

**INDOOR HEAT EXCHANGER, INDOOR MACHINE, OUTDOOR HEAT  
EXCHANGER, OUTDOOR MACHINE, AND AIR CONDITIONER**

**CROSS-REFERENCE TO RELATED APPLICATION**

[0001] This application claims the benefit of Japanese Patent Application No. 2013-151090,  
5 filed on July 19, 2013, the entire disclosure of which is incorporated by reference herein.

**FIELD**

[0002] The present invention relates to an indoor heat exchanger, an indoor machine, an  
outdoor heat exchanger, an outdoor machine, and an air conditioner.

**BACKGROUND**

10 [0003] Currently, Hydro Fluoro Carbon (HFC) refrigerant (for example, R410A) are typically  
used in the refrigerating cycle apparatuses of air conditioners. Unlike the conventional Hydro  
Chloro Fluoro Carbon (HCFC) refrigerant such as R22, R410A does not damage the ozone  
layer with zero Ozone Depletion Potential (ODP), provided, however, has high Global  
Warming Potential (GWP). Thus, as part of an effort to prevent global warming, the  
15 possibilities of shifting from HFC refrigerant with high GWP, such as R410A, to HFC  
refrigerant with low GWP have been under examination. The candidates of the HFC  
refrigerant with low GWP include R32 ( $\text{CH}_2\text{F}_2$ ; difluoromethane).

[0004] However, when above R32 is used as refrigerant of air conditioners, compared with  
the cases where R22, R410A, or R407C is used, the temperature of the refrigerant that flows  
20 in the condenser (that is, the indoor heat exchanger during heating operation, or the outdoor  
heat exchanger during cooling operation) becomes higher. Accordingly, the surface  
temperature of the refrigerant inlet piping connected to the condenser becomes high. In  
particular, when R32 is used as refrigerant of an air conditioner, the surface temperature of the  
refrigerant inlet piping becomes higher by 20°C than the surface temperature of the  
25 refrigerant inlet piping when R22, R410A, or R407C is used as refrigerant (for example, refer  
to Unexamined Japanese Patent Application Kokai Publication No. 2001-174075).

[0005] Indoor heat exchangers are attached with seal materials made of resin in order to seal

gaps other than the gaps between the fins so that air flows through only between the fins (for example, refer to Unexamined Japanese Patent Application Kokai Publications Nos. H9-26153 and H9-210388). Further, some outdoor heat exchangers are attached with a cushioning member made of foamed styrol in order to prevent damages in case of falling when transporting the products. Moreover, some outdoor heat exchangers are attached with band members made of resin in order to fix a plurality of fin units to one another (for example, refer to Unexamined Japanese Patent Application Kokai Publication No. 2012-163290).

[0006] When above R32 is used as refrigerant of air conditioners, if the refrigerant inlet piping is connected in the vicinity of the above seal materials, cushioning member, and band members, the heat of the refrigerant inlet piping is transferred to the members, subjecting the members to be heated. As the members are heated, deterioration of the sealing property of the seal materials, and degradation of the cushioning member and band members are caused.

[0007] To prevent the surface temperature of the refrigerant inlet piping from rising due to the use of R32 refrigerant, there can be considered to decrease the amount of the refrigerant circulating the refrigerating cycle to an amount smaller than the standard amount of refrigerant. Further, there can be considered to increase the flow amount from the expansion valve, that is, to increase Cv value of the expansion valve (a numerical value expressing the flow amount of water of 15.6°C flowing the valve at certain differential pressure), by widening the opening of the expansion valve. However, in either of the cases, the cooling and heating capabilities and operating efficiency of air conditioners are possibly lowered.

[0008] In addition, there is no need to decrease the amount of the refrigerant circulating the refrigerating cycle and to increase the Cv value of the expansion valve, if material with high heat resistance is used for the seal materials, cushioning member, and band members that are attached in the heat exchanger. However, since such a material with high heat resistance is often relatively high-priced, the production costs of the air conditioners are prone to be higher.

[0009] The present disclosure has been conceived to solve the above problem. The object of the present disclosure is to suppress the lowering of the cooling and heating capabilities and

operating efficiency of air conditioners while keeping the production costs low.

### SUMMARY

[0010] In order to achieve the above object, an indoor heat exchanger according to the present disclosure includes: a first fin unit that comprises a plurality of fins arranged side by side; a  
5 first seal material that is arranged at one end of the first fin unit so as to prevent air from flowing out from the one end side; and a plurality of heat transfer tubes that are arranged to penetrate through the fins of the first fin unit. The heat transfer tubes include: an inlet heat transfer tube that is connected to the inlet piping of refrigerant that circulates through a refrigerating cycle when the refrigerating cycle is a heating operation cycle, and a plurality of  
10 relay heat transfer tubes, at least one of which is arranged nearer the first seal material than the inlet heat transfer tube is, and, through which the refrigerant that is flowed out from the inlet heat transfer tube flows one after another.

[0011] According to the present disclosure, the inlet piping of the refrigerant is connected to the inlet heat transfer tube that is located farther from the first seal material than the relay heat  
15 transfer tubes are. As the relay heat transfer tubes are not directly connected to the inlet piping, the surface temperature of the relay heat transfer tubes become lower than the surface temperature of the inlet heat transfer tube. As such, the high heat of the inlet piping cannot be transferred as easily to the first seal material, suppressing lowering of the sealing property of the first seal material. Moreover, there is no need to use seal materials made of high-priced,  
20 high heat resistance material. As the result, lowering of the cooling and heating capabilities and operating efficiency of the air conditioners can be suppressed, while keeping the production costs low.

### BRIEF DESCRIPTION OF THE DRAWINGS

[0012] A more complete understanding of this application can be obtained when the  
25 following detailed description is considered in conjunction with the following drawings, in which:

FIG. 1 is a constitution diagram of the air conditioner according to an embodiment of

the present disclosure;

FIG. 2 is a section view of the indoor machine;

FIG. 3 is a perspective view schematically showing the indoor heat exchanger;

FIG. 4 is a perspective view of the indoor heat exchanger and the indoor machine chassis;

5 FIG. 5 is a section view of the indoor heat exchanger;

FIG. 6 is a perspective view of the indoor heat exchanger (part 1);

FIG. 7 is a perspective view of the indoor heat exchanger (part 2);

FIG. 8 is a section view of the outdoor machine;

FIG. 9 is a perspective view schematically showing the outdoor heat exchanger;

10 FIG. 10 is a perspective view of the outdoor heat exchanger and the outdoor machine chassis;

FIG. 11 is a front view of the outdoor heat exchanger viewed from the arrow B of FIG. 10;

FIG. 12 is a perspective view of the outdoor heat exchanger (part 1);

FIG. 13 is a side view of the outdoor heat exchanger viewed from the arrow C of FIG. 10;

FIG. 14 is a perspective view of the outdoor heat exchanger (part 2); and

15 FIG. 15 is a graph showing a relationship between the number of the heat transfer tubes through which R32 refrigerant that flowed in the condenser (the indoor heat exchanger during heating operation, or the outdoor heat exchanger during cooling operation) flows and the surface temperature of the heat transfer tubes.

#### DETAILED DESCRIPTION

20 [0013] The following will describe the air conditioner 10 according to the present embodiment with reference to FIGS. 1 to 15.

[0014] As shown in FIG. 1, the air conditioner 10 according to the embodiment of the present disclosure conditions the air of room R as the object of air conditioning by circulating the refrigerant in the refrigerating cycle 100. The air conditioner 10 is a separate type that has an  
25 indoor machine 20 and an outdoor machine 30. In addition to the indoor machine 20 and the outdoor machine 30, the air conditioner 10 has gas communication piping 11a and liquid communication piping 11b that connect the indoor machine 20 and the outdoor machine 30.

The air conditioner 10 uses refrigerant that consists only of R32 HFC refrigerant ( $\text{CH}_2\text{F}_2$ ; difluoromethane). R32 is refrigerant that has smaller Global Warming Potential (GWP) than R410A HFC refrigerant that is currently more widely used in air conditioners, and, thus, has relatively smaller influence to global warming. However, without limiting to R32 refrigerant,  
 5 R32-rich refrigerant with an R32 content of over 50% may also be used.

[0015] The indoor machine 20 is installed in the room R as the object of air conditioning, and has an indoor heat exchanger 21 and an indoor blower 22.

[0016] The indoor heat exchanger 21 cools or heats the air of the room R as the object of air conditioning by causing heat exchange between the refrigerant and the air of the room R. For  
 10 example, in the cooling operation, the indoor heat exchanger 21 functions as an evaporator and evaporates the supplied refrigerant. As such, the indoor heat exchanger 21 absorbs heat from the air around the indoor heat exchanger 21, thereby cooling the air of the room R.

Whereas, in the heating operation, the indoor heat exchanger 21 functions as a condenser and condenses the flowing-in vapor refrigerant. As such, the indoor heat exchanger 21 releases  
 15 heat to the air around the indoor heat exchanger 21, thereby heating the air of the room R.

[0017] The indoor blower 22 is installed in the vicinity of the indoor heat exchanger 21. The indoor blower 22 generates air flow that passes through the indoor heat exchanger 21. Then, the indoor blower 22 supplies the air that was heat-exchanged by the generated air flow to the room R as the object of air conditioning.

20 [0018] The outdoor machine 30 is installed outdoor, and has a compressor 31, a four-way selector 32, an outdoor heat exchanger 33, an expansion valve 34, and an outdoor blower 35.

[0019] The compressor 31 is a device that compresses the supplied refrigerant. The compressor 31 converts the supplied refrigerant to high temperature and high pressure vapor refrigerant by compressing the refrigerant. Then, the compressor 31 sends out the high  
 25 temperature and high pressure refrigerant to the four-way selector 32.

[0020] The four-way selector 32 is provided at the downstream side of the compressor 31. The four-way selector 32 switches the circulation direction of the refrigerant in the

refrigerating cycle 100. The four-way selector 32 switches the refrigerating cycle either to a heating operation cycle or a cooling operation cycle. The four-way selector 32 is controlled by the controller.

[0021] The outdoor heat exchanger 33 exchanges heat with air by evaporating or condensing the supplied refrigerant to cool or heat the air. For example, in the cooling operation, the outdoor heat exchanger 33 functions as a condenser and condenses the supplied refrigerant. Whereas, in the heating operation, the outdoor heat exchanger 33 functions as an evaporator and evaporates the supplied refrigerant.

[0022] The expansion valve 34 is a decompression device of which opening degree is changeable. The expansion valve 34 is configured by, for example, an electronically controlled expansion valve. The expansion valve 34 inflates the supplied refrigerant to decompress the high pressure refrigerant to low pressure. Then, the expansion valve 34 sends out the generated low pressure refrigerant.

[0023] The outdoor blower 35 is installed in the vicinity of the outdoor heat exchanger 33. The outdoor blower 35 generates an air flow that passes through the indoor heat exchanger 21. Then, the outdoor blower 35 exhausts the air that is heat-exchanged by the generated air flow to outdoor.

[0024] The refrigerating cycle 100 is configured by an indoor heat exchanger 21, a compressor 31, a four-way selector 32, an outdoor heat exchanger 33, an expansion valve 34, gas communication piping 11a, liquid communication piping 11b, and the like.

[0025] FIG. 2 is a section view of the indoor machine 20. As shown in FIG. 2, the indoor machine 20 further has an indoor machine chassis 23 that houses the indoor heat exchanger 21 and the indoor blower 22.

[0026] The indoor machine chassis 23 is equipped with air inlets 24, 25 for sucking the air of the room R as the object of air conditioning, and an air outlet 26 for supplying cold air or warm air to the room R. The air inlet 24 is formed on the upper surface of the indoor machine chassis 23 (+Z side surface). The air inlet 25 and the air outlet 26 are formed at the lower side

of the front panel 23a of the indoor machine chassis 23. Further, the air outlet 26 comprises a plurality of horizontal vanes 27 and a plurality of vertical flaps 28. The horizontal vanes 27 regulate the horizontal direction of air flowing out from the indoor blower 22. The vertical flap 28 regulates the vertical direction of air flowing out from the indoor blower 22.

5 [0027] Further, the indoor machine chassis 23 is equipped with condensate receivers 29A, 29B. The condensate receivers 29A, 29B are receptacles that receive droplets that are condensed by heat exchange of the indoor heat exchanger 21 in the cooling operation and the like. The condensate receiver 29A and the condensate receiver 29B are connected by a water channel, which is not shown, and the condensate water that the condensate receiver 29B  
10 received flows into the condensate receiver 29A. Then, the condensate water collected in the condensate receiver 29A is drained outside of the room R via drain piping and the like.

[0028] The indoor blower 22 has a blower fan 22a and a fan motor that rotates the blower fan 22a. In the present embodiment, the blower fan 22a of the indoor blower 22 is configured by the cross flow fan. When the blower fan 22a of the indoor blower 22 rotates, air flow A that  
15 passes through the indoor heat exchanger 21 is generated. Then, by the generated air flow A, the air from the indoor blower 22 passes through an air channel 23b formed at the lower side of the indoor blower 22 (-Z side), and is guided by the horizontal vane 27 and the vertical flap 28 to be blown out from the air outlet 26. It should be noted that, in the present embodiment, the blower fan 22a of the indoor blower 22 is configured by a cross flow fan, without  
20 limitation. The type of the blower fan 22a depends on the form of the indoor machine 20. For example, a turbo fan may be used according to the form of the indoor machine 20.

[0029] The indoor heat exchanger 21 is configured by fins and tube type heat exchangers, and arranged to cover the indoor blower 22. The indoor heat exchanger 21 has a front-side fin unit 41 comprising a plurality of fins, a back-side fin unit 42 comprising a plurality of fins, a  
25 plurality of heat transfer tubes T through which the refrigerant flows, and seal materials S1 to S3. Further, as shown in FIG. 3, the indoor heat exchanger 21 has hairpins 50 and U-shaped piping 51 that connect the heat transfer tubes T.

[0030] FIG. 4 is a perspective view of the indoor heat exchanger and the indoor machine chassis. It should be noted that the U-shaped piping 51 is omitted in FIG. 4. The front-side fin unit 41 is arranged, as shown in FIGS. 2 and 4, on the front side of the indoor blower 22 (-X side). The front-side fin unit 41 is configured by a plurality of fins that are arranged in parallel to the X-Z plane at even intervals. The fins are made of metal and formed in thin plate shapes. The gaps between the fins serve as flow channels that the air sucked by the indoor blower 22 passes through. Further, the front-side fin unit 41 has a plurality of through holes 45 that penetrate in the Y axis direction.

[0031] The back-side fin unit 42 is arranged to cover the upper side (+Z side) and the back-side (+X side) of the indoor blower 22. The back-side fin unit 42 is obliquely arranged so that the upper side end (+Z side end) of the back-side fin unit 42 comes in the close proximity to the upper side end (+Z side end) of the front-side fin unit 41. In the same way as the front-side fin unit 41, the back-side fin unit 42 is configured by a plurality of fins of thin metal plates that are arranged in parallel to the X-Z plane at even intervals. The gaps between the fins serve as flow channels through which the air sucked by the indoor blower 22 passes through. The back-side fin unit 42 has a plurality of through holes 45 that penetrate in the Y axis direction.

[0032] The heat transfer tubes T are pipes of which longitudinal direction is the Y axis direction. The heat transfer tubes T are made of metal. The heat transfer tubes T are, as shown in FIG. 2, inserted and fixed in the through holes 45 of the front-side fin unit 41 and the back-side fin unit 42. The heat transfer tubes T inserted in the through holes 45 are fixed in contact with the fins. The heat transfer tubes T are all formed in the same shapes and dimensions. The total length of the heat transfer tubes T (length in the Y axis direction) is, for example, 700 mm.

[0033] The heat transfer tubes T are arranged, as shown in FIG. 5, in two rows: a row that is upwind with respect to the air flow A; and a row that is downwind with respect thereto. The row pitch L1 that is an interval between the upwind row and the downwind row is, for

example, 12.7 mm. Further, the heat transfer tubes T are arranged at even intervals (in particular, at stage pitch L2) from the upper side (+Z side) ends of the front-side fin unit 41 and back-side fin unit 42 to the lower side (-Z side) ends thereof. The stage pitch L2 is, for example, 20.4 mm.

5 [0034] The indoor heat exchanger 21 has paths P1, P2 through which the refrigerant flows. It should be noted that the number of paths P1, P2 formed in the indoor heat exchanger 21 is arbitrary. In the present embodiment, an indoor heat exchanger 21 with two paths P1, P2 is exemplified. The heat transfer tubes T at the ends of the paths P1, P2 are referred to as the inlet heat transfer tubes T1 and outlet heat transfer tubes T3. Further, a plurality of heat  
10 transfer tubes T that connect the inlet heat transfer tubes T1 and the outlet heat transfer tubes T3 are referred to as the relay heat transfer tubes T2. When the refrigerating cycle is the heating operation cycle, the refrigerant flows in from the inlet heat transfer tubes T1, passes through the relay heat transfer tubes T2, and flows out from the outlet heat transfer tubes T3. It should be noted that when the refrigerating cycle is the cooling operation cycle, the flow of  
15 the refrigerant circulating through the refrigerating cycle becomes reverse; the refrigerant flows in from the outlet heat transfer tubes T3, passes through the relay heat transfer tube T2, and flows out from the inlet heat transfer tubes T1.

[0035] As shown in FIGS. 5 and 6, the hairpins 50 are connected to the -Y side ends of the heat transfer tubes T (the inlet heat transfer tubes T1, relay heat transfer tubes T2, and outlet  
20 heat transfer tubes T3). The hairpins 50 are made of metal. The hairpins 50 are formed in a general U shape. The hairpins 50 are coupled in a manner in which the hairpins 50 are exposed from the -Y side end plane of the front-side fin unit 41 and the back-side fin unit 42. The hairpins 50 are formed integrally to, for example, two of the heat transfer tubes T.

[0036] As shown in FIGS. 5 and 7, the U-shaped piping 51 is connected to the +Y side ends  
25 of the relay heat transfer tubes T2. The U-shaped piping 51 is made of metal. The U-shaped piping 51 is coupled to the relay heat transfer tubes T2, for example, by brazing.

[0037] The inlet piping 12 in which the refrigerant flows when the refrigerating cycle is the

heating operation cycle, is connected to the +Y side ends of the inlet heat transfer tubes T1. Also, the outlet piping 13 in which the refrigerant flows when the refrigerating cycle is the heating operation cycle, is connected to the outlet heat transfer tubes T3.

[0038] The seal material S1, as shown in FIG. 5, is a member that seals a gap between the front-side fin unit 41 and the back-side fin unit 42. The seal material S1 is attached at the upper side (+Z side) ends of the front-side fin unit 41 and the back-side fin unit 42 along the Y axis direction. As such, the air flow A is prevented from passing through the gap between the front-side fin unit 41 and the back-side fin unit 42 without passing through between the fins of the front-side fin unit 41 and the back-side fin unit 42. The material of the seal material S1 is, for example, resin or rubber. Preferably, the material of the seal material S1 is Ethylene Propylene Diene (EPDM) rubber foam with one side being an adhesive face. The heat resistant temperature of the EPDM rubber used for the seal material S1 according to the present embodiment is approximately 100°C.

[0039] A plurality of relay heat transfer tubes T2 are arranged between the seal material S1 as configured as above and the inlet heat transfer tube T1 of path P1. In the present embodiment, five relay heat transfer tubes T2 are arranged between the seal material S1 and the inlet heat transfer tube T1 (the five relay heat transfer tubes T2 are, specifically, the relay heat transfer tubes T2-1, T2-2, T2-3, T2-4, T2a shown in FIG. 5). As such, the relay heat transfer tubes T2 are arranged closer to the seal material S1 than the inlet heat transfer tube T1 is. Further, for convenience of explanation, the two relay heat transfer tubes T2 arranged nearest the seal material S1 are defined as the relay heat transfer tubes T2a. The relay heat transfer tubes T2a are respectively arranged in the vicinity of the uppermost end (+Z side end) of the front-side fin unit 41 and in the vicinity of the uppermost end (+Z side end) of the back-side fin unit 42.

[0040] The seal material S2 is a member that seals the gap between the front-side fin unit 41 and the condensate receiver 29A of the indoor machine chassis 23. The seal material S2 is attached along the Y axis direction at the lower side (-Z side) end of the front-side fin unit 41. As such, the air flow A is prevented from passing through the lower side of the front-side fin

unit 41 without passing through between the fins of the front-side fin unit 41. The material of the seal material S2 is, for example, resin or rubber. In the same way as the material of the seal material S1, the material of the seal material S2 is preferably Ethylene Propylene Diene (EPDM) rubber foam with one side being an adhesive face. The heat resistant temperature of the EPDM rubber used for the seal material S2 according to the present embodiment is approximately 100°C.

[0041] A plurality of relay heat transfer tubes T2 are arranged between the seal material S2 as configured as above and the inlet heat transfer tubes T1. In the present embodiment, three relay heat transfer tubes T2 are arranged between the seal material S2 and the inlet heat transfer tube T1 (the three relay heat transfer tubes T2 are, specifically, the relay heat transfer tubes T2-5, T2-6, T2b shown in FIG. 5). As such, the relay heat transfer tubes T2 are arranged closer to the seal material S2 than the inlet heat transfer tube T1 is. Hereinafter, for convenience of explanation, the two relay heat transfer tubes T2 arranged near the seal material S2 are defined as the relay heat transfer tubes T2b. The two relay heat transfer tubes T2b are arranged in the vicinity of the lowermost end (-Z side end) of the front-side fin unit 41.

[0042] The seal material S3 is a member that seals the gap between the back-side fin unit 42 and the condensate receiver 29B of the indoor machine chassis 23. The seal material S3 is attached along the Y axis direction at the lower side (-Z side) end of the back-side fin unit 42. As such, the air flow A is prevented from passing through the lower side of the back-side fin unit 42 without passing through between the fins of the back-side fin unit 42. The material of the seal material S3 is, for example, resin or rubber. In the same way as the material of the seal materials S1 and S2, the material of the seal material S3 is preferably Ethylene Propylene Diene (EPDM) rubber foam with one side being an adhesive face. The heat resistant temperature of the EPDM rubber used for the seal material S3 according to the present embodiment is approximately 100°C.

[0043] A relay heat transfer tube T2 is arranged closer to the seal material S3 as configured as

above than the inlet heat transfer tube T1 is. Hereinafter, for convenience of explanation, the relay heat transfer tube T2 arranged in the vicinity of the seal material S3 is defined as the relay heat transfer tube T2c. The relay heat transfer tube T2c is arranged in the vicinity of the lowermost end (-Z side end) of the back-side fin unit 42.

5 [0044] It should be noted that, the EPDM rubber foam used for the material of the seal materials S1-S3 in the present embodiment is the one used for general indoor machines 20, which is relatively low cost material.

[0045] If the above described gaps exist without having the seal materials S1-S3, in the cooling operation, the air that has been heat-exchanged through the indoor heat exchanger 21  
10 and has low temperature and low moisture and the air that passed through the gaps and has not been heat-exchanged are mixed in the air channel 23b and the like of the indoor machine 20 as shown in FIG. 2. Then, the moisture content in the air that has not been heat-exchanged is cooled below the dew point, condensed, and adheres as dews to the components inside the air channel 23b (for example, the indoor blower 22). The dews are discharged from the air  
15 outlet 26 and may possibly damage furniture and electrical appliances around the indoor machine 20. To prevent this, the seal materials S1-S3 are essential members.

[0046] FIG. 8 is a section view of the outdoor machine 30. The outdoor machine 30 has, as shown in FIG. 8, a compressor 31, an outdoor heat exchanger 33, and an outdoor blower 35, as well as an outdoor machine chassis 36 that houses the compressor 31, the outdoor heat  
20 exchanger 33, and the outdoor blower 35.

[0047] The outdoor machine chassis 36 is formed in a general rectangular parallelepiped. The outdoor machine chassis 36 has a partitioning plate 37 that partitions the interior into two spaces. The partitioning plate 37 is formed in a manner in which the partitioning plate 37 extends and protrudes from the bottom surface of the outdoor machine chassis 36 in the  
25 vertical direction (+Z direction). This partitioning plate 37 partitions the interior of the outdoor machine chassis 36 into a machine room M that houses the compressor 31 and the like and a blower room F that houses the outdoor blower 35 and the like. The machine room

M is formed on the +Y side of the inner space in the outdoor machine chassis 36, whereas the blower room F is formed on the -Y side of the inner space in the outdoor machine chassis 36. The partitioning plate 37 is equipped for preventing rainwater due to wind, rain, and the like from infiltrating the machine room M through the blower room F.

5 [0048] The outdoor blower 35 is installed in the vicinity of the outdoor heat exchanger 33, and has a blower fan 35a and a fan motor 35b that rotates the blower fan 35a. The outdoor blower 35 generates an air flow that passes through the outdoor heat exchanger 33 by rotation of the blower fan 35a. Then, the outdoor blower 35 discharges the air that was heat-exchanged by the generated air flow to outdoor. In the present embodiment, the blower fan  
10 35a is configured by a propeller fan that sucks air from the back side or lateral sides. Further, the outdoor blower 35 has one or two blower fans 35a.

[0049] In the same way as the indoor heat exchanger 21, the outdoor heat exchanger 33 is configured by a fin and tube heat exchanger. The outdoor heat exchanger 33 is arranged to cover the lateral side (-Y side) and the back side (+X side) of the outdoor blower 35. The  
15 outdoor heat exchanger 33 has a front-side fin unit 43 comprising a plurality of fins, a back-side fin unit 44 comprising a plurality of fins, a cushioning member 60, and band members 71, 72. Further, as shown in FIG. 9, the outdoor heat exchanger 33 has a plurality of heat transfer tubes T, hairpins 50, and U-shaped piping 51, through which the refrigerant flows.

[0050] FIG. 10 is a perspective view of the outdoor heat exchanger 33 and the outdoor  
20 machine chassis 36. It should be noted that the hairpins 50 and U-shaped piping 51 are omitted in FIG. 10. As shown in FIG. 10, the front-side fin unit 43 has a plurality of fins. The fins are made of metal and formed in thin plate shapes. The front-side fin unit 43 is configured by a plurality of fins that are arranged side by side at even intervals. The front-side fin unit 43 is formed in a general L shape when viewed in X-Y cross section. Further,  
25 the front-side fin unit 43 has a plurality of through holes.

[0051] The back-side fin unit 44 is arranged to abut the front-side fin unit 43. The back-side fin unit 44 has a plurality of fins. The fins are made of metal formed in thin plate shapes. The

back-side fin unit 44 is configured by arranging the fins at even intervals. The back-side fin unit 44 is formed in a general L shape when viewed in X-Y cross section. Further, the back-side fin unit 44 has a plurality of through holes.

[0052] As shown in FIG. 9, the heat transfer tubes T are pipes made of metal. As can be seen from FIG. 10, the heat transfer tubes T are inserted and fixed in the through holes of the front-side fin unit 43 and the back-side fin unit 44. The heat transfer tubes T are formed to have the same inner/outer diameters and the total length to one another. The total length of the heat transfer tubes T is, for example, 700 mm.

Further, the heat transfer tubes T are arranged, as shown in FIG. 11, in two rows: a row that is upwind with respect to the air flow A; and a row that is downwind with respect thereto. The row pitch L1 that is an interval between the upwind row and the downwind row is, for example, 12.7 mm. Further, the heat transfer tubes T are arranged at even intervals (in particular, at stage pitch L2) from the upper side (+Z side) ends of the front-side fin unit 43 and the back-side fin unit 44 to the lower side (-Z side) ends thereof along the Z axis direction. The stage pitch L2 is, for example, 20.4 mm.

[0053] The outdoor heat exchanger 33 has paths P3-P6 that are channels through which the refrigerant flows. It should be noted that the number of paths P3-P6 formed in the outdoor heat exchanger 33 is arbitrary. In the present embodiment, the outdoor heat exchanger 33 with four paths P3-P6 is exemplified. Hereinafter, the heat transfer tubes T at the end of the paths P3-P6 are defined as the inlet heat transfer tubes T1 and outlet heat transfer tubes T3. Further, a plurality of heat transfer tubes T that connect the inlet heat transfer tubes T1 and the outlet heat transfer tubes T3 are defined as the relay heat transfer tubes T2. When the refrigerating cycle is the cooling operation cycle, the refrigerant flows in from the inlet heat transfer tubes T1, passes through the relay heat transfer tubes T2, and flows out from the outlet heat transfer tubes T3. It should be noted that, when the refrigerating cycle is the heating operation cycle, the flow of the refrigerant circulating through the refrigerating cycle becomes reverse; the refrigerant flows in from the outlet heat transfer tubes T3, passes

through the relay heat transfer tubes T2, and flows out from the inlet heat transfer tubes T1.

[0054] As shown in FIGS. 11 and 12, the generally U-shaped hairpins 50 are connected to the -X side ends of the heat transfer tubes T (the inlet heat transfer tubes T1, relay heat transfer tubes T2, and outlet heat transfer tubes T3). The hairpins 50 are arranged in a manner in which the hairpins 50 are exposed from the -X side end plane of the front-side fin unit 43 and the back-side fin unit 44. The hairpins 50 are formed integrally to, for example, two of the heat transfer tubes T.

[0055] As shown in FIGS. 13 and 14, the U-shaped piping 51 is connected to the +Y side ends of the relay heat transfer tubes T2. The U-shaped piping 51 is coupled to the relay heat transfer tubes T, for example, by brazing.

[0056] The inlet piping 14 that the refrigerant flows in when the refrigerating cycle is the cooling operation cycle, is connected to the +Y side ends of the inlet heat transfer tubes T1. Also, the outlet piping 15 that the refrigerant flows in when the refrigerating cycle is the cooling operation cycle, is connected to the outlet heat transfer tubes T3.

[0057] The cushioning member 60 is arranged, as shown in FIGS. 8 and 10, between the inner wall surface of the outdoor machine chassis 36 and the outdoor heat exchanger 33. As such, the cushioning member 60 prevents the interference of the outdoor heat exchanger 33 to the outdoor machine chassis 36 while transporting the outdoor machine 30, and prevents damages in case of falling when transporting the products. In the present embodiment, the cushioning member 60 is arranged in the vicinity of the upper side of the -X side end plane of the front-side fin unit 43 of the outdoor heat exchanger 33. The material of the cushioning member 60 is, for example, foamed styrol material. The heat resistant temperature of the foamed styrol material used for the cushioning member 60 according to the present embodiment is approximately 80°C.

[0058] It should be noted that the foamed styrol material used for the cushioning member 60 in the present embodiment is the one used for general outdoor machines 30, which has relatively high commercial availability and is low cost.

[0059] As shown in FIG. 11, a plurality of relay heat transfer tubes T2 are arranged between the cushioning member 60 as configured as described above and the inlet heat transfer tube T1 of path P3. In the present embodiment, five relay heat transfer tubes T2 are arranged between the cushioning member 60 and the inlet heat transfer tube T1 (the five relay heat transfer tubes T2 are, specifically, relay heat transfer tubes T2-7, T2-8, T2-9, T2-10, T2d shown in FIG. 11). As such, the relay heat transfer tubes T2 of path P3 are arranged closer to the cushioning member 60 than the inlet heat transfer tube T1 of path P3 is. Hereinafter, for convenience of explanation, the relay heat transfer tube T2 arranged near the cushioning member 60 is referred to as the relay heat transfer tube T2d. The relay heat transfer tube T2d is arranged on the lower side (-Z side) of the cushioning member 60.

[0060] The band member 71 fixes the front-side fin unit 43 and the back-side fin unit 44 to one another as shown in FIGS. 11 and 12. The band member 71 is a string like member that ties the hairpins 50 of path P5 to one another. The material of the band member 71 is, for example, nylon, and preferably 6,6 nylon. The heat resistant temperature of 6,6 nylon used for the band members 71 according to the present embodiment is approximately 85°C.

[0061] As shown in FIG. 11, four relay heat transfer tubes T2 are arranged between the band member 71 as configured as described above and the inlet heat transfer tube T1 of path P5 (the four relay heat transfer tubes T2 are, specifically, relay heat transfer tubes T2-11, T2-12, T2f, T2e shown in FIG. 11). As such, the relay heat transfer tubes T2 of path P5 are arranged closer to the band member 71 than the inlet heat transfer tube T1 of path P5 is. Hereinafter, for convenience of explanation, the relay heat transfer tube T2 arranged near the band member 71 is defined to as the relay heat transfer tube T2e.

[0062] In the same way as the band member 71, the band member 72 is used to fix the front-side fin unit 43 and the back-side fin unit 44 to one another as shown in FIG. 13. The band member 72 is a string like member that ties the U-shaped piping 51 of path P5 to one another. The material of the band member 72 is, for example, nylon. Preferably, the material is 6,6 nylon in the same way as the band member 71. The heat resistant temperature of 6,6 nylon

used for the band member 72 according to the present embodiment is approximately 85°C.

[0063] Three relay heat transfer tubes T2 are arranged between the band member 72 as configured as described above and the inlet heat transfer tube T1 of path P5 (the three relay heat transfer tubes T2 are, specifically, relay heat transfer tubes T2-11, T2-12, T2f shown in FIG. 13). As such, the relay heat transfer tubes T2 of path P5 are arranged closer to the band member 72 than the inlet heat transfer tube T1 of path P5 is. It should be noted that, for convenience of explanation, the relay heat transfer tube T2 arranged near the band member 72 is defined as the relay heat transfer tube T2f.

[0064] It should be noted that 6,6 nylon used for the band members 71, 72 is the one used for general outdoor heat exchangers 33, which has relatively high commercial availability and is low cost.

[0065] The air conditioner 10 as configured as described above conditions the air of the room R as the object of air conditioning by performing the cooling operation and the heating operation. The following will describe the refrigerating cycle operation of the air conditioner 10 using FIG. 1. The solid arrow in FIG. 1 indicates the flow of the refrigerant in the cooling operation. Further, the dotted arrow in FIG. 1 indicates the flow of the refrigerant in the heating operation.

[0066] In the cooling operation, the four-way selector 32 can switch so that the refrigerant from the compressor 31 is sent out to the outdoor heat exchanger 33. Then, the refrigerant flows as indicated by the solid arrow in FIG. 1. In such a case, the outdoor heat exchanger 33 functions as a condenser, whereas the indoor heat exchanger 21 functions as an evaporator.

[0067] When the refrigerant flows in the compressor 31, the supplied refrigerant is first compressed by the compressor 31. Then, the pressure and specific enthalpy of the refrigerant increase to be converted to high temperature and high pressure vapor refrigerant, which is sent out from the compressor 31. The vapor refrigerant sent out from the compressor 31 passes through the four-way selector 32 and flows in the outdoor heat exchanger 33. In particular, the refrigerant flows in the paths P3-P6 of the outdoor heat exchanger 33 through a flow

divider tube, as shown in FIGS. 11 and 13.

[0068] In the present embodiment, R32 is used as refrigerant. Thus, the temperature of the refrigerant becomes higher than the cases, for example, when R22 and the like is used as refrigerant. As the result, the surface temperature of the inlet piping 14 of the outdoor heat exchanger 33 becomes higher by approximately 20°C than the temperature of the inlet piping when R22 is used as refrigerant. In particular, when R32 is used as refrigerant, the surface temperature of the inlet piping 14 becomes around 110°C.

[0069] FIG. 15 is a graph indicating a relationship between the number of the heat transfer tubes T through which the R32 refrigerant flowing in the condenser (the indoor heat exchanger 21 in the heating operation, and the outdoor heat exchanger 33 in the cooling operation) passes and the surface temperature of the heat transfer tubes T. The number of the heat transfer tubes T in the horizontal axis of FIG. 15, is a value indicating the first heat transfer tube T (inlet heat transfer tube T1) that the refrigerant flowing in the condenser passes through as "1;" the second heat transfer tube T as "2;" the third heat transfer tube T as "3;" the fourth heat transfer tube T as "4." It should be noted that the graph shown in FIG. 15 is a case where the heat transfer tubes T of total length 700 mm is used with the row pitch L1, between the heat transfer tubes T, of 12.7 mm and the stage pitch L2 of 20.4 mm. As can be seen from FIG. 15, the temperature of the first heat transfer tube T (inlet heat transfer tube T1) is around 110°C. Accordingly, the temperature of the second heat transfer tube T (relay heat transfer tube T2) and later becomes lower. In particular, the temperature of the second heat transfer tube T (relay heat transfer tube T2) decreases to around 92°C, and the temperature of the third heat transfer tube T (relay heat transfer tube T2) decreases to as low as around 75°C. Then, the heat transfer tubes T (relay heat transfer tubes T2) after fourth heat transfer tube T become stable around 70°C. It should be noted that, as the row pitch L1 and the stage pitch L2 are sufficiently smaller than the total length of the heat transfer tubes T, the same result as the graph of FIG. 15 can be obtained even in a case where there is somewhat changes in the dimensions of the row pitch L1 and the stage pitch L2.

[0070] As shown in FIG. 11, five relay heat transfer tubes T2 are arranged between the cushioning member 60 and the inlet heat transfer tube T1 of path P3. Thus, the relay heat transfer tube T2d nearest the cushioning member 60 corresponds to the sixth heat transfer tube T that the refrigerant flows through. Referring to FIG. 15, the temperature of the relay heat transfer tube T2d is around 70°C. Further, four relay heat transfer tubes T2 are arranged between the band member 71 and the inlet heat transfer tube T1 of path P5. Thus, the relay heat transfer tube T2e nearest the band member 71 corresponds to the fifth heat transfer tube T that the refrigerant flows through. Therefore, referring to FIG. 15, it can be seen that the temperature of the relay heat transfer tube T2e becomes around 70°C.

10 [0071] As shown in FIG. 13, three relay heat transfer tubes T2 are arranged between the band member 71 and the inlet heat transfer tube T1 of path P5. Thus, the relay heat transfer tube T2f near the band member 72 corresponds to the fourth heat transfer tube T that the refrigerant flows through. Referring to FIG. 15, it can be seen that the temperature of the relay heat transfer tube T2f becomes around 70°C.

15 [0072] Returning to FIG. 1, if the vapor refrigerant flows in the outdoor heat exchanger 33, the refrigerant is condensed by heat-exchanging with the outside air (outdoor air) supplied by the outdoor blower 35. Then, the specific enthalpy of the refrigerant falls while maintaining certain pressure. As such, the vapor refrigerant is converted to low temperature and high pressure liquid refrigerant. Then, the liquid refrigerant is sent out from the outdoor heat  
20 exchanger 33.

[0073] When the liquid refrigerant flows in the expansion valve 34, the liquid refrigerant is inflated by the expansion valve 34. Then, the liquid refrigerant is decompressed while maintaining certain specific enthalpy to be converted to a low pressure state. Then, this liquid refrigerant is sent out from the expansion valve 34.

25 [0074] The liquid refrigerant sent out from the expansion valve 34 passes through the liquid communication piping 11b, flows in the refrigerant flow channel of the indoor machine 20, then, flows in the indoor heat exchanger 21. In particular, the refrigerant flows in the paths

P1, P2 of the indoor heat exchanger 21 through the flow divider tube as shown in FIG. 5.

[0075] Returning to FIG. 1, when the liquid refrigerant flows in the indoor heat exchanger 21, the refrigerant is evaporated by heat-exchanging with the air, supplied by the indoor blower 22, of the room R as the object of air conditioning. Then, the specific enthalpy of the  
 5 refrigerant increases while maintaining certain pressure. As such, the refrigerant is converted to high temperature and low pressure heated vapor refrigerant. Also, the above heat exchange cools the air of the room R. As the result, the room temperature of the room R as the object of air conditioning decreases.

[0076] The heated vapor refrigerant that was sent out from the indoor heat exchanger 21  
 10 passes through the gas communication piping 11a, and flows in the refrigerant flow channel of the outdoor machine 30, then, flows in again the compressor 31 through the four-way selector 32 of the outdoor machine 30. Thereafter, the refrigerant circulates repeatedly above-described refrigerating cycle. It should be noted that, the refrigerating cycle in dehumidification operation is the same as the refrigerating cycle of the above described  
 15 cooling operation.

[0077] Next, in the heating operation, the four-way selector 32 can switch so that the refrigerant from the compressor 31 is sent out to the indoor heat exchanger 21. Then, the refrigerant flows as indicated by the dotted arrow in FIG. 1. In such a case, the outdoor heat exchanger 33 functions as an evaporator, whereas the indoor heat exchanger 21 functions as a  
 20 condenser.

[0078] The vapor refrigerant sent out from the compressor 31 passes through the four-way selector 32, and flows out from the outdoor machine 30. Then, the vapor refrigerant passes through the gas communication piping 11a, and flows in the refrigerant flow channel of the indoor machine 20. Then, the vapor refrigerant flows in the indoor heat exchanger 21 via the  
 25 inlet piping 12. In particular, the refrigerant flows in the paths P1, P2 of the indoor heat exchanger 21 through the flow divider tube as shown in FIG. 5.

[0079] As R32 is used as refrigerant in the present embodiment, as can be seen from FIG. 15,

the temperature of the inlet heat transfer tube T1 of the indoor heat exchanger 21 becomes around 110°C.

[0080] As shown in FIG. 5, the relay heat transfer tubes T2a arranged near the seal material S1 correspond to the twelfth and thirteenth heat transfer tubes T that the refrigerant flows through if the inlet heat transfer tube T1 is counted as the first heat transfer tube T. Therefore, referring to FIG. 15, it can be seen that the surface temperature of the relay heat transfer tubes T2a is around 70°C. Further, the relay heat transfer tubes T2b arranged near the seal material S2 correspond to the fourth and fifth heat transfer tubes T. Therefore, referring to FIG. 15, it can be seen that the surface temperature of the relay heat transfer tubes T2b is around 70°C.

10 Further, the relay heat transfer tube T2c arranged near the seal material S3 corresponds to the eighth heat transfer tube T. Therefore, referring to FIG. 15, it can be seen that the temperature of the relay heat transfer tube T2c is around 70°C.

[0081] Returning to FIG. 1, when the vapor refrigerant flows in the indoor heat exchanger 21, the refrigerant is condensed by heat-exchanging with the air, supplied by the indoor blower 22, of the room R as the object of air conditioning. Then, the specific enthalpy of the refrigerant falls while maintaining certain pressure. As such, the vapor refrigerant is converted to low temperature and high pressure supercooled liquid refrigerant. Also, the above heat exchange heats the air of the room R. As the result, the room temperature of the room R as the object of air conditioning rises.

20 [0082] The supercooled liquid refrigerant sent out from the indoor heat exchanger 21 passes through the liquid communication piping 11b, flows in the refrigerant flow channel of the outdoor machine 30, then, flows in the expansion valve 34 of the outdoor machine 30.

[0083] When the liquid refrigerant flows in the expansion valve 34, the liquid refrigerant is inflated by the expansion valve 34. Then, the liquid refrigerant is decompressed while maintaining certain specific enthalpy to be converted to low temperature and low pressure state, where the refrigerant becomes vapor refrigerant. Then, this vapor refrigerant is sent out from the expansion valve 34, and flows in the outdoor heat exchanger 33 of the outdoor

machine 30.

[0084] When the vapor refrigerant flows in the outdoor heat exchanger 33, the vapor refrigerant is condensed by heat-exchanging with the outside air (outdoor air) supplied by the outdoor blower 35. Then, the specific enthalpy of the refrigerant rises while maintaining  
 5 certain pressure. As such, the vapor refrigerant is converted to high temperature and low pressure heated vapor refrigerant. Then, the vapor refrigerant is sent out from the outdoor heat exchanger 33.

[0085] The heated vapor refrigerant sent out from the outdoor heat exchanger 33 flows again in the compressor 31 through the four-way selector 32. Thereafter, the refrigerant circulates  
 10 repeatedly above-described refrigerating cycle.

[0086] As described above, in the indoor heat exchanger 21 according to the present embodiment, as shown in FIG. 5, the inlet piping 12 is connected, instead of to the relay heat transfer tubes T2a, T2b, T2c arranged near the seal materials S1-S3, to the inlet heat transfer tube T1 arranged farther than the relay heat transfer tubes T2a, T2b, T2c are. As such, in the  
 15 heating operation, the high heat of the inlet piping 12 cannot be transferred as easily to the seal materials S1-S3, which suppresses lowering of the sealing property of the seal materials S1-S3.

[0087] For example, if the inlet piping 12 is connected to the relay heat transfer tubes T2a, T2b, T2c arranged near the seal materials S1-S3, the high heat of the inlet piping 12 is easily  
 20 transferred to the seal materials S1-S3 through the relay heat transfer tubes T2a, T2b, and T2c. As the result, the seal materials S1-S3 are likely to be high temperature. In particular, as R32 is used as refrigerant in the present embodiment, the temperature of the inlet piping 12 rises, and the surface temperature of the first heat transfer tube T that the refrigerant flows through reaches around 110°C (refer to FIG. 15). As such, the high heat of the first heat transfer tube  
 25 T1 that the refrigerant flows through is transferred to the seal materials S1-S3, which might possibly cause the temperature of the seal materials S1-S3 to exceed the heat resistant temperature of 100°C. As the result, the sealing property of the seal materials S1-S3 is

deteriorated, possibly causing the deterioration of reliability of the seal materials S1-S3.

[0088] However, in the present embodiment, the inlet piping 12 of the refrigerant is connected, instead of to the relay heat transfer tubes T2a, T2b, T2c arranged near the seal materials S1-S3, to the inlet heat transfer tube T1 that is arranged farther than the relay heat transfer tubes T2a, T2b, T2c are. As such, the high heat of the inlet piping 12 cannot be transferred as easily to the seal materials S1-S3, which suppresses lowering of the sealing property of the seal materials S1-S3.

[0089] Further, in the present embodiment, there is no need to reduce to the less amount of refrigerant circulating through the refrigerating cycle 100 than the standard amount of refrigerant nor to widen the opening degree of the expansion valve 34, that is, to increase Cv value of the expansion valve 34 in order to prevent rising of the surface temperature of the inlet piping 12 of the refrigerant in the heating operation. Therefore, lowering of the heating operation performance of the air conditioner 10 and the operating efficiency can be prevented.

[0090] In addition, in the present embodiment, there is no need to use high-priced heat resistant material for the seal materials S1-S3. As the result, an increase in the product costs can be suppressed. Further, even when R32 is used as refrigerant, the seal materials S1-S3 according to the present disclosure can show equivalent sealing performance to the cases in which R22, R410A, R407C, or the like is used as refrigerant.

[0091] Further, in the outdoor heat exchanger 33 according to the present embodiment, as shown in FIG. 11, the inlet piping 14 is connected, instead of to the relay heat transfer tube T2d arranged near the cushioning member 60, to the inlet heat transfer tube T1 that is arranged farther than the relay heat transfer tube T2d is. As such, in the cooling operation, the high heat of the inlet piping 14 cannot be transferred as easily to the cushioning member 60, which can suppress degradation of the shock mitigation performance of the cushioning member 60.

[0092] For example, if the inlet piping 14 is connected to the relay heat transfer tube T2d that is arranged near the cushioning member 60, the high heat of the inlet piping 14 is easily

transferred to the cushioning member 60 through the relay heat transfer tube T2d. As the result, the cushioning member 60 is prone to be heated to high temperature. Particularly, as R32 is used as refrigerant in the present embodiment, the high heat of the inlet piping 14 is transferred, causing the surface temperature of the first heat transfer tube T that the refrigerant  
5 flows through to reach around 110°C (refer to FIG. 15). As such, the high heat of the first heat transfer tube T that the refrigerant flows through is transferred to the cushioning member 60, possibly causing the temperature of the cushioning member 60 to exceed the heat resistant temperature of 80°C. As the result, the cushioning member 60 is easily degraded, lowering the shock mitigation performance.

10 [0093] However, in the present embodiment, the inlet piping 14 of the refrigerant is connected, instead of to the relay heat transfer tube T2d arranged near the cushioning member 60, to the inlet heat transfer tube T1 that is arranged farther than the relay heat transfer tube T2d is. As such, the high heat of the inlet piping 14 cannot be transferred as easily to the cushioning member 60, suppressing deterioration of the cushioning member 60.

15 [0094] Further, in the present embodiment, as shown in FIGS. 11 and 13, the inlet piping 14 is connected, instead of to the relay heat transfer tubes T2e, T2f arranged near the band members 71, 72, to the inlet heat transfer tube T1 that is arranged farther than the relay heat transfer tubes T2e, T2f are. As such, the high heat of the inlet piping 14 cannot be transferred as easily to the band members 71, 72 in the cooling operation, suppressing the degradation of  
20 the band members 71, 72.

[0095] For example, if the inlet piping 14 is connected to the relay heat transfer tubes T2e, T2f that are arranged near the band members 71, 72, the high heat of the inlet piping 14 is easily transferred to the band members 71, 72 through the relay heat transfer tubes T2e, T2f. As the result, the band members 71, 72 are prone to be heated to high temperature.

25 Particularly, as R32 is used as the refrigerant in the present embodiment, the high heat of the inlet piping 14 is transferred, causing the surface temperature of the first heat transfer tube T that the refrigerant flows through to reach around 110°C (refer to FIG. 15). As such, the high

heat of the first heat transfer tube T that the refrigerant flows through is transferred to the band members 71, 72, possibly causing the temperature of the band members 71, 72 to exceed the heat resistant temperature of 85°C. As the result, the band members 71, 72 are easily degraded.

5 [0096] However, in the present embodiment, the inlet piping 14 of the refrigerant is connected, instead of to the relay heat transfer tubes T2e, T2f arranged near the band members 71, 72, to the inlet heat transfer tube T1 that is arranged farther than the relay heat transfer tubes T2e, T2f are. As such, the high heat of the inlet piping 14 cannot be transferred as easily to the band members 71, 72, suppressing deterioration of the band members 71, 72.

10 [0097] Further, in the present embodiment, there is no need to reduce to the less amount of the refrigerant circulating through the refrigerating cycle 100 than the standard amount of the refrigerant nor to increase Cv value of the expansion valve 34 by widening the opening of the expansion valve 34 in order to prevent rising of the surface temperature of the inlet piping 14 of the refrigerant in the cooling operation. Therefore, lowering of the heating operation  
15 performance and operating efficiency of the air conditioner 10 can be prevented.

[0098] In addition, there is no need to use high priced, heat resistant material for the cushioning member 60 and the band members 71, 72. As the result, an increase in the product costs can be suppressed. Further, even when R32 is used as refrigerant, the cushioning member 60, band members 71, 72 according to the present embodiment can show equivalent  
20 performance to the cases in which R22, R410A, R407C, or the like is used as refrigerant.

[0099] So far, the embodiment of the present disclosure has been described without limiting the present disclosure to the above embodiment.

[0100] For example, in the present embodiment, as shown in FIG. 5, five relay heat transfer tubes T2 including the relay heat transfer tube T2a arranged nearest the seal material S1 are  
25 arranged between the seal material S1 and the inlet heat transfer tube T1. However, without limitation, at least one relay heat transfer tube T2 may be arranged between the seal material S1 and the inlet heat transfer tube T1. In other words, so as not to make the heat transfer tube

T nearest the seal material S1 become 100°C or more, in the heating operation, the inlet piping 12 of the refrigerant should not be connected to the heat transfer tube T nearest the seal material S1. This is because, as shown in FIG. 15, when R32 is the refrigerant, the surface temperature of the second heat transfer tube T decreases to around 92°C which is lower than  
5 100°C.

[0101] Further, in the present embodiment, as shown in FIG. 5, a plurality of relay heat transfer tubes T2, including the relay heat transfer tube T2b arranged nearest the seal material S2, are arranged between the seal material S2 and the inlet heat transfer tube T1. However, without limitation, at least one relay heat transfer tube T2 may be arranged between the seal  
10 material S2 and the inlet heat transfer tube T1. In other words, so as not to make the heat transfer tube T nearest the seal material S1 become 100°C or more, in the heating operation, the inlet piping 12 of the refrigerant should not be connected to the heat transfer tube T nearest the seal material S2. This is because, as shown in FIG. 15, when R32 is the refrigerant, the surface temperature of the second heat transfer tube T decreases to around  
15 92°C which is lower than 100°C.

[0102] Likewise, as long as the inlet piping 12 of the refrigerant in the heating operation is not connected to the heat transfer tube T nearest the seal material S3, the positions of the other heat transfer tubes T are arbitrary. That is, so as not to make the heat transfer tube T nearest the seal material S3 become 100°C or more, the inlet piping 12 should be connected to the  
20 heat transfer tube T.

[0103] Further, in the present embodiment, as shown in FIG. 11, five relay heat transfer tubes T2 including the relay heat transfer tube T2d arranged nearest the cushioning member 60 are arranged between the cushioning member 60 and the inlet heat transfer tube T1 of path P3. However, without limitation, four or less relay heat transfer tubes T2 may be arranged or six  
25 or more relay heat transfer tubes T2 may be arranged between the cushioning member 60 and the inlet heat transfer tube T1. However, taking into account that the heat resistant temperature of the cushioning member 60 is 80°C; the surface temperature of the second heat

transfer tube T is around 92°C; and the surface temperature of the third heat transfer tube T is around 75°C, as shown in FIG. 15, the relay heat transfer tube T2d shown in FIG. 11 is preferably not the first or second heat transfer tube T that the refrigerant passes through. That is, the relay heat transfer tube T2d arranged nearest the cushioning member 60 is preferably the third heat transfer tube T or later that the refrigerant passes through when the inlet heat transfer tube T1 is the first heat transfer tube T that the refrigerant passes through.

[0104] Further, in the present embodiment, as shown in FIG. 11, four relay heat transfer tubes T2 including the relay heat transfer tube T2e arranged nearest the band member 71 are arranged between the band member 71 and the inlet heat transfer tube T1 of path P5.

However, without limitation, three or less relay heat transfer tubes T2 may be arranged or five or more relay heat transfer tubes T2 may be arranged between the band member 71 and the inlet heat transfer tube T1. However, taking into account that the heat resistant temperature of the band member 71 is 85°C; the surface temperature of the second heat transfer tube T is around 92°C; and the surface temperature of the third heat transfer tube T is around 75°C, as shown in FIG. 15, the relay heat transfer tube T2e shown in FIG. 11 is preferably not the first or second heat transfer tube T that the refrigerant passes through. That is, the relay heat transfer tube T2e arranged nearest the band member 71 is preferably the third heat transfer tube T or later that the refrigerant passes through when the inlet heat transfer tube T1 is the first heat transfer tube T that the refrigerant passes through.

[0105] Further, in the present embodiment, as shown in FIG. 13, three relay heat transfer tubes T2 including the relay heat transfer tube T2f arranged nearest the band member 72 are arranged between the band member 72 and the inlet heat transfer tube T1 of path P5.

However, without limitation, two or less relay heat transfer tubes T2 may be arranged or four or more relay heat transfer tubes T2 may be arranged between the band member 72 and the inlet heat transfer tube T1. However, taking into account that the heat resistant temperature of the band member 72 is 85°C; the surface temperature of the second heat transfer tube T is around 92°C; and the surface temperature of the third heat transfer tube T is around 75°C, as

shown in FIG. 15, the relay heat transfer tube T2f shown in FIG. 13 is preferably not the first or second heat transfer tube T that the refrigerant passes through. That is, the relay heat transfer tube T2f arranged nearest the band member 72 is preferably the third heat transfer tube T or later that the refrigerant passes through when the inlet heat transfer tube T1 is the first heat transfer tube T that the refrigerant passes through.

[0106] Further, the indoor heat exchanger 21 according to the present embodiment has two fin units (front-side fin unit 41, back-side fin unit 42). However, without limitation, the indoor heat exchanger 21 may have three or more fin units. Likewise, the outdoor heat exchanger 33 according to the present embodiment has two fin units (front-side fin unit 43, back-side fin unit 44). However, without limitation, the outdoor heat exchanger 33 may have three or more fin units.

[0107] Further, the indoor heat exchanger 21 according to the present embodiment has two paths P1, P2 formed therein. However, without limitation, for example, one path or three or more paths may be formed in the indoor heat exchanger 21.

[0108] Further, the outdoor heat exchanger 33 according to the present embodiment has four paths P3-P6 formed therein. However, without limitation, for example, three or less paths, or five or more paths may be formed in the outdoor heat exchanger 33.

[0109] Further, in the present embodiment, the material of the seal materials S1-S3 is EPDM rubber foam with one side being an adhesive face, while other material may also be used without limitation. However, in view of costs and availability, EPDM rubber foam is preferable.

[0110] Further, while the material of the cushioning member 60 is foamed styrol material in the present embodiment, other material may also be used without limitation. However, in view of costs and availability, foamed styrol material is preferable.

[0111] Further, while the material of the band members 71, 72 is 6,6 nylon in the present embodiment, other material may also be used without limitation. However, in view of costs and availability, 6,6 nylon is preferable.

[0112] Further, in the present embodiment, the outdoor heat exchanger 33 has one cushioning member 60 as shown in FIGS. 10 and 11. However, without limitation, the outdoor heat exchanger 33 may have two or more cushioning members 60. Further, while, in the present embodiment, the cushioning member 60 is arranged on the -X side end plane of the front-side fin unit 43 without limitation, the position where the cushioning member 60 is arranged is arbitrary. For example, the cushioning member 60 may be arranged between the outdoor machine chassis 36 and the back-side fin unit 44, or other places.

[0113] Further, in the present embodiment, the outdoor heat exchanger 33 has two band members 71, 72 as shown in FIGS. 11 to 14. However, without limitation, the outdoor heat exchanger 33 has three or more band members 71, 72. Further, the places that the band members 71, 72 tie are also arbitrary. The band members 71, 72 may fix other places than the above-described places.

[0114] Further, in the present embodiment, refrigerant consisting only of R32 or R32-rich refrigerant with R32 content of 50% or more is used as the refrigerant used for the air conditioner 10. However, without limitation, other refrigerant (for example, R22, R410A, R407C or the like) may also be used. In such cases, it should be appreciated that the inlet piping 12 of the refrigerant in the heating operation and the inlet piping 14 of the refrigerant in the cooling operation do not become high temperature, thus, the seal materials S1-S3, the cushioning member 60, and the band members 71, 72 are not deteriorated.

[0115] Various embodiments and modifications of the present disclosure are possible without departing from the wide spirit and scope of the present disclosure. The above-described embodiment is only for explanation of the present disclosure without limiting the scope of the present disclosure.

[0116] The air conditioner according to the present disclosure is suitable for air conditioning the target of air conditioning. Further, the indoor heat exchanger, the indoor machine, the outdoor heat exchanger, and the outdoor machine according to the present disclosure are suitable to be used in air conditioners.

## [0117] legend

|    |                                                         |
|----|---------------------------------------------------------|
|    | 10 air conditioner                                      |
|    | 11a gas communication piping                            |
|    | 11b liquid communication piping                         |
| 5  | 12 inlet piping (for refrigerant in heating operation)  |
|    | 13 outlet piping (for refrigerant in heating operation) |
|    | 14 inlet piping (for refrigerant in cooling operation)  |
|    | 15 outlet piping (for refrigerant in cooling operation) |
|    | 20 indoor machine                                       |
| 10 | 21 indoor heat exchanger                                |
|    | 22 indoor blower                                        |
|    | 22a blower fan                                          |
|    | 23 indoor machine chassis                               |
|    | 23a front panel                                         |
| 15 | 23b air channel                                         |
|    | 24, 25 air inlet                                        |
|    | 26 air outlet                                           |
|    | 27 horizontal vane                                      |
|    | 28 vertical flap                                        |
| 20 | 29A, 29B condensate receiver                            |
|    | 30 outdoor machine                                      |
|    | 31 compressor                                           |
|    | 32 four-way selector                                    |
|    | 33 outdoor heat exchanger                               |
| 25 | 34 expansion valve                                      |
|    | 35 outdoor blower                                       |
|    | 35a blower fan                                          |

|    |                                                        |
|----|--------------------------------------------------------|
|    | 35b fan motor                                          |
|    | 36 outdoor machine chassis                             |
|    | 37 partitioning plate                                  |
|    | 41 front-side fin unit (first fin unit)                |
| 5  | 42 back-side fin unit (second fin unit)                |
|    | 43 front-side fin unit (third fin unit)                |
|    | 44 back-side fin unit (fourth fin unit)                |
|    | 45 through hole                                        |
|    | 50 hairpin (folded-back piping)                        |
| 10 | 51 U-shaped piping (folded-back piping)                |
|    | 60 cushioning member                                   |
|    | 71, 72 band member (fixing member)                     |
|    | 100 refrigerating cycle                                |
|    | S1-S3 seal material                                    |
| 15 | A air flow                                             |
|    | M machine room                                         |
|    | F blower room                                          |
|    | P1-P6 path                                             |
|    | R room                                                 |
| 20 | T heat transfer tube                                   |
|    | T1 inlet heat transfer tube                            |
|    | T2, T2a to T2f, T2-1 to T2-12 relay heat transfer tube |
|    | T3 outlet heat transfer tube                           |
|    | L1 row pitch                                           |
| 25 | L2 stage pitch                                         |

**CLAIMS**

What is claimed is:

1. An indoor heat exchanger includes:
  - a first fin unit that comprises a plurality of fins arranged side by side;
  - 5 a first seal material that is arranged at one end of the first fin unit so as to prevent air from flowing out from the one end side; and
  - a plurality of heat transfer tubes that are arranged to penetrate through the fins of the first fin unit, wherein
  - the heat transfer tubes include:
    - 10 an inlet heat transfer tube that is connected to inlet piping of refrigerant that circulates through a refrigerating cycle when the refrigerating cycle is a heating operation cycle, and
    - a plurality of relay heat transfer tubes, at least one of which is arranged nearer the first seal material than the inlet heat transfer tube is, and, through which the refrigerant that
    - 15 is flowed out from the inlet heat transfer tube flows one after another.
2. The indoor heat exchanger according to Claim 1, further comprising:
  - a second seal material that is arranged along the other end of the first fin unit so as to prevent air from flowing out from the other end side,
  - 20 wherein at least one of the relay heat transfer tubes is arranged nearer the second seal material than the inlet heat transfer tube is.
3. The indoor heat exchanger according to Claim 2, wherein
  - when the first fin unit is housed in an indoor machine chassis, the second seal
  - 25 material seals a gap between the other end of the first fin unit and the indoor machine chassis.

4. The indoor heat exchanger according to either Claim 2 or 3, wherein the second seal material is made of ethylene propylene diene rubber.

5. The indoor heat exchanger according to any one of Claims 1 to 4, further including:

a second fin unit that comprises a plurality of fins arranged side by side, wherein the second fin unit is arranged so that one end thereof abuts the one end of the first fin unit, and

the first seal material seals a gap between the one end of the first fin unit and the one end of the second fin unit.

6. The indoor heat exchanger according to any one of Claims 1 to 5, wherein the first seal material is made of ethylene propylene diene rubber.

7. An indoor machine including:

an indoor machine chassis;

the indoor heat exchanger according to any one of Claims 1 to 6 that is housed in the indoor machine chassis; and

the indoor blower that sends out air that is heat-exchanged by the indoor heat exchanger.

8. An outdoor heat exchanger including:

a third fin unit that comprises a plurality of fins arranged side by side;

a cushioning member that is arranged between the third fin unit and an outdoor machine chassis that houses the third fin unit; and

a plurality of heat transfer tubes that are arranged to penetrate through the fins of the third fin unit, and

further including:

an inlet heat transfer tube that is connected to inlet piping of refrigerant that circulates through a refrigerating cycle when the refrigerating cycle is a cooling operation cycle; and

5 a plurality of relay heat transfer tubes, at least one of which is arranged nearer the cushioning member than the inlet heat transfer tube is, and, through which the refrigerant that is flowed out from the inlet heat transfer tube flows one after another.

9. The outdoor heat exchanger according to Claim 8, wherein  
10 the cushioning member is made of foamed styrol material.

10. The outdoor heat exchanger according to Claim 9, wherein  
two of the relay heat transfer tubes are arranged between the inlet heat transfer tube and the cushioning member.

15 11. An outdoor heat exchanger including:

a third fin unit and a fourth fin unit that respectively comprise a plurality of fins arranged side by side;

a fixing member that fixes the third fin unit and the fourth fin unit to one another;

20 and

a plurality of heat transfer tubes that are arranged to penetrate through the fins of the third fin unit,

further including:

an inlet heat transfer tube that is connected to inlet piping of refrigerant that  
25 circulates through a refrigerating cycle when the refrigerating cycle is a cooling operation cycle; and

a plurality of relay heat transfer tubes, at least one of which is arranged nearer the fixing member than the inlet heat transfer tube is, and, through which the refrigerant that is flowed out from the inlet heat transfer tube flows one after another.

- 5           12.     The outdoor heat exchanger according to Claim 11 further including:  
a plurality pieces of folded-back piping that connect the heat transfer tubes to one another, wherein  
the fixing member is a band member that ties the folded-back piping to one another.

- 10          13.     The outdoor heat exchanger according to either Claim 11 or 12, wherein  
the fixing member is made of 6,6 nylon.

14.     The outdoor heat exchanger according to Claim 13, wherein  
two of the relay heat transfer tubes are arranged between the inlet heat transfer tube  
15   and the fixing member.

15.     An outdoor machine including:  
an outdoor machine chassis;  
the outdoor heat exchanger according to any one of Claims 8 to 14 that is housed in  
20   the outdoor machine chassis; and  
an outdoor blower that sends out air that is heat-exchanged by the outdoor heat exchanger.

16.     An air conditioner including:  
25   the indoor machine according to Claim 7;  
the outdoor machine according to Claim 15; and

communication piping that connects the indoor machine and the outdoor machine which refrigerant flows through.

17. The air conditioner according to Claim 16, wherein
- 5 the refrigerant contains 50% or more of R32 difluoromethane ( $\text{CH}_2\text{F}_2$ ).