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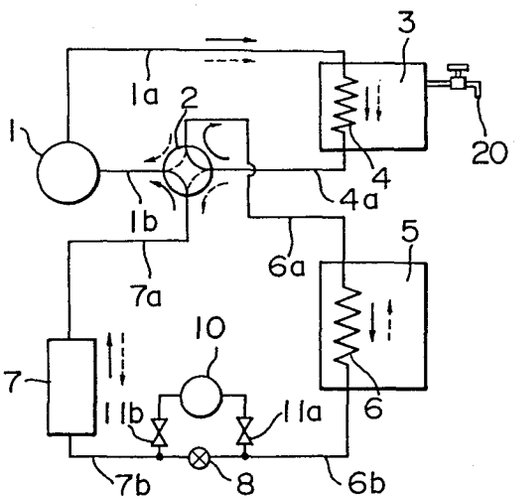
(54) Space cooling and heating and hot water supplying apparatus.

(57) A space cooling and heating and hot water supplying apparatus comprising a compressor (1), a first indoor heat exchanger (3) for hot water supply connected at one end thereof to the compressor at its discharge side via a conduit (1a), a second indoor heat exchanger for space cooling and heating (6) and an outdoor heat exchanger (7) each switchingly connected at one end thereof via a four-way valve (2) to an opposite end of the first indoor heat exchanger and a suction side of the compressor via conduits (7a, 1b, 4a, 6a), and an expansion valve (8) connecting together opposite ends of the second indoor heat exchanger and outdoor heat exchanger via conduits (6b, 7b). The apparatus further includes a first on-off valve (11a) and a second on-off valve (11b) operating in reverse actions connected at one end thereof to inlet and outlet ports of a refrigerant tank (10) for regulating the amount of a sealed-in refrigerant and at an opposite end thereof to the lower pressure conduit (7b) and the higher pressure conduit (6b), respectively, connected together by the expansion valve located at their boundary. In a space heating mode, the refrigerant tank is brought into communication with the lower pressure conduit when space heating and hot water supply are both needed, and when only the hot water supply is needed, and in a space cooling mode, the refrigerant tank is brought into communication with the lower pressure conduit when space cooling and hot water supply are both needed and when only the hot water supply is needed, and the refrigerant tank is brought into communication with the higher pressure conduit when only the space cooling is needed.



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SPACE COOLING AND HEATING AND HOT WATER SUPPLYING ARPARATUS

BACKGROUND OF THE INVENTION

This invention relates to a space cooling and heating and hot water supplying apparatus of a heat pump type capable of supplying hot water simultaneously as space cooling or heating is being performed and enabling space cooling, heating and hot water supplying operations to be selectively performed.

There has been an increasingly greater demand for cooling and heating equipment for household use that can be realized by providing an air conditioning system of a heat pump type having space cooling and heating function with a heating function for supplying hot water.

A space cooling and heating apparatus capable of supplying hot water is disclosed in Japanese Utility Model Application Laid-Open No. 79651/73, for example. In this space cooling and heating and hot water supplying apparatus, a compressor, a heat exchanger for heating water to supply hot water (hereinafter referred to as "hot water supplying heat exchanger"), a four-way valve, a space cooling and heating heat exchanger (indoor), an outdoor heat exchanger and an expansion valve are successively connected together by conduits to provide a refrigeration cycle or refrigeration circuit. In a space heating and hot water supplying mode, a refrigerant discharged from the compressor flows, as the four-way

valve is actuated, through the hot water supplying heat exchanger, four-way valve, space cooling and heating heat exchanger, expansion valve, outdoor heat exchanger and four-way valve before returning to the compressor, with the hot water supplying heat exchanger and space cooling and heating heat exchanger serving as condensers to perform the function of heating water for supplying hot water (hereinafter referred to as "hot water supplying function") and the space heating function.

In a space cooling and hot water supplying mode, the refrigerant discharged from the compressor flows, as the four-way valve is actuated, through the hot water supplying heat exchanger, four-way valve, outdoor heat exchanger, expansion valve, space cooling and heating heat exchanger and four-way valve before returning to the compressor, with the hot water supplying heat exchanger and outdoor heat exchanger serving as condensers and the space cooling and heating heat exchanger serving as an evaporator to perform the functions of hot water supply and space cooling.

In the apparatus of the aforesaid construction, when it is desired to perform the hot water supplying function preferentially in the space heating and hot water supplying mode, it is necessary to obtain sufficiently high heating capabilities by letting the hot water supplying heat exchanger perform the function of condensing all the refrigerant. However, when the space cooling and heating heat exchanger is low in temperature,

the majority of refrigerant undergoes condensation in the space cooling and heating heat exchanger, so that the hot water supplying heat exchanger is unable to satisfactorily perform a heating function and the heating capabilities of the apparatus for supplying hot water are reduced.

On the other hand, if the hot water supplying heat exchanger is low in temperature when it is desired to give priority to the space heating function, then the majority of refrigerant undergoes condensation in the hot water supplying heat exchanger and the heat given off by the space cooling and heating heat exchanger is markedly reduced in amount, thereby deteriorating the space heating function.

Thus, the apparatus of the aforesaid construction has the problem that difficulties are experienced in selectively performing a space heating operation or a hot water supplying operation by giving priority to one of them when it is desired to preferentially perform space heating or hot water supply. This is also the case when a space cooling and hot water supplying operation is performed.

When it is desired to give priority to the hot water supplying function, it is necessary that the majority of refrigerant be subjected to condensation in the hot water supplying heat exchanger. However, when the outdoor temperature is low, for example, the condensation of the refrigerant also takes place in the outdoor heat exchanger, making it impossible to let the refrigerant

give off heat in the hot water supplying heat exchanger in an amount great enough to heat water.

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OBJECT OF THE INVENTION

This invention has as its object the provision of an apparatus making it possible to selectively perform a hot water supplying operation and a space cooling or heating operation and allowing the respective heat exchanger to have priority over other heat exchangers in performing a heat exchange function, whereby the apparatus can function with a high degree of efficiency in accordance with a load applied thereto.

STATEMENT OF THE INVENTION

To accomplish the aforesaid object, the invention provides a space cooling and heating and hot water supplying apparatus comprising a compressor, a first indoor heat exchanger for hot water supply connected at one end thereof to the compressor at its discharge side via a conduit, a second indoor heat exchanger for space cooling and heating and an outdoor heat exchanger each switchingly connected at one end thereof via a four-way valve to an opposite end of the first indoor heat exchanger and a suction side of the compressor via conduits, and an expansion valve connecting together opposite ends of the second indoor heat exchanger and outdoor heat exchanger via conduits, characterized by further comprising a first on-off valve and a second on-off valve operating

in reverse actions connected at one end thereof to inlet and outlet ports of a refrigerant tank for regulating the amount of a sealed-in refrigerant and at an opposite end thereof to the lower pressure conduit and the higher pressure conduit, respectively, connected together by the expansion valve located at their boundary, and wherein the apparatus operates such that in a space heating mode, the refrigerant tank is brought into communication with the lower pressure conduit when space heating and hot water supply are both needed and when only the hot water supply is needed, and the refrigerant tank is brought into communication with the higher pressure conduit when only the space heating is needed, and in a space cooling mode, the refrigerant tank is brought into communication with the lower pressure conduit when space cooling and hot water supply are both needed and when only the hot water supply is needed, and the refrigerant tank is brought into communication with the higher pressure conduit when only the space cooling is needed.

The constructional feature that the on-off valves operating in reverse actions are connected at one end thereof to the inlet and outlet ports of the refrigerant tank and at an opposite end thereof to the lower pressure conduit and higher pressure conduit, respectively, enables the refrigerant tank to be selectively brought into communication with the lower pressure conduit and higher pressure conduit by the operation of the on-off valves.

When the refrigerant tank is brought into

communication with the lower pressure conduit, nearly all the refrigerant in the refrigerant tank is vaporized into a gaseous state with the refrigerant tank being mounted in an ambience of a temperature higher than the saturation temperature of the refrigerant corresponding to the pressure on the lower pressure side (vaporizing pressure). When the refrigerant tank is brought into communication with the higher pressure conduit, the refrigerant tank is filled with the refrigerant in a liquid state with the refrigerant tank being mounted in an ambience of a temperature higher than the saturation temperature of the refrigerant corresponding to the condensing pressure.

When space heating and hot water supply are both needed in a space heating mode, the pressure of the refrigerant in the refrigerant tank falls as the tank is brought into communication with the lower pressure conduit. This avoids collection of the refrigerant in a liquid state in the tank, and the sealed-in refrigerant in the refrigeration circuit all flows therethrough, so that the first indoor heat exchanger and second indoor heat exchanger satisfactorily perform heat exchange (condensation) to enable the apparatus to fully perform the space heating and hot water supplying functions.

When hot water supply is not needed and only the space heating is needed, the refrigerant in a liquid state collects in the refrigerant tank and the amount of the refrigerant circulating through the refrigeration circuit is reduced if the refrigerant tank is brought

into communication with the higher pressure conduit. This enables the heat exchanger for space cooling and heating to satisfactorily perform heat exchange (condensation) because no refrigerant in a liquid state collects therein, thereby enabling the space heating function to be fully performed. When no hot water supply is needed, warm water in a heat accumulating tank for hot water supply is considerably high in temperature, so that the first heat exchanger for hot water supply performs almost no condensation and the water in the heat accumulating tank for hot water supply is not heated.

When space cooling and hot water supply are both needed in a space cooling mode, the refrigerant in the refrigerant tank changes to a gaseous state of low pressure if the refrigerant tank is brought into communication with the low pressure conduit, so that all the sealed-in gas circulates through the refrigeration circuit without the refrigerant in a liquid state collecting in the refrigerant tank. The first indoor heat exchanger for hot water supply and the outdoor heat exchanger serve as condensers, and the refrigerant in a liquid state collects in the outdoor heat exchanger located on the downstream side. Almost no heat exchange (condensation) takes place between the refrigerant and air in the outdoor heat exchanger, so that almost all the energy of the gaseous refrigerant of high temperature discharged from the compressor is released in the first indoor heat exchanger for hot water supply. This is conducive to

improved hot water supply function due to condensation of gaseous refrigerant in the first indoor heat exchanger. Meanwhile, the second indoor heat exchanger for space cooling and heating serves as an evaporator to perform space cooling.

When no space cooling is needed but only the hot water supply is needed, the refrigerant tank is brought into communication with the lower pressure conduit as described hereinabove by referring to the space cooling mode. The hot water supply function is perferentially performed as in the space cooling mode described hereinabove. In this case, the space cooling capabilities not needed may be retained by accumulating heat in a heat accumulating tank for space cooling and heating. When no hot water supply is needed but only the space cooling is needed, the pressure in the refrigerant tank can be raised by bringing it into communication with the higher pressure conduit, with a result that the refrigerant in a liquid state collects in the refrigerant tank and the refrigerant flowing through the refrigeration circuit in circulation is reduced in amount. As the amount of the refrigerant flowing in circulation through the referigerant circuit is reduced, the outdoor heat exchanger functions as a condenser without the refrigerant collecting therein, so that the first indoor heat exchanger and the second heat exchanger serve as condensers. As a result, the condensing pressure (discharge pressure) falls, and when the saturation temperature

falls below the temperature of water in the heat accumulating tank for hot water supply, almost no heat exchange (condensation) occurs in the first indoor heat exchanger and no further rise in the temperature of warm water in the heat accumulating tank for hot water supply occurs. Meanwhile, the second indoor heat exchanger for space cooling and heating serves as an evaporator and performs space cooling.

The invention also provides another constructional form of the space cooling and heating and hot water supplying apparatus further comprising a third on-off valve connected in parallel with the expansion valve through a conduit, and a parallel circuit of a second expansion valve and a fourth on-off valve connected to a conduit connecting the four-way valve to the outdoor heat exchanger. In operation, when only the hot water supply is needed in a space cooling mode, the third on-off valve is opened and fourth on-off valve is closed. In other operation modes, the third on-off valve is closed and fourth on-off valve is opened.

In the aforesaid constructional form, when no space cooling is needed and only the hot water supply is needed in the space cooling mode, the first indoor heat exchanger for hot water supply serves as a condenser and the refregerant has its pressure reduced by the second expansion valve. The outdoor heat exchanger and second indoor heat exchanger for space cooling and heating serve as evaporators, and almost no vaporization takes place

in the second indoor heat exchanger located on the downstream side. Thus, there is no risk that water in a heat accumulating tank for space cooling and heating might freeze.

In the description of the constructional form set forth hereinabove and the description of another constructional form presently to be described, the terms "first indoor heat exchanger" and "second indoor heat exchanger" have been used. However, these two heat exchangers are not necessarily mounted in doors and they are intended to function as heat exchangers for performing hot water supply and space cooling and heating. Preferably, the first indoor heat exchanger is used for hot water supply, and although the term "first indoor heat exchanger for hot water supply" is used in this specification, this heat exchanger is not necessarily used exclusively for hot water supply and may be used for other purposes. It is to be understood that a heat exchanger for heating purposes is included in this heat exchanger.

The space cooling and heating and hot water supplying apparatus according to the invention can selectively perform with a high degree of efficiency the operation of simultaneously performing space heating and hot water supply, the operation of performing only the hot water supply and the operation of performing only the space heating in winter, and the operation of simultaneously performing hot water supply and space cooling, the operation of performing only the hot water supply and

the operation of performing only the space cooling in summer. The apparatus can achieve effects in conserving energy because it is possible for the apparatus to selectively perform each one of the aforesaid operations in accordance with a load.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a circuit diagram of the refrigeration circuit of the space cooling and heating and hot water supplying apparatus in accordance with one embodiment of the invention;

Fig. 2 is a circuit diagram of the refrigeration circuit of the space cooling and heating and hot water supplying apparatus in accordance with a modification of the embodiment shown in Fig. 1;

Fig. 3 is a circuit diagram of the refrigeration circuit of the space cooling and heating and hot water supplying apparatus in accordance with another embodiment; and

Fig. 4 is a circuit diagram of the refrigeration circuit of the space cooling and heating and hot water supplying apparatus in accordance with a modification of the embodiment shown in Fig. 3.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

One embodiment of the invention will now be described by referring to Fig. 1 showing refrigeration circuit of the apparatus.

As shown, a compressor 1 is connected at a discharge side thereof through a discharge conduit 1a to one end of a first indoor heat exchanger 4 disposed within a hot water supplying heat accumulating tank 3. The opposite end of the heat exchanger 4 is connected through a conduit 4a to a four-way valve 2. The compressor 1 is connected at a suction side thereof through a conduit 1b to the four-way valve 2. Mounted inside a cooling and heating heat accumulating tank 5 is a heat exchanger 6 connected at one end thereof through a conduit 6a to the four-way valve 2 and at an opposite end thereof through a conduit 6b to an expansion valve 8. An outdoor heat exchanger 7 is connected at one end thereof through a conduit 7b to the expansion valve 8 and at an opposite end thereof through a conduit 7a to the four-way valve 2. A sealed-in refrigerant amount regulating tank (Hereinafter referred to as "refrigerant tank") 10 has two inlet and outlet ports, one port being connected to a first on-off valve 11a and the other port being connected to a second on-off valve 11b. A conduit connecting the one inlet and outlet port to the first on-off valve 11a is connected to the conduit 6b connecting the expansion valve 8 to the second indoor heat exchanger 6, and a conduit connecting the other inlet and outlet port to the second on-off valve 11b is connected to the conduit 7b connecting the expansion valve 8 to the outdoor heat exchanger 7. The hot water supply heat accumulating tank 3 has a faucet 20 attached thereto.

Operation of the aforesaid constructional form of the invention will now be described by referring to Fig. 1. First, a hot water supply and space heating operation will be described. In this mode, the four-way valve 2 is brought to a solid line position in the figure to allow a refrigerant to flow in directions indicated by solid line arrows. The refrigerant of high temperature and pressure released from the compressor 1 flows into the first indoor heat exchanger 4 for hot water supply to heat the water in the heat accumulating tank 3, and then through the four-way valve 2 into the second indoor heat exchanger 6 for space cooling and heating to heat a medium (such as water) in the heat accumulating tank 5. Then, after having its pressure reduced by the expansion valve 8, the refrigerant flows into the outdoor heat exchanger 7 where it is vaporized by heat exchange with outdoor air into a gaseous state, before returning to the compressor 1 through the four-way valve 2.

In the aforesaid refrigeration circuit, the operation for performing space heating and hot water supply is as follows. In this case, the temperatures of water in the hot water supply heat accumulating tank 3 and space cooling and heating heat accumulating tank 5 are both low, for example, and it is necessary to make full use of the first indoor heat exchanger 4 and second indoor heat exchanger 6 to enable the refrigeration circuit to achieve a high performance. If the operation is performed by closing the first on-off valve 11a and

opening the second on-off valve 11b, then the pressure in the refrigerant tank 10 falls and no refrigerant collects therein, so that all the refrigerant sealed in the refrigeration circuit flows through the circuit in circulation and is effectively used.

The operation for space heating without providing hot water supply is as follows. In this case, the temperature t_1 of water in the hot water supply heat accumulating tank 3 is high enough but the temperature t_2 of water in the space cooling and heating heat accumulating tank 5 is low and needs further heating, for example. The second indoor heat exchanger 6 is exposed to a lower temperature than the first indoor heat exchanger 4, so that almost no refrigerant undergoes condensation in the first indoor heat exchanger 4 and the refrigerant is condensed in the second indoor heat exchanger 6. However, with the amount of the refrigerant sealed in the refrigeration circuit being constant, the refrigerant is inevitably gathered together in the second indoor heat exchanger 6, with the result that the second indoor heat exchanger 6 has a greater liquid refrigerant zone and a reduced function as a condenser, raising the discharge pressure (condensing pressure) of the compressor 1. As the saturation temperature of the refrigerant (corresponding to the condensing pressure) rises above the water temperature t_1, the refrigerant begins to condense in the first indoor heat exchanger 4 too and the water temperature t_1 rises, thereby unnecessarily

raising the hot water temperature. At this time, if the amount of the refrigerant flowing through the refrigeration circuit is reduced, then the second indoor heat exchanger 6 fully functions as a condenser without being sealed by the liquid condenser, to thereby raise the temperature t_2 in the space cooling and heating heat accumulating tank 5 and avoid a rise in condensing pressure. Thus, the refrigerant does not undergo condensation in the first indoor heat exchanger 4 and the water in the hot water supply heat accumulator 3 is hardly heated. To effect adjustments of the amount of the sealed-in refrigerant as noted above, one only has to open the first on-off valve 11a, close the second on-off valve 11b and set the ambient temperature of the refrigerant tank 10 at a level lower than the saturation temperature of the refrigerant corresponding to the condensing pressure. By this arrangement, the excess refrigerant is all contained in the refrigerant tank 10.

The operation of performing hot water supply without performing space heating is as follows. In this case, the first on-off valve 11a is closed and second on-off valve 11b is opened while the pressure in the refrigerant tank 10 falls. By placing the refrigerant tank 10 in a space of an ambient temperature higher than the saturation temperature of the refrigerant corresponding to the pressure (vaporizing pressure) on a lower pressure side of the refrigeration circuit, it is possible to cause the refrigerant in the refrigerant tank 10 to

vaporize, and the refrigerant tank 10 is filled with only the refrigerant in a gaseous state, thereby increasing the effective amount of the refrigerant flowing through the refrigeration circuit in circulation.

A hot water supply and space cooling operation will now be described. By bringing the four-way valve 2 to a broken line position shown in Fig. 1, the refrigerant can be made to flow in the directions of broken line arrows. The refrigerant of high temperature and pressure released from the compressor 1 first gives off heat in the first indoor heat exchanger 4 for hot water supply, and then flows through the four-way valve 2 into the outdoor heat exchanger 7 where it gives off heat and condenses into a liquid state. The refrigerant in a liquid state has its pressure reduced by the expansion valve 8 and absorbs heat in the second indoor heat exchanger 6 to vaporize into a gaseous state. The gaseous refrigerant returns to the compressor 1 through the four-way valve 2.

The operation of simultaneously performing space cooling and hot water supply in the aforesaid refrigeration circuit will be described. In this case, the amount of the refrigerant flowing in circulation through the refrigeration circuit is increased to fill the outdoor heat exchanger 7 with the liquid refrigerant. This results in almost no heat exchange taking place in the heat exchanger 7 between the heat source (such as outdoor air) and the refrigerant. Consequently, all the

energy of the gaseous refrigerant of high temperature can be released into the hot water supply heat accumulating tank 3, thereby increasing the hot water supply performance. To increase the amount of the refrigerant flowing through the refrigeration circuit in circulation, the pressure in the refrigerant tank 10 is lowered by opening the first on-off valve 11a and closing the second on-off valve 11b.

The operation of performing hot water supply without performing space cooling is as follows. The operation is similar to that described by referring to hot water supply and space cooling operation, and one only has to store unnecessary cooling capabilities in the space cooling and heating heat accumulating tank 5 in the form of accumulated heat.

The operation of performing space heating without performing hot water supply is as follows. In this case, the first on-off valve 11a is closed and second on-off valve 11b is opened to allow the refrigerant to collect in the refrigerant tank 10 and reduce the amount of the refrigerant flowing through the refrigeration circuit in circulation. As the amount of the refrigerant flowing in circulation through the refrigeration circuit decreases, the outdoor heat exchanger 7 functions as a condenser, so that the condenser increases in size becasue both the first indoor heat exchanger 4 and outdoor heat exchanger 7 both function as condensers. As a result, the condensing pressure (discharge pressure) falls. As the satutation temperature of the refrigerant falls to

a level below the water temperature t_1, almost no heat exchange takes place in the first indoor heat exchanger 4, thereby avoiding a further raise of the temperature t_1 of warm water in the hot water supply heat accumulating tank 3.

In the constructional form shown in Fig. 1 and described hereinabove, the first on-off valve 11a is connected to the conduit 6b and the second on-off valve 11b is connected to the conduit 7b. However, the connections of the first and second on-off valves 11a and 11b may be made as shown in a modification shown in Fig. 2.

In the modification shown in Fig. 2, the first on-off valve 11a' connected at one end thereof to one inlet and outlet port of the refrigerant tank 10 is connected at an opposite end thereof to the conduit 6a connecting the second indoor heat exchanger 6 to the four-way valve 2, and the second on-off valve 11b' connected at one end thereof to an opposite inlet and outlet port of the refrigerant tank 10 is connected at an opposite end thereof to the conduit 7a connecting the outdoor heat exchanger 7 to the four-way valve 2.

Even if the first and second on-off valves 11a' and 11b' are connected as described hereinabove, no change is caused to occur in the function of the refrigerant tank 10 which performs the function of regulating the amount of the sealed-in refrigerant as described by referring to the first embodiment shown in Fig. 1. Other parts of the modification shown in Fig. 2 are similar to

those shown in Fig. 1 and designated by like reference characters, so that their detailed description will be omitted.

In another modification of the embodiment shown in Fig. 1, the first on-off valve 11a' may be located in a solid line position and the second on-off valve 11b may be located in a broken line position. In still another modification, the second on-off valve 11b' may be located in a solid line position and the first on-off valve 11a may be located in a broken line position.

Fig. 3 shows another embodiment of the space cooling and heating and hot water supplying apparatus in accordance with the invention, which is distinct from the embodiment shown in Fig. 1 in that a third on-off valve 21 for bypassing is connected in parallel with the expansion valve 8, and a parallel circuit of a second expansion valve 22 and a fourth on-off valve 23 for bypassing is connected to the conduit 7a connecting the outdoor heat exchanger 7 and four-way valve 2 together. Other parts are similar to those shown in Fig. 1 and designated by like reference characters, so that their detailed description will be omitted. In the figure, solid line arrows indicate the directions of flow of the refrigerant in a space heating mode and broken line arrows indicate the directions of flow of the refrigerant in a space cooling mode. When space cooling is not needed and only the hot water supply is needed in the space cooling operation, the refrigerant flows through the

second expansion valve 22 and third on-off valve 21 in directions indicated by double broken line arrows.

The embodiment shown in Fig. 3 operates in the same manner as described by referring to the embodiment shown in Fig. 1 in the operation of simultaneously performing space heating and hot water supply, the operation of performing space heating without performing hot water supply, the operation of performing hot water supply without performing space heating, the operation of simultaneously performing space cooling and hot water supply and the operation of performing space cooling without performing hot water supply. When the aforesaid operations are performed in the refrigeration circuit shown in Fig. 3, the third on-off valve 21 is closed and the fourth on-off valve 23 is opened.

The operation of performing hot water supply without performing space cooling will be described. The first on-off valve 11a is opened and the second on-off valve 11b is closed. When it is impossible to store, in the form of accumulated heat, cooling capabilities produced by the second indoor heat exchanger 6 for cooling (heating) or it is desired to avoid damage to the heat accumulating tank 5 or conduits which might occur when the water in the tank 5 freezes, the fourth on-off valve 23 is closed and the third on-off valve 21 is opened. At this time, the refrigerant flows in directions indicated by double broken lines. More specifically, the refrigerant of high temperature released from the

compressor 1 gives off heat in the first indoor heat exchanger 4 for hot water supply and is condensed into a liquid state, and the liquid refrigerant flows through the four-way valve 2 to the second expansion valve 22 where it has its pressure reduced. From the expansion valve 22, the refrigerant flows to the outdoor heat exchanger 7 where it absorbes heat from a heat source (such as air) and undergoes vaporization to change into gaseous refrigerant which flows through the third on-off valve 21 to the second indoor heat exchanger 6 for cooling (heating) where it is slightly super-heated before flowing through the four-way valve 2 to the compressor 1. As the refrigerant flows as described hereinabove, almost no cooling operation is performed by the second indoor heat exchanger 6, and freezing of the cold water in the heat accumulating tank 5 can be avoided, thereby keeping the parts from suffering damage.

In the constructional form shown in Fig. 3, the first on-off valve 11a is connected to the conduit 6b and the second on-off valve 11b is connected to the conduit 7b. However, the connections of the two on-off valves 11a and 11b may be made as shown in Fig. 4 which illustrates a modification of the embodiment shown in Fig. 3. In Fig. 4, the first on-off valve 11a' connected at one end thereof to the refrigerant tank 10 is connected at an opposite end thereof to the conduit 6a, and the second on-off valve 11b' connected at one end thereof to the refrigerant tank 10 is connected at an opposite end

thereof to the conduit 7a connecting a junction 25 of the second expansion valve 22 and the fourth on-off valve 23 to the four-way valve 2. The first on-off valve 11a' may be located in a solid line position, and the second on-off valve 11b may be located in a broken line position. Alternatively, the first on-off valve 11a may be located in a broken line position and the second on-off valve 11b' may be located in a solid line position. Other parts are similar to those which are shown in Fig. 3 and designated by like reference characters, so that their detailed description will be omitted. The refrigerant tank 10 shown in Fig. 4 performs the same function as the refrigerant tank 10 shown in Fig. 3 for regulating the amount of the refrigerant sealed in the refrigeration circuit.

CLAIMS

1. A space cooling and heating and hot water supplying apparatus comprising a compressor (1), a first indoor heat exchanger (3) for hot water supply connected at one end thereof to the compressor (1) at its discharge side via a conduit (1a), a second indoor heat exchanger (6) for space cooling and heating and an outdoor heat exchanger (7) each switchingly connected at one end thereof via a four-way (2) valve to an opposite end of the first indoor heat exchanger (3) and a suction side of the compressor (1) via conduits (7a, 1b, 4a, 6a),and an expansion valve (8) connecting together opposite ends of the second indoor heat exchanger (6) and outdoor heat exchanger (7) via conduits (6b, 7b), characterized by further comprising:

a first on-off valve (11a) and a second on-off valve (11b) operating in reverse actions connected at one end thereof to inlet and outlet ports of a refrigerant tank (10) for regulating the amount of a sealed-in referigerant and at an opposite end thereof to the lower pressure conduit (7b) and the higher pressure conduit (6b), respectively, connected together by the expansion valve (8) located at their boundary, and wherein the apparatus operates such that in a space heating mode, the refrigerant tank (10) is brought into communication with the lower pressure conduit (7b) when space heating and hot water supply are both needed and when only the hot water supply is needed, the refrigerant tank (10) is brought into communication with the higher pressure conduit (6b) when only the space heating is needed, and in a space cooling mode, the refrigerant tank (10) is brought into communication with the lower pressure conduit (7b) when space cooling and hot water supply are both needed and when only the hot water supply is needed, and the refrigerant tank (10) is brought into communication with the higher pressure conduit (6b) when only

the space cooling is needed.

2. A space cooling and heating and hot water supplying apparatus as claimed in claim 1, wherein the higher pressure conduits (6b) and lower pressure conduits (7b) comprise a conduit connecting the expansion valve (8) to the four-way valve (2) via the second indoor heat exchanger (6), and a conduit connecting the expansion valve (8) to the four-way valve (2) via the outdoor heat exchanger (7), respectively.

3. A space cooling and heating and hot water supplying apparatus as claimed in claim 1, wherein the first on-off valve (11a') is connected to the conduit connecting the expansion valve (8) to the four-way valve (2) via the second indoor heat exchanger (6), and the second on-off valve (11b') is connected to the conduit connecting the expansion valve (8) to the four-way valve (2) via the outdoor heat exchanger (7), and wherein in the space heating mode, the first on-off valve (11a') is closed and the second on-off valve (11b') is opened when space heating and hot water supply are both needed and when only the hot water supply is needed and the first on-off valve (11a') is opened and the second on-off valve (11b') is closed when only the space heating is needed, and in the space cooling mode, the first on-off valve (11a') is opened and the second on-off valve (11b') is closed when space cooling and hot water supply are both needed and when only the hot water supply is needed, and the first on-off valve (11a') is closed and the second on-off valve (11b') is opened when only the space cooling is needed.

4. A space cooling and heating and hot water supplying apparatus as claimed in claim 1, wherein the first indoor heat exchanger (3) is located within a heat accumulating tank (3) for hot water supply.

5. A space cooling and heating and hot water supplying apparatus as claimed in claim 1, wherein the second indoor heat exchanger (6) is located within a heat accumulating tank (5) for space cooling and heating.

6. A space cooling and heating and hot water supplying apparatus as claimed in claim 1, further comprising a third on-off valve (21) connected in parallel with the expansion valve (8) via a conduit, and a parallel circuit of a second expansion valve (22) and a fourth on-off valve (23) connected to a conduit (25) connecting the four-way valve (2) to the outdoor heat exchanger (7), and wherein in the space cooling mode, the third on-off valve (21) is opened and the fourth on-off (23) valve is closed when only the hot water supply is needed and in other operation modes, the third on-off valve (21) is closed and the fourth on-off valve (23) is opened.

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FIG. 1

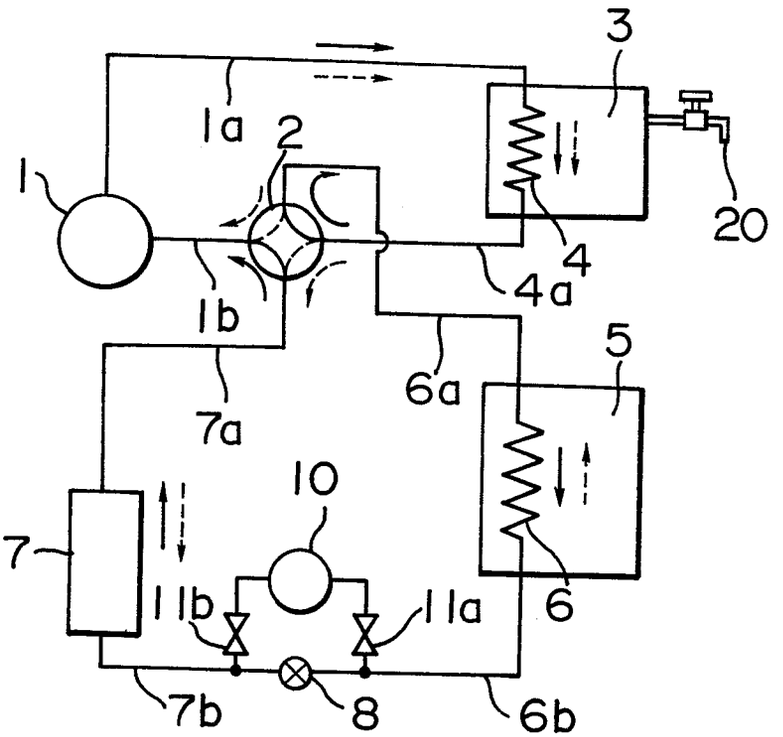

FIG. 2

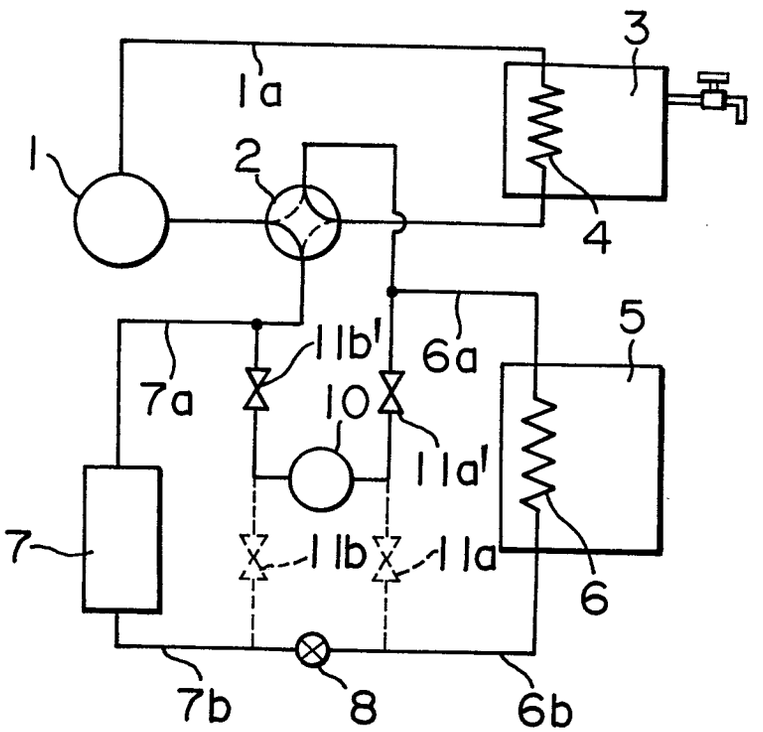

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FIG. 3

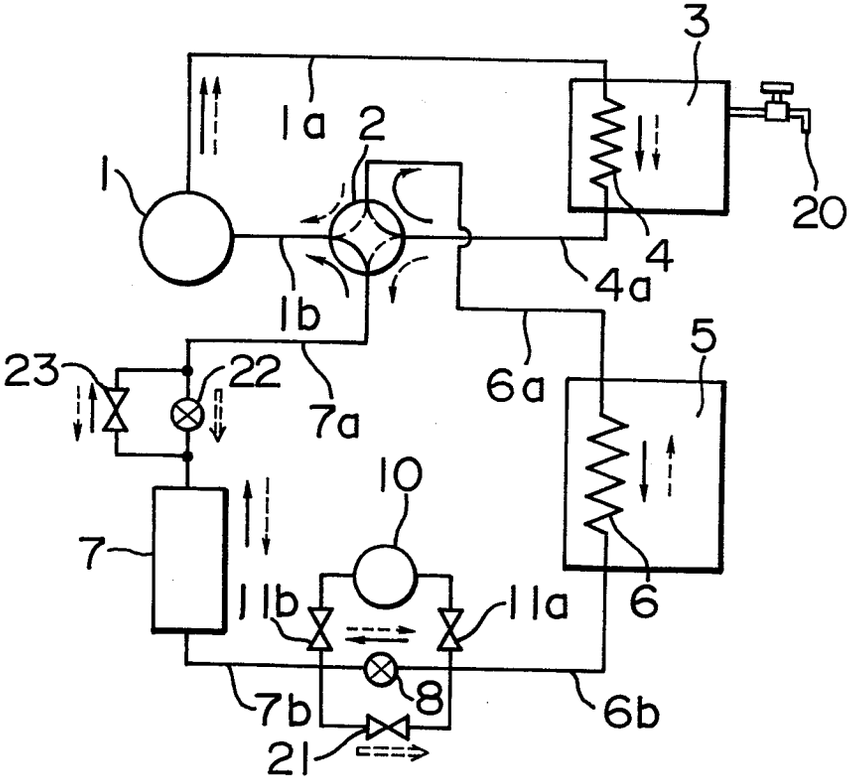

FIG. 4