers the evaporator unit 1 and the frame 6 which supports the parts of the evaporator unit 1 in the roof cover 5 are unnecessary, thereby reducing the number of the parts, making the assembly of the device simpler and easier, and reducing the size, weight and the manufacturing cost of the device.

The duct case 25 is attached to the upper portion of the side wall of the evaporator case 23, the configuration space S for the fan motors 8, which are secured on the lower cover 26b of the duct case 25, is located adjacent to the lower portion of the side wall of the evaporator case 23, and this reduces the evaporator unit 21 in size. The lower portion of the side wall of the evaporator case 23 is the dew shield plate 23a, which prevents the dew, produced when cooling the air drawn through the evaporator coils 24, from entering the duct case 25 and makes the dew fall into the lower drain pan 13.

The fan motors 8A to 8D are attached on the lower cover 26a of the duct case 25 so that their outlet openings 8b are directed in the direction of extension of the duct 22. In particular, the fan motors 8B and C, of the fan motors 8A to 8C whose outlet openings 8b are directed to the rear of the vehicle 2, are shifted in the vehicle-width direction to prevent the discharged air from interfering with the fan motors 8A to 8B located downstream, and the blow angles are appropriately adjusted. Thus, the air blown from the fan motors 8A to 8C is led smoothly through the duct 22. This prevents pressure loss and occurrence of noise due to the interference of the air blown from the fan motors 8 with the fan motors 8 located downstream and with the walls of the duct 22.

Because the fan motors 8 are centrifugal multiblade blowers which blow air toward the outside, the effect can be enhanced by slightly adjusting the positions and the angles of the fan motors 8.

This invention may be embodied in other forms or carried out in other ways without departing from the spirit thereof. The present embodiments are therefore to be considered in all respects illustrative and not limiting, the scope of the invention being

indicated by the appended claims, and all modifications falling within the meaning and range of equivalency are intended to be embraced therein.

What is claimed is:

1. A vehicle air conditioning device comprising:

an evaporator unit, attached to a ceiling of a vehicle, for discharging cooled air into a duct extending from the front to the rear of said vehicle at an upper corner of said vehicle;

a compressor for compressing refrigerant, said compressor being driven by an engine; and

a condenser for cooling and liquefying said refrigerant compressed by said compressor and sending said refrigerant to said evaporator unit,

wherein

said evaporator unit comprises: an evaporator for absorbing heat by vaporizing said refrigerant sent from said condenser and by returning said refrigerant to said compressor; a duct case attached to a side wall of said evaporator; and a plurality of fan motors, attached to a bottom plate of said duct case, for drawing the air through said evaporator into said duct case to cool the air and discharging the cooled air into said duct,

said evaporator unit is arranged inside said duct, and

said fan motors are arranged so that outlet openings of said fan motors are directed in the direction of extension of said duct and so that the cooled air discharged from said outlet openings is prevented from interfering with said fan motors located downstream.

2. A vehicle air conditioning device according to claim 1, wherein said duct case is



attached to an upper portion of said side wall of an evaporator case of said evaporator in communication with an opening in said upper portion of said side wall of said evaporator case, and

said fan motors are positioned adjacent to the lower portion of said side wall of said evaporator case, said lower portion of said side wall of said evaporator case to which said duct case is attached is a dew shield plate for preventing dew produced when cooling the air from entering said duct case.

