ROOF STRUCTURE OF RAILWAY VEHICLE

Field of the Invention

The present invention relates to a roof structure of a railway vehicle, belonging to the field of railway vehicles.

Background of the Invention

Nowadays, people's requirements for air-conditioning refrigeration performance, air distribution, temperature uniformity, and noise performance of passenger compartments of railway vehicles are increasingly high. However, when railway vehicles run in tunnels, ground or elevated lines, vehicle size and on-board equipment installation are constrained by line vehicle gauges, and running environments are very complex, so it is quite difficult to improve ride comfort of railway vehicles, reduce interior noise, and the like.

At present, air supply and air return of air-conditioning systems of urban rail transit vehicles mainly include bottom air supply and bottom air return of air-conditioning units, two-end air supply and bottom air return of air-conditioning units, and end air supply and end air return of air-conditioning units. By combining different ways of air supply and air return of air-conditioning units, different solutions are currently used for vehicle top covers in the market. The three types of air supply and air return units substantially correspond to two types of vehicle top structures. One is a "full-length roof" structure used on the top of the vehicle, and the other is a "high and low roof" structure used on the top of the vehicle.

"Full length roof" structure: The vehicle top cover is an equal height arc roof, which is only applicable to air-conditioning units of bottom air supply and bottom air return. Specific structures are shown in FIG. 1 and FIG. 2. The full-length roof structure 1 has advantages of simplicity, easy vehicle welding and machining, low workload, light weight, and the like. However, this structure is limited to adaptability to air supply and air return of air-conditioning units, and cannot satisfy end air supply and end air return, and end air supply and bottom air return of air-conditioning units.

"High and low roof structure": The vehicle top cover is welded from a high arc roof and

a low flat roof. This roof structure is only applicable to bottom air supply and bottom air return of air-conditioning units, two-end air supply and bottom air return of air-conditioning units, and end air supply and end air return of air-conditioning units. Specific structures are shown in FIGs. 3, 4, and 5.

The "high and low roof" can adapt to bottom air supply and bottom air return of air-conditioning units, two-end air supply and bottom air return of air-conditioning units, and end air supply and end air return of air-conditioning units, but the vehicle top cover has curved and planar sections, so the structure is complex. High and low roof portions are connected by welding, causing deficiencies in difficult control on welding precision, high welding difficulty, large workload of welding and machining, heavy top cover structure, and the like.

Chinese utility model patent CN202593527U discloses a sunken air-conditioning installation structure for railway vehicles, which includes a bottom plate, partition plates arranged at front and rear ends of the bottom plate, and connecting beams arranged on left and right sides respectively. Left and right ends of the bottom plate are connected to the corresponding connecting beams through connecting plates respectively. For the convenience of air return, an air return port is formed on the bottom plate. For the convenience of air supply, air supply ports are provided on the partition plates. The utility model has high strength, high stiffness, and good universality, can meet installation requirements of different specifications of air-conditioning units without changing existing mature installation methods of air-conditioning units, and achieves modular design of structures. The sunken air-conditioning installation structure in CN202593527U employs end supply and bottom return, that is, the partition plates are provided with air supply ports on sides, and the bottom plate is provided with an air return port.

Chinese utility model patent CN207631254U discloses an air-conditioning system for ultra-silent railway vehicles, which includes two-end air supply and two-end air return type air-conditioning units, and is characterized in that a silencing box is arranged at each of two ends of the air-conditioning units; the silencing box is provided with an air supply inlet, an air supply outlet, an air return inlet, and an air return outlet; and the air supply inlet, the air supply outlet, the air return inlet, and the air return outlet are connected to

air supply ports and air return ports of the air-conditioning units through connecting air ducts, respectively. In the utility model, air supplied to internal air ducts is more stable and uniform. When an air supply volume of a single air-conditioning unit reaches 6400 m^3/s, internal noise can be controlled within 56 dB (A). The air-conditioning system has advantages of low air supply resistance of two-end air supply and two-end air return units, low air speed in the air ducts, easy adjustment on uniformity, and the like. Meanwhile, special air-conditioning unit platforms are not required for lower air supply and lower air return units, and water drainage is easy. Air supply ports may be provided at all positions in the length direction of the vehicle, so there is no dead zone of air supply inside the vehicle. The air-conditioning installation structure with silencing boxes in CN207631254U converts two-end air supply and two-end air return of the units into lower air supply and lower air return of the silencing boxes.

Summary of the Invention

The present invention aims to provide a roof structure of a railway vehicle in order to meet different user requirements of railway vehicles, adapt to different air supply and air return of air-conditioning units, improve performance of railway vehicles, improve ride environments of railway vehicles, optimize vehicle design and manufacturing structures, and reduce complexity of vehicle manufacturing processes, vehicle welding work, and vehicle manufacturing costs. The roof structure can:

1) Solve installation, air supply and air return problems of air-conditioning units that share the same vehicle section and profile and are suitable for different air supply and air return;

2) Solve a problem of complex structure of a vehicle top cover; and

3) Solve universality of vehicle profiles for full-length roof structures.

In order to achieve the above objective, the technical solution employed by the present invention is as follows:

A roof structure of a railway vehicle has a full-length roof, where air-conditioning unit mounting bases for fixing air-conditioning units are provided on the roof, and the air-conditioning units are communicated with internal air ducts of the vehicle;

Air-conditioning installation devices each having an integrated cavity are installed on the

roof, and the integrated cavities are used as static pressure boxes for air supply of the air-conditioning units and distribution boxes for bottom air supply and bottom air return, end air supply and end air return, and end air supply and bottom air return;

A plurality of roof air supply and return interface devices are provided on a vehicle top cover of the roof, and the roof air supply and return interface devices are communicated with the air conditioning units;

The integrated cavities are reserved with corresponding air supply ports and air return ports, and installation interfaces of the air-conditioning units are distributed on the same vehicle section and profile;

Different air supply ports and air return ports are reserved on the same roof, and different reserved ports are activated during design; the roof structure of the railway vehicle adapts to any of the following cases:

i. In a case of bottom air supply and bottom air return, air supply ports and air return ports of the air-conditioning units are arranged on the top of the vehicle to implement air supply of the air-conditioning units to passenger compartment air ducts and air return to the units;

ii. In a case of end air supply and end air return, air supply ports and air return ports are arranged on the top of the vehicle at two ends of the air-conditioning units, the air-conditioning units supply air to air ducts at the lower part of the roof through the roof air supply ports at the ends of the units, the air is delivered to the inside of the vehicle through the air ducts, and air inside passenger compartments is extracted to the outside of the vehicle through the air return ports; and

iii. In a case of end air supply and bottom air return, air supply ports are arranged on the top of the vehicle at ends of the air-conditioning units, air return ports are reserved on the top of the vehicle at lower parts of the air-conditioning units, the air-conditioning units supply air to the air ducts at the lower part of the roof through the roof air supply ports, the air is delivered to the inside of the vehicle through the air ducts, and air inside the passenger compartments is extracted to the outside of the vehicle through the air return ports.

The same vehicle section and profile mentioned in the present invention indicate that the vehicle section with air-conditioning units is the same as the section without air-

conditioning units. Currently, the section is variable, that is, the vehicle section with air-conditioning units is different from the section without air-conditioning units.

In this art, the same vehicle can use only one way of air supply and air return. Through the present invention, different vehicles can use different ways of air supply and air return, but can use identical sections and profiles.

In this case, the roof structure of the present invention can adapt to bottom air supply and bottom air return of air-conditioning units, two-end air supply and bottom air return of air-conditioning units, and end air supply and end air return of air-conditioning units, simplify the top structure of the vehicle, and reduce welding difficulty and workload. This will become a direction of future development of vehicle top structures.

The integrated cavity of the present invention provides a space for end air supply and air return, and air supply and air return functions can be integrated in this space.

The present invention solves the problem of applying the same vehicle section and profile to interfaces of air-conditioning units with different air supply and air return in railway vehicles (if necessary, different air supply ports and air return ports can be reserved on the same roof, and different reserved ports are activated after leaving the factory), unifies the vehicle section, improves universality of the vehicle profile, reduces vehicle process difficulty and workload, provides a good solution for interconnectivity of rail transit vehicles and personalized needs of users in different lines, reduces vehicle manufacturing costs, improves product quality and passenger comfort, and providing more alternative solutions.

In addition, the present invention creatively adjusts the functions of the air supply static pressure boxes and distribution boxes of the air-conditioning units from the inside of the vehicle to the roof outside the vehicle, which is beneficial to reducing air supply noise in the passenger compartments. Generally, the wind resistance to the entire vehicle can be ignored under medium to low speed (80 km/h) running conditions, and is approximately 3%-5% when the speed is more than 80 km/h.

According to the embodiments of the present invention, the present invention may be further optimized. The following are technical solutions formed after optimization:

In one preferred embodiment, in the case of bottom air supply and bottom air return, the

air-conditioning unit mounting bases are located on left and right sides of the roof, the roof air supply ports and the roof air return ports are located between the air-conditioning unit mounting bases on the left and right sides, the roof air supply ports are located on the left and right sides, the roof air return ports are located on front and rear sides, and the roof air supply ports arranged on the left and right sides and the roof air return ports arranged on the front and rear sides form a square structure as a whole.

In one preferred embodiment, in the case of end air supply and bottom air return, the air-conditioning unit mounting bases are located on the left and right sides of the roof, the roof air supply ports and the roof air return ports are located between the air-conditioning unit mounting bases on the left and right sides, and the two groups of roof air return ports arranged on the front and rear sides are located between the roof air supply ports arranged on the front and rear sides.

In one preferred embodiment, in the case of end air supply and end air return, the air-conditioning unit mounting bases are located on the left and right sides of the roof, the roof air supply ports and the roof air return ports are located between the air-conditioning unit mounting bases on the left and right sides, and the roof air supply ports and the roof air return ports are divided into front and rear groups and located in the same horizontal position, wherein the roof air supply ports are located between the roof air supply ports in the same group of roof air supply ports and roof air return ports.

In order to improve uniformity of air supply from air conditioners to the passenger compartments of the vehicle and improve ride comfort, in one preferred embodiment, deflectors are arranged inside the roof air supply and return interface devices, and the deflectors are used for adjusting air supply volumes in the passenger compartment air ducts.

Therefore, the roof structure of the present invention can adapt to air supply of different air-conditioning systems, and requires only fine adjustment on air supply ports and air outlets, thereby meeting different user requirements, improving the uniformity of air supply from the air conditioners to the passenger compartments, reducing air supply and air return noise of the air-conditioning systems, improving the comfort of the passenger compartments, ensuring effective utilization of existing platforms for related components

of the vehicle, simplifying the process flow, reducing the welding workload of the vehicle top cover, and reducing vehicle design and manufacturing costs.

Generally, three types of air supply ports and air outlets can be reserved. For vehicles of different air supply modes, different air supply ports and air outlets can be activated to ensure mass production and reduce costs.

The premise of the present invention is to unify vehicles of all projects into a vehicle section. On the basis of unified design, one vehicle can realize three air-conditioning forms in a case of modular design of the vehicle.

Compared with the prior art, the beneficial effects of the present invention are as follows: the present invention can achieve installation of air-conditioning units with different air supply and air return and meet air supply and air return functional requirements of the air-conditioning units in a case of same vehicle section and profile.

Compared with CN202593527U and CN207631254U, the present invention is different in ways of air supply and air return and layout of air supply port and air return port installation interfaces, employs an air-conditioning installation structure with integrated cavities, and applies the same vehicle section and profile to the interfaces of air-conditioning units with different air supply and air return.

Brief Description of the Drawings

FIG. 1 is a schematic diagram of an existing "full-length roof" at the top of a vehicle;

FIG. 2 is a cross-sectional view of FIG. 1;

FIG. 3 is a schematic diagram of an existing "high and low roof" at the top of a vehicle;

FIG. 4 and FIG. 5 are cross-sectional views of different positions in FIG. 3;

FIG. 6 is a schematic diagram of a vehicle top port structure for bottom air supply and bottom air return according to the present invention;

FIG. 7 is a top view of FIG. 6;

FIG. 8 is a schematic diagram of a vehicle top structure for end air supply according to the present invention;

FIG. 9 is a schematic diagram of a vehicle top port structure for end air supply and bottom air return according to the present invention (top view);

FIG. 10 is a schematic diagram of a vehicle top port structure for end air supply and end air return according to the present invention (top view);

FIG. 11 is a layout diagram of a vehicle top structure adapted to different air supply and air return of air-conditioning units according to the present invention;

FIG. 12 is a cross-sectional view of FIG. 11;

FIG. 13 is a partially enlarged cross-sectional view of a roof air supply and return interface device 16 of the present invention;

FIG. 14 is a schematic diagram of the roof air supply and return interface device of the present invention; and

FIG. 15 is a front view of FIG. 14.

In the figures:

1 - full-length roof top cover; 11 - high roof cover; 12 - low roof cover; 13 - air-conditioning unit mounting base; 14 - roof air supply port; 15 - roof air return port; 16 - roof air supply and return interface device; 17 - first passenger compartment air duct; 18 - deflector; 19 - second passenger compartment air duct; 161 - air supply port of the roof air supply and return interface device; 162 - air return port of the roof air supply and return interface device; 163 - crimping surface between the roof air supply and return interface device and the air-conditioning unit; 164 - roof air supply and return interface device and vehicle welding device.

Detailed Description of the Embodiments

The present invention will be described in detail below with reference to the accompanying drawings and in combination with embodiments. It should be noted that the embodiments in the present invention and the features in the embodiments can be combined with each other without conflicts. For ease of narrative, the terms "upper", "lower", "left", and "right" described below are only consistent with the upper, lower, left and right directions of the drawings, and do not limit the structure.

A roof structure of a railway vehicle has a main body of a full-length roof structure. Air-conditioning units are fixed on the top of the vehicle through mounting bases on the full-length roof structure 1. The roof structure of this embodiment is welded to corresponding

positions of ends of two sides of the air-conditioning units to connect the air-conditioning units with air ducts inside the vehicle.

The roof structure of this embodiment includes air-conditioning installation devices each having an integrated cavity. The cavity structures function as static pressure boxes for air supply of the air-conditioning units and distribution boxes for bottom air supply and bottom air return, end air supply and end air return, and end air supply and bottom air return. The cavity structures welded to corresponding positions of ends of two sides of the air-conditioning units, and are reserved with corresponding air supply ports and air return ports. Installation interfaces of the air-conditioning units with different air supply and air return are distributed on the same vehicle section and profile, to achieve communication between the air-conditioning units and the internal air ducts of the vehicle. Deflectors 18 are arranged inside the roof structure of this embodiment to distribute and adjust air supply volumes in passenger compartment air ducts.

The static pressure boxes and distribution boxes of this embodiment are of existing technologies and are separately arranged in the vehicle, and differences in this embodiment are only to integrate functions of the static pressure boxes and distribution boxes of the air-conditioning units and to adjust the roof from the inside of the vehicle to the outside of the vehicle.

As shown in FIG. 8, this embodiment has innovative design based on the full-length roof structure 1. In a case of ensuring that the vehicle section and profile are consistent with the vehicle section and profile of bottom air supply and bottom air return air-conditioning units, the full-length roof structure 1 can adapt to application of end air supply and end air return, and end air supply and bottom air return air-conditioning units.

When the bottom air supply and bottom air return air-conditioning units are used, air supply ports and air return ports of the air-conditioning units are directly machined on the top of the vehicle to implement air supply of the air-conditioning units to passenger compartment air ducts and air return to the units. As shown in FIG. 6 and FIG. 7, the air-conditioning unit mounting bases 13 are located on left and right sides of the roof, roof air supply ports 14 and roof air return ports 15 are located between air-conditioning unit mounting bases 13 on the left and right sides, the roof air supply ports 14 are located on

the left and right sides, the roof air return ports 15 are located on front and rear sides, and the two groups of roof air supply ports 14 arranged on the left and right sides and the two groups of roof air return ports 15 arranged on the front and rear sides form a square structure as a whole.

When the end air supply and bottom air return air-conditioning units are used, air supply ports are reserved on the top of the vehicle at ends of the air-conditioning units, air return ports are reserved on the top of the vehicle at lower parts of the air-conditioning units, the air-conditioning units supply cool air to air ducts at the lower part of the roof through the roof air supply ports, the cool air is delivered to every corner inside the vehicle through the air ducts, air inside passenger compartments is extracted to the outside of the vehicle through the air return ports, and air flow and cooling in the passenger compartments are implemented by internal air exchange. As shown in FIG. 9, the air-conditioning unit mounting bases 13 are located on the left and right sides of the roof, roof air supply ports 14 and roof air return ports 15 are located between the air-conditioning unit mounting bases 13 on the left and right sides, and the two groups of roof air return ports 15 arranged on the front and rear sides are located between the roof air supply ports 14 arranged on the front and rear sides.

When the end air supply and end air return air-conditioning units are used, air supply ports and air return ports are reserved on the top of the vehicle at two ends of the air-conditioning units, the air-conditioning units supply cool air to the air ducts at the lower part of the roof through the roof air supply ports at the ends of the units, the cool air is delivered to every corner inside the vehicle through the air ducts, air inside the passenger compartments is extracted to the outside of the vehicle through the air return ports, and air flow and cooling in the passenger compartments are implemented by internal air exchange. As shown in FIG. 10, the air-conditioning unit mounting bases 13 are located on the left and right sides of the roof, roof air supply ports 14 and roof air return ports 15 are located between the air-conditioning unit mounting bases 13 on the left and right sides, and the roof air supply ports 14 and the roof air return ports 15 are divided into front and rear groups and located in the same horizontal position, where the roof air supply ports 14 are located between the roof air supply ports 14 in the same group of roof air supply

ports 14 and roof air return ports 15.

In this embodiment, corresponding air supply ports and air return ports (if any) are reserved on crimping surfaces between the roof structure and the air-conditioning units to achieve communication between the air-conditioning units and the internal air ducts of the vehicle.

This embodiment determines air supply ports and air return ports according to air-conditioning forms in a design phase, and different reserved ports are activated in the design phase according to air supply and air return of the air-conditioning units.

The roof structure of this embodiment integrates the functions of the air supply static pressure boxes and distribution boxes of the air-conditioning units to form integrated cavities, so as to adjust the roof from the inside of the vehicle to the outside of the vehicle and reduce air supply noise in the passenger compartments.

The position of the roof structure of this embodiment on the vehicle top cover can be flexibly adjusted. According to the sizes of the air-conditioning units and the requirements for the positions of the air supply ports and the air return ports, roof air supply and return interface devices 16 are welded to appropriate positions of the vehicle top cover, thereby crimping the air-conditioning units with crimping surfaces of the roof air supply and return interface devices, ensuring smooth air supply and air return of the air-conditioning units, as shown in FIG. 14 and FIG. 15, and further applying the same vehicle section and profile to installation and air supply/return crimping of air-conditioning units with different air supply and air return.

As shown in FIG. 13, angles of the deflectors 18 arranged inside the roof structure are adjusted according to the air supply volume and air return requirements of the air-conditioning units and in combination with the sizes of air ducts inside the passenger compartments, the requirements for uniformity of air supply and air return, and the actual resistance of the air ducts, so as to flexibly distribute the total air volume delivered out by the units according to requirements and achieve uniform air supply at different positions in the passenger compartments.

The content illustrated by the foregoing embodiments should be understood as these embodiments are merely used for explaining the present invention more clearly, rather

than limiting the scope of the present invention. Various equivalent modifications made to the embodiments by those skilled in the art after reading the present invention fall within the scope defined by the appended claims of the present invention.

Claims

1. A roof structure of a railway vehicle, having a full-length roof, wherein air-conditioning unit mounting bases for fixing air-conditioning units are provided on the roof, and the air-conditioning units are communicated with internal air ducts of the vehicle;

air-conditioning installation devices each having an integrated cavity are installed on the roof, and the integrated cavities are used as static pressure boxes for air supply of the air-conditioning units and distribution boxes for bottom air supply and bottom air return, end air supply and end air return, and end air supply and bottom air return;

a plurality of roof air supply and return interface devices (16) are provided on a vehicle top cover of the roof, and the roof air supply and return interface devices (16) are communicated with the air conditioning units;

the integrated cavities are reserved with corresponding air supply ports and air return ports, and installation interfaces of the air-conditioning units are distributed on the same vehicle section and profile;

different air supply ports and air return ports are reserved on the same roof, and different reserved ports are activated during design phase;

the roof structure of the railway vehicle adapts to any of the following cases:

i. in a case of bottom air supply and bottom air return, air supply ports and air return ports of the air-conditioning units are arranged on the top of the vehicle to implement air supply of the air-conditioning units to passenger compartment air ducts and air return to the units;

ii. in a case of end air supply and end air return, air supply ports and air return ports are arranged on the top of the vehicle at two ends of the air-conditioning units, the air-conditioning units supply air to air ducts at the lower part of the roof through the roof air supply ports at the ends of the units, the air is delivered to the inside of the vehicle through the air ducts, and air inside passenger compartments is extracted to the outside of the vehicle through the air return ports; and

iii. in a case of end air supply and bottom air return, air supply ports are arranged on the top of the vehicle at ends of the air-conditioning units, air return ports are reserved on

the top of the vehicle at lower parts of the air-conditioning units, the air-conditioning units supply air to the air ducts at the lower part of the roof through the roof air supply ports, the air is delivered to the inside of the vehicle through the air ducts, and air inside the passenger compartments is extracted to the outside of the vehicle through the air return ports.

2. The roof structure of the railway vehicle according to claim 1, wherein in the case of bottom air supply and bottom air return, the air-conditioning unit mounting bases (13) are located on left and right sides of the roof, the roof air supply ports (14) and the roof air return ports (15) are located between the air-conditioning unit mounting bases (13) on the left and right sides, the roof air supply ports (14) are located on the left and right sides, the roof air return ports (15) are located on front and rear sides, and the roof air supply ports (14) arranged on the left and right sides and the roof air return ports (15) arranged on the front and rear sides form a square structure as a whole.

3. The roof structure of the railway vehicle according to claim 1, wherein in the case of end air supply and bottom air return, the air-conditioning unit mounting bases (13) are located on the left and right sides of the roof, the roof air supply ports (14) and the roof air return ports (15) are located between the air-conditioning unit mounting bases (13) on the left and right sides, and the two groups of roof air return ports (15) arranged on the front and rear sides are located between the roof air supply ports (14) arranged on the front and rear sides.

4. The roof structure of the railway vehicle according to claim 1, wherein in the case of end air supply and end air return, the air-conditioning unit mounting bases (13) are located on the left and right sides of the roof, the roof air supply ports (14) and the roof air return ports (15) are located between the air-conditioning unit mounting bases (13) on the left and right sides, and the roof air supply ports (14) and the roof air return ports (15) are divided into front and rear groups and located in the same horizontal position, wherein the roof air supply ports (14) are located between the roof air supply ports (14) in the same group of roof air supply ports (14) and roof air return ports (15).

5. The roof structure of the railway vehicle according to any one of claims 1-4, wherein deflectors (18) are arranged inside the roof air supply and return interface devices (16),

and the deflectors (18) are used for adjusting air supply volumes in the passenger compartment air ducts.