

DESCRIPTION

TITLE OF INVENTION

Fin-and-Tube Type Heat Exchanger and Air Conditioner

5 TECHNICAL FIELD

The present invention relates to a fin-and-tube type heat exchanger and air conditioner and, more particularly, relates to a fin-and-tube type heat exchanger for heat exchange between a refrigerant and a fluid to be heated, and an air conditioner including such a fin-and-tube type heat exchanger.

10 BACKGROUND ART

For conventional hot-water supply machines, for example, Japanese Patent Laying-Open No. 2003-65602 discloses a heat pump bath hot-water supply machine intended to reduce its size and compact its shape (PTD 1).

15 The heat pump bath hot-water supply machine disclosed in PTD 1 is a hot-water supply machine for heating water in a hot-water storage tank and in a bath tub using a refrigeration cycle, which includes a refrigerant/water heat exchanger capable of heat exchange between a refrigeration circuit and a hot-water supply circuit and between the refrigeration circuit and a bath-tub circuit. As the refrigerant/water heat exchanger, it employs a multi-tube system which includes a tube in the hot-water supply circuit and a
20 tube in the bath-tub circuit which are inserted into a tube in the refrigeration circuit for flowing a refrigerant therethrough, or a contact-tube system which includes a tube in the refrigerant circuit, a tube in the hot-water supply circuit and a tube in the bath-tub circuit which are brought into contact with each other and are secured to each other through a brazing material.

25 Further, Japanese Utility Model Laying-Open No. 59-79778 discloses a heat-pump type hot-water supply cooling/heating apparatus intended to reduce pressure losses during flowing a refrigerant therethrough, to reduce the number of solenoid valves and, also, to enable cooling/heating hot-water supply running with only inexpensive unidirectional solenoid valves (PTD 2). The heat pump type hot-water

supply cooling/heating apparatus disclosed in PTD 2 includes an outdoor-side heat exchanger and a hot-water supply heat exchanger. During cooling-only running and during heating-only running, the refrigerant is supplied to the outdoor-side heat exchanger. During hot-water-supply/cooling concurrent running and during hot-water-supply-only running, the refrigerant is supplied to the hot-water supply heat exchanger.

Further, Japanese Patent Laying-Open No. 58-66764 discloses a heat pump type cooling/heating hot-water supply machine intended to provide a multi-function air conditioner by adding a hot-water supply function to a conventional cooling/heating type room air conditioner (PTD 3). The heat pump type cooling/heating hot-water supply machine disclosed in PTD 3 includes an outdoor heat exchanger and a water heat exchanger. During cooling running and during heating running, the outdoor heat exchanger is supplied with a refrigerant. During cooling heat dissipation running and during hot-water-supply-dedicated running, which are for hot water supply using condensation heat generated by cooling, the water heat exchanger is supplied with the refrigerant.

CITATION LIST

PATENT DOCUMENT

- PTD 1: Japanese Patent Laying-Open No. 2003-65602
 PTD 2: Japanese Utility Model Laying-Open No. 59-79778
 PTD 3: Japanese Patent Laying-Open No. 58-66764

SUMMARY OF INVENTION

TECHNICAL PROBLEM

As disclosed in the aforementioned PTD 1, as hot-water supply heat exchangers, there have been used multi-tube systems including additional tubes inserted into tubes or tube contact systems including tubes bonded to each other. However, these systems have the advantage of higher efficiency of heat exchange, but have the problem of complicity and higher costs of production systems.

Therefore, it is an object of the present invention to overcome the

aforementioned problem and to provide a fin-and-tube type heat exchanger and an air conditioner which can be fabricated with lower costs.

SOLUTION TO PROBLEM

5 A fin-and-tube type heat exchanger according to the present invention is adapted to perform heat exchange between a refrigerant and a fluid to be heated for heating the fluid to be heated. The fin-and-tube type heat exchanger includes: a plurality of fins which have a flat-plate shape and are arranged with an interval interposed therebetween; and a multi-row tube which extends while penetrating through the plurality of the fins, and is routed within a plurality of imaginary planes
10 being orthogonal to the fins and arranged in parallel with each other. The multi-row tube includes a fluid tube through which the fluid to be heated flows, and a refrigerant tube through which the refrigerant flows. Each of the fins is formed from an integrated plate member in a direction of arrangement of the imaginary planes.

15 With the heat-and-tube type heat exchanger having this structure, since each of the fins is formed from the integrated plate member in the direction of the arrangement of the imaginary planes, it is possible to perform efficient heat exchange between the fluid to be heated and the refrigerant. This enables fabricating the heat exchanger for heating the fluid to be heated with lower costs, by utilizing a production facility for conventional fin-and-tube type heat exchangers.

20 Further, preferably, the plurality of imaginary planes are constituted with a first plane, and a second plane arranged with an interval interposed between the second plane and the first plane. The fluid tube and the refrigerant tube are routed within the first plane and the second plane, respectively.

25 With the heat-and-tube type heat exchanger having this structure, the multi-row tube is made to have a simple structure, which enables fabrication of the heat exchanger with further-lowered costs.

An air conditioner according to the present invention has a function of heating a fluid to be heated. The air conditioner includes one of the aforementioned fin-and-tube type heat exchangers; a refrigeration circuit which forms a heat pump cycle; and a

fluid circuit through which the fluid to be heated flows. The refrigerant is supplied from the refrigeration circuit to the refrigerant tube, and the fluid to be heated is supplied from the fluid circuit to the fluid tube.

5 With the air conditioner having this structure, since it includes the fin-and-tube type heat exchanger fabricated with lower costs, it is possible to enable wide spread use of air conditioners having functions for heating fluids to be heated.

Further, preferably, the air conditioner includes an outdoor-side heat exchanger which is provided on a pathway in the refrigeration circuit and is installed outside a room together with the fin-and-tube type heat exchanger, a fan for supplying outdoor
10 air to the outdoor-side heat exchanger, a detection portion adapted to detect a flow of the fluid to be heated in the fluid circuit, and a control portion which is adapted to stop the fan when the detection portion detects a flow of the fluid to be heated, and is adapted to drive the fan when the detection portion detects no flow of the fluid to be heated.

15 With the air conditioner having this structure, when the detection portion detects a flow of the fluid to be heated, the fan for supplying outdoor air to the outdoor-side heat exchanger is stopped, in order to cause the fin-and-tube type exchanger to perform heat exchange between the fluid to be heated and the refrigerant. On the other hand, when the detection portion detects no flow of the fluid to be heated, the fan
20 for supplying outdoor air to the outdoor-side heat exchanger is driven, in order to cause the outdoor-side heat exchanger to perform heat exchange between outdoor air and the refrigerant.

Further, preferably, the air conditioner further includes a compressor which is provided on the pathway in the refrigeration circuit and is adapted to circulate the
25 refrigerant therethrough, and an indoor unit installed inside the room. The indoor unit includes an indoor-side heat exchanger provided on the pathway in the refrigeration circuit. The control portion is mounted inside the indoor unit. The compressor is placed outside the room. The control portion controls the fan and the compressor.

With the air conditioner having this structure, the control portion mounted in the

indoor unit is adapted to control the compressor outside the room and the fan outside the room. This eliminates the necessity of providing the control portion in the outdoor side, which can simplify the structure of the air conditioner.

Further, preferably, the detection portion is placed in the portion provided outside the room, out of the fluid circuit. This eliminates the necessity of providing the control portion in the outdoor side, which can simplify the structure of the air conditioner.

Further, preferably, the control portion includes first to fifth terminals, first and second switches, and a signal generating circuit adapted to control the first and second switches in response to signals from the detection portion. The first terminal is a terminal for supplying electric power from a power supply to the fan. The second terminal is a terminal for inputting signals from the detection portion to the signal generating circuit. The third terminal is a terminal for supplying electric power from the power supply to the compressor. The fourth terminal is a neutral terminal for the power supply. The fifth terminal is a grounding terminal for the power supply. The first switch is connected between the power supply and the first terminal. The second switch is connected between the power supply and the third terminal. The air conditioner further includes a terminal plate including first and second power-supply terminals, a signal terminal, a neutral terminal and a grounding terminal, and first to fifth wirings for connecting the first to fifth terminals on the control substrate to the first power-supply terminal, the signal terminal, the second power-supply terminal, the neutral terminal and the grounding terminal on the terminal plate, respectively. The first power-supply terminal on the terminal plate is connected to the fan. The second power-supply terminal on the terminal plate is connected to the compressor. The signal terminal on the terminal plate is connected to the detection portion and is adapted to receive signals from the detection portion.

With the air conditioner having this structure, the control substrate in the indoor unit can be electrically connected to the terminal plate outside the room, through the five wirings. Further, the fan and the compressor outside the room can be controlled

by the control portion provided in the indoor unit. This eliminates the necessity of a control substrate in the outdoor unit.

Further, preferably, the fin-and-tube type heat exchanger and the outdoor-side heat exchanger are provided integrally. With the air conditioner having this structure,
5 it is possible to compactly structure the outdoor unit in the air conditioner.

Further, preferably, the fin-and-tube type heat exchanger and the outdoor-side heat exchanger are provided integrally. The air conditioner further includes a compressor which is provided on the pathway in the refrigeration circuit and is adapted to compress the refrigerant to be supplied to the outdoor-side heat exchanger, and a
10 pressure switch which is provided on the pathway in the refrigeration circuit and is adapted to detect a pressure of the refrigerant. The control portion is adapted to drive the fan, when the detection portion detects a flow of the fluid to be heated and the pressure switch detects that the pressure of the refrigerant is greater than or equal to a predetermined value.

15 With the air conditioner having this structure, when the pressure of the refrigerant in the refrigeration circuit is greater than or equal to the predetermined value, the fan is driven to cause the outdoor-side heat exchanger to cool the refrigerant more actively. This can inhibit excessive loads from being exerted on the compressor in the refrigeration circuit, thereby improving the reliability of the compressor.

20 ADVANTAGEOUS EFFECTS OF INVENTION

As described above, according to the present invention, it is possible to provide a fin-and-tube type heat exchanger and an air conditioner which are fabricated with lower costs.

BRIEF DESCRIPTION OF DRAWINGS

25 Fig. 1 is a view illustrating the circuit structure of an air conditioner provided with a hot-water supply function according to a first embodiment of the present invention.

Fig. 2 is a perspective view illustrating an outdoor unit in the air conditioner in Fig. 1.

Fig. 3 is a perspective view partially illustrating a water heat exchanger included in the air conditioner in Fig. 1.

Fig. 4 is a front view illustrating the water heat exchanger in Fig. 3.

Fig. 5 is a perspective view illustrating a modification example of the water heat exchanger illustrated in Fig. 3.

Fig. 6 is a block diagram illustrating the structure of the air conditioner in Fig. 1.

Fig. 7 is a circuit diagram illustrating the structure relating to the control of the air conditioner in Fig. 1.

Fig. 8 is a view illustrating the circuit structure of an air conditioner provided with a hot-water supply function, according to a third embodiment of the present invention.

Fig. 9 is a view illustrating the circuit structure of an air conditioner provided with a hot-water supply function, according to a fourth embodiment of the present invention.

Fig. 10 is a circuit diagram illustrating the structure relating to control of the air conditioner in Fig. 9.

DESCRIPTION OF EMBODIMENTS

Embodiments of the present invention will be described, with reference to the drawings. Further, throughout the drawings which will be referred hereinafter, like reference numerals designate like or corresponding members.

(First Embodiment)

Fig. 1 is a view illustrating the circuit structure of an air conditioner provided with a hot-water supply function according to a first embodiment of the invention.

Fig. 2 is a perspective view illustrating an outdoor unit in the air conditioner in Fig. 1.

Referring to Figs. 1 and 2, an air conditioner 10 according to the present embodiment has a hot-water supply function. Air conditioner 10 is an air conditioner dedicated for cooling.

Air conditioner 10 includes, as circuit structures, a refrigeration circuit 21 which forms a heat pump cycle and through which a refrigerant circulates, and a hot-water

supply circuit 31 through which water (city water, in the present embodiment) as a fluid to be heated, flows. The water which flows through hot-water supply circuit 31 is heated through heat exchange with the refrigerant circulating through refrigeration circuit 21.

5 Through refrigeration circuit 21, the refrigerant for cooling an indoor space is circulated. As the refrigerant, for example, HC (hydrocarbon) or HFC (hydrofluorocarbon) is employed. Refrigeration circuit 21 is constituted with a refrigerant circulation path 21p forming an annular-shaped circulation path, and a refrigerant branch path 21q which is branched from refrigerant circulation path 21p.

10 Refrigeration circuit 21 is provided with an indoor-side heat exchanger (air-refrigerant heat exchanger) 25, an outdoor-side heat exchanger (air-refrigerant heat exchanger) 23, a compressor 22 and an expansion valve 24. Indoor-side heat exchanger 25, outdoor-side heat exchanger 23, compressor 22 and expansion valve 24 are provided on the pathway in refrigerant circulation path 21p. In Fig. 1, the
15 direction of the flow of the refrigerant during hot-water supply is representatively indicated by arrows.

Indoor-side heat exchanger 25 performs heat exchange between the refrigerant circulating through refrigeration circuit 21, and air in the indoor space. Indoor-side heat exchanger 25 is provided in an indoor unit 14 installed inside a room. Indoor unit
20 14 is further provided with a fan 27 for supplying indoor air to indoor-side heat exchanger 25. For example, fan 27 is constituted with a cross-flow fan.

Outdoor-side heat exchanger 23 performs heat exchange between outdoor air and the refrigerant circulating through refrigeration circuit 21. Outdoor-side heat exchanger 23 is provided in an outdoor unit 12 installed outside the room. Outdoor
25 unit 12 is further provided with a fan 26 for supplying outdoor air to outdoor-side heat exchanger 23. Fan 26 is placed oppositely to outdoor-side heat exchanger 23. For example, fan 26 is constituted with a propeller fan.

On the pathway in refrigerant circulation path 21p, compressor 22 is placed between indoor-side heat exchanger 25 and outdoor-side heat exchanger 23.

Compressor 22 compresses the refrigerant supplied from indoor-side heat exchanger 25. On the pathway in refrigerant circulation path 21p, expansion valve 24 is placed between outdoor-side heat exchanger 23 and indoor-side heat exchanger 25. Expansion valve 24 is placed in the opposite side from compressor 22 with indoor-side heat exchanger 25 and outdoor-side heat exchanger 23 being interposed therebetween. Expansion valve 24 decompresses the refrigerant supplied from outdoor-side heat exchanger 23. Compressor 22 and expansion valve 24 are provided in outdoor unit 12, together with outdoor-side heat exchanger 23.

Refrigerant branch path 21q is provided in such a way as to branch from the pathway in refrigerant circulation path 21p between compressor 22 and outdoor-side heat exchanger 23, and, further, in such a way as to merge with the pathway in refrigerant circulation path 21p between outdoor-side heat exchanger 23 and expansion valve 24.

Refrigeration circuit 21 is further provided with a water heat exchanger (water-refrigerant heat exchanger) 51, a flow-path changeover valve 28, and a flow-path changeover valve 29. Water heat exchanger 51 is provided on the pathway in refrigerant branch path 21q. Flow-path changeover valve 28 is provided between compressor 22 and outdoor-side heat exchanger 23, on the pathway in refrigerant circulation path 21p. Flow-path changeover valve 29 is provided between compressor 22 and water heat exchanger 51, on the pathway in refrigerant branch path 21q.

Water heat exchanger 51 performs heat exchange between the refrigerant flowing through refrigeration circuit 21 and the water flowing through hot-water supply circuit 31. Flow-path changeover valve 28 is an on-off valve capable of opening and closing the refrigerant flow path between compressor 22 and outdoor-side heat exchanger 23. Flow-path changeover valve 29 is a valve member capable of opening and closing the refrigerant flow path between compressor 22 and water heat exchanger 51.

Water heat exchanger 51, flow-path changeover valve 28, and flow-path changeover valve 29 are provided in outdoor unit 12.

Also, instead of flow-path changeover valve 28, and flow-path changeover valve 29, it is possible to provide a three-way valve adapted to selectively flow the refrigerant discharged from compressor 22 to outdoor-side heat exchanger 23 or water heat exchanger 51, at the position at which flow-path changeover valve 28 is provided.

5 On the pathway in hot-water supply circuit 31, there are provided aforementioned water heat exchanger 51, and a flow switch 33 as a detection portion. Flow switch 33 detects water flows in hot-water supply circuit 31. Hot-water supply circuit 31 is provided with a water communication port 35 for communicating hot-water supply circuit 31 with a water supply source, at its one end (the upstream end of
10 water flows in hot-water supply circuit 31). Hot-water supply circuit 31 is communicated with a hot-water supply terminal 34 such as a shower, at its other end (the downstream end of water flows in hot-water supply circuit 31).

Further, flow switch 33 is not particularly limited, provided that it is capable of detecting water flows. For example, a member called a flow rate sensor or a flow
15 meter is employed.

There will be described the flow of the refrigerant during cooling running of air conditioner 10. At first, the refrigerant is subjected to adiabatic compression in compressor 22. As the refrigerant is compressed, the refrigerant is raised in pressure and temperature and, thus, is changed to a superheated vapor at a higher temperature
20 and a higher pressure and, then, the refrigerant is discharged from compressor 22. Flow-path changeover valve 28 is in an opened state, so that the refrigerant flowed from compressor 22 flows into outdoor-side heat exchanger 23. In outdoor-side heat exchanger 23, the refrigerant dissipates heat to the outdoor air supplied thereto along with the driving of fan 26 and, thus, is cooled to be condensed (liquefied). The
25 refrigerant flowed from outdoor-side heat exchanger 23 is directed to expansion valve 24.

In expansion valve 24, the refrigerant in the super-cooled liquid state is expanded through throttling and, thus, is decreased in temperature and pressure to form a moist vapor at a lower temperature and a lower pressure in a vapor/liquid mixed state.

The refrigerant flowed from expansion valve 24 is directed to indoor-side heat exchanger 25. The refrigerant in the vapor/liquid mixed state which is supplied from expansion valve 24 is caused to absorb heat from the air in the indoor space to be vaporized, in indoor-side heat exchanger 25. Thereafter, the refrigerant in the vapor phase is subjected to adiabatic compression in compressor 22, again.

The refrigerant continuously and repeatedly undergoes state changes, which are compression, condensation, expansion through throttling, and vaporization, along with the aforementioned cycle.

Further, air conditioner 10 provided with the hot-water supply function according to the present embodiment is enabled to perform hot-water supply running, along with cooling running. When air conditioner 10 performs hot-water supply running, if flow switch 33 detects a water flow in hot-water supply circuit 31, flow-path changeover valve 29 is brought into an opened state. Thus, the refrigerant flowed from compressor 22 flows into water heat exchanger 51 through refrigerant branch path 21q. At this time, the refrigerant dissipates heat to the water flowing through hot-water supply circuit 31 and, thus, is cooled to be condensed (liquefied), in water heat exchanger 51. The refrigerant flowed from water heat exchanger 51 merges into the refrigerant circulation path 21p from refrigerant branch path 21q and, thereafter, is directed to expansion valve 24. The water having been heated by water heat exchanger 51, which forms hot water, is supplied to hot-water supply terminal 34.

Subsequently, there will be described the structure of water heat exchanger 51 according to the first embodiment of the present invention, which is included in air conditioner 10 in Fig. 1.

Fig. 3 is a perspective view partially illustrating the water heat exchanger included in the air conditioner in Fig. 1. Fig. 4 is a front view illustrating the water heat exchanger in Fig. 3.

Referring to Figs. 3 and 4, water heat exchanger 51 according to the present embodiment is a fin-and-tube type heat exchanger, which includes a plurality of fins 52 and a multi-row tube 53.

Fins 52 have a flat-plate shape. Fins 52 have a thin-plate shape. Fins 52 are formed from plate members having excellent thermal conductivity, such as aluminum plates, for example. The plurality of fins 52 are arranged in such a way as to be aligned in a single direction, which is designated by an arrow 101 in Fig. 3. The plurality of fins 52 are placed with intervals interposed between respective fins 52. The plurality of fins 52 are placed at even intervals.

Fins 52 have a flat-plate shape having a rectangular shape. When viewed in the direction of the arrangement designated by arrow 101, fins 52 have a rectangular shape having a longer side in a direction designated by an arrow 103 which is orthogonal to the direction designated by arrow 101 and, further, having a shorter side in a direction designated by an arrow 102 (the depthwise direction of water heat exchanger 51), which is orthogonal to the direction designated by arrow 101 and the direction designated by arrow 103.

Multi-row tube 53 is formed from a tube member having excellent thermal conductivity. Multi-row tube 53 extends while penetrating through the plurality of fins 52. Assuming an imaginary plane 210 and an imaginary plane 220 which are orthogonal to fins 52 and are arranged in parallel to each other, multi-row tube 53 is routed in such a way as to extend within imaginary plane 210 and imaginary plane 220. Imaginary plane 210 and imaginary plane 220 are placed with an interval interposed therebetween, in the depthwise direction of water heat exchanger 51, which is designated by arrow 102. In the present embodiment, multi-row tube 53 is provided in such a way as to form two rows in the depthwise direction of water heat exchanger 51.

Multi-row tube 53 is constituted with a refrigerant tube 53m which is supplied with the refrigerant flowing through refrigeration circuit 21, and a water tube 53n which supplied with the water flowing through hot-water supply circuit 31. Refrigerant tube 53m is connected at its opposite ends to the tube which forms refrigerant branch path 21q in refrigeration circuit 21, and water tube 53n is connected at its opposite ends to the tube which forms hot-water supply circuit 31. Refrigerant

tube 53m and water tube 53n are provided as respective tubes independent of each other.

Refrigerant tube 53m is routed within imaginary plane 210, while water tube 53n is routed within imaginary plane 220. As illustrated in Fig. 4, refrigerant tube 53m is routed within imaginary plane 210, in such a way as to repeat sections 56 extending in a single direction while penetrating through the plurality of fins 52, sections 57 reversed in a U shape, and sections 58 extending in the opposite direction while penetrating through the plurality of fins 52. Water tube 53n is routed in the same manner as that of refrigerant tube 53m, within imaginary plane 220.

In water heat exchanger 51 according to the present embodiment, each of fins 52 is formed from an integrated plate member, in the direction of the arrangement of imaginary plane 210 and imaginary plane 220. In other words, fins 52 are provided with no slit for separating refrigerant tube 53m in the first row and water tube 53n in the second row from each other in the depthwise direction in water heat exchanger 51, and the plurality of fins 52, each of which is constituted with a single integrated member, are arranged in the direction designated by arrow 101.

Fig. 5 is a perspective view illustrating a modification example of the water heat exchanger illustrated in Fig. 3. Referring to Fig. 5, in the present modification example, refrigerant tube 53m is routed within imaginary plane 210 and imaginary plane 220, and water tube 53n is routed within imaginary plane 210 and imaginary plane 220. Refrigerant tube 53m and water tube 53n are placed in such a way as to be alternately arranged, in each of imaginary plane 210 and imaginary plane 220.

Further, the structure of multi-row tube 53 in water heat exchanger 51 described above is merely an example, and the number of arranged rows in multi-row tube 53 in the depthwise direction of water heat exchanger 51, the routing of the tubes in the respective imaginary planes, and the like are changed as appropriate.

In the present embodiment, in the multi-row type heat exchanger having the tubes provided in the plural rows in the depthwise direction of water heat exchanger 51, fins 52 are provided in the state of being coupled to each other between the plural rows.

This structure enables efficient heat exchange between the refrigerant flowing through refrigerant tube 53m and the water flowing through water tube 53n.

There will be comprehensively described the structure of water heat exchanger 51 according to the first embodiment of the present invention, which has been
5 described above. Water heat exchanger 51 as a fin-and-tube type heat exchanger according to the present embodiment is adapted to perform heat exchange between the refrigerant and water as a fluid to be heated, thereby heating the water. Water heat exchanger 51 includes the plurality of fins 52 which have a flat-plate shape and are arranged with intervals interposed between the respective fins, and multi-row tube 53
10 which extends while penetrating through the plurality of fins 52, and is routed within the plurality of imaginary planes 210 and 220 being orthogonal to fins 52 and arranged in parallel with each other. Multi-row tube 53 includes water tube 53n as a fluid tube through which water flows, and refrigerant tube 53m as a refrigerant tube through which the refrigerant flows. Each of fins 52 is formed from an integrated plate
15 member in the direction of the arrangement of imaginary plane 210 and imaginary plane 220.

Further, air conditioner 10 according to the present embodiment includes water heat exchanger 51 as a fin-and-tube type heat exchanger, refrigeration circuit 21 which forms a heat pump cycle, and hot-water supply circuit 31 as a fluid circuit through
20 which water as a fluid to be heated flows. The refrigerant is supplied from refrigeration circuit 21 to refrigerant tube 53m as a refrigerant tube, while the water is supplied from hot-water supply circuit 31 to water tube 53n as a fluid tube.

With water heat exchanger 51 and air conditioner 10 which have the aforementioned structures, according to the first embodiment of the present invention,
25 it is possible to divert a production facility for fin-and-tube type heat exchangers, which have been conventionally incorporated in air conditioners, to the fabrication of water heat exchanger 51. This facilitates the production of water heat exchanger 51, which can reduce the fabrication cost. This results in wide spread use of air conditioner 10 having the hot-water supply function.

Further, in assuming a hot-water supply system having a water heat exchanger housed within a hot-water storage tank, there is a need for works for coupling or welding a refrigerant tube extending from a compressor to the water heat exchanger within the hot-water storage tank, at the site where the hot-water storage tank should be installed. On the other hand, in the present embodiment, water heat exchanger 51 is incorporated in outdoor unit 12, which enables enclosing the refrigerant therein during the processing for producing air conditioner 10. In this case, it is possible to implement checkups of hot-water boiling operations, as well as checkup of cooling running operations, as inspections at the shipment of air conditioner 10, which can improve the reliability of air conditioner 10 having the hot-water supply function, as a product. Further, it is possible to eliminate the necessity of works for enclosing the refrigerant during the installation of air conditioner 10, which can lower the installation cost.

(Second Embodiment)

In the present embodiment, there will be described an example of fan control during supply of hot water, which can be applied to air conditioner 10 according to the first embodiment. Fig. 6 is a block diagram illustrating the structure of the air conditioner in Fig. 1.

Referring to Fig. 6, air conditioner 10 includes a control portion 61 for controlling the driving of various types of devices mounted in air conditioner 10.

When flow switch 33 has detected no water flow in hot-water supply circuit 31, control portion 61 brings flow-path changeover valve 28 into an opened state and, further, brings flow-path changeover valve 29 into a closed state and, further, drives fan 26. Thus, the refrigerant ejected from compressor 22 is directed to outdoor-side heat exchanger 23, and outdoor-side heat exchanger 23 is caused to perform heat exchange between the refrigerant and outdoor air supplied thereto through the driving of fan 26.

On the other hand, if flow switch 33 detects a water flow in hot-water supply circuit 31, control portion 61 brings flow-path changeover valve 28 into a closed state and, further, brings flow-path changeover valve 29 into an opened state and, also, stops

the driving of fan 26. Thus, the refrigerant ejected from compressor 22 is directed to water heat exchanger 51, and water heat exchanger 51 is caused to perform heat exchange between the refrigerant and the water flowing through hot-water supply circuit 31.

5 Fig. 7 is a circuit diagram illustrating the structure relating to the control of the air conditioner in Fig. 1. Referring to Fig. 7, control portion 61 is mounted inside indoor unit 14 and is adapted to control compressor 22 and fan 26 in outdoor unit 12. On the other hand, flow switch 33 (the detection portion) for detecting water flows is placed in outdoor unit 12. Namely, flow switch 33 (the detection portion) is placed in
10 the portion provided outside the room, out of hot-water supply circuit 31 (the fluid circuit).

Control portion 61 can be realized as a control substrate, for example. Control portion 61 includes switches 62a and 62b, a signal generating circuit 63, and a terminal portion 64 which is provided with terminals T1 to T5. Terminal portion 64 can be
15 realized by a connector, for example.

Terminal T1 as a first terminal is a terminal for supplying electric power from a power supply 65 to fan 26 (in Fig. 7, the motor for fan 26 is illustrated) in outdoor unit 12. Terminal T2 as a second terminal is a terminal for receiving signals from flow switch 33. The signals inputted to terminal T2 are transmitted to signal generating
20 circuit 63. Terminal T3 as a third terminal is a terminal for supplying electric power from power supply 65 to compressor 22 in outdoor unit 12. Terminal T4 as a fourth terminal is a neutral terminal for power supply 65. Terminal T5 as a fifth terminal is a grounding terminal for power supply 65.

Switch 62a as a first switch is connected between power supply 65 and terminal
25 T1 and is turned on and off according to signals from signal generating circuit 63. Switch 62b as a second switch is connected between power supply 65 and terminal T3 and is turned on and off according to signals from signal generating circuit 63.

Outdoor unit 12 includes a terminal plate 67 including terminals T11 to T15. Terminals T11 and T13 are power-supply terminals. Terminal T12 is a signal

terminal. Terminal T14 is a neutral terminal. Terminal T15 is a grounding terminal.

Terminal T11 is electrically connected to fan 26 (the fan motor) and also is electrically connected to terminal T1 in control portion 61 through a wiring L1 as a first wiring. Terminal T12 is electrically connected to flow switch 33 and also is
 5 electrically connected to terminal T2 in control portion 61 through a wiring L2 as a second wiring. Terminal T13 is electrically connected to compressor 22 and also is electrically connected to terminal T3 in control portion 61 through a wiring L3 as a third wiring. Terminal T14 is electrically connected to terminal T12 with flow switch 33 interposed therebetween and also is electrically connected to terminal T4 in control
 10 portion 61 through a wiring L4 as a fourth wiring. Terminal T15 is electrically connected to terminal T5 in control portion 61 through a wiring L5 as a fifth wiring. The aforementioned order of the arrangement of the terminals is merely an example, and the order of the arrangement of the terminals is not limited to this example.

Fan 26 is provided with an over-temperature protection circuit 67a. Further,
 15 an overload protection circuit 67b is provided between terminal T13 and compressor 22.

In cases of air conditioning for the inside of the room or in cases of hot-water supply, signal generating circuit 63 generates a signal for turning on switch 62b and transmits this signal to switch 62b. Since switch 62b is turned on, compressor 22 is supplied with electric power from power supply 65, so that compressor 22 is operated.

20 If water flows through hot-water supply circuit 31 (see Fig. 1), flow switch 33 is turned on. On the other hand, if no water flows through hot-water supply circuit 31 (see Fig. 1), flow switch 33 is turned off. The electric potential at terminal T12 is changed according to On/Off of flow switch 33. The change of this electric potential, which forms a signal indicative of the result of the detection by flow switch 33, is
 25 inputted to terminal T2 in control portion 61 through wiring L2. Signal generating circuit 63 receives the signal from flow switch 33 through terminal T2. This signal indicates the result of the detection by flow switch 33.

If the result of the detection by flow switch 33 indicates a water flow in hot-water supply circuit 31, signal generating circuit 63 generates a signal for turning off

switch 62a and transmits this signal to switch 62a. Since switch 62a is turned off, fan 26 is stopped. On the other hand, if the result of the detection by flow switch 33 does not indicate a water flow in hot-water supply circuit 31, control portion 61 generates a signal for turning on switch 62a and transmits this signal to switch 62a. Since switch
 5 62a is turned on, fan 26 is supplied with electric power from power supply 65 and, thus, fan 26 is operated.

According to the second embodiment, control portion 61 mounted in indoor unit 14 is adapted to control compressor 22 and fan 26 which are incorporated in outdoor unit 12. Further, flow switch 33 as the detection portion is placed in the portion
 10 provided outside the room, out of hot-water supply circuit 31. This eliminates the necessity of a control substrate in outdoor unit 12. This enables reduction of the cost for the air conditioner.

Further, according to the second embodiment, there is a need for only five wirings for electrically connecting indoor unit 14 and outdoor unit 12 to each other.
 15 This eliminates the necessity of a control substrate in outdoor unit 12. This enables controlling the outdoor unit with the simple control circuit.

(Third Embodiment)

Fig. 8 is a view illustrating the circuit structure of an air conditioner provided with a hot-water supply function, according to a third embodiment of the present
 20 invention. The air conditioner according to the present embodiment basically includes the same structure as that of air conditioner 10 according to the first embodiment. Hereinafter, the corresponding structures therein will not be described redundantly.

Referring to Fig. 8, in the present embodiment, refrigeration circuit 21 is not provided with refrigerant branch path 21q in Fig. 1, and refrigeration circuit 21 is
 25 structured to be a simple circulation path. Further, in the present embodiment, instead of outdoor-side heat exchanger 32 and water heat exchanger 51 in Fig. 1, an integrated heat exchanger 71 is provided. Further, refrigeration circuit 21 is not provided with flow-path changeover valve 28 and flow-path changeover valve 29.

Integrated heat exchanger 71 is provided on the pathway in refrigeration circuit

21. Integrated heat exchanger 71 is a fin-and-tube type heat exchanger which has been described with reference to Figs. 3 to 5 in the first embodiment. Namely, refrigerant tube 53m and water tube 53n, which form multi-row tube 53, are routed within integrated heat exchanger 71. Integrated heat exchanger 71 is a heat exchanger having both the functions of an outdoor-side heat exchanger for heat exchange between a refrigerant and outdoor air, and a water heat exchanger for heat exchange between the refrigerant and water. Integrated heart exchanger 71 has the same structure as that of water heat exchanger 51 illustrated in Fig. 3. Fan 26 is provided oppositely to integrated heat exchanger 71.

If flow switch 33 detects no water flow in hot-water supply circuit 31, fan 26 is driven. Thus, integrated heat exchanger 71 is caused to perform heat exchange between the refrigerant and outdoor air supplied thereto through the driving of fan 26. On the other hand, if flow switch 33 detects a water flow in hot-water supply circuit 31, the driving of fan 26 is stopped. Thus, integrated heat exchanger 71 is caused to perform heat exchange between the refrigerant and water flowing through hot-water supply circuit 31.

With this structure, due to the use of integrated heat exchanger 71 having both the functions of the air/refrigerant heat exchanger and the water/refrigerant heat exchanger, it is possible to compactly structure outdoor unit 12 and, also, it is possible to further reduce the fabrication cost for the air conditioner.

With the air conditioner having the aforementioned structure, according to the third embodiment of the present invention, similarly, it is possible to provide the effects described in the first embodiment.

(Fourth Embodiment)

Fig. 9 is a view illustrating the circuit structure of an air conditioner provided with a hot-water supply function, according to a fourth embodiment of the present invention. Fig. 10 is a circuit diagram illustrating the structure relating to control of the air conditioner in Fig. 9. The air conditioner according to the present embodiment basically includes the same structure as that of the air conditioner according to the third

embodiment. Hereinafter, the corresponding structures therein will not be described redundantly.

Referring to Figs. 9 and 10, in the air conditioner according to the present embodiment, refrigeration circuit 21 is further provided with a pressure switch 81. On
5 the pathway in refrigeration circuit 21, pressure switch 81 is placed between compressor 22 and integrated heat exchanger 71. Pressure switch 81 is connected, through brazing (welding), to a connection pipe near the ejection port of compressor 22.

Pressure switch 81 is adapted to detect the pressure of a refrigerant flowing through refrigeration circuit 21, at the position of the ejection from compressor 22.

10 In the electric circuit diagram illustrated in Fig. 10, pressure switch 81 is connected in series to flow switch 33, between terminal T12 and terminal T14. Pressure switch 81 is of an automatic-reset type which is adapted to automatically reset the opening/closing of a contact point therein, when the detected pressure has been restored to a constant value.

15 In the present embodiment, even when flow switch 33 detects a water flow in hot-water supply circuit 31, if pressure switch 81 detects that the refrigerant pressure is greater than or equal to a predetermined value, the contact point in pressure switch 81 is opened, thereby driving fan 26. At this time, in integrated heat exchanger 71, the refrigerant is caused to perform heat exchange with outdoor air supplied thereto
20 through the driving of fan 26, as well as with the water flowing through hot-water supply circuit 31. This lowers the temperature of the refrigerant in integrated heat exchanger 71 and, also, lowers the pressure of the refrigerant at the position of the ejection from compressor 22. If pressure switch 81 detects that the refrigerant pressure has lowered to the constant value, the contact point in pressure switch 81 is
25 closed, thereby stopping the driving of fan 26.

With this structure, even when the flow rate of hot water discharged from hot-water supply terminal 34 is extremely smaller and, also, the outdoor air temperature is higher, it is possible to perform hot-water supply operations without exerting excessive loads on compressor 22, by monitoring the pressure of the refrigerant in refrigeration

circuit 21. This can improve the reliability of compressor 22.

With the air conditioner having the aforementioned structure, according to the fourth embodiment of the present invention, similarly, it is possible to provide the effects described in the first embodiment.

5 The presently disclosed embodiments are to be considered in all respects as illustrative and not restrictive. The scope of the present invention is indicated by the claims rather than by the foregoing description, and all changes that come within the meaning and range of equivalency of the claims are intended to be embraced therein.

INDUSTRIAL APPLICABILITY

10 The present invention is mainly applicable to air conditioners provided with hot-water supply functions.

REFERENCE SIGNS LIST

10: Air conditioner, 12: Outdoor unit, 14: Indoor unit, 21: Refrigeration circuit, 21p: Refrigeration circulation path, 21q: Refrigeration branch path, 22: Compressor, 15 23: Outdoor-side heat exchanger, 24: Expansion valve, 25: Indoor-side heat exchanger, 26, 27: Fan, 28, 29: Fluid-path changeover valve, 31: Hot-water supply circuit, 33: Flow switch, 34: Hot-water supply terminal, 35: Water communication port, 51: Water heat exchanger, 52: Fin, 53: Multi-row tube, 53m: Refrigerant tube, 53n: Water tube, 56, 57, 58: Section, 61: Control portion, 62a, 62b: Switch, 63: Signal generating circuit, 20 64: Terminal plate, 65: Power supply, 67: Terminal plate, 67a: Over-temperature protection circuit, 67b: Overload protection circuit, 71: Integrated heat exchanger, 81: Pressure switch, 210, 220: Imaginary plane

CLAIMS

1. A fin-and-tube type heat exchanger for performing heat exchange between a refrigerant and a fluid to be heated for heating the fluid to be heated, comprising:
 - 5 a plurality of fins which have a flat-plate shape and are arranged with an interval interposed therebetween; and
 - a multi-row tube which extends while penetrating through the plurality of said fins, and is routed within a plurality of imaginary planes being orthogonal to said fins and arranged in parallel with each other, wherein
 - 10 the multi-row tube includes a fluid tube through which the fluid to be heated flows and a refrigerant tube through which the refrigerant flows, and
 - each of said fins is formed from an integrated plate member in a direction of arrangement of said imaginary planes.
- 15 2. The fin-and-tube type heat exchanger according to claim 1, wherein
 - said plurality of imaginary planes include a first plane, and a second plane arranged with an interval interposed between the second plane and said first plane, and
 - said fluid tube and said refrigerant tube are routed within said first plane and said second plane, respectively.
- 20 3. An air conditioner having a function of heating a fluid to be heated, comprising:
 - the fin-and-tube type heat exchanger according to claim 1 or 2;
 - a refrigeration circuit which forms a heat pump cycle; and
 - 25 a fluid circuit through which the fluid to be heated flows, wherein
 - a refrigerant is supplied from said refrigeration circuit to said refrigerant tube, and the fluid to be heated is supplied from said fluid circuit to said fluid tube.
4. The air conditioner according to claim 3, comprising

an outdoor-side heat exchanger which is provided on a pathway in said refrigeration circuit and is installed outside a room together with said fin-and-tube type heat exchanger;

a fan for supplying outdoor air to said outdoor-side heat exchanger;

5 a detection portion adapted to detect a flow of the fluid to be heated in said fluid circuit; and

a control portion which is adapted to stop said fan when said detection portion detects a flow of the fluid to be heated, and is adapted to drive said fan when said detection portion detects no flow of the fluid to be heated.

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5. The air conditioner according to claim 3 or 4, further comprising

an outdoor-side heat exchanger which is provided on a pathway in said refrigeration circuit and is installed outside a room together with said fin-and-tube type heat exchanger, wherein

15 said fin-and-tube type heat exchanger and said outdoor-side heat exchanger are provided integrally.

6. The air conditioner according to claim 4, wherein

20 said fin-and-tube type heat exchanger and said outdoor-side heat exchanger are provided integrally,

said air conditioner further comprises:

a compressor which is provided on the pathway in said refrigeration circuit and is adapted to compress the refrigerant to be supplied to said outdoor-side heat exchanger; and

25 a pressure switch which is provided on the pathway in said refrigeration circuit and is adapted to detect a pressure of the refrigerant, and

the control portion is adapted to drive said fan when said detection portion detects a flow of the fluid to be heated and said pressure switch detects that the pressure of the refrigerant is greater than or equal to a predetermined value.

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