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(54) THREE-FLUID HEAT EXCHANGER AND AIR-CONDITIONING/WATER-HEATING SYSTEM USING SAME

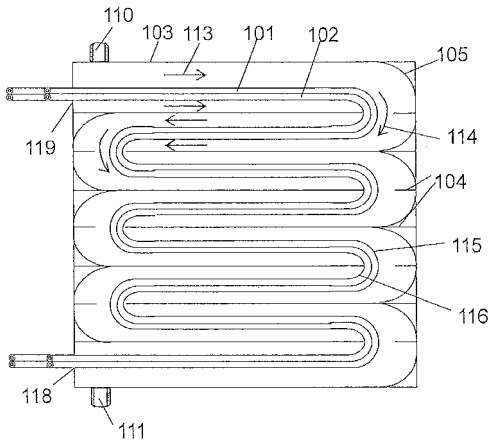
(57) [Problem]

To enhance the heat-transfer performance of a heat exchanger among three fluids used in an air conditioning cycle, a hot-water supply cycle and a natural energy cycle and to miniaturize the heat exchanger.

[Solution]

The heat exchanger is used for an air-conditioning hot-water supply system provided with a refrigerant circuit for air conditioning, a refrigerant circuit for hot-water supply and a warm-water refrigerant circuit utilizing natural energy, the three-fluid heat exchanger that exchanges heat among a refrigerant for air conditioning, a refrigerant for hot-water supply and a warm-water refrigerant includes plural inner tubes 101, 102 in which the refrigerant for air conditioning and the refrigerant for hot-water supply respectively flow and a outer shell 103 which involves the plural inner tubes and in which the warm-water refrigerant 113 flows, the inner tubes 101, 102 have a planar winding shape configured by straight parts and bends in the outer shell 103, a partition plate 104 that partitions each straight part of the inner tubes has a rectangular shape in the outer shell 103 in parallel with the straight part, and the partition plate has a hole for passing the bend of the inner tube.

FIG. 2



EP 2 541 171 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to a three-fluid heat exchanger and an air-conditioning hot-water supply system using the same, especially relates to a three-fluid heat exchanger and an air-conditioning hot-water supply system using the same suitable for an air-conditioning hot-water supply system in which a refrigerant circuit for controlling air temperature for switching cooling and heating, a refrigerant circuit for hot-water supply that stores hot water and a warm-water refrigerant circuit used for a heat storage tank are connected via the three-fluid heat exchanger and form a refrigeration cycle.

BACKGROUND ART

[0002] To enhance the energy saving performance of an air conditioner and hot-water supply equipment, an air-conditioning hot-water supply system in which a refrigerant circuit for hot-water supply and a refrigerant circuit for controlling air temperature are combined is disclosed in a patent literature 1 and a patent literature 2. The air-conditioning hot-water supply system is a system which is provided with the refrigerant circuit for hot-water supply, the refrigerant circuit for controlling air temperature and a cold/warm water circuit for controlling air temperature and in which the refrigerant circuit for hot-water supply and the refrigerant circuit for controlling air temperature exchange heat via a water heat exchanger provided in the cold/warm water circuit for controlling air temperature.

[0003] The water heat exchanger disclosed in the patent literatures 1, 2 is a multiple-tube type heat exchanger which includes an outer tube and plural inner tubes and in which the predetermined number of inner tubes is used for the refrigerant circuit for controlling air temperature, the remaining inner tubes are used for the refrigerant circuit for hot-water supply and cold/warm water in the cold/warm water circuit for controlling air temperature flows in clearance between the outer tube and the inner tube. It is described in the patent literatures 1, 2 that according to this multiple-tube type heat exchanger, as the refrigerant circuit for hot-water supply and the refrigerant circuit for controlling air temperature have relation as partners of heat exchange via the cold/warm water, the evaporating pressure of the refrigerant circuit for hot-water supply enables the efficient tapping of high-temperature hot water in the case of a water heat source without being low as in the case of an air heat source and in addition, cooling and heating are also possible.

[0004] Besides, in a patent literature 3, for technology that inhibits area in which a heat exchanger for hot-water supply is installed from being large-sized, configuration that the installed area is miniaturized, maintaining the area of a heat-transfer surface by spirally winding a multiple-tube type heat exchanger is disclosed. It is described in the patent literature 3 that according to this spirally wound heat exchanger, even if a heat-transfer tube is extended, the heat exchanger can be downsized.

CITATION LIST

PATENT LITERATURE

[0005]

PATENT LITERATURE 1: JP-A No. S60-248963
PATENT LITERATURE 2: JP-A No. S60-248965
PATENT LITERATURE 3: JP-A No. 2005-69620

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0006] To enhance the further energy saving performance of an air-conditioning hot-water supply system, it is conceivable to utilize natural energy such as warm water acquired in a solar energy collector for example for a heat source of heating and hot-water supply. To turn the system disclosed in the patent literature 1 and the patent literature 2 a system in which heat exchange with a warm water circuit based upon natural energy is enabled, an intermediate heat exchanger for heat exchange between a refrigerant circuit for hot-water supply and a warm water circuit based upon natural energy and an intermediate heat exchanger for heat exchange between a refrigerant circuit for air conditioning and the warm water circuit based upon natural energy are required to be increased in addition to an intermediate heat exchanger for heat exchange between the refrigerant circuit for hot-water supply and a refrigerant circuit for controlling air temperature, and a problem that the system is large-sized occurs.

[0007] Besides, in a case that the multiple-tube type heat exchanger disclosed in the patent literature 3 is used for a three-fluid heat exchanger in which heat exchange is enabled among first fluid, second fluid and third fluid that flows in the outer tube when the multiple-tube type heat exchanger includes the two types of inner tubes of the inner tube in which the first fluid flows and the inner tube in which the second fluid flows, the performance of heat transfer is deteriorated because the first fluid and the second fluid exchange heat via the third fluid.

[0008] To enhance the performance of heat exchange between the first fluid and the second fluid, it is conceivable to join the inner tube in which the first fluid flows and the inner tube in which the second fluid flows. In this case, a method of mechanically joining (for example, joining by screwing and banding) and a method of metallurgically joining (for example, joining by brazing which is one type of welding, press welding and others) can be given as joining. Brazing is also called soldering; however, brazing shall be used below. However, when the configuration that the inner tubes are joined is applied to the method

of miniaturization disclosed in the patent literature 3, the inner tubes are hardened by the joining of the inner tubes and it is difficult to miniaturize the multiple-tube type heat exchanger with the multiple-tube type heat exchanger spirally wound.

[0009] An object of the present invention is to provide a heat exchanger and an air-conditioning hot-water supply system using the same where the air-conditioning hot-water supply system utilizing natural energy is configured, energy saving performance is further enhanced, the heat-transfer performance of the three-fluid heat exchanger used in an air conditioning cycle, a hot-water supply cycle and a natural energy cycle is enhanced and the three-fluid heat exchanger is miniaturized.

SOLUTION TO PROBLEM

[0010] To achieve the object, the present invention mainly adopts the following configuration.

A three-fluid heat exchanger exchanges heat among a refrigerant for air conditioning, a refrigerant for hot-water supply and a warm-water refrigerant flowing in respective refrigerant circuits of a refrigerant circuit for air conditioning in which the refrigerant for air conditioning circulates, in a refrigerant circuit for hot-water supply in which the refrigerant for hot-water supply circulates and a warm-water refrigerant circuit in which the warm-water refrigerant that reserves heat utilizing natural energy circulates. The three-fluid heat exchanger includes plural inner tubes in which the refrigerant for air conditioning and the refrigerant for hot-water supply respectively flow and a outer shell which involves the plural inner tubes and in which the warm-water refrigerant flows. The inner tubes in which different refrigerants flow and which are joined form a planar winding shape configured by straight parts and bends in the outer shell, and a partition plate that partitions each straight part in the winding shape of the inner tube is arranged in the outer shell in parallel with the straight part of the inner tube, is a rectangular and has a hole for passing the bend of the inner tube.

[0011] Besides, in the three-fluid heat exchanger, a straightening vane that guides a flow of the warm-water refrigerant along the bend of the inner tube is provided at a corner of the outer shell at which a direction of the flow of the warm-water refrigerant flowing in the outer shell is inverted. Further, the hole of the partition plate is provided in the substantial center in a vertical direction of the rectangular partition plate by a dimension for passing the inner tube, the inner tube is joined and fixed to an inside edge of the hole and the inner tube is fixed in the substantial center in the vertical direction on an inlet side and on an outlet side of the outer shell inside which the inner tube passes. Furthermore, the inner tubes are joined by brazing or are fixed by a band after the inner tube is bent to form a bend and are loaded into the outer shell.

[0012] In addition, in the three-fluid heat exchanger, the plural inner tubes in which the refrigerant for air conditioning and the refrigerant for hot-water supply respectively flow are two inner tubes and the two inner tubes are joined with the two inner tubes vertically superposed. Further, the plural inner tubes in which the refrigerant for air conditioning and the refrigerant for hot-water supply respectively flow are two inner tubes, the two inner tubes are joined with the two inner tubes horizontally arranged and the inside of the inner tube having a larger bend radius is joined to the outside of the inner tube having a smaller bend radius in the bend of the inner tube. Furthermore, the outer shell is a type of a stainless steel box and the warm-water refrigerant flows in an axial direction of the inner tube in the outer shell partitioned by partition plates.

[0013] Besides, in the three-fluid heat exchanger, the outer shell is made of resin and has curved structure, and the curved structure is formed at both ends of the outer shell at which a direction of a flow of the warm-water refrigerant flowing in the outer shell is inverted and guides the flow of the warm-water refrigerant along the bend of the inner tube. Further, the curved structure is acquired by forming a section of the outer shell perpendicular to the axial direction of the straight part of the inner tube to be substantially round. Furthermore, the outer shell and the partition plate are made of resin and are integrated.

[0014] In addition, the present invention provides an air-conditioning hot-water supply system including an air conditioning system which is equipped with the refrigerant circuit for air conditioning and in which the three-fluid heat exchanger is used, a hot-water supply system which is equipped with the refrigerant circuit for hot-water supply and in which the three-fluid heat exchanger is used and a heat reserve system utilizing natural energy which is equipped with the warm-water refrigerant circuit and in which the three-fluid heat exchanger is used.

ADVANTAGEOUS EFFECT OF INVENTION

[0015] According to the present invention, as natural energy (reproducible energy) such as solar heat and ground heat can be utilized for a heat source for air conditioning and hot-water supply, the energy saving performance of the air-conditioning hot-water supply system can be further enhanced.

[0016] Besides, according to the present invention, as a minimum bend radius is determined by a diameter of the inner tube, compared with a case that a minimum bend radius is determined by a diameter of an outer tube when the existing multiple-tube type heat exchanger is spirally wound as it is, the three-fluid heat exchanger can be miniaturized, maintaining heat transfer performance, compared with the related art.

BRIEF DESCRIPTION OF DRAWINGS

[0017]

[Fig. 1] Fig. 1 is a system diagram showing the whole configuration of an air-conditioning hot-water supply system equivalent to an embodiment of the present invention.

[Fig. 2] Fig. 2 is a plan showing inner tube bending structure and outer tube structure in a first embodiment related to the three-fluid heat exchanger equivalent to the embodiment of the present invention.

[Fig. 3] Fig. 3 is a sectional view showing a perpendicular face to an axial direction of straight parts of an inner tube and an outer tube in the first embodiment related to the three-fluid heat exchanger equivalent to this embodiment.

[Fig. 4] Fig. 4 is a sectional view showing a perpendicular face to an axial direction of bends of the inner tube and the outer tube in the first embodiment related to the three-fluid heat exchanger equivalent to this embodiment.

[Fig. 5] Fig. 5 is a sketch showing the whole structure of the bend of the inner tube, the outer tube (the outer shell) and a partition plate in the first embodiment related to the three-fluid heat exchanger equivalent to this embodiment.

[Fig. 6] Fig. 6 is a sectional view showing a second embodiment in which two inner tubes are vertically superposed by brazing in a box type outer shell forming an outer tube in the three-fluid heat exchanger equivalent to this embodiment.

[Fig. 7] Fig. 7 is a sectional view showing a third embodiment in which two inner tubes are flatly combined by brazing in a box type outer shell forming an outer tube in the three-fluid heat exchanger equivalent to this embodiment.

[Fig. 8] Fig. 8 is a plan showing a fourth embodiment showing curved structure at an end of a resin outer shell forming an outer tube and inner tube bending structure in the resin outer shell in the three-fluid heat exchanger equivalent to this embodiment.

[Fig. 9] Fig. 9 is a sectional view showing a perpendicular face to an axial direction of straight parts of an inner tube and the outer tube (the resin outer shell) in the fourth embodiment related to the three-fluid heat exchanger equivalent to this embodiment.

DESCRIPTION OF EMBODIMENTS

[0018] Referring to the drawings, a three-fluid heat exchanger and an air-conditioning hot-water supply system using the same according to an embodiment of the present invention will be described in detail below. First, a summary of the air-conditioning hot-water supply system utilizing natural energy equivalent to the embodiment of the present invention will be described and next, the configuration, the functions and the effects of the three-fluid heat exchanger used for the air-conditioning hot-water supply system utilizing natural energy according to this embodiment will be described.

[0019] Fig. 1 is a system diagram showing the whole configuration of the air-conditioning hot-water supply system equivalent to the embodiment of the present invention. As its basic configuration, the air-conditioning hot-water supply system is provided with an air conditioning system mainly including a compressor for air conditioning 21, a four-way valve 22, the three-fluid heat exchanger (the heat exchanger for heat recovery) 23, a heat exchanger between the air conditioning side and the heat source side 24, an expansion valve 27 and a heat exchanger on a user side for air conditioning 28, a hot-water supply system mainly including a compressor for hot-water supply 41, a heat exchanger on a user side for hot-water supply 42, an expansion valve 43, the three-fluid heat exchanger 23 and an exchanger on a heat source side for hot-water supply 44, a hot water storage system mainly including a service water supply port 78, a hot water tank 70, the heat exchanger on the user side for hot-water supply 42 and a warm water supply port 79, a solar concentration system mainly including a solar energy collector 4 and a heat exchanger for solar heat 91, a thermal storage system mainly including the service water supply port 78, a heat storage tank 50, intermediate warm water pipes 52, 53, the three-fluid heat exchanger 23, the heat exchanger for solar heat 91, a hot-water supply remaining heat exchanger 92 and the warm water supply port 79 and a cold/warm water system for indoor air conditioning mainly including the heat exchanger on the user side for air conditioning 28, the hot-water supply remaining heat exchanger 92 and an indoor heat exchanger 61.

[0020] Besides, from another view point, the air-conditioning hot-water supply system equivalent to this embodiment is provided with a refrigerant circuit for air conditioning 5 for switching cooling operation and heating operation, a refrigerant circuit for hot-water supply 6 that supplies hot water, an intermediate warm water circulation circuit (a heat carrier circuit) 7 that exchanges heat between refrigerants circulated in the refrigerant circuit for air conditioning 5 and the refrigerant circuit for hot-water supply 6 and circulates water reserving warm or cold, a cold/warm water circulation circuit for air conditioning 8 that exchanges heat with the refrigerant circuit for air conditioning 5 for indoor air conditioning, a hot-water supply circuit 9 that exchanges heat with the refrigerant circuit for hot-water supply 6 to supply hot water, a heat carrier circulation circuit for solar concentration 10 that circulates a heat carrier medium reserving solar heat concentrated by the solar energy collector 4, an outgoing hot water path 11 for supplying warm water in the hot-water supply circuit 9 to the outside and a hot-water supply remaining heat warm water circulation circuit 12 that exchanges heat with the heat carrier circulation circuit for solar concentration 10, circulates water reserving warm and exchanges heat with the cold/warm water circulation circuit for air conditioning 8. In addition, the air-conditioning hot-water supply system equivalent to this embodiment has unit structure provided with a heat pump unit 1 arranged outdoors, an indoor unit 2 including an

indoor heat exchanger arranged indoors, a hot-water supply/heat reserve tank unit 3 arranged outdoors and the solar energy collector 4 arranged outdoors.

[0021] The air-conditioning hot-water supply system equivalent to this embodiment shown in Fig. 1 can be operated in operational patterns 1 to 5 under control over operation by a control device 1a and an outline of the operational patterns will be described below.

[0022] In cooing/hot-water supply operation as the operational pattern 1, an air conditioning cycle is equivalent to compression cooling operation, the heat exchanger on the heat source side for air conditioning 24 radiates heat to outside air, a pipe for air conditioning 23a radiates heat to both a pipe for hot-water supply 23b and a heat reserve intermediate warm water pipe 23c in the three-fluid heat exchanger 23, the divided heat exchangers on the user side for air conditioning 28a, 28b absorb heat from the cold/warm water circulation circuit for indoor air conditioning 8, and a room is cooled by the absorption of heat. Besides, in the cooling/hot-water supply operation, a hot-water supply cycle is equivalent to compression hot-water supply operation, the exchanger on the heat source side for hot-water supply 44 absorbs heat from outside air, the pipe for hot-water supply 23b absorbs heat from the pipe for air conditioning 23a in the three-fluid heat exchanger 23 and the vaporization of a refrigerant for hot-water supply is accelerated, and the heat exchanger on the user side for hot-water supply 42 radiates heat to warm water for hot-water supply to the hot water tank 70.

[0023] In this operational pattern 1, evaporating temperature in the hot-water supply cycle is raised by using exhaust heat in the air conditioning cycle for a heat source of the hot-water supply cycle, electric power consumption in the hot-water supply cycle and in the air conditioning cycle can be reduced by dropping condensing temperature in the air conditioning cycle, and system efficiency can be enhanced.

[0024] In heating/hot-water supply operation as the operational pattern 2, an air conditioning cycle is equivalent to compression heating operation, the heat exchanger on the heat source side for air conditioning 24 absorbs heat from outside air, the pipe for air conditioning 23a absorbs heat from the heat reserve intermediate warm water pipe 23c in the three-fluid heat exchanger 23, the divided heat exchangers on the user side for air conditioning 28a, 28b radiate heat to the cold/warm water circulation circuit for indoor air conditioning 8, and the room is heated. Besides, in the heating/hot-water supply operation, a hot-water supply cycle is equivalent to compression hot-water supply operation, the exchanger on the heat source side for hot-water supply 44 absorbs heat from outside air, the pipe for hot-water supply 23b absorbs heat from the heat reserve intermediate warm water pipe 23c in the three-fluid heat exchanger 23 and the vaporization of the refrigerant for hot-water supply is accelerated, and the heat exchanger on the user side for hot-water supply 42 radiates heat to warm water in a pipe for hot-water supply 72 to the hot water tank 70. Besides, cold/warm water for air conditioning in the cold/warm water circulation circuit for indoor air conditioning 8 that absorbs heat from the divided heat exchangers on the user side for air conditioning 28a, 28b radiates heat into warm water in the hot-water supply remaining heat warm water circulation circuit 12 in the hot-water supply remaining heat exchanger 92, and the utilization of heat is more accelerated.

[0025] In this operational pattern 2, when the heat exchanger on the heat source side for air conditioning 24 and the exchanger on the heat source side for hot-water supply 44 utilize outside air for a heat source, similar operation to the operation of the existing air conditioner and hot-water supply equipment is enabled. Besides, when a heat reserve medium is utilized for a heat source using the three-fluid heat exchanger 23, efficiency can be enhanced by using the higher-temperature heat source except outside air such as solar heat and exhaust heat from equipment. Further, when the temperature of outside air is low and the heat exchanger on the heat source side for air conditioning 24 or the exchanger on the heat source side for hot-water supply 44 is frosted, a high-temperature refrigerant (a high-temperature refrigerant by the absorption of heat from the high-temperature heat reserve medium) is made to flow into the heat exchanger 24 or 44 and frost can be dissolved.

[0026] In cooling and natural circulation compatible/hot-water supply operation as the operational pattern 3, an air conditioning cycle is equivalent to operation in which compression cooling operation and natural circulation cooling operation are compatible, in the case of the compression cooling operation, a medium for air conditioning compressed by the compressor for air conditioning 21 passes the expansion valve 27b, the divided heat exchanger on the user side for air conditioning 28a absorbs heat from the cold/warm water circulation circuit for indoor air conditioning 8, and the room is cooled. In the case of the natural circulation cooling operation, the medium for air conditioning passes the expansion valve 27a from the heat exchanger on the heat source side for air conditioning 24 installed in a high position and provided with a function of a condenser without using the compressor for air conditioning 21, the divided heat exchanger on the user side for air conditioning 28b absorbs heat from the cold/warm water circulation circuit for indoor air conditioning 8, and the room is cooled. At this time, the medium for air conditioning vaporized by the absorbed heat returns to the heat exchanger on the heat source side for air conditioning 24. Besides, in the cooling and natural circulation compatible/hot-water supply operation, a hot-water supply cycle is equivalent to compression hot-water supply operation, the exchanger on the heat source side for hot-water supply 44 absorbs heat from outside air, the pipe for hot-water supply 23b absorbs heat from the pipe for air conditioning 23a in the three-fluid heat exchanger 23, and the heat exchanger on the user side for hot-water supply 42 radiates heat

into warm water for hot-water supply to the hot water tank 70. In addition, the heat reserve intermediate warm water pipe 23c in the three-fluid heat exchanger 23 absorbs heat from the pipe for air conditioning 23a and heat reserve intermediate warm water to the heat storage tank 50 is warmed by the absorbed heat.

[0027] In this operational pattern 3, a part of a load of air conditioning can be radiated into outside air without passing the compressor 21 and the workload of the compressor can be reduced. Further, when only the three-fluid heat exchanger 23 is used for an evaporator for hot-water supply, the efficiency of the hot-water supply cycle can be also enhanced by the rise of the evaporating temperature of the hot-water supply cycle.

[0028] In cooling natural circulation operation by outside air utilizing a hot-water supply cycle as the operational pattern 4, an air conditioning cycle is equivalent to natural circulation possible operation by outside air utilizing a hot-water supply cycle, in one of the natural circulation possible operation, the medium for air conditioning passes the expansion valve 27a from the heat exchanger on the heat source side for air conditioning 24 installed in the high position and provided with the function of the condenser, the divided heat exchanger on the user side for air conditioning 28b absorbs heat from the cold/warm water circulation circuit for indoor air conditioning 8, and the room is cooled. At this time, the medium for air conditioning vaporized by the absorbed heat returns to the heat exchanger on the heat source side for air conditioning 24. In the other of the natural circulation possible operation, heat in the pipe for air conditioning 23a is absorbed by the pipe for hot-water supply 23b in the hot-water supply cycle in operation in the three-fluid heat exchanger 23, the medium for air conditioning is condensed and afterward, passes the expansion valve 27b, the divided heat exchanger on the user side for air conditioning 28a absorbs heat from the cold/warm water circulation circuit for indoor air conditioning 8, and the room is cooled. Besides, in the cooling natural circulation operation by outside air utilizing the hot-water supply cycle, the hot-water supply cycle is equivalent to compression hot-water supply operation, the exchanger on the heat source side for hot-water supply 44 absorbs heat from outside air and the heat exchanger on the user side for hot-water supply 42 radiates heat into warm water for hot-water supply to the hot water tank 70.

[0029] In this operational pattern 4, as cooling operation is enabled without operating the compressor 21 in the air conditioning cycle by only the operation of the compressor 41 in the hot-water supply cycle even if outside air temperature is high to some extent, power consumption can be reduced in the whole system.

[0030] In natural circulation cooling operation utilizing outside air as the operational pattern 5, an air conditioning cycle is equivalent to outside air natural circulation operation not using the compressor for air conditioning 21, in the natural circulation operation, the medium for air conditioning passes the expansion valve 27a from the heat exchanger on the heat source side for air conditioning 24 installed in the high position and provided with the function of the condenser, the divided heat exchangers on the user side for air conditioning 28b, 28a absorb heat from the cold/warm water circulation circuit for indoor air condition 8, and the room is cooled. At this time, the medium for air conditioning vaporized by the absorbed heat returns to the heat exchanger on the heat source side for air conditioning 24. Besides, in the natural circulation cooling operation utilizing outside air, a hot-water supply cycle is equivalent to compression hot-water supply operation, the exchanger on the heat source side for hot-water supply 44 absorbs heat from outside air, and the heat exchanger on the user side for hot-water supply 42 radiates heat into warm water for hot-water supply to the hot water tank 70. Further, the pipe for hot-water supply 23b absorbs heat from the heat reserve intermediate warm water pipe 23c in the three-fluid heat exchanger 23 and the vaporization of the refrigerant for hot-water supply on the back stream side of the expansion valve for hot-water supply 43 is accelerated.

[0031] In this operational pattern 5, as cooling operation is enabled without operating the compressor in the air conditioning cycle, power consumption can be reduced.

[0032] In the above-mentioned all operational patterns 1 to 5, in the heat exchanger for solar heat 91, heat is radiated from a pipe for solar concentration 83 to the hot-water supply remaining heat warm water circulation circuit 12 and solar heat is ordinarily effectively utilized.

[0033] Next, structure in which each component used in the air-conditioning hot-water supply system equivalent to the embodiment of the present invention is connected will be described. The heat pump unit 1 is provided with the refrigerant circuit for air conditioning 5 and the refrigerant circuit for hot-water supply 6. Further, the three-fluid heat exchanger 23 is arranged between the refrigerant circuit for air conditioning 5 and the refrigerant circuit for hot-water supply 6. The three-fluid heat exchanger 23 has structure in which heat exchange between three fluids of the refrigerant circulated in the refrigerant circuit for air conditioning 5, the refrigerant circulated in the refrigerant circuit for hot-water supply 6 and a heat carrier circulated in the intermediate warm water circulation circuit 7 is enabled and functions as a heat exchanger for heat recovery. Concretely, the three-fluid heat exchanger 23 has structure where the refrigerant heat-transfer pipe for air conditioning 23a in which the refrigerant for air conditioning flows and the refrigerant heat-transfer pipe for hot-water supply 23b in which the refrigerant for hot-water supply flows are inserted in a joined condition into the outer pipe 23c in which water in the intermediate warm water circulation circuit 7 flows. The concrete structure of the three-fluid heat exchanger 23 will be described in detail referring to the drawings later; however, the concrete structure shows a main characteristic of the present invention.

[0034] The refrigerant circuit for air conditioning 5 is a

circuit in which the refrigerant for air conditioning circulates, and the compressor for air conditioning 21 that compresses the refrigerant for air conditioning, the four-way valve 22 that switches a course of the refrigerant, the three-fluid heat exchanger 23, the heat exchanger on the heat source side for air conditioning 24 that exchanges heat with air sent by a fan 25, a first refrigerant tank 26a, a second refrigerant tank 26b, the first expansion valve 27a and the second expansion valve 27b that respectively decompress the refrigerant for air conditioning and the heat exchanger on the user side for air conditioning 28 that exchanges heat with the cold/warm water circulation circuit for air conditioning 8 are annularly connected by piping for the refrigerant. In this embodiment, the heat exchanger on the user side for air conditioning 28 is divided into the first divided heat exchanger on the user side for air conditioning 28a and the second divided heat exchanger on the user side for air conditioning 28b, and the first divided heat exchanger on the user side for air conditioning 28a and the second divided heat exchanger on the user side for air conditioning 28b are connected in series by the piping for the refrigerant.

[0035] Further, the configuration of the refrigerant circuit for air conditioning 5 will be described in detail below. The refrigerant circuit for air conditioning 5 is first provided with a refrigerant main circuit for air conditioning 5a annularly formed by connecting a discharge port 21b of the compressor for air conditioning 21, the four-way valve 22, the three-fluid heat exchanger 23, the first refrigerant tank 26a, the first expansion valve 27a, the second divided heat exchanger on the user side for air conditioning 28b, the first divided heat exchanger on the user side for air conditioning 28a, the four-way valve 22 and a suction port 21a of the compressor for air conditioning 21 in order by the piping for the refrigerant.

[0036] The refrigerant circuit for air conditioning 5 is configured in such a manner that five refrigerant branch circuits for air conditioning provided to the refrigerant main circuit for air conditioning 5a. The first refrigerant branch circuit for air conditioning is a refrigerant branch circuit for air conditioning connected to the three-fluid heat exchanger 23 in parallel and concretely, is the refrigerant branch circuit for air conditioning which is branched from a branch point I located between the four-way valve 22 and the three-fluid heat exchanger 23, which passes the heat exchanger on the heat source side for air conditioning 24 and which merges at a branch point J located between the three-fluid heat exchanger 23 and the first refrigerant tank 26a.

[0037] The second refrigerant branch circuit for air conditioning is a refrigerant branch circuit for air conditioning that bypasses the suction port 21a and the discharge port 21b of the compressor for air conditioning 21 and concretely, is the refrigerant branch circuit for air conditioning formed by connecting a branch point A located between the first divided heat exchanger on the user side for air conditioning 28a and the four-way valve 22 and a branch point B located between the four-way valve 22 and the branch point I by a refrigerant bypass pipe for air conditioning 29. At the branch point A, a three-way valve 34a is provided and at the branch point B, a three-way valve 34b is provided.

[0038] The third refrigerant branch circuit for air conditioning is a refrigerant branch circuit for air conditioning which is branched from a branch point D located between the three-fluid heat exchanger 23 and the branch point J, which sequentially passes the second refrigerant tank 26b and the second expansion valve 27b and which merges at a branch point E located between the first divided heat exchanger on the user side for air conditioning 28a and the second divided heat exchanger on the user side for air conditioning 28b. At the branch point D, a three-way valve 34d is provided and at the branch point E, a three-way valve 34e is provided.

[0039] The fourth refrigerant branch circuit for air conditioning is a refrigerant branch circuit for air conditioning which is branched from a branch point H located between the second expansion valve 27b provided to the third refrigerant branch circuit for air conditioning and the branch point E and which merges at a branch point G located between the first expansion valve 27a provided to the refrigerant main circuit for air conditioning 5a and the second divided heat exchanger on the user side for air conditioning 28b.

[0040] The fifth refrigerant branch circuit for air conditioning is a refrigerant branch circuit for air conditioning formed by connecting a branch point C located between the branch point I and the heat exchanger on the heat source side for air conditioning 24 and a branch point F located between the second divided heat exchanger on the user side for air conditioning 28b and the branch point E by piping for the refrigerant. At the branch point F, a three-way valve is provided.

[0041] The three-fluid heat exchanger 23 is a heat exchanger for heat recovery in which the refrigerant heat-transfer pipe for air conditioning 23a, the refrigerant heat-transfer pipe for hot-water supply 23b and the heat carrier heat-transfer pipe (the intermediate warm-water refrigerant heat-transfer pipe) 23c are integrated so that they are mutually thermally touched. The first expansion valve 27a and the second expansion valve 27b decompress the pressure of the refrigerant for air conditioning by controlling an opening of the valve and the ratio in a flow rate of the refrigerant for air conditioning that flows in the three-fluid heat exchanger 23 and the heat exchanger on the heat source side for air conditioning 24 can be controlled. The first divided heat exchanger on the user side for air conditioning 28a and the second divided heat exchanger on the user side for air conditioning 28b are installed in a lower position than the position of the heat exchanger on the heat source side for air conditioning 24 and the reason is that a natural circulation cycle of the refrigerant for air conditioning is made to function by the installation in the low position. For the refrigerant for air conditioning that circulates in the refrigerant circuit for air conditioning 5, R410a, R134a, HFO1234yf and

HFO1234ze for example can be used.

[0042] Next, the cold/warm water circulation circuit for air conditioning (the heat carrier medium circulation circuit for air conditioning) 8 is provided with two circuits of a cold/warm water main circuit for air conditioning 8a that exchanges heat with the refrigerant circuit for air conditioning 5 and a cold/warm water branch circuit for hot-water supply remaining heat 8b that exchanges heat with the hot-water supply remaining heat warm water circulation circuit 12. The heat carrier medium flowing in the cold/warm water circulation circuit for air conditioning 8 is water (cold or warm water), however, when the air-conditioning hot-water supply system is used in a cold district, brine such as ethylene glycol may be also used in place of water.

[0043] The cold/warm water main circuit for air conditioning 8a is a circuit annularly formed by sequentially connecting an indoor heat exchanger 61 installed in a house 60, a cold/warm water circulating pump for air conditioning 67, the second divided heat exchanger on the user side for air conditioning 28b and the first divided heat exchanger on the user side for air conditioning 28a by cold/warm water pipes for air conditioning 65a, 65b, 65c as shown in Fig. 1. A first cold/warm water branch pipe for air conditioning 66a and a second cold/warm water branch pipe for air conditioning 66b are provided to the cold/warm water main circuit for air conditioning 8a so that they solidly cross (they are subjected to so-called cross-coupled manner).

[0044] One end of the first cold/warm water branch pipe for air conditioning 66a is connected to the cold/warm water pipe for air conditioning 65a that connects the indoor heat exchanger 61 and the second divided heat exchanger on the user side for air conditioning 28b via a three-way valve 62a and the other end is directly connected to the cold/warm water pipe 65c for air conditioning 65c without a three-way valve. Besides, one end of the second cold/warm water branch pipe for air conditioning 66b is connected to the cold/warm water pipe for air conditioning 65c that connects the indoor heat exchanger 61 and the first divided heat exchanger on the user side for air conditioning 28a via a three-way valve 62b and the other end is directly connected to the cold/warm water pipe for air conditioning 65a without a three-way valve. Directions in which water flows into the heat exchangers on the user side for air conditioning 28a, 28b can be switched by operating the three-way valves 62a, 62b.

[0045] Besides, a third cold/warm water branch pipe for air conditioning 66c for bypassing the indoor heat exchanger 61 is provided. One end of the third cold/warm water branch pipe for air conditioning 66c is connected to the cold/warm water pipe for air conditioning 65a via a three-way valve 62c and the other end is directly connected to the cold/warm water pipe for air conditioning 65c without a three-way valve. The ratio in a flow rate of water that flows in the indoor heat exchanger 61 and water that flows in the third cold/warm water branch pipe for air conditioning 66c can be controlled by an opening of the three-way valve 62c.

[0046] The cold/warm water branch circuit for hot-water supply remaining heat 8b is an annular circuit formed by connecting an outlet of the first divided heat exchanger on the user side for air conditioning 28a and an inlet of the cold/warm water circulating pump for air conditioning 67 by a cold/warm water pipe for hot-water supply remaining heat 63 and by incorporating the hot-water supply remaining heat exchanger 92 described later in the cold/warm water pipe for hot-water supply remaining heat 63. A two-way valve 64a is attached in a position between the hot-water supply remaining heat exchanger 92 and the cold/warm water circulating pump for air conditioning 67 in the cold/warm water pipe for hot-water supply remaining heat 63.

[0047] In the cold/warm water circulation circuit for air conditioning 8 configured as described above, when the two-way valve 64a is closed, water sent from the cold/warm water circulating pump for air conditioning 67 is circulated in the cold/warm water main circuit for air conditioning 8a. In the meantime, when the two-way valve 64a is open, water sent from the cold/warm water circulating pump for air conditioning 67 is circulated not only in the cold/warm water main circuit for air condition 8a but in the cold/warm water branch circuit for hot-water supply remaining heat 8b. Therefore, when the two-way valve 64a is open, warm received from the first heat exchanger on the user side for air conditioning 28a and the second heat exchanger on the user side for air conditioning 28b can be transmitted to the hot-water supply remaining heat warm water circulation circuit 12 via the hot-water supply remaining heat exchanger 92.

[0048] Next, the refrigerant circuit for hot-water supply 6 is a circuit in which the refrigerant for hot-water supply is circulated and is annularly formed by connecting the compressor for hot-water supply 41 that compresses the refrigerant for hot-water supply, the heat exchanger on the user side for hot-water supply 42 that exchanges heat with the hot-water supply circuit 9, a refrigerant tank for hot-water supply 46, the expansion valve for hot-water supply 43 that decompresses the refrigerant for hot-water supply, the three-fluid heat exchanger 23 and the heat exchanger on the heat source side for hot-water supply 44 that exchanges heat with air sent by a fan 45 by piping for the refrigerant.

[0049] Next, the configuration of the refrigerant circuit for hot-water supply 6 will be described in detail. The refrigerant circuit for hot-water supply 6 is first provided with a refrigerant main circuit for hot-water supply 6a annularly formed by connecting a discharge port of the compressor for hot-water supply 41, the heat exchanger for hot-water supply 42, the refrigerant tank for hot-water supply 46, the expansion valve for hot-water supply 43, the three-fluid heat exchanger 23 and a suction port of the compressor for hot-water supply 41 in order by the piping for the refrigerant.

[0050] In the refrigerant circuit for hot-water supply 6,

two refrigerant branch circuits for hot-water supply are provided to the refrigerant main circuit for hot-water supply 6a. The first refrigerant branch circuit for hot-water supply is a refrigerant branch circuit for air conditioning connected to the three-fluid heat exchanger 23 in parallel and concretely, is a refrigerant branch circuit for hot-water supply which is branched from a branch point K located in a position between the expansion valve for hot-water supply 43 and the three-fluid heat exchanger 23, which passes the heat exchanger on the heat source side for hot-water supply and for air conditioning 44 and which merges at a branch point L located in a position between the three-fluid heat exchanger 23 and a suction port 41a of the compressor for hot-water supply 41.

[0051] The second refrigerant branch circuit for hot-water supply 48 is formed by laying piping for the refrigerant from the refrigerant tank for hot-water supply 46 to a branch point M located in a position between the branch point K and the heat exchanger on the heat source side for hot-water supply 45. The second refrigerant circuit for hot-water supply 48 is a bypass pipe for hot-water supply. At the branch point M, a three-way valve is provided. A two-way valve is provided in a position in the vicinity of an outlet of the heat exchanger on the user side for hot-water supply 42, a two-way valve is provided in a position in the vicinity of an outlet of the three-fluid heat exchanger 23, two-way valves are respectively provided in positions in the vicinity of an inlet and an outlet of the heat exchanger on the user side for hot-water supply 44, and a two-way valve is provided in a position between the branch point L and the compressor 41.

[0052] The capacity of the compressor for hot-water supply 41 can be controlled by control by an inverter like the compressor for air conditioning 21 and its rotational speed is variable from low speed to high speed. The heat exchanger on the user side for hot-water supply 42 is configured so that the refrigerant heat-transfer pipe for hot-water supply and a water heat-transfer pipe for hot-water supply are touched. The expansion valve for hot-water supply 43 decompresses the pressure of the refrigerant for hot-water supply by controlling an opening of the valve and the ratio in a flow rate of the refrigerant for hot-water supply flowing in the three-fluid heat exchanger 23 and the heat exchanger on the heat source side for hot-water supply 44 can be controlled. For the refrigerant for hot-water supply circulated in the refrigerant circuit for hot-water supply 6, R134a, HFO1234yf and HFO1234zz for example can be used.

[0053] Next, the hot-water supply circuit 9 is a circuit annularly formed by connecting a lower part of the hot water tank 70 and one end of the heat exchanger on the user side for hot-water supply 42 by a pipe for hot-water supply 72 and connecting the other end of the heat exchanger on the user side for hot-water supply 42 and an upper part of the hot water tank 70 by a pipe for hot-water supply 73. A circulating pump for hot-water supply 71 and a flow rate sensor for hot-water supply (not shown) that detects a flow rate of water flowing in the hot-water supply circuit 9 are incorporated in the pipe for hot-water supply 72. Water in the hot water tank 70 flows into the heat exchanger on the user side for hot-water supply 42 by driving the circulating pump for hot-water supply 71, becomes warm water by heat exchange with the refrigerant for hot-water supply in the heat exchanger on the user side for hot-water supply 42, and is returned to the hot water tank 70. A flow of the refrigerant for hot-water supply and a flow of water are counter in the heat exchanger on the user side for hot-water supply 42.

[0054] Next, the heat carrier circulation circuit for solar concentration 10 is a circuit annularly formed by connecting the solar energy collector 4 and the heat exchanger for solar heat 91 by the pipes for solar concentration 82, 83. A circulating pump for solar concentration 85 for circulating a heat carrier for solar concentration is incorporated in the pipe for solar concentration 82. The heat carrier heated by the solar energy collector 4 exchanges heat with the hot-water supply remaining heat warm water circulation circuit 12 while the heat carrier is circulated in the heat carrier circulation circuit for solar concentration 10 by driving the circulating pump for solar concentration 85 and flows in the heat exchanger for solar heat 91.

[0055] Next, the intermediate warm water circulation circuit (the heat carrier circuit) 7 is a circuit annularly formed by connecting a lower part of the heat storage tank 50 and one end of the three-fluid heat exchanger 23 by the pipe for intermediate warm water 52 and connecting the other end of the three-fluid heat exchanger 23 and the heat storage tank 50 by the pipe for intermediate warm water 53. A circulating pump for intermediate warm water 51 is incorporated in the pipe for intermediate warm water 52. Water in the intermediate warm water circulation circuit 7 flows into the three-fluid heat exchanger 23 by driving the circulating pump for intermediate warm water 51 and is returned to the heat storage tank 50, exchanging heat with the refrigerant circuit for air conditioning 5 and the refrigerant circuit for hot-water supply 6 in the three-fluid heat exchanger 23. The heat storage tank 50 is filled with heat reserve material and warm or cold acquired from the three-fluid heat exchanger 23 is reserved in the heat storage tank 50. The service water supply pipe 78 for supplying service water to the heat storage tank 50 is connected to the heat storage tank 50.

[0056] Next, the hot-water supply remaining heat warm water circulation circuit 12 is a circuit annularly formed by connecting a lower part of the heat storage tank 50 and one end of the heat exchanger for solar heat 91 by a pipe for hot-water supply remaining heat warm water 94, connecting the other end of the heat exchanger for solar heat 91 and one end of the hot-water supply remaining heat exchanger 92 which is incorporated in the heat pump unit 1 and which exchanges heat with the cold/warm water circulation circuit for air conditioning 8 by a pipe for hot-water supply remaining heat warm water 95 and connecting the other end of the hot-water supply

remaining heat exchanger 92 and an upper part of the heat storage tank 50 by a pipe 96. A circulating pump for hot-water supply remaining heat warm water 93 is incorporated in the pipe for hot-water supply remaining heat warm water 94. Water in the heat storage tank 50 exchanges heat with the heat carrier circulation circuit for solar concentration 10 in the heat exchanger for solar heat 91 by driving the circulating pump for hot-water supply remaining heat warm water 93, further, flows, exchanging heat with the circulation circuit for air conditioning 7 in the hot-water supply remaining heat exchanger 92, and is returned to the heat storage tank 50.

[0057] Directions in which two fluids flowing in the heat exchanger for solar heat 91 flow are counter and directions in which two fluids flowing in the hot-water supply remaining heat exchanger 92 flow are also similarly counter.

[0058] Next, the outgoing hot water path 11 is provided with three paths of a warm water supply path 74 for supplying warm water stored in the hot water tank 70 to a user, an intermediate warm water supply path 75 for supplying intermediate warm water reserved in the heat storage tank 50 to the user and a service water supply path 76 for supplying service water to the hot water tank 70, the heat storage tank 50 and the user.

[0059] The warm water supply path 74 is provided with a warm water supply pipe 74a one end of which is connected to the hot water tank 70 and the other end of which is connected to the warm water supply port 79 and a warm water supply pipe 74b one end of which is connected to the hot water tank 70 and the other end of which is connected to a halfway location of the warm water supply pipe 74a, and a three-way valve 77 is provided in a part in which the warm water supply pipe 74a and the warm water supply pipe 74b merge. The intermediate warm water supply path 75 is provided with an intermediate warm water supply pipe 75a one end of which is connected to the heat storage tank 50 and the other end of which is connected to a halfway location of the warm water supply pipe 74a and an intermediate warm water supply pipe 75b one end of which is connected to the heat storage tank 50 and the other end of which is connected to a halfway location of the intermediate warm water supply pipe 75a, and a three-way valve 77 is provided to a part in which the intermediate warm water supply pipe 75a and the warm water supply pipe 74b merge. The service water supply path 76 is provided with a service water supply pipe 76a connected to the hot water tank 70 from the service water supply port 78 to which service water is supplied, a service water supply pipe 76b branched from a halfway location of the service water supply pipe 76a and connected to the heat storage tank 50 and a service water supply pipe 76c branched from a halfway location of the service water supply pipe 76a and connected to a halfway location of the warm water supply pipe 74a, and a three-way valve 77 is provided to a part in which the service water supply pipe 76c and the warm water supply pipe 74a merge.

[0060] According to the outgoing hot water path 11 configured as described above, not only service water, intermediate warm water reserved in the heat storage tank 50 and warm water stored in the hot water tank 70 are respectively supplied to the user from the warm water supply port 79 by suitably opening or closing the respective three-way valves 77 but at least two types of service water, intermediate warm water and warm water can be supplied in a mixed state to the user from the warm water supply port 79.

[0061] The control device 1a receives signals from a remote control not shown and a temperature sensor provided to each part of the air-conditioning hot-water supply system equivalent to this embodiment and controls the compressor for air conditioning 21, the compressor for hot-water supply 41, the four-way valve 22, the expansion valves 27, 43 and the circulating pumps 51, 67, 71, 85, 93 based upon these signals.

[0062] As described in the explanation of mainly the operation modes, the air-conditioning hot-water supply system equivalent to this embodiment is a system in which an air conditioner and hot-water supply equipment can be arbitrarily and simultaneously operated at high energy efficiency by using the above-mentioned three-fluid heat exchanger independent of the dimension of a load for air conditioning/hot-water supply. Besides, as natural energy such as solar heat and ground heat can be utilized for a heat source for air conditioning and hot-water supply, the performance of the energy saving of the air-conditioning hot-water supply system can be further enhanced.

[0063] Next, the three-fluid heat exchanger equivalent to the embodiment of the present invention will be described below referring to Figs. 2 to 9. Fig. 2 is a plan showing inner tube bending structure and outer tube structure in a first embodiment related to the three-fluid heat exchanger equivalent to the embodiment of the present invention. Fig. 3 is a sectional view showing a perpendicular face to an axial direction of straight parts of an inner tube and an outer tube in the first embodiment related to the three-fluid heat exchanger equivalent to this embodiment. Fig. 4 is a sectional view showing a perpendicular face to an axial direction of bends of the inner tube and the outer tube in the first embodiment related to the three-fluid heat exchanger equivalent to this embodiment. Fig. 5 is a sketch showing the whole structure of the bend of the inner tube, the outer tube (the outer shell) and a partition plate in the first embodiment related to the three-fluid heat exchanger equivalent to this embodiment.

[0064] Fig. 6 is a sectional view showing a second embodiment in which two inner tubes are vertically superposed by brazing in a box type outer shell forming the outer shell in the three-fluid heat exchanger equivalent to this embodiment. Fig. 7 is a sectional view showing a third embodiment in which two inner tubes are flatly combined by brazing in a box type outer shell forming the outer shell in the three-fluid heat exchanger equivalent

to this embodiment. Fig. 8 is a plan showing a fourth embodiment showing curved structure at an end of a resin outer shell forming an outer tube and inner tube bending structure in the resin outer shell in the three-fluid heat exchanger equivalent to this embodiment. Fig. 9 is a sectional view showing a perpendicular face to an axial direction of straight parts of an inner tube and the outer tube (the resin outer shell) in the fourth embodiment related to the three-fluid heat exchanger equivalent to this embodiment.

[0065] As shown in Figs. 2 to 9, a reference sign 101 denotes the inner tube for air conditioning, 102 denotes the inner tube for hot-water supply, 103 denotes the outer shell (the box type outer tube), 104 denotes the partition plate, 105 denotes a straightening vane, 107 denotes a refrigerant channel for air conditioning, 108 denotes a refrigerant channel for hot-water supply, 110 denotes a warm water inlet, 111 denotes a warm water outlet, 113 denotes an inner tube straight part warm water channel, 114 denotes an inner tube bend warm water channel, 115 denotes a major diameter, 116 denotes a minor diameter, 117 denotes heat insulation material, 118 denotes the inlet side of the heat exchanger, 119 denotes the outlet side of the heat exchanger, 121 denotes a joint of the inner tubes, 122 denotes a joint of the inner tube and the partition plate, 123 denotes a guide for holding the height of the inner tube, 130 denotes a resin outer shell, 135 denotes a bend of the resin outer shell, 136 denotes upper and lower planar parts of the resin outer shell, and 137 denotes a curved corner of the resin outer shell.

[First Embodiment]

[0066] Referring to Figs. 2 to 4, a first embodiment related to the embodiment of the present invention will be described below. Fig. 2 is a plan showing inner tube bending structure and outer tube structure in the first embodiment related to the three-fluid heat exchanger equivalent to this embodiment. Fig. 3 is a sectional view showing a perpendicular face to an axial direction of straight parts of an inner tube and an outer tube in the first embodiment related to the three-fluid heat exchanger equivalent to this embodiment. Fig. 4 is a sectional view showing a perpendicular face to an axial direction of bends of the inner tube and the outer tube in the first embodiment related to the three-fluid heat exchanger equivalent to this embodiment.

[0067] The inner tubes for air conditioning 101 and the inner tubes for hot-water supply 102 which are four tubes in total respectively having a winding shape and made of cupper are housed in a stainless steel box type outer shell 103 . To explain in reference to the winding shape, as clear from the structure of the inner tubes 101, 102 shown in Fig. 2, the inner tubes 101, 102 form a reciprocating path configured by straight parts and bends, a shape of the reciprocating path is called the winding shape, and the winding shape will be used in the similar meaning below. The straight part is not necessarily limited to only a linear shape and it includes a portion having a slight nonlinear shape. Further, a reciprocating route of the inner tube is not limited to a parallel route in the strict sense of the word. The winding bend of the inner tube has a combined shape of a major diameter 115 and a minor diameter 116. The inner tube for air conditioning 101 and the inner tube for hot-water supply 102 are joined by brazing 121 as shown in Fig. 3 and are housed so that heat conduction is satisfactory. That is, the inner tubes for air conditioning 101 or the inner tubes for hot-water supply 102 are arranged on a diagonal line and adjacent inner tubes, that is, the inner tubes 101, 102 are joined by brazing 121. For a method of fixing the inner tubes 101, 102, a band may be also wound on the outermost periphery of the bundled inner tubes to fix them in addition to brazing 121.

[0068] The two inner tubes for air conditioning 101 and the two inner tubes for hot-water supply 102 are provided, the inside of the inner tube for air conditioning functions as a refrigerant channel for air conditioning 107, and the inside of the inner tube for hot-water supply functions as a refrigerant channel for hot-water supply 108. After the inner tubes 101, 102 in which different refrigerants flow are machined in the winding shape, the inner tube 101 and the inner tube 102 are joined by brazing 121 in the straight parts of the inner tubes 101, 102 as shown in Fig. 3. Further, the bends of the inner tubes 101, 102 are joined by brazing 121 so that the bend having the major diameter 115 is touched to the outside of the bend having the minor diameter 116 (see Fig. 4). The two inner tubes 101, 102 are round tubes having the same inside diameter.

[0069] The stainless steel box type outer shell 103 functions as a warm water circuit based upon natural energy (an intermediate warm-water refrigerant circuit 7) (see Fig. 1). A partition plate 104 and a straightening vane 105 are provided to the outer shell 103. The straightening vane 105 is provided to corners (right and left ends in Fig. 2) of the outer shell 103 at which a direction of a flow 113 of a warm-water refrigerant flowing in the outer shell 103 is inverted and the straightening vane guides so that the warm water refrigerant flows along the bend of the inner tube. The straightening vane 105 is provided to both ends of the outer shell 103 to inhibit the disturbance of the flow of the warm water refrigerant. As clear from the sectional view shown in Fig. 3, the partition plate 104 abuts on an upper wall and a lower wall of the outer shell 103 and is provided between the right and left ends along the warm water channel 113, and further, as shown in Fig. 4, a hole including space which the inner tubes 101, 102 pierce and space for a warm water channel 114 is provided to the partition plate 104 in the bend of the inner tube.

[0070] The warm water circuit based upon natural energy flowing in the outer shell 103 is formed with the channels so that the warm water circuit flows in the vicinity outside respective refrigerant circuits in the inner tube

for air conditioning 101 and the inner tube for hot-water supply 102 by providing the partition plate 104 in parallel with the straight parts of the inner tubes 101, 102 in internal space of the box type outer shell 103. That is, as shown in Fig. 1, the inner tube straight part warm water channel 113 and the inner tube bend warm water channel 114 are formed.

As shown in Fig. 4, the partition plate 104 is made of a rectangular plate that produces space as a result of partitioning the inside of the outer shell 103 in which the inner tube straight part warm water channel 113 and the inner tube bend warm water channel 114 respectively flowing inside the outer shell 103 are formed. Ends of the partition plate 104 are fixed to the outer shell 103. The inner tubes 101, 102 are inserted in the space formed by the partition plates 104. Walls of the hole (the upper and lower sides on the left end side of the hole in Fig. 4) which the bends of the inner tubes 101, 102 pierce of the partition plate 104 and some of the bends of the inner tubes 101, 102 are joined by brazing and a joint 122 of the inner tubes and the partition plate is formed. Further, as shown in Fig. 4, a guide for holding the height direction of the inner tube 123 is formed by providing the hole of the partition plate 104 in the vertical center of the partition plate 104 and the inner tubes 101, 102 can be arranged in the substantial center in the height of the outer shell 103. Besides, the inner tubes 101, 102 are joined to the outer shell 103 both on the inlet side 118 and on the outlet side 119 of the three-fluid heat exchanger. The inner tubes 101, 102 are stably fixed in the heat exchanger because the inner tubes are fixed to the outer shell 103 and the partition plate 104 as described above.

[0071] As shown in Fig. 5, the warm-water refrigerant that intrudes into from a warm water inlet 110 of the outer shell 103 flows in the axial direction of the inner tubes 101, 102 in the space partitioned by the partition plates 104 that partition the inside of the outer shell 103 and forms the channel 113. As the inner tubes 101, 102 are arranged in the substantial center in the partitioned space, the warm-water refrigerant fulfills uniform heat transfer performance to the inner tubes. The warm-water refrigerant goes out from the warm water outlet after it flows in the channel directions of a flow of which are inverted plural times in the outer shell 103. The outer shell 103 is encircled by heat insulation material 117 as shown in Fig. 3 to inhibit heat transfer to outside air.

[0072] As described above, as in the first embodiment related to this embodiment, a multiple-tube type three-fluid heat exchanger is configured by the box type outer tube 103 and the winding inner tubes 101, 102, the heat exchanger can be miniaturized, maintaining heat transfer performance. Besides, as the joint 121 of the inner tubes is formed after bending work is applied to the inner tubes 101, 102, a bend radius of the inner tubes can be reduced and it contributes to the miniaturization. Further, as the inner tubes 101, 102 can be firmly arranged in the center of the outer shell 103 because the inner tubes are joined to the partition plate 104 in their bends, the fluid in the outer shell evenly flows in the whole circumference of the inner tubes 101, 102 and heat transfer performance is satisfactory. Furthermore, effect that the disturbance of a flow of the fluid is also reduced in the bend in which a direction of the flow greatly changes is produced by providing the straightening vane 105.

[Second Embodiment]

[0073] A second embodiment related to the embodiment of the present invention will be described below referring to Fig. 6. Fig. 6 is a sectional view showing the second embodiment in which two inner tubes are vertically superposed by brazing inside a box type outer shell forming an outer shell in the three-fluid heat exchanger equivalent to this embodiment.

[0074] The two winding copper inner tubes 101, 102 are vertically housed in the stainless steel box type outer shell 103 . In Fig. 6, the inner tube for air conditioning 101 is arranged on the upside and the inner tube for hot-water supply 102 is arranged on the downside, however, the arrangement of each tube may be also inverse. The two inner tubes are the same type and a bend radius of each inner tube is the same because each inner tube 101, 102 is vertically arranged. That is, as the inner tubes 101, 102 are vertically superposed, a minor diameter and a major diameter by bending are not made in their bends (see the major diameter 115 and the minor diameter 116 shown in Fig. 2).

[0075] One of the two inner tubes is for air conditioning, the residual one is for hot-water supply, and the inner tubes in which different refrigerants flow are vertically superposed and are joined by brazing 121. The outer shell 103 functions as a warm water circuit based upon natural energy (the intermediate warm-water refrigerant circuit 7 shown in Fig. 1). The outer shell 103 is encircled by heat insulation material 117 to inhibit heat transfer to outside air. The two inner tubes 101, 102 are round tubes having the same inside diameter. When the inner tubes are joined by brazing 121 after bending work is applied to the inner tubes 101, 102, the bend radius of the bend can be reduced and further, as the inner tubes are vertically arranged, bend radiuses of the inner tubes 101, 102 are made the same and the machining is facilitated.

[0076] As shapes of the inner tubes are the same and the configuration is simple using the configuration in the second embodiment, the three-fluid heat exchanger can be simply produced at a low price. Besides, as the number of the inner tubes is small, a diameter of the outer shell (the outer tube) that involves the inner tubes can be reduced and the three-fluid heat exchanger can be downsized.

[0077] In the second embodiment, it is described that the two inner tubes are round tubes having the same inside diameter, however, a diameter of each inner tube may be also differentiated depending upon a type and a characteristic of the refrigerant flowing in each inner tube, in this case, the bend radius in the bend of the whole

inner tubes is determined according to the bend radius of the inner tube the diameter of which is larger, and the inner tube the diameter of which is smaller has only to be bent in accordance with the determined bend radius.

[Third Embodiment]

[0078] A third embodiment related to the embodiment of the present invention will be described below referring to Fig. 7. Fig. 7 is a sectional view showing the third embodiment in which two inner tubes are flatly combined by brazing inside a box type outer shell in the three-fluid heat exchanger equivalent to this embodiment.
The two winding copper inner tubes 101, 102 are housed in the box stainless steel type outer shell 103. A winding shape of the inner tubes 101, 102 is a shape in which the straight part of the inner tube shown in Fig. 2 and a bend having a major diameter 115 or a minor diameter 116 are combined. One of the inner tubes is for air conditioning, the residual one is for hot-water supply, the inner tubes 101, 102 are configured in the bends of the inner tubes so that the inside of the bend having the major diameter 115 is touched to the outside of the bend having the minor diameter 116, and the inner tubes are joined by brazing 121 and seem a plate. In this case, when brazing 121 is applied after bending work is applied to the inner tube, a bend radius can be reduced and the three-fluid heat exchanger can be miniaturized. The outer shell 103 functions as a warm water circuit based upon natural energy (the intermediate warm-water refrigerant circuit 7 shown in Fig. 1). The two inner tubes 101, 102 are round tubes having the same inside diameter.
[0079] As a shape of the inner tube is the same as that of another inner tube and the configuration is simple using the third embodiment, the three-fluid heat exchanger can be simply produced at a low price. As the number of the inner tubes is small, a diameter of the outer shell (the outer tube) that involves the inner tubes can be reduced and the three-fluid heat exchanger can be downsized. Besides, as the inner tubes are flatly arranged, the height of the three-fluid heat exchanger can be restrained and the three-fluid heat exchanger can be further downsized.
[0080] In the third embodiment, it is described that the two inner tubes are round tubes having the same inside diameter, however, a diameter of each inner tube may be also differentiated depending upon a type and a characteristic of the refrigerant flowing in each inner tube, in this case, the bend radius of the bend of the whole inner tubes is determined by the bend radius of the inner tube the diameter of which is larger, and the inner tube having a smaller diameter has only to be bent in accordance with the determined bend radius.

[Fourth Embodiment]

[0081] A fourth embodiment related to the embodiment of the present invention will be described below referring to Figs. 8 and 9. Fig. 8 is a plan showing the fourth embodiment showing curved structure 135 at an end of a resin outer shell 130 and forming an outer tube and inner tube bending structure inside the resin outer shell 130 in the three-fluid heat exchanger equivalent to this embodiment. Fig. 9 is a sectional view showing a perpendicular face to an axial direction of straight parts of inner tubes 101, 102 and an outer tube (a resin outer shell 130) in the fourth embodiment related to the three-fluid heat exchanger equivalent to this embodiment.
[0082] In Fig. 9, the total four copper inner tubes 101, 102 and having a winding shape are housed inside the resin outer shell 130. The inner tubes 101, 102 have the winding shape configured by the straight parts and bends as shown in Fig. 2, and the outer shell 130 and a partition plate 104 are integrated. The inner tubes 101, 102 are configured in the bends so that the inside of the inner tube having a major diameter 115 is opposite to the outside of the inner tube having a minor diameter 116. The inner tubes 101, 102 in which different refrigerants flow are joined by brazing 121 so that the inside of the bend having the major diameter 115 is touched to the outside of the bend having the minor diameter 116 after bending work is applied to the inner tubes in the bends. Out of the inner tubes 101, 102, the two inner tubes are channels for air conditioning 107 and the residual two are channels for hot-water supply 108.
[0083] To describe the configuration of the resin outer shell 130 which is one of characteristics of the fourth embodiment, a curved part 135 of the resin outer shell is formed at right and left ends of the resin outer shell 130 as shown in Fig. 8 and further, a section of the straight part between the right and left ends of the outer shell 130 has upper and lower flat parts 136 formed on upper and lower surfaces of the outer shell and outer shell corner curved parts 137 that connect with the upper and lower flat parts 136 as shown in Fig. 8.
[0084] The two inner tubes including the inner tube for air conditioning 101 and the inner tube for hot-water supply 102 are round tubes having the same inside diameter. A minor-diameter part 116 of the inner tube in the bend of the inner tube is fastened to the partition plate 104 by a fastening member as shown in Fig. 4, further, the inner tubes 101, 102 are fastened by a sealing member on the inlet side 118 and on the outlet side 119 of the resin outer shell 130, and in the inner tubes 101, 102, heat is evenly transferred by warm water forming a channel 113 by these fastening. The resin outer shell 130 functions as a warm water circuit based upon natural energy, and the inner tube straight part warm water channel 113 and an inner tube bend warm water channel 114 are formed.
[0085] The outer shell 130 in the fourth embodiment can function as a heat exchanger excellent in heat insulation from outside air because the outer shell 130 is made of resin. Besides, a shape of the outer shell can be more freely designed because the outer shell is made of resin. That is, as a flow of warm water is apt to be disturbed at a corner at both ends of the straight part of the inner tube when the outer shell is a box type, a

straightening vane is provided (see the straightening vane 105 shown in Fig. 2), however, both ends can be formed in a shape along the bend of the inner tube by making the outer shell 130 of resin, and the disturbance of a flow of fluid flowing in the outer shell can be inhibited without providing a straightening vane. Besides, as the section of the straight part of the inner tube inside the outer shell 130 has the upper and lower flat parts 136 and the corner curved part 137 and is substantially round, the outer shell has high pressure tightness. As the outer shell 130 and the partition plate 104 are integrated, the number of parts is reduced and the three-fluid heat exchanger can be manufactured at a low price. In the fourth embodiment, a bend radius can be also reduced by joining the inner tubes by brazing 121 after bending work is applied to the inner tubes to form the bends and as a result, the three-fluid heat exchanger can be miniaturized.

[0086] In the fourth embodiment, it is described that the two inner tubes are round tubes having the same inside diameter, however, a diameter of each inner tube may be also differentiated depending upon a type and a characteristic of the refrigerant flowing in each inner tube, in this case, the bend radius of the bend of the whole inner tubes is determined by the bend radius of the inner tube having a larger diameter, and the inner tube having a smaller diameter has only to be bent in accordance with the determined bend radius.

[Fifth Embodiment]

[0087] A fifth embodiment related to the embodiment of the present invention proposes the application of any of the three-fluid heat exchangers disclosed in the first to fourth embodiments to the three-fluid heat exchanger used for the air-conditioning hot-water supply system shown in Fig. 1.

[0088] In the three-fluid heat exchanger 23 shown in Fig. 1, the three fluids of intermediate warm water flowing in the intermediate warm-water refrigerant circuit 7, the refrigerant flowing in the refrigerant circuit for air conditioning 5 and the refrigerant flowing in the refrigerant circuit for hot-water supply 6 flow and heat is exchanged between the respective fluids. In other words, in the air-conditioning hot-water supply system provided with the refrigerant circuit for air conditioning, the refrigerant circuit for hot-water supply and the heat carrier circuit (the intermediate warm-water refrigerant circuit) that exchanges heat between the respective refrigerants circulated in the refrigerant circuit for air conditioning and the refrigerant circuit for hot-water supply in the three-fluid heat exchanger and reserves the heat, efficient heat exchange is made between the respective fluids in the three-fluid heat exchanger 23 according to various operational patterns.

[0089] According to the system configuration shown in Fig. 1, intermediate warm water in the intermediate warm-water refrigerant circuit 7 continuously flows in the same direction in the three-fluid heat exchanger 23, however, when a three-way valve is provided as a cross-coupled circuit on the inlet side and on the outlet side of the intermediate warm-water refrigerant circuit 7, a direction of a flow of intermediate warm water in the three-fluid heat exchanger 23 can be inverted according to a control instruction and such circuit configuration that the connection on the inlet side and on the outlet side of the three-fluid heat exchanger 23 is inverted may be also adopted. A direction of a flow of any fluid flowing in the three-fluid heat exchanger 23 can be inverted by adopting inverse connection on the inlet side and on the outlet side.

[0090] The performance of heat exchange can be enhanced by setting a flow of fluid in the three-fluid heat exchanger 23 as follows. That is, when heat is exchanged between the refrigerant on the high-pressure side in the refrigerant circuit for air conditioning 5 and the refrigerant on the low-pressure side in the refrigerant circuit for hot-water supply 6 (for example, in cooling/hot-water supply operation), a direction of a flow of the refrigerant for air conditioning and that of the refrigerant for hot-water supply are made counter. Besides, when heat is exchanged among the refrigerant on the low-pressure side in the refrigerant circuit for air conditioning 5, the refrigerant on the low-pressure side in the refrigerant circuit for hot-water supply 6 and intermediate warm water based upon natural energy in the intermediate warm-water refrigerant circuit 7 (for example, in heating/hot-water supply operation), a direction of a flow of the refrigerant for air conditioning and that of the refrigerant for hot-water supply are made counter apart from the intermediate warm water based upon natural energy.

REFERENCE SIGN LIST

[0091]

1	Heat pump unit
1a	Control device
2	Indoor unit
3	Hot-water supply/heat reserve tank unit
4	Solar energy collector
5	Refrigerant circuit for air conditioning
6	Refrigerant circuit for hot-water supply
7	Intermediate warm-water refrigerant circuit
8	Cold/warm water circulation circuit for indoor air conditioning
9	Hot-water supply circuit

10 Heat carrier circulation circuit for solar concentration

11 External outgoing hot water circuit

12 Hot-water supply remaining heat warm water circulation circuit

21 Compressor for air conditioning

22 Four-way valve

23 Three-fluid heat exchanger (Heat exchanger for heat recovery)

23a Pipe for air conditioning

23b Pipe for hot-water supply

23c Heat reserve intermediate warm water pipe

26 Refrigerant tank

27 Expansion valve

28 Heat exchanger on user side for air conditioning

28a First divided heat exchanger on user side for air conditioning

28b Second divided heat exchanger on user side for air conditioning

29 Refrigerant bypass pipe for air conditioning

34 Three-way valve

35 Closing valve

41 Compressor for hot-water supply

42 Heat exchanger on user side for hot-water supply

43 Expansion valve for hot-water supply

44 Heat exchanger on heat source side for hot-water supply

45 Fan

46 Refrigerant tank for hot-water supply

47 Three-way valve

48 Refrigerant branch circuit for hot-water supply

50 Heat storage tank

52 Pipe for intermediate warm water

53 Pipe for intermediate warm water

60 House

61 Indoor heat exchanger

62 Three-way valve

63 Cold/warm water bypass pipe for remaining heat

64 Two-way valve

65 Cold/warm water pipe for air conditioning

66 Cold/warm water bypass pipe for air conditioning

67 Cold/warm water circulating pump for indoor air conditioning

70 Hot water tank

71 Circulating pump for hot-water supply

72 Pipe for hot-water supply

73 Pipe for hot-water supply

74 Warm water supply path

75 Intermediate warm water supply path

76 Service water supply path

77 Three-way valve

78 Service water supply port

79 Warm water supply port

81 Circulating pump for solar concentration

82 Pipe for solar concentration

83 Pipe for solar concentration

91 Heat exchanger for solar heat

92 Hot-water supply remaining heat exchanger

93 Circulating pump for hot-water supply remaining heat warm water

94 Pipe for hot-water supply remaining heat warm water

95 Pipe for hot-water supply remaining heat warm

water

101 Inner tube for air conditioning

102 Inner tube for hot-water supply

103 Outer shell (Box type outer tube)

104 Partition plate

105 Straightening vane

107 Refrigerant channel for air conditioning

108 Refrigerant channel for hot-water supply

110 Warm water inlet

111 Warm water outlet

113 Inner tube straight part warm water channel

114 Inner tube bend warm water channel

115 Major diameter

116 Minor diameter

117 Heat insulation material

118 Inlet side of heat exchanger

119 Outlet side of heat exchanger

121 Inner tube joint

122 Joint of inner tube and partition plate

123 Guide for holding height of inner tube

130 Resin crust

135 Curved part of resin outer shell

136 Upper and lower flat parts of resin outer shell

137 Corner curved part of resin outer shell

Claims

1. A three-fluid heat exchanger that exchanges heat among a refrigerant for air conditioning, a refrigerant for hot-water supply and a warm-water refrigerant flowing in respective refrigerant circuits of a refrigerant circuit for air conditioning in which the refrigerant for air conditioning circulates, a refrigerant circuit for hot-water supply in which the refrigerant for hot-water supply circulates and a warm-water refrigerant circuit in which the warm-water refrigerant where heat is reserved utilizing natural energy circulates, the three-fluid heat exchanger comprising:

a plurality of inner tubes in which the refrigerant for air conditioning and the refrigerant for hot-water supply respectively flow; and
an outer shell which involves the plurality of inner tubes and in which the warm-water refrigerant flows, wherein:

the inner tubes in which the different refrigerants flow and which are joined form a planar winding shape configured by straight parts and bends inside the outer shell; and a partition plate that partitions each straight part in the winding shape of the inner tube is arranged in the outer shell in parallel with the straight part of the inner tube, is rectangular, and has a hole for passing the bend of the inner tube.

2. The three-fluid heat exchanger according to Claim 1, further comprising:

a straightening vane that guides a flow of the warm-water refrigerant along the bend of the inner tube and that is provided at a corner of the outer shell where a direction of the flow of the warm-water refrigerant that flows in the outer shell is inverted.

3. The three-fluid heat exchanger according to Claim 1 or 2, wherein:

the bend of the inner tube has a shape in which the inside of the inner tube having a larger bend radius is joined to the outside of the inner tube having a smaller bend radius by brazing.

4. The three-fluid heat exchanger according to Claim 1 or 2, wherein:

the hole of the partition plate is opened in the substantial center in a vertical direction of the rectangular partition plate by a dimension for passing the inner tube; and
the inner tube is joined and fixed to an inside edge of the hole and is fixed in the substantial centers in a vertical direction on an inlet side and on an outlet side of the outer shell inside which the inner tube passes.

5. The three-fluid heat exchanger according to Claim 1 or 2, wherein:

the inner tubes are joined by brazing or are fixed

by a band after the inner tube is bent to form the bend and are loaded into the outer shell.

6. The three-fluid heat exchanger according to Claim 1 or 2, wherein:

the three-fluid heat exchanger has structure that ends of four sides of the rectangular partition plate abut on the outer shell.

7. The three-fluid heat exchanger according to Claim 1 or 2, wherein:

the plurality of inner tubes in which the refrigerant for air conditioning and the refrigerant for hot-water supply respectively flow are two inner tubes; and
the two inner tubes are joined with the two inner tubes vertically superposed.

8. The three-fluid heat exchanger according to Claim 1 or 2, wherein:

the plurality of inner tubes in which the refrigerant for air conditioning and the refrigerant for hot-water supply respectively flow are two inner tubes;
the two inner tubes are joined with the two inner tubes horizontally arranged; and
the inside of the inner tube having a larger bend radius is joined to the outside of the inner tube having a smaller bend radius in the bend of the inner tube.

9. The three-fluid heat exchanger according to any of Claims 1 to 8, wherein:

the outer shell is a type of a stainless steel box; and
the warm-water refrigerant flows in an axial direction of the inner tube in the outer shell partitioned by the partition plates.

10. The three-fluid heat exchanger according to Claim 1, wherein:

the outer shell is made of resin and has curved structure; and
the curved structure is formed at both ends of the outer shell at which the direction of the flow of the warm-water refrigerant that flows in the outer shell is inverted and guides the flow of the warm-water refrigerant along the bend of the inner tube.

11. The three-fluid heat exchanger according to Claim 10, wherein:

the curved structure is acquired by forming a section of the outer shell perpendicular to the axial direction of the straight part of the inner tube to be substantially round.

12. The three-fluid heat exchanger according to Claim 10 or 11, wherein:

the outer shell and the partition plate are made of resin and are integrated.

13. The three-fluid heat exchanger according to any one of Claims 1 to 12, wherein:

when heat is exchanged between the refrigerant on a high-pressure side in the refrigerant circuit for air conditioning and the refrigerant on a low-pressure side in the refrigerant circuit for hot-water supply, a direction of a flow of the refrigerant for air conditioning and that of the refrigerant for hot-water supply are counter.

14. The three-fluid heat exchanger according to any one of Claims 1 to 12, wherein:

when heat is exchanged among the refrigerant on the low-pressure side in the refrigerant circuit for air conditioning, the refrigerant on the low-pressure side in the refrigerant circuit for hot-water supply and the warm-water refrigerant in the warm-water refrigerant circuit, the direction of the flow of the warm-water refrigerant and those of the refrigerant for air conditioning and the refrigerant for hot-water supply are counter.

15. An air-conditioning hot-water supply system, comprising:

an air conditioning system in which the three-fluid heat exchanger according to any one of Claims 1 to 14 is used and which is provided with the refrigerant circuit for air conditioning;
a hot-water supply system in which the three-fluid heat exchanger according to any one of Claims 1 to 14 is used and which is provided with the refrigerant circuit for hot-water supply; and
a heat reserve system utilizing natural energy in which the three-fluid heat exchanger according to any one of Claims 1 to 14 is used and which is provided with the warm-water refrigerant circuit.

FIG. 1

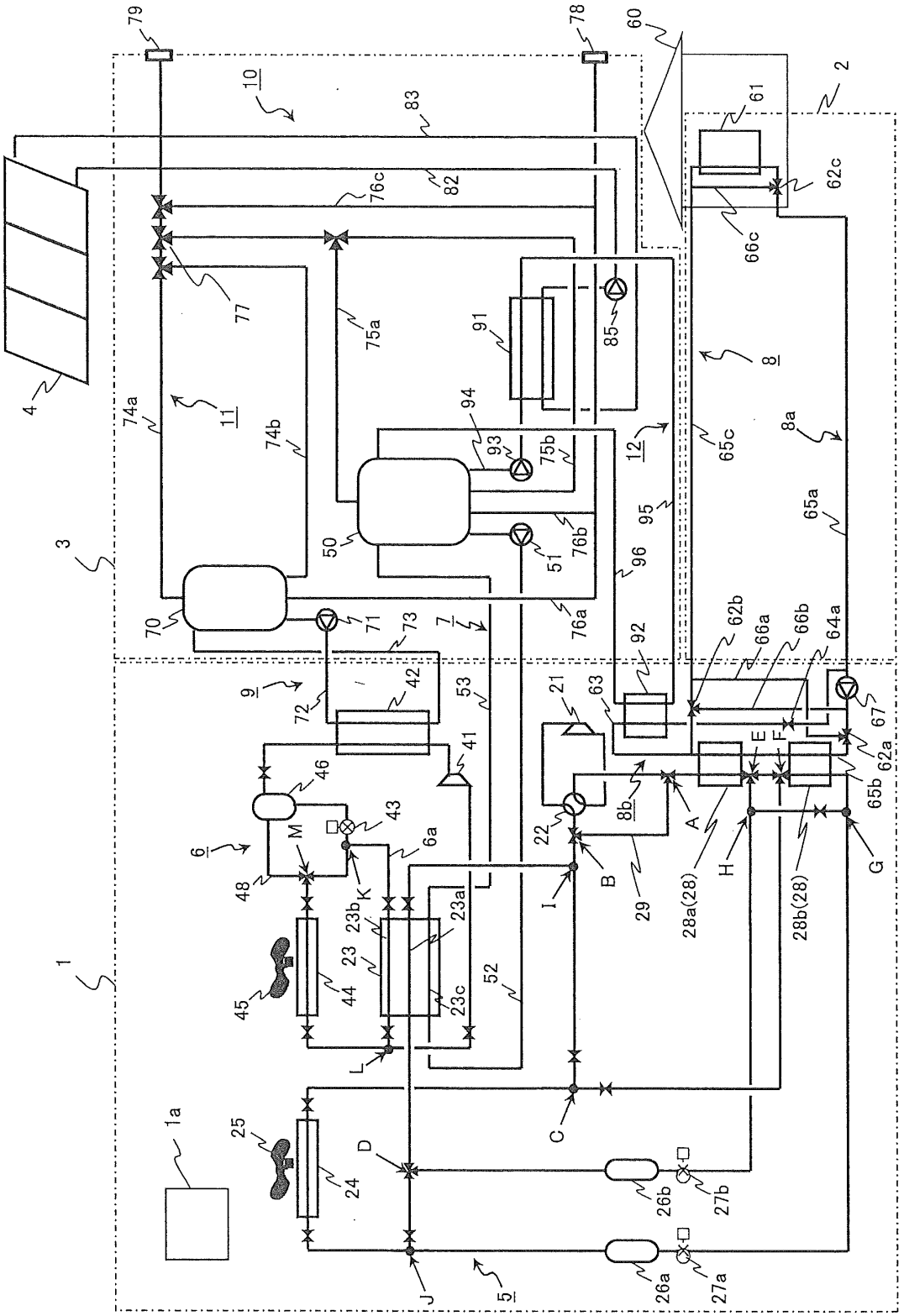

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FIG. 2

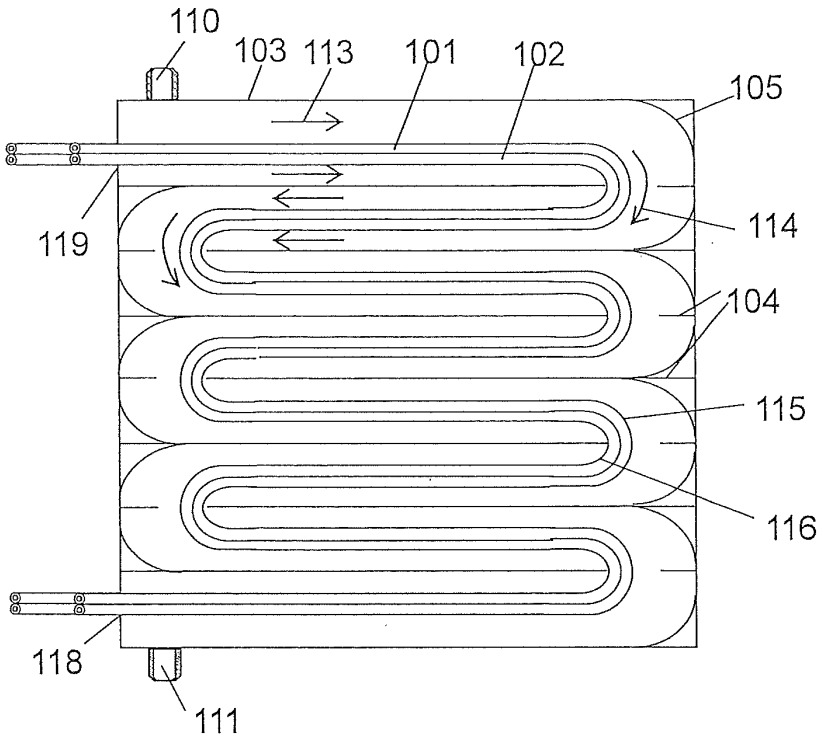

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FIG. 3

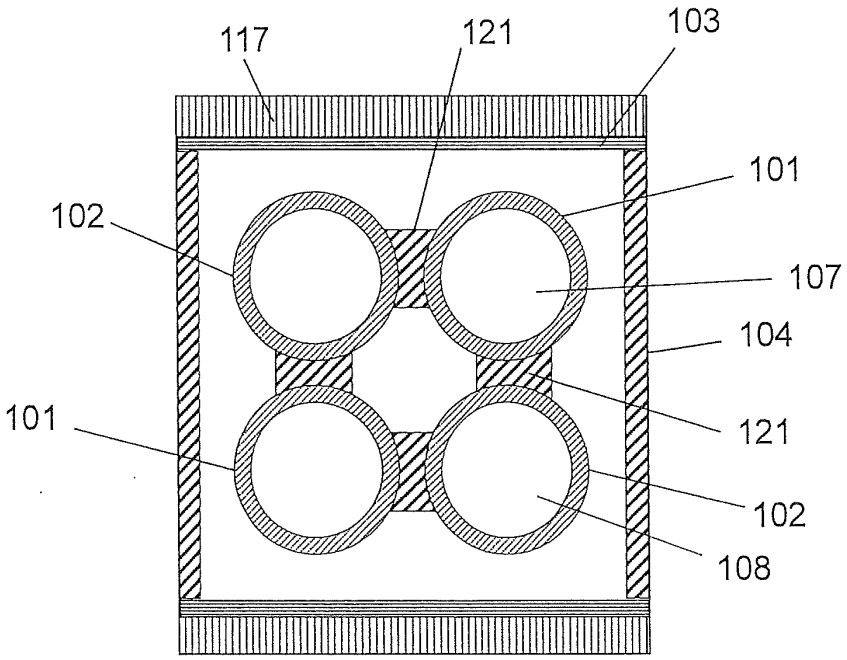

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FIG. 4

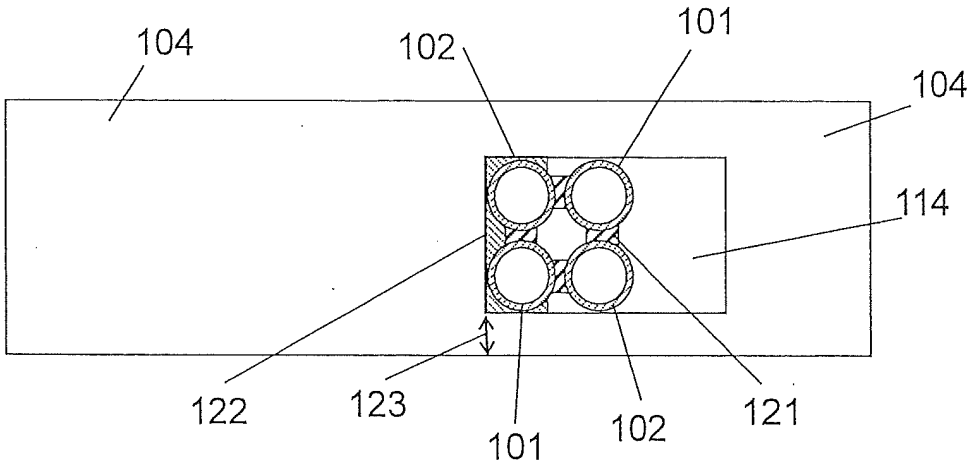

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FIG. 5

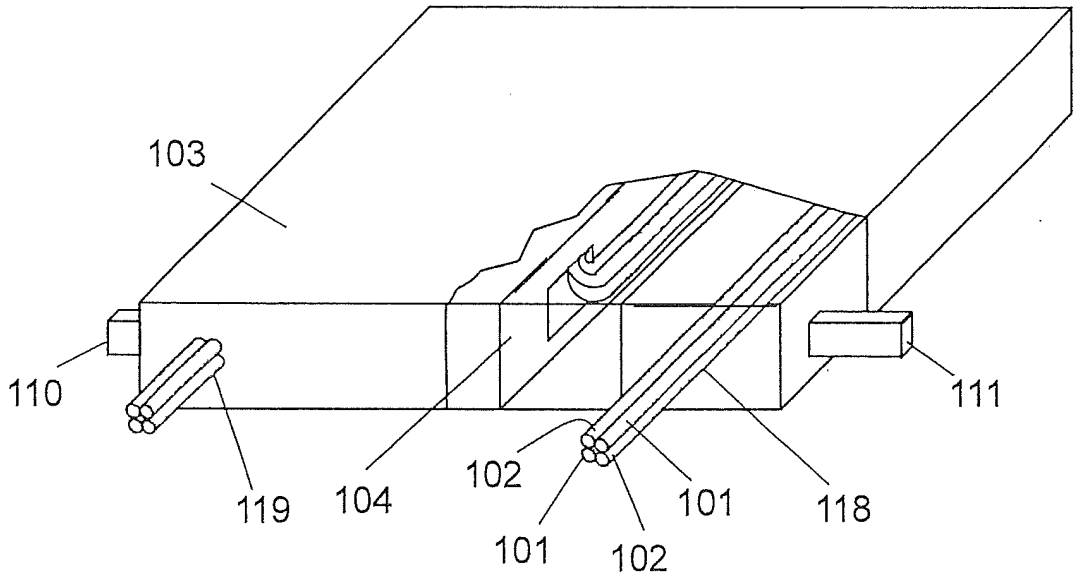

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FIG. 6

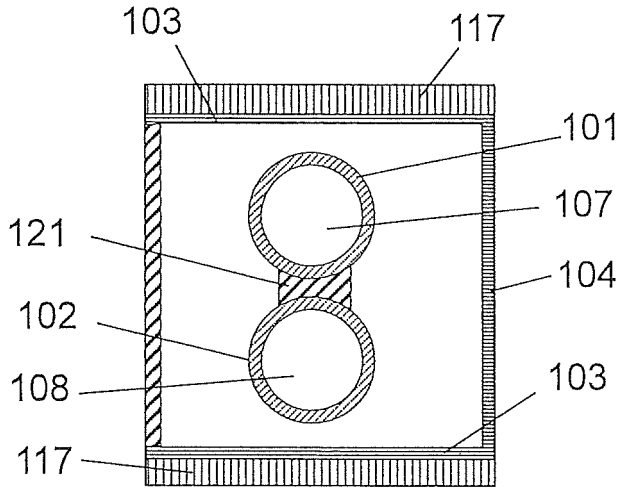

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FIG. 7

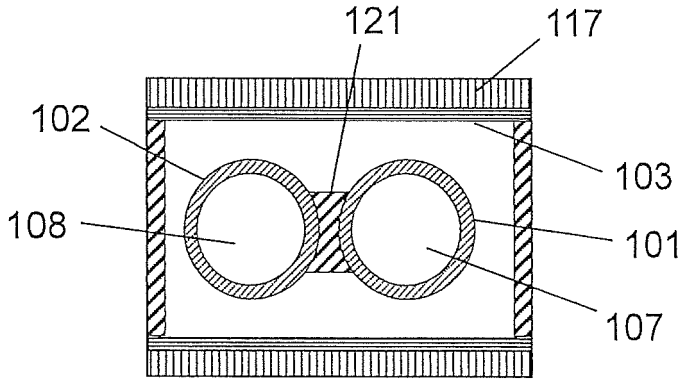

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FIG. 8

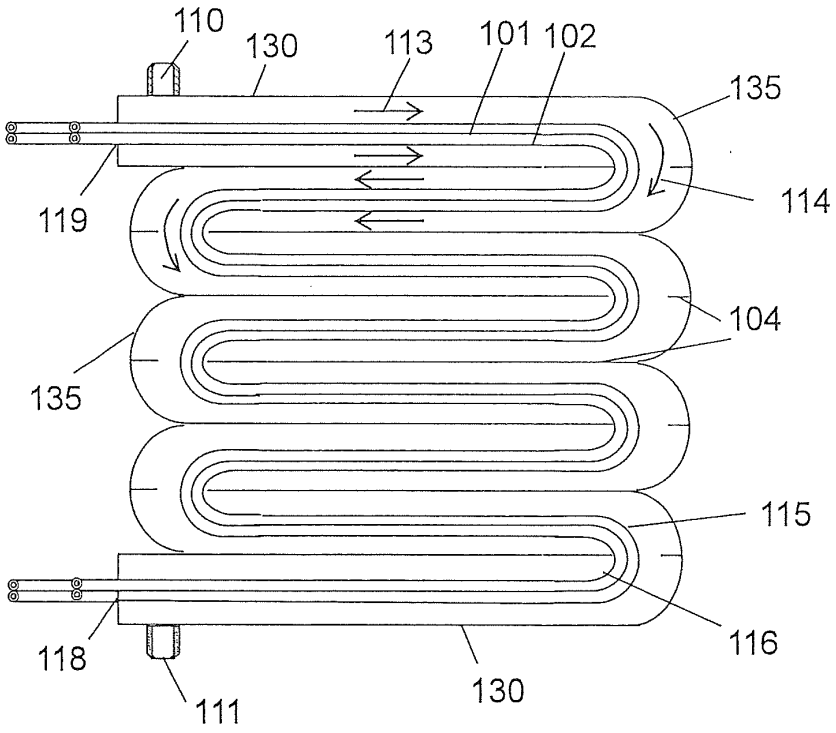
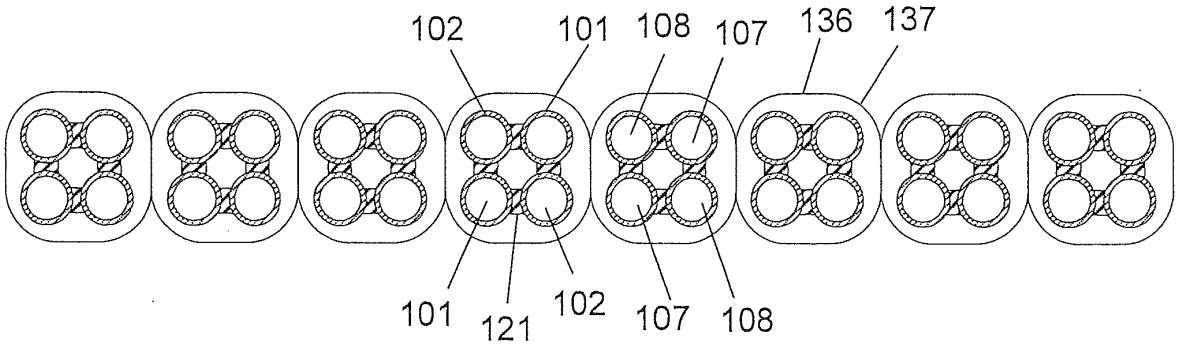

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FIG. 9


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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2010/053141

A. CLASSIFICATION OF SUBJECT MATTER
F25B29/00(2006.01)i, *F28D7/08*(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F25B29/00, F28D7/08

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2010
Kokai Jitsuyo Shinan Koho 1971-2010 Toroku Jitsuyo Shinan Koho 1994-2010

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2007-232282 A (Sharp Corp.), 13 September 2007 (13.09.2007), claims; paragraphs [0001] to [0031]; fig. 1 to 8 (Family: none)	1-15
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 151460/1986(Laid-open No. 61667/1988) (Kenju FUKAYAMA), 23 April 1988 (23.04.1988), claims; fig. 1 to 2 (Family: none)	1-15

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 May, 2010 (11.05.10)	18 May, 2010 (18.05.10)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2010/053141

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2010-71583 A (Mitsubishi Electric Corp.), 02 April 2010 (02.04.2010), claims; paragraphs [0001] to [0026]; fig. 1 to 7 (Family: none)	1-15
Y	JP 2006-234254 A (Sanyo Electric Co., Ltd.), 07 September 2006 (07.09.2006), claims; paragraphs [0001] to [0039]; fig. 1 to 5 (Family: none)	3-15
Y	JP 2009-264686 A (Sharp Corp.), 12 November 2009 (12.11.2009), paragraph [0019] (Family: none)	3-15
A	JP 60-248963 A (Mitsubishi Electric Corp.), 09 December 1985 (09.12.1985), entire text; all drawings (Family: none)	1-15
A	JP 60-248965 A (Mitsubishi Electric Corp.), 09 December 1985 (09.12.1985), entire text; all drawings (Family: none)	1-15
A	JP 2005-69620 A (Toyo Radiator Co., Ltd.), 17 March 2005 (17.03.2005), entire text; all drawings (Family: none)	1-15

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP S60248963 A **[0005]**
- JP S60248965 A **[0005]**
- JP 2005069620 A **[0005]**