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COOLING UNIT FOR AN AIR CONDITIONER

Field of the Invention

The present invention relates to a cooling unit for an air conditioner, which has a plurality of blowers provided in opposition to each other with a predetermined spaced interval on the downstream side of a heat exchanger for cooling in an air flow direction. The cooling unit of the present invention can be preferably used as an air-conditioning apparatus for air-conditioning the inside of a double-decker bus.

Description of Related Art

Conventionally, as disclosed in Japanese Patent Laid-open Publication No. Hei 2-234835, the air-conditioning apparatus is installed on a bulkhead positioned in the rear of a bus to cool air by a heat exchanger for cooling (evaporator of refrigerating cycle) incorporated in the air-conditioning apparatus, and the cool air is blown out to the inside of the bus by a centrifugal blower.

In this conventional air-conditioning apparatus, the centrifugal blowers for the upper and lower portions of the bus are provided at each of left-hand and right-hand sides of the air-conditioning apparatus on the downstream side of the heat exchanger for cooling in an air flow direction. The cool air generated by the left and right centrifugal blowers is blown out to the inside of the upper and lower portions of the bus through air outlet ducts.

In the above-mentioned conventional air-conditioning

apparatus, however, the air flow direction is forcibly bent perpendicularly at the suction side of each centrifugal blower and consequently the pressure loss on the suction side thereof is greatly increased, because the centrifugal blowers for the lower and upper decks of the bus are provided at each of the left-hand and right-hand sides of the air-conditioning apparatus on the downstream side of the heat exchanger for cooling in the air flow direction. In this way, in the conventional air-conditioning apparatus, there is a problem that the performance of the centrifugal blowers deteriorates and a noise of wind blowing by the centrifugal blowers is caused.

In the conventional air-conditioning apparatus, the left-hand and right-hand side blowers are provided on each deck. When such air-conditioning apparatus is applied to a large vehicle such as a bus, it is unavoidable to provide the air-conditioning apparatus with blowers having fans of large diameters and driving motors having large outputs in order to improve the cooling performance. Consequently, the degree of noise and vibration are increased due to the fans having large diameters and the driving motors having large outputs.

To overcome such problem, a plurality of centrifugal blowers may be provided at each of left-hand and right-hand sides of the air-conditioning apparatus on the downstream side of the heat exchanger for cooling in the air flow direction. In this case, however, it is necessary to provide the air-conditioning apparatus with a specific duct having a

complicated structure for unifying air ducts located at the blow-out side of the centrifugal blowers with each other, thereby increasing the manufacturing cost.

SUMMARY OF THE INVENTION

In view of the above-described problems, and it is an object of the present invention to provide a cooling unit for an air conditioner capable of reducing the pressure loss at the suction side and easily installing a large number of compact blowers without a specific duct having a complicated structure.

According to the invention, a wall member is disposed in an air passage on a downstream side of an evaporator so as to face the evaporator in such a manner that an air chamber for introducing air by a blower is formed. In this way, the cool air which has passed through the evaporator flows linearly and is sucked by the blowers. Thus, the cool air is sucked by the blower on the suction side thereof at a very small pressure loss and thus the cooling unit keep a favorable air supply performance. Further, the degree of noise generated in the airflow can be reduced.

Further, the air chamber is formed downstream the wall plates so as to face the evaporator, and the blower is disposed in the air chamber. Thus, even when many blowers are provided, air blown out from many blowers flows into the air chamber. As a result, the pressure of the air in the air chambers rises. Then, the air can be flowed to an air supply ducts. Therefore, it is not necessary to provide a specific duct having a

complicated structure on the blow-out side of the blowers. Thus, many compact blowers can be easily installed.

By using many compact blowers to satisfy the required cooling performance, the degree of noise and vibration generated thereby can be effectively reduced.

By providing the air chamber, the air supply duct can be provided comparatively freely. Therefore, the cooling unit can be easily mounted even in a vehicle having a limited space for accommodating it.

In addition, when at least three of said blowers are arranged stepwise horizontally in such a manner that air blow-out directions of said blowers are different from each other stepwise, air blown out from the air outlet port of each blower is prevented from colliding or interfering with each other, the air blown out from the air outlet port of each blower flows smoothly. The degree of noise and pressure loss is reduced remarkably.

Further, when the air outlet ports of three blowers are directed toward one air outlet duct positioned at the center of the case, the air blown out from the air outlet port of each blower flows smoothly. The degree of noise and pressure loss is reduced remarkably.

BRIEF DESCRIPTION OF THE DRAWINGS

Additional objects and advantages of the present invention will be more readily apparent from the following detailed description of preferred embodiments thereof when

taken together with the accompanying drawings in which:

FIG. 1 is a longitudinal cross-sectional view showing an air-conditioning apparatus according to an embodiment of the present invention;

FIG. 2 is a perspective view of a rear portion of a bus showing an installation of the air-conditioning apparatus shown in FIG. 1;

FIG. 3 is a cross-sectional view taken along the line III-III of FIG. 1;

FIG. 4 is a cross-sectional view taken along the line IV-IV of FIG. 1;

FIG. 5 is a sectional view showing main portions of blowers 22 and 25 shown in FIG. 1; and

FIG. 6 is a perspective view of the entire bus showing the installation of the air-conditioning apparatus shown in FIG. 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The preferred embodiment of present invention are described with reference to the drawings.

FIGS. 1 through 6 show an embodiment in which the present invention is applied to an air-conditioning apparatus of a double-decker bus. FIG. 6 shows an entire construction of the bus. In FIG. 6, an air-conditioning unit 1 is installed on a bulkhead positioned at the rear of the bus, and an air outlet duct 2 for an upper deck introduces air conditioned by the air-conditioning unit 1 into a ceiling in the inside of the upper

deck of the bus. The air supply duct 2 for the upper deck of the bus is installed at each of left-hand and right-hand sides of the ceiling in the inside of the upper deck of the bus, thus extending over a long distance in the longitudinal direction of the bus.

An air supply duct 3 for a lower deck introduces air conditioned by the air-conditioning unit 1 into a ceiling in the inside of the lower deck of the bus. The air supply duct 3 for the lower deck is installed in the center of the ceiling in the inside of the lower deck of the bus, thus extending over a long distance in the longitudinal direction of the bus.

A large number of air outlet ports are formed on the air supply ducts 2 and 3 for the upper deck and the lower deck, respectively.

An outside air inlet port 4 introduces outside air for cooling condenser into a condensing unit 12 from a side surface of the bus. The condenser will be described later. An air (warm air) which has cooled the condenser is discharged from an air discharge port 5 through the rear surface of the bus. A blower 6 for the condenser includes a plurality of axial fans (six fans in this embodiment) arranged in parallel with each other. Although the air discharge port 5 is not shown clearly in FIG. 6, it is formed on the rear surface of the bus in an almost entire length in the width direction of the bus in opposition to the plurality of the blowers 6 for the condenser.

FIGS. 1 through 4 show the air-conditioning unit 1 to explain the main portion of the present invention. Referring

to FIGS. 1 through 4, a case 10 for forming the outer configuration of the air-conditioning unit 1 is formed in a substantially rectangular solid, the width of which is longer than the length thereof, as shown in FIG. 2. The case 10 is made of a metal plate such as an iron plate and is heat-insulated and partitioned vertically into two sections. A cooling unit 11 is formed in the upper section, whereas the condensing unit 12 is formed in the lower section. A long evaporator 13 extending in the width direction of the bus is provided in the cooling unit 11 on a side thereof corresponding to the front side of the bus. The evaporator 13 is provided in a refrigerating cycle where refrigerant is circulated by the operation of a compressor driven by an engine (not shown) for running the vehicle so as to cool air supplied thereto by the latent heat of vaporization of the refrigerant.

As shown in FIG. 2, first inside air inlet ports 14, which are vertically long, are formed on the front surface of the cooling unit 11 at each of the left-hand and right-hand sides thereof.

As shown in FIG. 2, the air supply duct 3 for the lower deck is mounted in the center of the cooling unit 11 in the width direction thereof so as to be sandwiched between the first inside air-intake ports 14. A second inside air inlet port 15 is provided above the air supply duct 3 for the lower deck.

Thus, air (inside air) in the inside of the bus is sucked into the cooling unit 11 from the first inside air inlet

ports 14 and the second inside air inlet port 15, thus flowing into the evaporator 13.

On the downstream side (rear side of bus) of the evaporator 13 in the air-flow direction, there are provided wall plates 16a and 16b extending vertically in opposition to the evaporator 13 spaced at a predetermined interval therefrom. The wall plates 16a and 16b are each made of a metal plate such as an iron plate.

A flow duct positioned on the downstream side (rear side of bus) of the evaporator 13 in an air flow direction is partitioned into an upper duct 18 and a lower duct 19 by a partitioning wall plate 17 extending horizontally. The wall plate 16a crosses the upper duct 18, whereas the wall plate 16b crosses the lower duct 19. In the upper duct 18, an upper air chamber 20 is formed downstream the wall plate 16a, whereas in the lower duct 19, a lower air chamber 21 is formed downstream the wall plate 16b.

As shown in FIG. 3, the wall plate 16a positioned in the upper duct 18 is formed stepwise in such a manner that the central portion thereof in the width direction of the bus is positioned farthest from the evaporator 13. A plurality of blowers 22 are installed on the wall plate 16a. In this embodiment, six blowers 22 are installed.

Describing the installation of the blower 22 more specifically, air openings 23, the number of which is equal to that of the installed blowers 22, are formed on the wall plate 16a. A casing 22a of each blower 22 is fixed to the wall plate

16a by a screw or the like in such a manner that each air opening 23 communicates with an inlet port 22b of the casing 22a of each blower 22.

Each blower 22 is disposed in the upper air chamber 20. As shown in FIG. 1, each blower 22 includes a centrifugal multi-blade fan (sirocco fan) 22c accommodated in a scroll-shaped casing 22a thereof. The centrifugal multi-blade fan 22c is driven by a motor 22e via a rotary shaft 22d thereof.

An air outlet port 24 is formed on the ceiling of the upper air chamber 20 at each of the left-hand and right-hand sides thereof. An entrance of each of the air outlet ducts 2 for the upper deck is connected with each of the air outlet ports 24.

The direction of an air outlet port 22f of each of the six blowers 22, for blowing air into the upper air chamber 20 from the scroll-shaped casing 22a of each of the six blowers 22 is set to allow the air to flow smoothly to the air outlet ports 24. That is, as shown in FIG. 5, the three blowers 22 positioned at the left-hand side in FIG. 5 are disposed to direct the air outlet ports 22f toward the air outlet port 24 positioned at the left side in FIG. 5, whereas the three blowers 22 positioned at the right-hand side in FIG. 5 are disposed to direct the air outlet ports 22f thereof toward the air outlet port 24 positioned at the right side in FIG. 5.

As shown in FIG. 4, the wall plate 16b positioned in the lower duct 19 is formed to extend linearly in the width direction of the bus. A plurality of blowers 25 are also

installed on the wall plate 16b. In this embodiment, six blowers 25 are also installed.

The blowers 25 in the lower duct 19 are installed in the same manner as the blowers 22. That is, air openings 26, the number of which is equal to that of the installed blowers 25, are formed on the wall plate 16b. A casing 25a of each blower 25 is fixed to the wall plate 16b by a screw or the like in such a manner that each air opening 25 communicates with an intake port 25b of the casing 25a of each blower 25.

Each blower 25 is installed in the lower air chamber 21. As shown in FIG. 1, each blower 25 includes a centrifugal multi-blade fan (sirocco fan) 25c accommodated in a scroll-shaped casing 25a thereof. The centrifugal multi-blade fan 25c is driven by a motor 25e via a rotary shaft 25d thereof.

A connection duct 27 is installed in the lower portion of the air chamber 21 and below the evaporator 13, thus extending in the case 10 toward the front side of the bus, thus communicating with an air outlet port 28. The air outlet port 28 is installed to be positioned in the center of the case 10 in the width direction of the bus on an end surface thereof corresponding to the front side of the bus. The air outlet port 28 is connected with an entrance of the air supply duct 3 for the lower deck.

The direction of an air outlet port 25f of each of the six blowers 2, for blowing air into the lower air chamber 21 from the scroll-shaped casing 25a of each of the six blowers 25 is set to allow the air to flow smoothly to the air outlet port

28 positioned in the above-described center of the case 10. That is, as shown in FIG. 5, the direction of each of the three air outlet ports 25f at the left-hand side in FIG. 5 is set to be half right with respect to a vertical line, whereas the direction of each of the three air outlet ports 25f at the right-hand side in FIG. 5 is set to be half left with respect to a vertical line.

Referring to FIG. 1, a condenser 29 cools and condenses refrigerant gas discharged from a compressor (not shown) by performing a heat exchange between the refrigerant gas and the outside air generated by the blower 6. A motor 6a drives the blower 6. Referring to FIG. 2, a seat 30 is located at the rear end in the lower deck, and the bulkhead 31 is located at the rear end of the bus.

An operation of the air-conditioning cooling apparatus of the embodiment having the above-described construction is described below. When the compressor of the refrigerating cycle is driven by the engine and operates, the refrigerant circulates through the evaporator 13 and the condenser 29 of the refrigerating cycle. As a result, the evaporator 13 evaporates the refrigerant gas and the condenser 29 condenses the refrigerant gas.

When the driving motors 22e, 25e and 6a of each of the blowers 22, 25 and 6 are energized with electric current, the blowers 22, 25 and 6 are actuated. After the blowers 22 and 25 are actuated, the air in the inside of the bus is introduced into the case 10 from the first and second inside air inlet

ports 14 and 15 and passes through the evaporator 13 for cooling the air therein, thus generating cool air.

After the air passes through the evaporator 13, the cool air flows almost linearly without being bent, thus being sucked by the blowers 22 and 25 through the air openings 23 and 26 of each of the wall plates 16a and 16b at a small pressure loss. The cool air flows into the upper and lower air chambers 20 and 21, after the cool air is pressurized by the blowers 22 and 25.

The cool air which has been introduced into the upper air chamber 20 flows into the air supply ducts 2 for the upper deck through the air outlet ports 24 and is then blown into the inside of the upper deck from the ceiling of the upper deck through a large number of air outlet ports formed on the air supply ducts 2 for the upper deck, thus cooling the inside of the upper deck.

The cool air which has been introduced into the lower air chamber 21 reaches the air outlet port 28 through the connection duct 27, thus flowing into the air supply duct 3 for the lower deck from the air outlet port 28. The cool air is then blown into the inside of the lower deck from the ceiling of the lower deck through a large number of air outlet ports formed on the air supply ducts 3 for the lower deck, thus cooling the inside of the lower deck.

Outside air is introduced into the condensing unit 12 from the outside air-intake port 4 by the operation of the blower 6, thus passing through the condenser 29 which cools the

refrigerant gas to condense it. When the air passes through the condenser 29, temperature of the air is increased, and the air is discharged to the outside from the air discharge port 5 located at the rear surface of the bus.

The outside air which has been introduced into the condensing unit 12 from the outside air inlet port 4 positioned on the side surface of the bus can be introduced to the upstream side of the evaporator 13 as necessary through an outside air-introducing duct (not shown) and a damper mechanism provided thereon. Thus, the inside of the bus can be ventilated as necessary by introducing the outside air into the upstream side of the evaporator 13.

The air-conditioning cooling apparatus having the above-described construction of the embodiment has the following operation and effect.

Firstly, the air chambers 20 and 21 are formed downstream the wall plates 16a and 16b in opposition to the evaporator 13, and the blowers 22 and 25 are installed in each of the air chambers 20 and 21. Thus, even when many blowers 22 and 25 are provided, air blown out from the blowers 22 and 25 flows into the air chambers 20 and 21 temporarily. After the pressure of the air in the air chambers 20 and 21 increases, the air can be flowed toward the air supply ducts. Therefore, it is not necessary to provide the specific duct having a complicated construction on the blow-out side of the blowers 22 and 25 and further, the wall plates 16a and 16b can be formed as simple plates. Thus, many compact blowers 22 and 25 can be

easily installed.

By using many compact blowers 22 and 25 to satisfy the required cooling performance, the degree of noise and vibration generated by the blowers 22 and 25 can be effectively reduced.

When holes for installing the casings 22a and 25a of each of the blowers 22 and 25 are formed on the wall plates 16a and 16b, respectively, many holes are formed in advance along a circle with its center as the rotation center of each of the blowers 22 and 25, by utilizing the installing hole formed on each of the casings 22a and 25a. The installing position (blow-out direction of air outlet ports 22f and 25f) of the casings 22a and 25a of each of the blowers 22 and 25 can be easily adjusted by appropriately selecting holes from the holes having been formed on the wall plates 16a and 16b.

Because a large number of the blowers 22 and 25 are accommodated in each of the air chambers 20 and 21, the air chambers 20 and 21 are capable of reducing the operation sound of the motors for driving the blowers 22 and 25 and the noise of wind blowing by the fans, thus reducing the sound or noise propagating to the outside.

By providing the air chambers 20 and 21, it is possible for the position of the air blow-off ports 24 and 28 to be set comparatively freely. Thus, the installation of the air supply ducts 2 and 3 can be set comparatively freely. Therefore, the air-conditioning apparatus 1 can be easily mounted even in a vehicle having a limited space therefor.

Further, because cool air which has passed through the

evaporator 13 flows linearly and is sucked by a large number of the blowers 22 and 25, the cool air is sucked by the blowers 22 and 25 on the suction side thereof at a very small pressure loss.

As shown in FIG. 3, because the six blowers 22 are arranged in the upper air chamber 20 stepwise to prevent air blown out from the air outlet port 22f of each blower 22 from colliding or interfering with each other, the air blown out from the air outlet port 22f of each blower 22 flows smoothly, thus reducing the degree of noise and pressure loss remarkably.

As shown in FIG. 5, because the air outlet ports 25f of the six blowers 25 are directed toward the air outlet port 28 positioned at the center of the case 10 in the lower air chamber 21, the air blown out from the air outlet port 22f of each blower 22 flows smoothly, thus reducing the degree of noise and pressure loss remarkably.

In the above-described embodiment, the present invention is applied to the air-conditioning apparatus of the bus. However, the present invention is not limited thereto, but can be widely applied to the cooling unit for the air conditioner.

The present invention has been described in connection which what are presently considered to be the most practical preferred embodiments. However, the invention is not meant to be limited to the disclosed embodiments, but rather is intended to include all modifications and alternative arrangements included within the spirit and scope of the appended claims.

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WHAT IS CLAIMED IS:

1. A cooling unit for an air-conditioner comprising:

a casing having an air passage in which air flows;

an exchanger disposed in said air duct for cooling air;

a wall member disposed on a downstream side of said heat exchanger in the air flow direction so as to face said cooling heat exchanger at a predetermined interval therewith, said wall member forming an air chamber in said air passage and having an air opening to introduce the cooled air into said air chamber therethrough;

a blower disposed in said air chamber for sucking air into said air chamber through said air opening; and

an air supply duct connected with said air chamber for introducing the air in said air chamber into space to be air-conditioned.

2. A cooling unit for an air-conditioner comprising:

a casing having an air passage in which air flows horizontally;

a heat exchanger disposed in said air duct for cooling air;

a partitioning member for partitioning said air passage on a downstream side of said heat exchanger into an upper air passage and a lower air passage;

a first wall member disposed in said upper air passage so as to face said heat exchanger at a predetermined interval therewith, said first wall member forming a first air chamber



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in said upper air passage and having a first air opening to introduce the cooled air into said first air chamber therethrough;

a second wall member disposed in said upper air passage so as to face said heat exchanger at a predetermined interval therewith, said second wall member forming a second air chamber in said lower air passage and having a second air opening to introduce the cooled air into said second air chamber therethrough;

a first blower disposed in said first air chamber for sucking air and blowing out the air into said first air chamber through said first air opening;

a second blower disposed in said second air chamber for sucking air and blowing out the air into said second air chamber through said second air opening;

a first air supply duct connected with said first air chamber for introducing the air in said first air chamber into a first space to be air-conditioned; and

a second air supply duct connected with said second air chamber for introducing the air in said second air chamber into a second space to be air-conditioned.

3. A cooling unit for an air-conditioner according to any one of claims 1 and 2, wherein,

said blower is positioned immediately backward said air opening, and

said blower includes:

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a centrifugal multi-blade fan for feeding air sucked from said air opening,

a blower casing accommodating said centrifugal multi-blade fans and having an air outlet port for blowing air fed by said centrifugal multi-blade fans into said air chamber.

4. A cooling unit for an air-conditioner according to any one of claims 1 and 2, wherein,

a horizontal size of the cooling heat exchanger is longer than a vertical size thereof, and

at least three of said blowers are arranged horizontally in parallel with each other.

5. A cooling unit for an air-conditioner according to claim 4, wherein,

at least three of said blowers are arranged stepwise horizontally in such a manner that air blow-out directions of said blowers are different from each other stepwise.

6. A cooling unit for an air-conditioner according to claim 4, wherein,

at least three of said blowers are arranged linearly in a horizontal direction,

said air supply duct is positioned at a center of three of said blowers in a horizontal direction, and

said air outlet port of each of said blowers for blowing out air into said second air chamber faces said air

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outlet duct.

7. A cooling unit for an air-conditioner for a double-decker bus having an upper deck and a lower deck, said cooling unit comprising:

a casing having an air passage in which air flows horizontally;

a heat exchanger disposed in said air duct for cooling air;

a partitioning member for partitioning said air passage on a downstream side of said heat exchanger into an upper air passage and a lower air passage;

a first wall member disposed in said upper air passage so as to face said heat exchanger at a predetermined interval therewith, said first wall member forming a first air chamber in said upper air passage and having a first air opening to introduce the cooled air into said first air chamber therethrough;

a second wall member disposed in said upper air passage so as to face said heat exchanger at a predetermined interval therewith, said second wall member forming a second air chamber in said lower air passage and having a second air opening to introduce the cooled air into said second air chamber therethrough;

a first blower disposed in said first air chamber for sucking air and blowing out the air into said first air chamber through said first air opening;

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a second blower disposed in said second air chamber for sucking air and blowing out the air into said second air chamber through said second air opening;

a first air supply duct connected with said first air chamber for introducing the air in said first air chamber into said upper deck; and

a second air supply duct connected with said second air chamber for introducing the air in said second air chamber into said lower deck.