# SPECIFICATION

# AIR CONDITIONER OUTDOOR UNIT, AIR CONDITIONER, AND COMPRESSOR UNIT

## TECHNICAL FIELD

The present invention relates to an air-conditioning outdoor unit, an air conditioner, and a compressor unit.

## BACKGROUND ART

Usually, as shown in FIG. 8, an air conditioner is disposed with a compressor 51, a four-way switching valve 52, an outdoor heat exchanger 53, an expansion valve (decompression mechanism) 54, and an indoor heat exchanger 55. A pair of primary ports 56a and 56b of the four-way switching valve 52 is connected to a discharge port and an intake port of the compressor 51. One secondary port 57a of a pair of secondary ports 57a and 57b of the four-way switching valve 52 is connected to a gas pipe 58. The gas pipe 58 is connected to the indoor heat exchanger 55 via a gas closing valve 59. The other secondary port 57b of the pair of secondary ports 57a and 57b of the four-way switching valve 52 is connected to the outdoor heat exchanger 53. The expansion valve 54 is connected to the outdoor heat exchanger 53. The expansion valve 54 and the indoor heat exchanger 55 are connected via a liquid closing valve 60. An accumulator 61 is disposed between the four-way switching valve 52 and the intake port of the compressor 51.

Incidentally, an air-conditioning outdoor unit is configured as a result of the compressor 51, the four-way switching valve 52, the outdoor heat exchanger 53, the expansion valve 54 and the like being housed inside an outdoor unit casing (not shown). The gas closing valve 59 and the liquid closing valve 60 are disposed close to the air-conditioning outdoor unit and function as external connection ports for connecting to an indoor unit.

In the above air-conditioning outdoor unit, as shown in FIG. 8, when the compressor 51 is driven when the four-way switching valve 52 is in the state represented by the solid lines, refrigerant discharged from the compressor 51 sequentially flows through the four-way switching valve 52, the indoor heat exchanger 55, the expansion valve 54 and the outdoor heat exchanger 53, and the indoor heat exchanger 55 functions as a condenser and the outdoor heat exchanger 53 functions as an evaporator such that a room interior can be heated. Further, when the four-way switching valve 52 is switched to the state represented by the dotted lines and the compressor 51 is driven, the refrigerant discharged from the compressor 51 sequentially flows through the four-way switching valve 52, the outdoor heat exchanger

53, the expansion valve 54 and the indoor heat exchanger 55, and the outdoor heat exchanger 53 functions as a condenser and the indoor heat exchanger 55 functions as an evaporator such that the room interior can be cooled.

As described above, the compressor 51, the four-way switching valve 52, the outdoor heat exchanger 53, the expansion valve 54 and the like are housed inside the outdoor unit casing of the air-conditioning outdoor unit. For this reason, vibration and noise of the compressor 51 and the like are transmitted to the outdoor unit casing via pipes and the like, and leak to the outside from the outdoor unit casing. In order to avoid this phenomenon, air-conditioning outdoor units are known where a vibration absorbing mechanism comprising a trap portion or a loop portion is disposed in pipes laid inside the outdoor unit casing (e.g., see Patent Document 1 and Patent Document 2). In these air-conditioning outdoor units, as shown in FIG. 9, a vibration absorbing mechanism 63 is disposed between the four-way switching valve 52 and the compressor 51, and alleviates the vibration and noise of the compressor 51 and the like.

<Patent Document 1>

Japanese Patent Application Publication (JP-A) No. 8-14705 (FIG. 1)

<Patent Document 2>

Japanese Patent Application Publication (JP-A) No. 9-89417 (FIG. 1)

**DISCLOSURE OF THE INVENTION**

However, when the vibration absorbing mechanism 63 comprising a loop portion or the like is disposed, a large amount of space becomes necessary inside the outdoor unit casing for the vibration absorbing mechanism 63, and the overall outdoor unit becomes large.

Further, when the vibration absorbing mechanism 63 is disposed, the number of assembly man-hours is large and the outdoor unit has poor assemblability (productivity) because it is necessary to dispose the trap portion or the loop portion.

Moreover, the refrigerant intake path of the compressor 51 becomes longer as a result of disposing the vibration absorbing mechanism 63, which leads to an increase in pressure loss at the intake side, and the COP (Coefficient of Performance) drops.

Furthermore, because the vibration absorbing mechanism 63 is disposed between the four-way switching valve 52 and the compressor 51, the vibration absorbing mechanism 63 becomes disposed at a site far from a pipe fixing portion such as the connection port of the outdoor unit casing and the outdoor heat exchanger. For this reason, even if the vibration and noise of the compressor 51 are reduced by the vibration absorbing mechanism 63, the vibration and noise generated between the vibration absorbing mechanism 63 and the pipe

fixing portion such as the connection port cannot be reduced, and the vibration and noise leaking from the outdoor unit casing cannot be efficiently reduced.

The present invention has been made in order to address these conventional drawbacks, and it is an object thereof to provide an air-conditioning outdoor unit, an air conditioner and a compressor unit that can be made compact and reduce noise, and which have excellent assemblability.

In the present invention, a pair of primary ports of a four-way switching valve is respectively connected to a discharge port and an intake port of a compressor, and flexible pipes are connected to a pair of secondary ports of the four-way switching valve. For this reason, the vibration and noise of the compressor are damped by the flexible pipes, and it becomes difficult for them to be transmitted close to objects connected to the opposite side of the secondary ports of the flexible pipes. Thus, the air-conditioning outdoor unit and the air conditioner can be made compact and reduce noise. Further, because flexible pipes are used, the air-conditioning outdoor unit has excellent assemblability

Further, when one of the secondary ports of the four-way switching valve and an external connection port are connected by a flexible pipe and the other secondary port of the four-way switching valve and an outdoor heat exchanger are connected by a flexible pipe, the flexible pipes become disposed in positions close to pipe fixing portions that are the outdoor heat exchanger and the external connection port in an outdoor unit casing. Thus, the vibration and noise from the compressor and the like can be absorbed at portions close to the pipe fixing portions in the outdoor unit casing, and vibration and noise leaking to the outside via the outdoor unit casing can be more reliably reduced. Thus, an air conditioner that is quiet with little vibration and noise can be provided.

Further, when the pair of primary ports of the four-way switching valve is directly connected to the discharge port and the intake port of the compressor without intervening a vibration absorbing mechanism such as a trap portion or a loop portion, it becomes unnecessary to dispose space for the vibration absorbing mechanism. Consequently, the overall air-conditioning outdoor unit can be made compact. Moreover, because a vibration absorbing mechanism is not disposed, the number of assembly man-hours is reduced by that much, and a reduction in cost and an improvement in assemblability (productivity) are realized. Moreover, as a result of a vibration absorbing mechanism not being disposed, the intake path of the compressor becomes shorter, an increase in pressure loss at the intake side can be suppressed, and the COP is improved.

**BRIEF DESCRIPTION OF THE DRAWINGS**

FIG. 1 is a refrigerant circuit diagram of an air conditioner disposed with an air-conditioning outdoor unit pertaining to an embodiment of the invention.

FIG. 2 is a perspective view of relevant portions of the air-conditioning outdoor unit pertaining to the embodiment of the invention.

FIG. 3 is a front view of relevant portions of the air-conditioning outdoor unit pertaining to the embodiment of the invention.

FIG. 4 is a plan view of relevant portions of the air-conditioning outdoor unit pertaining to the embodiment of the invention.

FIG. 5 is a perspective view of relevant portions of an air-conditioning outdoor unit pertaining to another embodiment.

FIG. 6 is a front view of relevant portions of the air-conditioning outdoor unit pertaining to the other embodiment.

FIG. 7 is a plan view of relevant portions of the air-conditioning outdoor unit pertaining to the other embodiment.

FIG. 8 is a refrigerant circuit diagram of an air conditioner disposed with a conventional air-conditioning outdoor unit.

FIG. 9 is a simplified view of relevant portions of the conventional air-conditioning outdoor unit.

**DESCRIPTION OF REFERENCE NUMERALS**

| | |
|---|---|
| 1 | Compressor |
| 1a | Discharge Port |
| 1b | Intake Port |
| 2 | Four-Way Switching Valve |
| 3 | Outdoor Heat Exchanger |
| 6a, 6b | Primary Ports |
| 7a, 7b | Secondary Ports |
| 11 | External Connection Port |
| 20, 21 | Flexible Pipes |

**BEST MODES FOR CARRYING OUT THE INVENTION**

Next, specific embodiments of an air-conditioning outdoor unit pertaining to the invention will be described in detail with reference to the drawings.

<Configuration of Air Conditioner>

FIG. 1 shows an air conditioner disposed with the air-conditioning outdoor unit pertaining to the invention. The air conditioner is disposed with a compressor 1, a four-way

switching valve 2, an outdoor heat exchanger 3, a decompression mechanism (expansion valve) 4, and an indoor heat exchanger 5.

A pair of primary ports 6a and 6b of the four-way switching valve 2 is connected to a discharge port 1a and an intake port 1b of the compressor 1. That is, the discharge port 1a of the compressor 1 and the one primary port 6a of the four-way switching valve 2 are connected via a discharge pipe 8. The intake port 1b of the compressor 1 and the other primary port 6b of the four-way switching valve 2 are connected via an intake pipe 10, on which an accumulator 9 is disposed. The intake pipe 10 comprises a compressor side pipe 10a and a switching valve side pipe 10b. The compressor side pipe 10a connects the accumulator 9 and the intake port 1b of the compressor 1. The switching valve side pipe 10b connects the accumulator 9 and the other primary port 6b of the four-way switching valve 2.

One secondary port 7a of a pair of secondary ports 7a and 7b of the four-way switching valve 2 is connected to an external connection port 11. The other secondary port 7b is connected to an outdoor heat exchanger 3. That is, the one secondary port 7a of the four-way switching valve 2 is connected to a first refrigerant pipe 12 to which the external connection port 11 is coupled. The other secondary port 7b of the four-way switching valve 2 is connected to the outdoor heat exchanger 3 via a second refrigerant pipe 13. The outdoor heat exchanger 3 and the expansion valve 4 are connected via a third refrigerant pipe 14. The expansion valve 4 is connected to the indoor heat exchanger 5 via an external connection port 15. A fourth refrigerant pipe 16 coupled to the indoor heat exchanger 5 is connected to the external connection port 11.

Here, the air-conditioning outdoor unit is configured as a result of the compressor 1, the four-way switching valve 2, the outdoor heat exchanger 3, the expansion valve 4 and the like being housed inside an outdoor unit casing (not shown). An air-conditioning indoor unit is configured as a result of the indoor heat exchanger 5 and the like being housed inside an unillustrated indoor unit casing. The one external connection port 11 is configured by a gas closing valve 17 (see FIG. 2). The other external connection port 15 is configured by a liquid closing valve 18. The gas closing valve 17 and the liquid closing valve 18 are attached to the outdoor unit casing such that they are exposed to the outside of the outdoor unit casing.

A first flexible pipe 20 is disposed between the one secondary port 7a of the four-way switching valve 2 and the one external connection port 11. That is, the first flexible pipe 20 is intervened the first refrigerant pipe 12.

A second flexible pipe 21 is disposed between the other secondary port 7b of the four-way switching valve 2 and the outdoor heat exchanger 3. That is, the second flexible pipe 21 is intervened in the second refrigerant pipe 13.

Next, the vicinity of the compressor 1 will be described in greater detail. As shown in FIGS. 2 to 4, the accumulator 9 is attached to a casing 22 of the compressor 1. The four-way switching valve 2 is disposed above the accumulator 9. The first flexible pipe 20 intervened in the first refrigerant pipe 12 and the second flexible pipe 21 intervened in the second refrigerant pipe 13 are linearly arranged along the vertical direction adjacent to the accumulator 9. The first refrigerant pipe 12 comprises a pipe 12a (e.g., a stainless steel pipe) at the switching valve side projecting from the four-way switching valve 2, the first flexible pipe 20, and a pipe 12b (e.g., a stainless steel pipe) connected to the external connection port 11. The second refrigerant pipe 13 comprises a pipe 13a (e.g., a stainless steel pipe) at the switching valve side projecting from the four-way switching valve 2, the second flexible pipe 21, and a pipe 13b (e.g., a stainless steel pipe) connected to the outdoor heat exchanger 3.

As shown in FIG. 3, the flexible pipes 20 and 21 are configured by metal pipes 23 (e.g., stainless steel pipes) formed in bellows and outer cover members 24 that cover the metal pipes 23. A fiber material such as KEVLAR (aromatic polyamide) is used for the outer cover members 24. The flexible pipes 20 and 21 can damp (reduce) vibration due to their flexibility. Because the flexible pipes 20 and 21 have this configuration, it is difficult for them to be bent and used, and it is preferable for them to be used linearly (straight pipes) as shown in FIG. 2.

As shown in FIG. 2 and FIG. 3, the first flexible pipe 20 is disposed in the vicinity of the gas closing valve 17 that configures the external connection port 11. Here, the gas closing valve 17 is fixed to the outdoor unit casing as described above. Consequently, the first flexible pipe 20 becomes disposed in a position close to the external connection port 11 (= pipe fixing portion) in the outdoor unit casing. Further, the second flexible pipe 21 is disposed in the vicinity of the outdoor heat exchanger 3. For this reason, the second flexible pipe 21 also becomes disposed in a position close to the outdoor heat exchanger 3 (= pipe fixing portion) in the outdoor unit casing.

<Operation of Air Conditioner>

In the air conditioner having the configuration described above, as shown in FIG. 1, when the four-way switching valve 2 is in the state represented by the solid lines and the compressor 1 is driven, refrigerant discharged from the compressor 1 sequentially flows

through the four-way switching valve 2, the indoor heat exchanger 5, the expansion valve 4 and the outdoor heat exchanger 3. Thus, the indoor heat exchanger 5 functions as a condenser and the outdoor heat exchanger 3 functions as an evaporator, whereby a room interior can be heated.

When the four-way switching valve 2 is switched to the state represented by the dotted lines and the compressor 1 is driven, the refrigerant discharged from the compressor 1 sequentially flows through the four-way switching valve 2, the outdoor heat exchanger 3, the expansion valve 4 and the indoor heat exchanger 5. Thus, the outdoor heat exchanger 3 functions as a condenser and the indoor heat exchanger 5 functions as an evaporator, whereby the room interior can be cooled.

<Characteristics of Air Conditioner>

In the air conditioner, the first flexible pipe 20 is disposed between the one secondary port 7a and the external connection port 11, and the second flexible pipe 21 is disposed between the other secondary port 7b and the outdoor heat exchanger 3. Thus, the first flexible pipe 20 can be disposed in a position close to the pipe fixing portion that is the external connection port 11, and the second flexible pipe 21 can be disposed in a position close to the pipe fixing portion that is the outdoor heat exchanger 3 in the outdoor unit casing. For this reason, vibration and noise from the compressor 1 and the like can be absorbed at the portions close to the pipe fixing portions in the outdoor unit casing, vibration and noise leaking to the outside via the outdoor unit casing are reduced, and the air conditioner becomes quiet with little vibration and noise. The metal pipes 23 of the flexible pipes 20 and 21 are covered by the outer cover members 24 comprising fiber material (KEVLAR fiber), and the flexible pipes 20 and 21 are excellent in terms of strength and exhibit an excellent damping effect.

Further, the pair of primary ports 6a and 6b of the four-way switching valve 2 is directly connected to the discharge port 1a and the intake port 1b of the compressor 1 without intervening a vibration absorbing mechanism such as a trap portion or a loop portion. For this reason, it is not necessary to dispose space for the vibration absorbing mechanism, and the overall air-conditioning outdoor unit can be made compact. Moreover, because a vibration absorbing mechanism is not disposed, the number of assembly man-hours is reduced by that much, and a reduction in cost and an improvement in assemblability (productivity) are realized. Moreover, as a result of a vibration absorbing mechanism not being disposed, the intake path of the compressor becomes shorter, an increase in pressure loss at the intake side can be suppressed, and the COP is improved. Specifically, the COP is

improved by 0.6% to 1.2% in an air-conditioning outdoor unit having a capability of 2.2 kW to 6.3 kW.

<Another Embodiment>

FIGS. 5 to 7 show another embodiment. Here, the accumulator 9 is omitted. The intake pipe 10 comprises a base portion 25, a branch portion 26, and branch pipes 27 and 27. The base portion 25 is connected to the primary port 6b of the four-way switching valve 2. The branch pipes 27 and 27 are connected to the intake port 1b of the compressor 1. The remaining configuration is the same as that in the preceding embodiment shown in FIGS. 2 to 4, so identical reference numerals will be given to identical members and description of those members will be omitted.

In the air-conditioning outdoor unit shown in FIGS. 5 to 7, the first flexible pipe 20 is disposed between the one secondary port 7a and the external connection port 11, and the second flexible pipe 21 is disposed between the other secondary port 7b and the outdoor heat exchanger 3. Consequently, the first flexible pipe 20 can be disposed in a position close to the external connection port 11 (= pipe fixing portion), and the second flexible pipe 21 can be disposed in a position close to the outdoor heat exchanger 3 (= pipe fixing portion) in the outdoor unit casing. For this reason, the same action and effects as those of the air-conditioning outdoor unit shown in FIGS. 2 to 4 can also be exhibited by the air-conditioning outdoor unit shown in FIGS. 5 to 7.

Specific embodiments of the invention have been described above, but the present invention is not limited to the preceding embodiments and can be variously changed and implemented within the range of the scope of the invention. For example, the concavity-convexity pitch, the axial-direction length, and the radial dimensions of the concave portions and convex portions of the bellows metal pipes 23 configuring the flexible pipes 20 and 21 can be optionally set as long as the flexible pipes 20 and 21 can absorb the vibration and noise from the compressor 1. Further, the metal pipes 23 of the flexible pipes 20 and 21 are not limited to stainless steel pipes. Various metal pipes through which the refrigerant stably flows, which can form bellows, and which can absorb vibration and noise can also be utilized as the metal pipes 23. Moreover, the outer cover members 24 covering the metal pipes 23 can also be configured by various kinds of rubber or synthetic resins, other than KEVLAR fiber (trademark).

**CLAIMS**

1. An air-conditioning outdoor unit comprising:

a compressor (1) that includes a discharge port (1a) and an intake port (1b);

an outdoor heat exchanger (3);

an external connection port (11); and

a four-way switching valve (2) that includes a pair of primary ports (6a) (6b) respectively connected to the discharge port (1a) and the intake port (1b) of the compressor (1) and a pair of secondary ports (7a) (7b),

wherein one secondary port (7a) of the pair of secondary ports (7a) (7b) is connected to the external connection port (11),

the other secondary port (7b) of the pair of secondary ports (7a) (7b) is connected to the outdoor heat exchanger (3), and

flexible pipes (20) (21) are respectively arranged between the one secondary port (7a) and the external connection port (11) and between the other secondary port (7b) and the outdoor heat exchanger (3).

2. The air-conditioning outdoor unit of claim 1, wherein the pair of primary ports (6a) (6b) of the four-way switching valve (2) is directly connected to the discharge port (1a) and the intake port (1b) of the compressor (1) without intervening a vibration absorbing mechanism such as a trap portion or a loop portion.

3. An air conditioner comprising:

the air-conditioning outdoor unit of claim 1 or 2; and

an air-conditioning indoor unit that includes an indoor heat exchanger (5) and to which the air-conditioning outdoor unit is connected.

4. A compressor unit comprising:

a compressor (1) that includes a discharge port (1a) and an intake port (1b); and

a four-way switching valve (2) that includes a pair of primary ports (6a) (6b) respectively connected to the discharge port (1a) and the intake port (1b) of the compressor (1) and a pair of secondary ports (7a) (7b),

wherein flexible pipes are respectively connected to the pair of secondary ports (7a) (7b) of the four-way switching valve (2).

5. The compressor unit of claim 4, wherein the pair of primary ports (6a) (6b) of the four-way switching valve (2) is directly connected to the discharge port (1a) and the intake port (1b) of the compressor (1) without intervening a vibration absorbing mechanism such as a trap portion or a loop portion.