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(54) Abstract Title: **REFRIGERATION CYCLE APPARATUS FOR VEHICLE USE.**

(57) A refrigeration cycle apparatus can provide heating or cooling to the passenger cabin 2 of a vehicle. The apparatus includes within a refrigerant fluid circuit, a compressor 10, a condenser 14, fluid control devices 13, 17, 22, a condenser bypass arrangement 15, and a cabin heat exchanger 5. The apparatus can function as a cooling device or as a heating device by providing the heat exchanger with either condensed and expanded refrigerant such that the heat exchanger functions as an evaporator, or providing the heat exchanger with high temperature refrigerant that has bypassed the condenser. While the heat exchanger is located in the cabin, the compressor, the condenser, the fluid control devices, and the bypass arrangement, are all located in the engine compartment 1. Therefore, a maximum of two conduits pass through the engine compartment bulkhead 3 into the passenger cabin for fluid supply and return from the heat exchanger. The fluid control devices include a temperature-compensated expansion valve 17 which includes a temperature detecting pressure chamber (56 fig 2) which may be insulated (24 fig 2) in order to reduce the influence of engine compartment temperature.

Fig. 1

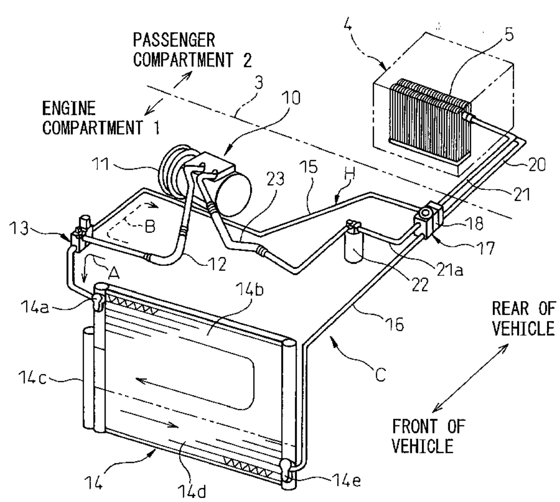

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Fig.1

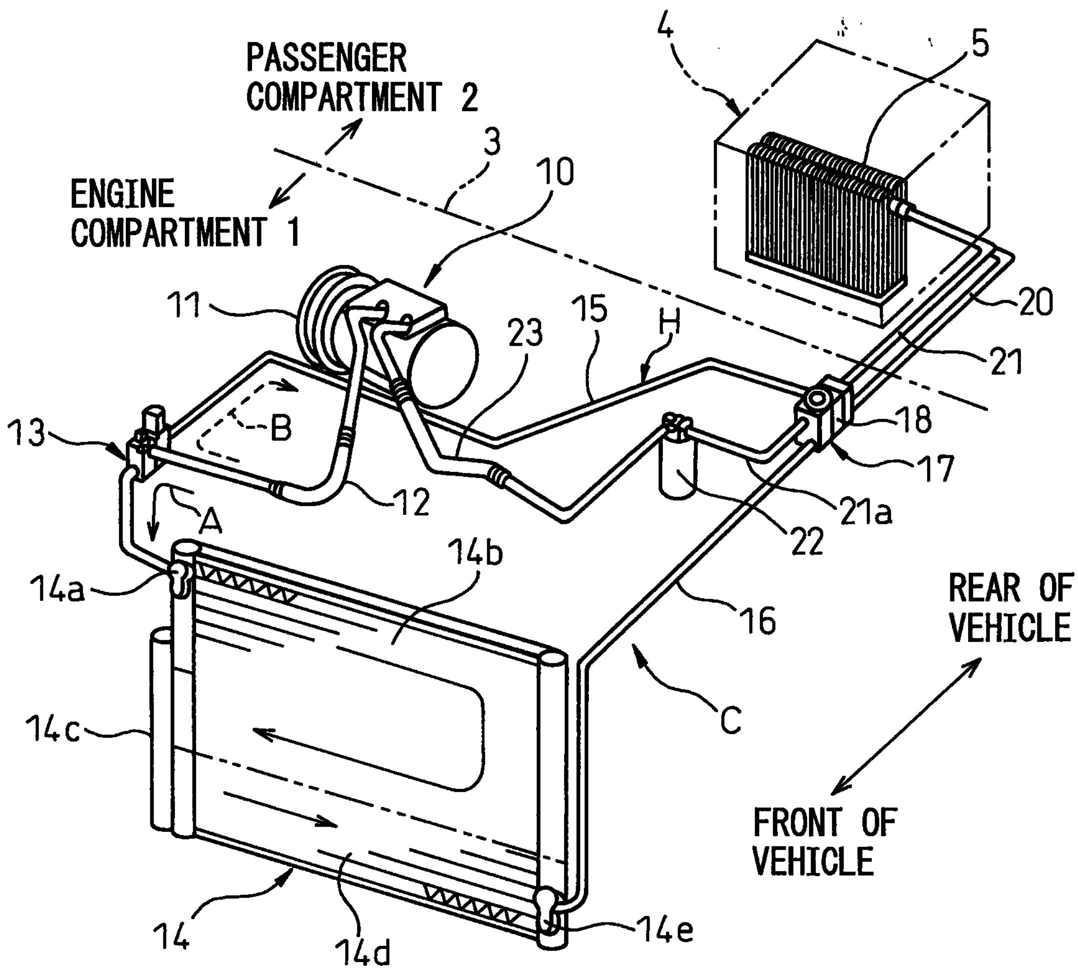

PASSENGER COMPARTMENT 2
ENGINE COMPARTMENT 1
3
4
5
10
11
12
13
14
14a
14b
14c
14d
14e
15
16
17
18
20
21
21a
22
23
A
B
C
H
REAR OF VEHICLE
FRONT OF VEHICLE

Fig.2

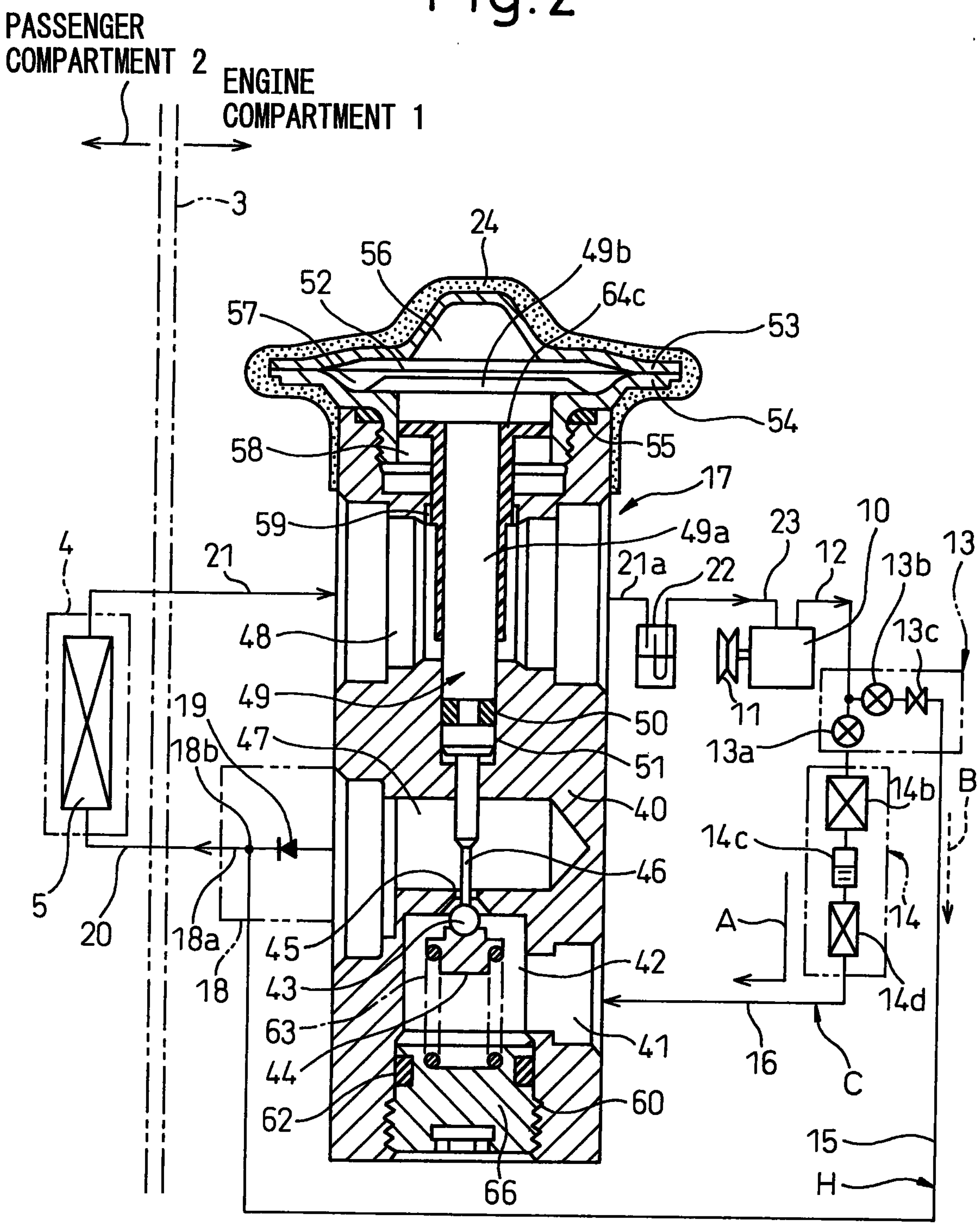

PASSENGER COMPARTMENT 2
ENGINE COMPARTMENT 1
3
24
56
49b
52
64c
57
53
54
58
55
17
59
49a
23
10
4
21
21a
22
12
13b
13
48
13c
11
49
50
19
47
51
18b
13a
40
B
14b
14c
46
5
20
18a
45
A
14
42
18
43
14d
63
41
16
44
C
62
60
15
66
H

Fig. 3

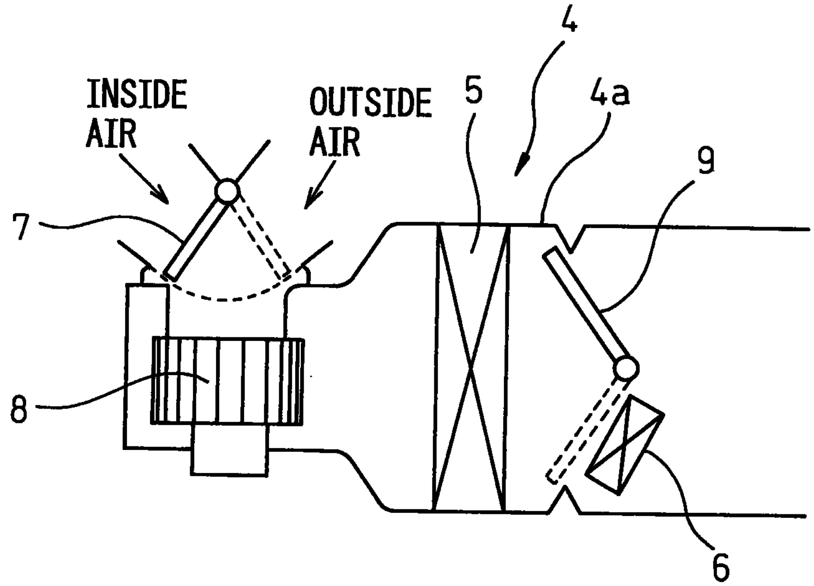

INSIDE AIR
OUTSIDE AIR
4
5
4a
9
7
8
6

Fig. 4

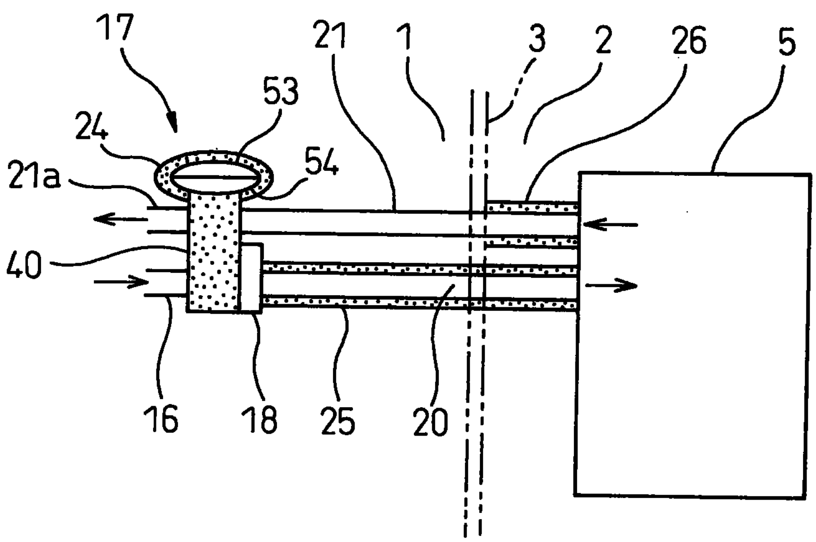

17
21
1
3
2
26
5
53
24
54
21a
40
16
18
25
20

Fig. 5A

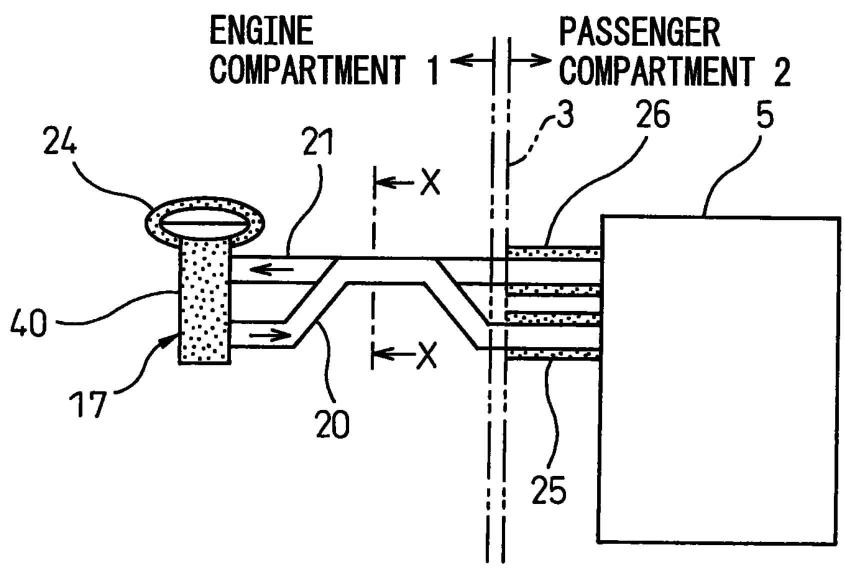
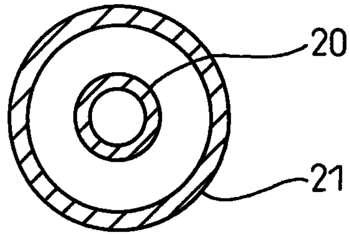


Fig. 5B



X – X

Fig. 6A

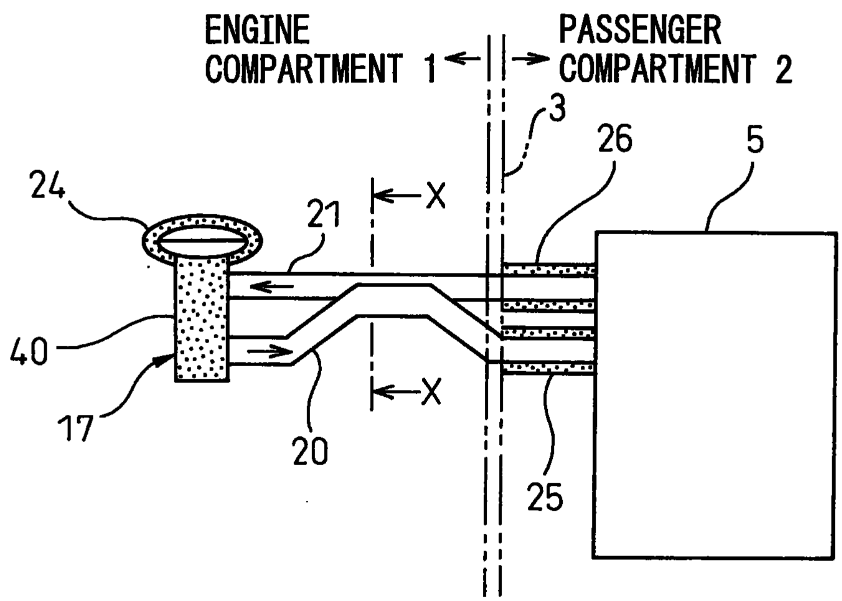
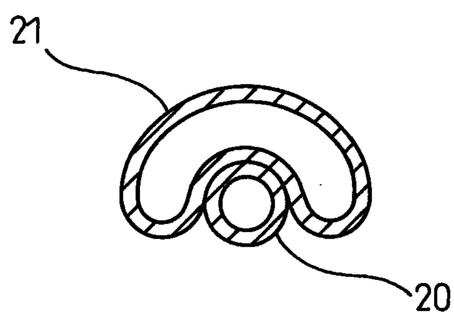
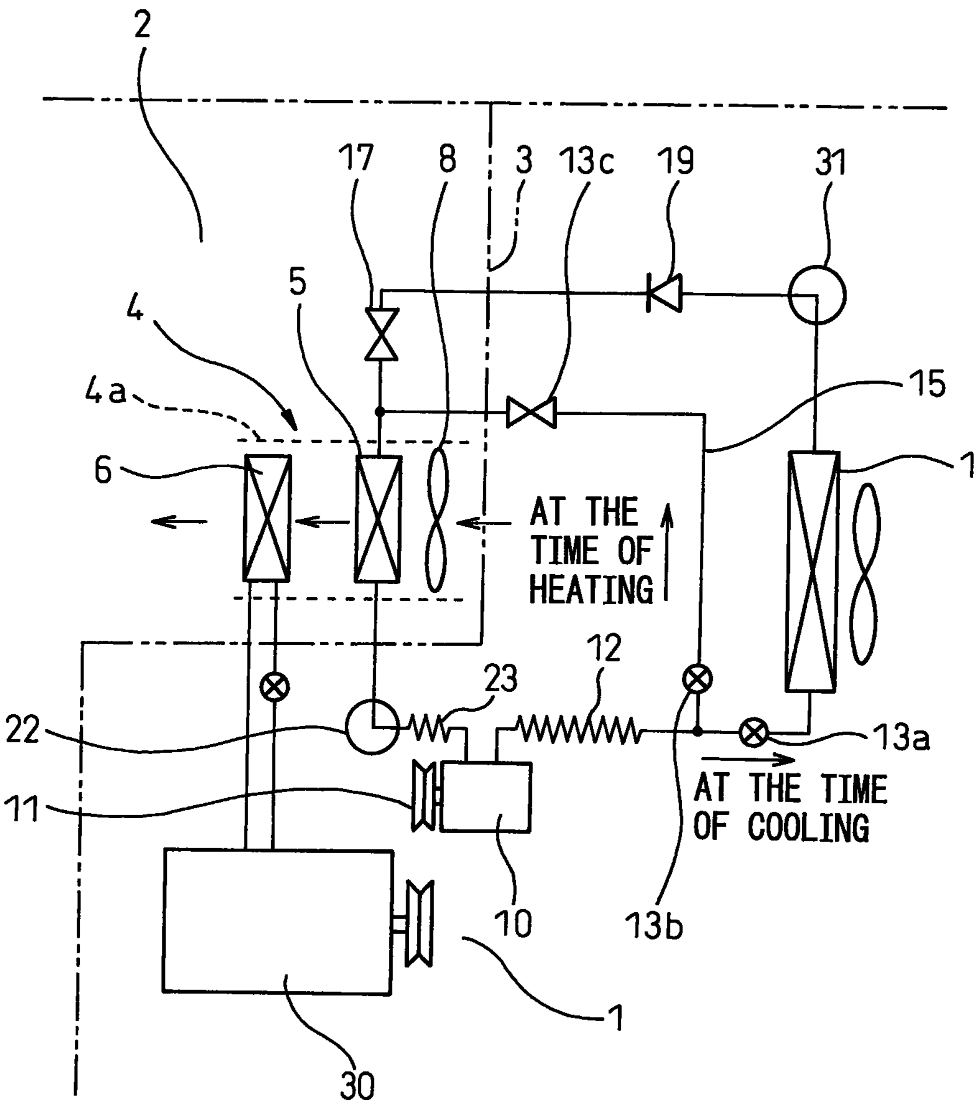


Fig. 6B



X−X

Fig.7


2
17
8
3
13c
19
31
5
4
4a
15
6
14
AT THE TIME OF HEATING
12
23
22
13a
AT THE TIME OF COOLING
11
10
13b
1
30

REFRIGERATING CYCLE DEVICE FOR VEHICLE USE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a refrigerating cycle device for vehicle use capable of exhibiting a hot gas heater function when an evaporator is used as a radiator for radiating heat from a gas refrigerant by directly introducing the gas refrigerant (hot gas), which has been discharged from a compressor at the time of heating, into the evaporator while the gas refrigerant is bypassing a condenser.

2. Description of the Related Art

In a conventional air conditioner for vehicle use, when a temperature of hot water (engine coolant), which is a heat source at the time of heating in winter, is low, a temperature of air blown into a passenger compartment is so lowered that it becomes impossible to obtain a necessary heating capacity, using the air conditioner.

In order to overcome this shortcoming, various refrigerating cycle devices have been conventionally proposed which are capable of exhibiting a heating function by bypassing hot gas. As shown in Fig. 7, this conventional device is composed as follows. On the discharge side of the compressor 10, the hot gas bypass pipe 15 is provided which bypasses the condenser 14, which is a radiator arranged on the high pressure side, and directly connects with the entrance side of the evaporator 5. The decompression device 13c for heating is provided in this hot gas bypass pipe 15. Further, the electromagnetic valve 13a for cooling to open and close the refrigerant passage to the condenser 14 is provided, and the electromagnetic valve 13b for heating to open and close the hot gas bypass pipe 15 is provided.

In the air conditioning unit 4, the hot water type heater core 6 for heating is arranged on the downstream side of the evaporator 5. At the time of heating in winter, when the temperature of hot water circulating in the heater core 6 for heating is lower than a predetermined temperature, that is, when the vehicle engine 30 starts and warms up, the electromagnetic valve 13a for cooling is closed and the electromagnetic valve 13b for heating is opened. Then the gas refrigerant at high temperature (hot gas), which has been just discharged from the compressor 10, is made to flow into the hot gas bypass pipe 15.

After this hot gas has been decompressed by the decompressing device 13c for heating, it is directly introduced into the evaporator 5, so that heat can be radiated from the gas refrigerant into the conditioned air by the evaporator 5. In this way, the heating function can be exhibited.

The receiver 31 is arranged on the downstream side of the condenser 14. In this receiver 31, gas and liquid contained in the refrigerant (saturated refrigerant partially containing gas refrigerant), which has passed through the condenser 14, are separated from each other and the redundant refrigerant is stored. At the time of heating conducted by hot gas, the gas refrigerant (hot gas) at high temperature discharged from the compressor 10 is directly introduced into the evaporator 5 via the hot gas bypass pipe 15. Therefore, the accumulator 22 (gas and liquid separator on the low pressure side) for separating gas and liquid contained in the refrigerant is arranged between the outlet of the evaporator 5 and the suction side of the compressor 10, and the gas refrigerant separated in this accumulator 22 is sucked into the compressor 10.

In this connection, in Fig. 7, the compressor 10, condenser 14, receiver 31, accumulator 22 and so forth, which compose the refrigerating cycle device, are arranged on the engine compartment 1 side in which the vehicle engine 30 is mounted. On the other hand, the temperature-type expansion valve 17, which composes a decompression device of the refrigerating cycle device, and the evaporator 5 are arranged in the passenger compartment 2.

In this connection, in the refrigerating cycle of the above conventional device, the receiver 31 functioning as a gas and liquid separator is arranged on the downstream side of the condenser 14. The receiver 31 is provided being based on a so-called receiver cycle. In the receiver cycle, in order to adjust a flow rate of the refrigerant according to the heat load given to the evaporator 5 at the time of cooling, the temperature-type expansion valve 17 for adjusting the flow rate of the refrigerant according to the degree of superheating of the refrigerant at the outlet of the evaporator 5 is used as a decompression device for cooling.

This temperature-type expansion valve 17 is arranged in the passenger compartment for the following reasons.

First, when the temperature-type expansion valve 17 is arranged in the engine compartment 1, it is impossible for the temperature-type expansion valve 17 to appropriately control the degree of superheating of the refrigerant at the outlet of the evaporator because the temperature-type expansion valve 17 is affected by the heat in the engine compartment 1. Specifically, the temperature-type expansion valve 17 is provided with a temperature detecting mechanism, which is a mechanism to detect the temperature of the refrigerant at the outlet of the evaporator and convert it to a change in the pressure, for controlling the degree of superheating of the refrigerant. However, if the temperature-type expansion valve 17 is arranged in the engine compartment 1, the temperature detecting mechanism of the temperature-type expansion valve 17 is affected by the radiant heat of the engine and any hot air in the engine compartment 1. Therefore, it becomes impossible to accurately detect the temperature of the refrigerant at the outlet of the evaporator. As a result, it becomes impossible to appropriately control the degree of superheating of the refrigerant at the outlet of the evaporator.

Secondly, if the temperature-type expansion valve 17 is arranged in the engine compartment 1, the two-phase refrigerant at low temperature on the low pressure side, which has been decompressed by the throttle passage in the temperature-type expansion valve 17, absorbs heat from the engine compartment 1, and the cooling performance of the evaporator 5 is deteriorated.

For the above first and the second reason, the temperature-type expansion valve 17 composing the decompression device for cooling is arranged in the passenger compartment 2 so that the problems caused by the heat in the engine compartment 1 can be avoided.

However, when the temperature-type expansion valve 17 composing the decompression device for cooling is arranged in the passenger compartment 2, the length of the hot gas pipe 15 is greatly extended. The reason can be described as follows. The devices on the cycle high pressure side such as the compressor 10, condenser 14 and receiver 31 are arranged in the engine compartment 1. Especially, the condenser 14 is arranged in the front portion of the engine compartment 1 so that any cooling air can be made to flow to the condenser 14. As the rubber hose 12 for absorbing vibration is provided right after the discharge port of the compressor 10, the inlet portion (inlet portion of the electromagnetic valve 13b for heating) of the hot gas bypass pipe 15 is located close to the condenser 14, that is, the inlet portion of the hot gas bypass pipe 15 is located at the front portion of the engine compartment 1. The outlet side of the hot gas bypass pipe 15 must be directly connected to the inlet side of the evaporator 5 while bypassing the temperature-type expansion valve 17.

As a result, the hot gas bypass pipe 15 is arranged from the front portion of the engine compartment 1 to the inlet side of the evaporator 5 in the passenger compartment 2, that is, the hot gas bypass pipe 15 becomes very long. Accordingly, when this long hot gas bypass pipe 15 is arranged in the confined engine compartment 1, the laying of the refrigerant pipe becomes complicated, which raises the manufacturing cost. Further, it becomes difficult to ensure space for the piping.

SUMMARY OF THE INVENTION

The present invention has been accomplished in view of the above points. It is an object of the present invention to enhance the property of mounting a refrigerating cycle device for vehicle use, in which a heating function is exhibited by the hot gas heater cycle, on a vehicle by simplifying an arrangement of laying the cycle pipe.

In order to accomplish the above object, according to a first aspect of the present invention, there is provided a refrigerating cycle device for vehicle use capable of changing over between a refrigerating cycle (C) for cooling and a hot gas heater cycle (H),

a decompressing device for cooling is a temperature-type expansion valve (17) including: a throttle passage (45) for decompressing and expanding the high pressure side refrigerant; a first pressure chamber (56), the pressure of which changes according to a temperature of the outlet refrigerant of the evaporator (5); a second pressure chamber (57) into which the refrigerant pressure of the evaporator (5) is introduced; a diaphragm (52) displaced by a pressure difference between the first pressure chamber (56) and the second pressure chamber (57); and a valve body (43) for adjusting the degree of opening of the throttle passage (45) according to a displacement of the diaphragm (52), wherein

the evaporator (5) is arranged in a passenger compartment (2) and the compressor (10), the high pressure side radiator (14) and the temperature-type expansion valve (17) are arranged in an engine compartment (1),

an outlet side of the throttle passage (45) is connected to an inlet side of the evaporator (5), an outlet portion of the hot gas bypass pipe (15) is joined to an outlet side of the throttle passage (45) in the engine compartment (1), and

at least a portion of the temperature-type expansion valve (17) in the periphery of the first pressure chamber (56) is covered with a heat-insulating material (24).

Due to the present invention, it is possible to arrange the entire hot gas bypass pipe (15) in the engine compartment (1). Accordingly, unlike the prior art shown in Fig. 7, it is unnecessary to arrange the hot gas bypass pipe (15) from the discharge side of the compressor (10) in the engine compartment (1) to the inside of the passenger compartment (2). Therefore, it becomes possible to reduce the length of the hot gas bypass pipe (15). For the above reasons, the arrangement of the cycle refrigerant pipe can be simplified, and the property of mounting the refrigerating cycle device on a vehicle can be enhanced.

According to the prior art shown in Fig. 7, it is necessary for three refrigerant pipes including the hot gas bypass pipe (15) to be penetrated through the vehicle bulkhead (3). However, according to the first aspect of the present invention, the number of the refrigerant pipes penetrating the vehicle bulkhead (3), which is provided between the engine compartment (1) and the passenger compartment (2), can be only two. The refrigerant pipes penetrating the vehicle bulkhead (3) are pipes (20, 21) arranged on the inlet side and the outlet side of the evaporator (5). Therefore, irrespective of the existence of the hot gas heater mechanism, the number of the through-holes for the refrigerant pipes formed on the vehicle bulkhead (3) can be advantageously standardized to be two.

On the other hand, when the temperature-type expansion valve (17) is arranged in the engine compartment (1), problems might be caused when the temperature-type expansion valve (17) is affected by heat generated in the engine compartment (1). However, according to the first aspect of the present invention, the problems can be solved as follows. At least, a peripheral portion of the first pressure chamber (56) composing the temperature detecting pressure chamber is covered with the heat insulating material (24). Therefore, the peripheral portion of the first pressure chamber (56) can be heat-insulated from the high temperature environment in the engine compartment (1).

Accordingly, even when the temperature-type expansion valve (17) is arranged in the engine compartment (1), pressure in the first pressure chamber (56) can be prevented from being raised by the influence of heat in the engine compartment (1), and pressure in the first pressure chamber (56) can be appropriately changed according to the temperature of the refrigerant at the outlet of the evaporator. Therefore, the function of controlling the degree of superheating of the refrigerant at the outlet of the evaporator, which is original to the temperature-type expansion valve (17), can be excellently exhibited.

According to a second aspect of the present invention, a portion of the pipe (20) for connecting the outlet side of the throttle passage (45) to the inlet side of the evaporator (5), the portion being located in the engine compartment (1), is covered with a heat-insulating material (25).

In this connection, when the temperature-type expansion valve (17) is arranged in the engine compartment (1), a portion of the inlet side pipe (20) of evaporator (5) is necessarily located in the engine compartment (1). Accordingly, the gas-liquid two phase refrigerant at low temperature and low pressure in the inlet side pipe (20) of evaporator (5) may absorb heat from the engine compartment (1) and the cooling performance may be deteriorated. However, according to the second aspect of the present invention, the inlet side pipe (20) is covered with the heat-insulating material (25), and the inlet side pipe (20) can be heat-insulated from the environment at high temperature in the engine compartment (1). Therefore, it is possible to prevent the gas-liquid two phase refrigerant at low temperature and low pressure in the inlet side pipe (20) from absorbing heat from the engine compartment (1), and deterioration of the cooling performance can be suppressed.

According to a third aspect of the present invention, the pipe (20) for connecting the outlet side of the throttle passage (45) to the inlet side of the evaporator (5) and the outlet side pipe (21) of the evaporator (20) may be made to come into contact with each other so that a portion of the pipe (20) for connecting the outlet side of the throttle passage (45) to the inlet side of the evaporator (5), the portion being located in the engine compartment (1), can be covered with a portion of the outlet side pipe (21) of the evaporator (5), the portion being located in the engine compartment (1).

In this connection, the outlet side pipe (21) of the evaporator (5) is kept in the state of a sufficiently low temperature compared with the environment of high temperature in the engine compartment (1). Therefore, according to the third aspect, attention is paid to this outlet side pipe (21) of the evaporator (5), and both the inlet side pipe (20) of the evaporator and the outlet side pipe (21) of the evaporator are contacted with each other so that a portion of inlet side pipe (20) located in the engine compartment can be covered with the outlet side pipe (21) of the evaporator. Therefore, even a portion of the inlet side pipe of evaporator is located in the engine compartment (1), it can be maintained in the state of a relatively low temperature being covered with the outlet side pipe (21) of evaporator.

Therefore, it is possible to prevent the gas-liquid two phase refrigerant at low temperature and low pressure in the inlet side pipe (20) from absorbing heat from the engine compartment (1), and deterioration of the cooling performance can be suppressed.

According to a fourth aspect of the present invention, a portion of the pipe (20) for connecting the outlet side of the throttle passage (45) to the inlet side of the evaporator (5), the portion being located in the engine compartment (1), and a portion of the outlet side pipe (21) of the evaporator (5), the portion being located in the engine compartment (1), may be composed of a double pipe structure, the pipe (20) on the evaporator inlet side may be composed of an inner pipe of the double pipe structure, and the evaporator outlet side pipe (21) may be composed of an outer pipe of the double pipe structure.

Due to the above structure, the outlet side pipe (21) of the evaporator composing an outer pipe of the double pipe structure can cover the inlet side pipe (20) of the evaporator composing an inner pipe of the double pipe structure. Therefore, even a portion of the inlet side pipe (20) of the evaporator is located in the engine compartment (1), it can be maintained in the state of a relatively low temperature being covered with the outlet side pipe (21) of evaporator. Therefore, it is possible to prevent the gas-liquid two phase refrigerant at low temperature and low pressure in the inlet side pipe (20) from absorbing heat from the engine compartment (1), and deterioration of the cooling performance can be suppressed.

According to a fifth aspect of the present invention, a joint portion (18) is provided in the temperature-type expansion valve (17) on the outlet side of the throttle passage (45), a refrigerant passage (18a) for communicating the outlet side of the throttle passage (45) with the inlet side of the evaporator (5) is formed in the joint portion (18), and an outlet portion of the hot gas bypass pipe (15) is joined to the refrigerant passage (18a).

According to a sixth aspect of the present invention, there is provided a refrigerating cycle device for vehicle use capable of changing over between a refrigerating cycle (C) for cooling and a hot gas heater cycle (H),

a decompressing device for cooling is a temperature-type expansion valve (17) including: a throttle passage (45) for decompressing and expanding the high pressure side refrigerant; a first pressure chamber (56), the pressure of which changes according to a temperature of the outlet refrigerant of the evaporator (5); a second pressure chamber (57) into which the refrigerant pressure of the evaporator (5) is introduced; a diaphragm (52) displaced by a pressure difference between the first pressure chamber (56) and the second pressure chamber (57); and a valve body (43) for adjusting the degree of opening of the throttle passage (45) according to a displacement of the diaphragm (52), wherein

the evaporator (5) is arranged in a passenger compartment (2), and the compressor (10), the high pressure side radiator (14) and the temperature-type expansion valve (17) are arranged in an engine compartment (1), and

an outlet side of the throttle passage (45) is connected to an inlet side of the evaporator (5), an outlet portion of the hot gas bypass pipe (15) is joined to an outlet side of the throttle passage (45) in the engine compartment (1).

Due to the above structure, the entire hot gas pipe (15) can be arranged in the engine compartment (1). Accordingly, in the same manner as that of the first aspect of the present invention, the length of the hot gas bypass pipe (15) can be reduced and the piping arrangement of the cycle refrigerant pipe can be simplified. Accordingly, the property of mounting the refrigerating cycle device on a vehicle can be enhanced.

The number of the refrigerating pipes penetrating the vehicle bulkhead (3), which is provided between the engine compartment (1) and the vehicle chamber (2), can be only two. They are the low pressure pipes (20, 21) provided on the inlet side and the outlet side of the evaporator (5).

According to a seventh aspect of the present invention, a joint portion (18) is provided in the temperature-type expansion valve (17) on the outlet side of the throttle passage (45), a refrigerant passage (18a) for communicating the outlet side of the throttle passage (45) with the inlet side of the evaporator (5) is formed in the joint portion (18), and an outlet portion of the hot gas bypass pipe (15) is joined to the refrigerant passage (18a).

Incidentally, the reference numerals in parentheses, to denote the above means, are intended to show the relationship of the specific means which will be described later in an embodiment of the invention.

The present invention may be more fully understood from the description of preferred embodiments of the invention set forth below, together with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

Fig. 1 is a perspective view showing an outline of the state of mounting a refrigerating cycle device of the first embodiment of the present invention on a vehicle;

Fig. 2 is an arrangement view of the refrigerating cycle including a sectional arrangement view of the expansion valve of the first embodiment;

Fig. 3 is a sectional view showing an outline of the interior air conditioning unit of the first embodiment;

Fig. 4 is an arrangement view of the refrigerant pipe, which is provided between the expansion valve and the evaporator, in the first embodiment;

Fig. 5A is an arrangement view of the refrigerant pipe, which is provided between the expansion valve and the evaporator, in the second embodiment;

Fig. 5B is a sectional view taken on line X - X in Fig. 5A;

Fig. 6A is an arrangement view of the refrigerant pipe, which is provided between the expansion valve and the evaporator, in the third embodiment;

Fig. 6B is a sectional view taken on line X - X in Fig. 6A; and

Fig. 7 is an arrangement view showing an outline of the refrigerating cycle for vehicle use of the prior art.

DESCRIPTION OF PREFERRED EMBODIMENTS

First, the first embodiment will be explained below. Fig. 1 is a perspective view showing an outline of the state of mounting a refrigerating cycle device of the first embodiment on a vehicle, and Fig. 2 is an arrangement view of the refrigerating cycle of the refrigerating cycle device for vehicle use of the first embodiment, wherein a specific structure of the temperature-type expansion valve is exemplarily shown in this view.

In a vehicle to which the first embodiment of the present invention is applied, the engine compartment 1, which is located on the front side of the vehicle, and the passenger compartment 2, which is located on the rear side of the vehicle, are separated from each other by the vehicle bulkhead (fire wall) 3. In the neighborhood of the front portion of the passenger compartment 2, in other words, in the side portion right after the vehicle bulkhead 3, the interior air conditioning unit 4 for the air conditioner for vehicle use is arranged. In the interior air conditioning unit 4, the evaporator 5 of the refrigerating cycle device is arranged. This evaporator 5 functions as a cooler at the time of the cooling mode and also functions as a radiator at the time of the heating mode.

Fig. 3 is a view showing an outline of the interior air conditioning unit 4. This interior air conditioning unit 4 includes a case 4a composing a passage in which air flows into the passenger compartment 2. In this case 4a, the heater core 6 composing a heat exchanger for heating is arranged on the downstream side of air flow of the evaporator 5. This heater core 6 heats air by hot water (engine coolant) supplied from a vehicle engine (not shown) arranged in the engine compartment 1.

This interior air conditioning unit 4 is operated as follows. The interior air conditioning unit 4 blows the outside air (air outside the passenger compartment) or the inside air (air inside the passenger compartment), which is introduced being changed by the inside and outside air changeover door 7, to the evaporator 5 side by the centrifugal electric fan 8. After the thus blown air has passed through the evaporator 5 and the heater core 6, it is blown out from one of the face opening portion, the foot opening portion and the defroster opening portion, which are not shown in the drawing, into the passenger compartment. Alternatively, the thus blown air is blown out from a plurality of the face opening portion, the foot opening portion and the defroster opening portion into the passenger compartment. The temperature of air blown out into the passenger compartment is adjusted by a well-known air mixing door 9.

Devices except for the evaporator 5 of the refrigerating cycle device used for vehicle air conditioning, that is, the compressor 1, the changeover valve 13, the condenser 14, the temperature-type expansion valve 17 and the accumulator 22 are arranged in the engine compartment 1. The compressor 10 is driven and rotated by a vehicle engine not shown, which is arranged in the engine compartment 1, via the electromagnetic clutch 11.

The discharge side of the compressor 10 is connected to the changeover valve device 13 via the rubber hose 12. As shown in Fig. 2, this changeover valve device 13 includes: a valve 13a for cooling arranged in the inlet passage of the condenser 14; and a valve 13b for heating arranged in the inlet portion of the hot gas bypass pipe 15. Therefore, this changeover valve device 13 distributes the refrigerant, which has been discharged from the compressor 10, between the inlet side of the condenser 14 and the inlet side of the hot gas bypass pipe 15.

The changeover valve device 13 includes an electromagnetic mechanism not shown. By the signal of turning on and off this electromagnetic mechanism, the valve 13a for cooling and the valve 13b for heating can be electrically controlled to be opened or closed. On the outlet side of the valve 13b for heating, the decompressing device 13c for heating, which is composed of a fixed throttle such as an orifice or capillary tube, is arranged as shown in Fig. 2.

The condenser 14 composes a high pressure side radiator for radiating heat of the refrigerant, which has been discharged from the compressor, into the outside air blown by the electric cooling fan not shown. The condenser 14 has the inlet joint 14a into which the refrigerant, which has been discharged from the compressor, is introduced via the passage of the valve 13a for cooling. The refrigerant, which has been discharged from the compressor and sent from this inlet joint 14a, is condensed by the condensing section 14b. Gas and liquid refrigerant, which has passed through this condensing section 14b, is separated by the gas and liquid separator 14c. The liquid refrigerant separated in this gas and liquid separator 14c is supercooled by the supercooling section 14d. At the outlet section of this supercooling section 14d, the outlet joint 14e is arranged, and the supercooled liquid refrigerant is made to flow out from this outlet joint 14e.

This outlet joint 14e is connected to the temperature-type expansion valve 17 composing a decompressing device for cooling. As is well known, in this temperature-type expansion valve 17, the degree of valve opening is adjusted so that the degree of superheating of the outlet refrigerant of the evaporator 5 can be a predetermined value so as to adjust a flow rate of the refrigerant. In this case, referring to Fig. 2, a specific example of the structure of the temperature-type expansion valve 17 will be explained below. The main body case 40 of the expansion valve 17 is made of metal such as aluminum and formed into a rectangular parallelepiped. On the right of the lower portion of this main body case 40, the refrigerant inlet 41 is open, into which the high pressure liquid refrigerant flows from the high pressure liquid pipe 16.

This refrigerant inlet 41 is communicated with the valve body accommodating chamber 42. In this valve body accommodating chamber 42, the spherical valve body 43 of the expansion valve 17 and the support member 44 for supporting this valve body 43 are accommodated. This valve body 43 is arranged being opposed to the throttle passage 45 for decompressing the liquid refrigerant sent from the refrigerant inlet 41. The degree of opening of this throttle passage 45 is adjusted by the valve body 43.

The valve rod 46 is arranged penetrating the center of the throttle passage 45. A lower end portion of this valve rod 46 comes into contact with the spherical valve body 43. On the downstream side of the throttle passage 45, the refrigerant flow-out passage 47 is formed, in which the gas and liquid two phase refrigerant at low temperature and low pressure, which has passed through the throttle passage 45 and been decompressed, flows.

In the main body case 40, the confluence joint 18 is integrally attached to the face (the left face shown in Fig. 2). In this confluence joint 18, the refrigerant passage 18a communicating with the outlet side of the refrigerant flow-out passage 47 is formed. This refrigerant passage 18a is connected to the outlet section of the hot gas bypass pipe 15. In the refrigerant passage 18a inside this confluence joint 18, the check valve 19 is arranged on the upstream side of the confluence point 18b of the outlet section of the hot gas bypass pipe 15.

This check valve 19 is provided for the object of preventing hot gas, which has been sent from the hot gas bypass pipe 15 at the time of heating mode, from passing through the inside of the expansion valve 17 and flowing onto the condenser 14 side. The refrigerant passage 18a in the confluence joint 18 is connected to the inlet side low pressure pipe 20. This inlet side low pressure pipe 20 penetrates the vehicle bulkhead 3 and connects with the refrigerant inlet section of the evaporator 5 provided in the passenger compartment 2.

On the other hand, in the main body case 40, in an upper portion of the refrigerant flow-out passage 47, the evaporator outlet side passage 48 is formed in such a manner that the evaporator outlet side passage 48 cylindrically penetrates the upper portion of the refrigerant flow-out passage 47 in the lateral direction. In this evaporator outlet side passage 48, the superheated refrigerant gas flows which has evaporated in the evaporator 5. Therefore, the inlet end (the left end shown in Fig. 2) of the evaporator outlet side passage 48 is connected to the refrigerant outlet section of the evaporator 5 by the outlet side low pressure pipe 21 which is arranged penetrating the vehicle bulkhead 3.

The outlet end (the right end shown in Fig. 2) of this evaporator outlet side passage 48 is connected to the accumulator 22 by the outlet side low pressure pipe 21a. The outlet section of this accumulator 22 is connected to the suction port of the compressor 10 via the rubber hose on the suction side. In this accumulator 22, gas and liquid in the refrigerant are separated from each other, and the liquid refrigerant is stored, and the gas refrigerant and a small quantity of liquid refrigerant, in which oil is dissolved, stored in the bottom portion of the accumulator 22 is returned to the suction side of the compressor 10.

In the main body case 40 of the expansion valve 17, the temperature detecting rod 49 is arranged which penetrates the evaporator outlet side passage 48. This temperature detecting rod 49 is formed into a columnar shape made of metal, the heat conductivity of which is high, such as aluminum. Since this temperature detecting rod 49 is located in a current of the superheated gas refrigerant in the evaporator outlet side passage 48, heat is conducted from the superheated gas refrigerant to the temperature detecting rod 49. Therefore, the temperature of the temperature detecting rod 49 becomes the same as that of the superheated gas refrigerant. Accordingly, the temperature detecting rod 49 functions as a temperature detecting means for detecting the temperature of the superheated gas refrigerant.

Specifically, this temperature detecting rod 49 includes: a shaft section 49a penetrating the evaporator outlet side passage 48; and a diaphragm stopper section 49b coming into contact with the diaphragm 52 described later.

A lower end face of the shaft section 49a of the temperature detecting rod 49 comes into contact with an upper end face of the valve rod 46. In the outer circumferential groove section in the neighborhood of the lower end section of the shaft section 49a of the temperature detecting rod 49, the O-ring 50 for sealing is arranged. Therefore, the temperature detecting rod 49 is air-tightly, slidably engaged in the hole 51 formed in the main body case 40.

The diaphragm stopper section 49b formed in the upper end portion of the temperature detecting rod 49 comes into contact with the diaphragm (the member moved according to pressure) 52 arranged on the outer face side in the uppermost portion of the main body case 40. Accordingly, when this diaphragm 52 is vertically displaced, the valve body 43 is displaced via the columnar temperature detecting rod 49 and the valve rod 46 according to this displacement of the diaphragm 52. Therefore, the temperature detecting rod 49 also functions as a displacement transmitting member for displacing the valve body 43.

The outer circumferential edge section of the diaphragm 52 is supported by being interposed between the upper 53 and the lower diaphragm case member 54. These diaphragm case members 53, 54 are made of metal such as stainless steel (SUS 304) and joined into one body by means of welding or soldering. The lower side diaphragm case member 54 is fixed to the uppermost portion of the main body case 40 by means of screwing. The fixing portion of this lower side diaphragm case member 54 is air-tightly sealed by the elastic sealing member (packing) 55 made of rubber.

The space formed between the diaphragm case members 53, 54 is partitioned into the upper side chamber 56 and the lower side chamber 57 by the diaphragm 52. The upper side chamber 56 is an air-tightly closed space. In this upper side chamber 56, the same refrigerant gas as the refrigerant circulating in the refrigerating cycle is charged in a state in which gas and liquid are mixed with each other. The superheated gas refrigerant temperature at the evaporator outlet, which has been detected by the temperature detecting rod 49, is transmitted to the enclosed gas in the upper side chamber 56 via the diaphragm 52 made of metal. Therefore, this enclosed gas shows a change of the saturated pressure according to the superheated gas refrigerant temperature. Accordingly, the upper side chamber 56 composes a first pressure chamber of the present invention, that is, the upper side chamber 56 composes a temperature detecting pressure chamber.

In this connection, it is preferable that the diaphragm 52 is made of a highly elastic and tough material, the heat conductivity of which is high. In this connection, the lower side chamber 57 is communicated with the evaporator outlet side passage 48 via the gap formed in the periphery of the diaphragm stopper section 49b of the temperature detecting rod 49, the space 58 for introducing pressure formed in the lower portion of this gap and the annular communicating passage 59, and the refrigerant pressure in the evaporator outlet side passage 48 is introduced into the lower side chamber 57. Accordingly, the pressure in the lower side chamber 57 becomes substantially the same as the pressure in the passage 48. The lower side chamber 57 composes a second pressure chamber of the present invention.

On the other hand, in the lowermost portion of the main body case 40, the screw hole 60, which is open to the outside, is provided. The adjusting nut 61 is fixed by being screwed to this screw hole 60. O-ring 62 used for sealing air-tightly seals between this adjusting nut 61 and the screw hole 60.

The coil spring 63 is a spring means for pushing the valve body 43 in the valve closing direction and arranged between the adjusting nut 61 and the support member 44. When the fastening position of the adjusting nut 61 is adjusted, the attaching load generated by the coil spring 63 is adjusted so that the degree of superheating of the evaporator outlet refrigerator can be adjusted.

In this connection, in the temperature-type expansion valve 17, the heat insulating material 24 is attached to the outer faces of the upper 53 and the lower diaphragm case member 54. This heat insulating material 24 is provided for heat-insulating the upper side chamber 56 in which the refrigerant gas, the pressure of which changes according to the temperature of the evaporator outlet refrigerant, is enclosed. Accordingly, the heat insulating material 24 covers at least the peripheral portion of the upper side chamber 56.

However, in this embodiment, a face of the main body case 40, on which the refrigerant pipe connecting section is not arranged, is covered with the heat insulating material 24, so that various corrosive substances such as moisture can not attach to the main body case 40 made of a metal such as aluminum. Therefore, the corrosion resistant property can be enhanced. In the main body case 40, the right and the left face shown in Fig. 2 are faces on which the refrigerant pipe connecting section is provided. On the other hand, the refrigerant pipe is not connected to the face on the viewer's side in the direction perpendicular to the surface of Fig. 2 and further the refrigerant pipe is not connected to the face on the inner side in the direction perpendicular to the surface of Fig. 2. Therefore, the face on the viewer's side and the face on the inner side in the direction perpendicular to the surface of Fig. 2 are covered with the heat-insulating material 24. In this connection, the heat-insulating material 24, which is attached to both the diaphragm case members 53, 54 and the main body case 40 of the temperature-type expansion valve 17, is shown by small dots in Fig. 4.

In this embodiment, as shown in Fig. 4, the entire circumference of the outer circumferential face of the inlet side low pressure pipe 20, in which the low pressure gas-liquid two phase refrigerant flows from the throttle passage 45 of the expansion valve 17 after the refrigerant has been decompressed, is covered with the heat insulating material 25. This heat-insulating material 25 covers both the portion of the inlet side low pressure pipe 20 arranged in the engine compartment and the portion arranged in the passenger compartment 2. Due to the foregoing, deterioration of the cooling performance caused by the absorption of the low pressure gas-liquid two phase refrigerant in the inlet side low pressure pipe 20 can be prevented, and dewing caused on the pipe surface can be prevented.

In this connection, the superheated gas refrigerant right after the evaporation flows in the outlet side low pressure pipe 21 of the evaporator 5. Therefore, a quantity of heat absorbed by the refrigerant is much smaller than that of the inlet side low pressure pipe 20. Therefore, a portion of the outlet side low pressure pipe 21 arranged in the engine compartment 1 is not covered with the heat-insulating material. On the other hand, a portion of the outlet side low pressure pipe 21 arranged in the passenger compartment 2 is covered with the heat-insulating material 26 for the prevention of dewing on the pipe surface.

In the case where devices, on which dewing must not be caused, are arranged in the lower portion of the outlet side low pressure pipe 21 in the engine compartment 1, it is preferable that the portion of the outlet side low pressure pipe 21 arranged in the engine compartment 1 is covered with the heat-insulating material.

In this connection, concerning the specific material of the heat-insulating material 24, 25, it is preferable to use material capable of enduring against a temperature change from -40°C in winter to 120°C in summer. According to experiments made by the present inventors, it was confirmed that the foamed material of polypropylene is effectively used for the material capable of enduring against the above temperature change.

Concerning the position at which the expansion valve 17 is arranged in the vehicle engine compartment 1, in the case where a position of relatively good ventilation can be selected or alternatively a position distant from the vehicle engine can be selected, the temperature in the periphery of the expansion valve 17 is raised to only about 100°C. In the case where the maximum heat resistant temperature may be about 100°C as described above, the specific material of the heat-insulating material 24, 25 can be a foamed material of polyethylene.

In this connection, as the temperature in the passenger compartment is raised to only about 60°C even in summer, the temperature resistant property of the heat-insulating material 26 may be lower than that of the heat-insulating material 24, 26.

In Figs. 1 and 2, a closed circuit is formed, which starts from the discharge side of the compressor 10 and returns to the suction side of the compressor 10 via the valve 13a for cooling of the changeover valve device 13 → the condenser 14 → the throttle passage 45 of the temperature-type expansion valve 17 → the check valve 19 → the evaporator 5 → the evaporator outlet side passage 48 of the temperature-type expansion valve 17 → the accumulator 22. By this closed circuit, the common refrigerating cycle C for cooling can be composed.

On the other hand, a closed circuit is formed, which starts from the discharge side of the compressor and returns to the suction side of the compressor 10 via the valve 13b for heating of the changeover valve device 13 → the decompressing device 13c for heating → the hot gas bypass pipe 15 → the confluence joint 18 → the evaporator 5 → the evaporator outlet side passage 48 of the temperature-type expansion valve 17 → the accumulator 22. By this closed circuit, the hot gas heater cycle H for heating can be composed.

Operation of this embodiment composed as described above will be explained below. When the cooling mode is set by an air conditioner operation panel, not shown, the valve 13a for cooling of the changeover valve 13 is opened and the valve 13b for heating is closed by an air conditioner control unit not shown. Accordingly, the electromagnetic clutch 11 is connected. When the compressor 10 is driven by the vehicle engine, the discharge gas refrigerant discharged from the compressor 10 passes through the valve 13a for cooling which is open. Then, the refrigerant flows into the condenser 14.

In the condensing section 14b of the condenser 14, the compressor discharge gas refrigerant radiates heat into the outside air blown by a cooling fan not shown and condenses. After the refrigerant has passed through the condensing section 14b, gas and liquid contained in the refrigerant are separated from each other by the gas and liquid separator 14c, and only the liquid refrigerant is introduced into the supercooling section 14d. The thus introduced liquid refrigerant radiates heat again into the outside air and is supercooled.

This supercooled high pressure liquid refrigerant flows into the temperature-type expansion valve 17 and the pressure of the liquid refrigerant is reduced by the throttle passage 45. Therefore, the refrigerant is put into the two phase state of gas and liquid. Next, this low pressure refrigerant passes through the check valve 19 and flows into the evaporator 5 and absorbs heat from the conditioned air blown by the fan 8 and evaporates. The conditioned air cooled by the evaporator 5 blows out into the passenger compartment and cools it. The gas refrigerant evaporated by the evaporator 5 passes through the evaporator outlet side passage 43 in the temperature-type expansion valve 17 and the accumulator 22 and is sucked into the compressor 10 and compressed. Accordingly, in the cooling mode, the refrigerant circulates from the discharge side of the compressor 10 into the refrigerating cycle C for cooling, and the evaporator 5 conducts an air cooling function.

On the other hand, when the heating mode, which is conducted by the hot gas heater cycle H, is set by the air conditioner operation panel, the valve 13a for cooling is closed by the air conditioner control unit, and the electromagnetic valve 13b for heating is opened. Therefore, the hot gas bypass pipe 15 is opened. Therefore, the high temperature discharge gas refrigerant (hot gas) discharged from the compressor 10 passes through the valve 13b for heating which is open, and then the gas refrigerant flows into the hot gas bypass pipe 15.

As this compressor discharge gas refrigerant is decompressed by the decompressing device 13c for heating of the hot gas bypass pipe 15, the refrigerant directly flows into the evaporator 5 by the hot gas bypass pipe 15. The thus decompressed gas refrigerant radiates heat into the air blown to the evaporator 5, so that the air can be heated. In this case, a quantity of heat emitted from the gas refrigerant in the evaporator 5 corresponds to a work load of compression of the compressor 10. The gas refrigerant, the heat of which has been radiated by the evaporator 5, passes through the evaporator outlet side passage 48 in the temperature-type expansion valve 17 and the accumulator 22 and is sucked into the compressor 10 and compressed. Accordingly, at the time of the heating mode, the refrigerant circulates from the discharge side of the compressor 10 into the aforementioned hot gas heater cycle H, and the evaporator 5 conducts an action of heating air.

Since the blown air, which has been heated by the evaporator 5, can be further heated by the heater core 6, the air of higher temperature heated by both the evaporator 5 and the hot water type heater core 6 can be blown out into the passenger compartment 2 even in a very cold season.

In this connection, at the time of the heating mode, the gas refrigerant can be prevented from flowing from the hot gas bypass pipe 15 into the condenser 14 via the temperature-type expansion valve 17 by the check valve 19. Therefore, it is possible to prevent the refrigerant from staying in the condenser 14 exposed to the outside air at low temperature in winter.

Next, the operational effect of this embodiment will be explained as follows.

(1) The evaporator 5 is arranged in the passenger compartment 2, and the compressor 10, the condenser (the radiator on the high pressure side) 14 and the temperature-type expansion valve 17 are arranged in the engine compartment 1, and the outlet side of the throttle passage 45 of the temperature-type expansion valve 17 is connected to the inlet side of the evaporator 5. Further, the outlet section of the hot gas bypass pipe 15 is joined to the outlet side of the throttle passage 45 in the engine compartment 1. Therefore, the entire hot gas bypass pipe 15 can be arranged in the engine compartment 1.

Accordingly, different from the arrangement of the prior art shown in Fig. 7, it is unnecessary to arrange the hot gas bypass pipe 15 from the discharge side of the compressor 10 in the engine compartment 2 into the passenger compartment 2. Therefore, the length of the hot gas bypass pipe 15 can be reduced. Accordingly, the arrangement of the cycle refrigerant pipe can be simplified, and the property of mounting the refrigerating cycle device on a vehicle can be enhanced.

(2) According to the arrangement of the prior art shown in Fig. 7, three refrigerant pipes including the hot gas bypass pipe 15 must be arranged through the vehicle bulkhead 3. However, according to the present

embodiment, the number of the refrigerant pipes penetrating the vehicle bulkhead 3 between the engine compartment 1 and the passenger compartment 2 may be only two, that is, the number of the refrigerant pipes penetrating the vehicle bulkhead 3 may be the low pressure pipes 20, 21 provided on the inlet side and the outlet side of the evaporator 5. Therefore, irrespective of the existence of the hot gas heater, the number of the through-holes for the refrigerant pipe formed on the vehicle bulkhead 3 can be advantageously standardized to be two.

(3) In the case where the temperature-type expansion valve 17 is directly incorporated into the refrigerant inlet section of the evaporator 5, according to the existence of the hot gas heater mechanism, the shape of the case 4a (shown in Fig. 3) of the interior air conditioning unit 4 must be changed between the case in which the confluence joint 18 is provided and the case in which the confluence joint 18 is not provided. However, according to the present embodiment, the confluence joint 18 is integrated with the temperature-type expansion valve 17 in the engine compartment 1. Therefore, irrespective of the existence of the hot gas heater mechanism, the shape of the case 4a of the interior air conditioning unit can be standardized to be one type. Accordingly, the manufacturing cost of the case 4a of the interior air conditioning unit 4 can be reduced.

In this connection, in the interior air conditioning unit 4, when a profile of the temperature-type expansion valve 17 is utilized as a sealing member to prevent the leakage of any air or utilized as a member to regulate the position of the refrigerant pipe to be connected, a dummy block, the profile of which is the same as that of the temperature-type expansion valve 17, is incorporated into the interior air conditioning unit 4. This dummy block can exhibit a function of the sealing member to prevent the leakage of any air. This dummy block can also exhibit a function of the pipe position regulating member.

(4) When the temperature-type expansion valve 17 is arranged in the engine compartment 1, it may be affected by the heat in the engine compartment 1. However, according to the temperature-type expansion valve 17 of this embodiment, the peripheries of the diaphragm cases 53, 54 of the temperature-type expansion valve 17 are covered with the heat-insulating material 24. Therefore, the temperature of the refrigerant gas enclosed in the upper side chamber 56 of the diaphragm 52 can be prevented from being raised by the heat in the engine compartment 1.

Accordingly, even when the temperature-type expansion valve 17 is arranged in the engine compartment 1, the pressure in the upper side chamber 56, which composes a temperature detecting pressure chamber, can be prevented from being increased by the heat in the engine compartment 1. Therefore, it is possible to appropriately change the pressure in the upper side chamber 56 according to the temperature of the evaporator outlet refrigerant, and the superheating degree control function of controlling the evaporator outlet refrigerant, which is original to the temperature-type expansion valve 17, can be excellently exhibited.

In this connection, in this embodiment, the heat-insulating material 24 covers not only the peripheries of the diaphragm case members 53, 54 but also the main body case 40. Therefore, as described before, the corrosion-resistant property of the main body case 40 can be enhanced.

(5) When the temperature-type expansion valve 17 is arranged in the engine compartment 1, a portion of the inlet side pipe 20 of evaporator 5 is necessarily located in the engine compartment 1. Accordingly, the gas-liquid two phase refrigerant at low temperature and low pressure

in the inlet side pipe 20 of evaporator 5 may absorb heat from the engine compartment 1 and the cooling performance may be deteriorated. However, according to this embodiment of the present invention, the inlet side pipe 20 is covered with the heat-insulating material 25, and the inlet side pipe 20 can be heat-insulated from the environment of high temperature in the engine compartment 1. Therefore, it is possible to prevent the gas-liquid two phase refrigerant at low temperature and low pressure in the inlet side pipe 20 from absorbing heat from the engine compartment 1, and deterioration of the cooling performance can be suppressed.

Next, the second embodiment will be explained below. In the first embodiment, the heat-insulating material 25 covers the inlet side pipe 20 so that the evaporator inlet side refrigerant can be prevented from absorbing the heat from the engine compartment 1. However, in the second embodiment, the double pipe structure is adopted so that the evaporator inlet side refrigerant can be prevented from absorbing the heat from the engine compartment 1.

The gas refrigerant at a relatively low temperature, which has passed through the evaporator 5, flows in the outlet side pipe 21 of the evaporator 5, and this outlet side pipe 21 can be maintained at a relatively low temperature. Attention should be paid to this fact. In the second embodiment, portions of the inlet side pipe 20 and the outlet side pipe 21 of the evaporator 5, which are located in the engine compartment 1, are composed of a double pipe structure as shown in Figs. 5A and 5B, and the inlet side pipe 20 is composed of an inner pipe and the outlet side pipe 21 is composed of an outer pipe.

Due to the above structure, the heat absorption of the gas-liquid two phase refrigerant at low temperature and pressure in the inlet side pipe 20 can be excellently suppressed by the heat-shielding action of the outlet side pipe 21 of the outer pipe. For the above reasons, it becomes unnecessary to cover the portion of the inlet side pipe 20, which is located in the engine compartment 1, with the heat-insulating material 25.

In the case where devices, on which dewing must not be caused, are arranged in the lower portion of the inlet side pipe 20 and the outlet side pipe 21 in the engine compartment 1, it is preferable that the double pipe structure portion is covered with the heat-insulating material 25.

In this connection, in the second embodiment, a portion of the inlet side pipe 20, which is located in the passenger compartment 2, is covered with the heat-insulating material 25 so as to prevent the occurrence of dewing.

Finally, the third embodiment will be explained below. The third embodiment is a variation of the second embodiment. As shown in Figs. 6A and 6B, the inlet side pipe 20 and the outlet side pipe 21 are made to come into contact with each other so that the portion of the inlet side pipe 20 located in the engine compartment 1 can be covered with the portion of the outlet side pipe 21 located in the engine compartment 1. Due to this structure, the heat absorption of the inlet side pipe 20 from the engine compartment 1 can be suppressed.

In the third embodiment, a shape of the cross-section of the portion of the outlet side pipe 21 located in the engine compartment 1 is formed into an arcuate shape along the outer circumferential face of the inlet side pipe 20, so that a covered area (contacted area) of the inlet side pipe 20 by the outlet side pipe 21 can be increased.

While the invention has been described by reference to specific embodiments chosen for purposes of illustration, it should be apparent that numerous modifications could be made thereto by those skilled in the art without departing from the basic concept and scope of the invention.

CLAIMS

1. A refrigerating cycle device for vehicle use capable of changing over between a refrigerating cycle (C) for cooling in which a refrigerant discharged from a compressor (10) is returned to the compressor (10) via a high pressure side radiator (14), a decompressing device (17) for cooling and an evaporator (5), and a hot gas heater cycle (H) for heating in which the refrigerant discharged from the compressor (10) is directly introduced into the evaporator (5) by a hot gas bypass pipe (15) and returned to the compressor (10) so that the evaporator (5) can be activated as a radiator,

the decompressing device for cooling is a temperature-type expansion valve (17) including: a throttle passage (45) for decompressing and expanding the high pressure side refrigerant; a first pressure chamber (56), the pressure of which changes according to a temperature of the outlet refrigerant of the evaporator (5); a second pressure chamber (57) into which the refrigerant pressure of the evaporator (5) is introduced; a diaphragm (52) displaced by a pressure difference between the first pressure chamber (56) and the second pressure chamber (57); and a valve body (43) for adjusting the degree of opening of the throttle passage (45) according to a displacement of the diaphragm (52), wherein

the evaporator (5) is arranged in a passenger compartment (2), and the compressor (10), the high pressure side radiator (14) and the temperature-type expansion valve (17) are arranged in an engine compartment (1),

an outlet side of the throttle passage (45) is connected to an inlet side of the evaporator (5), an outlet portion of the hot gas bypass pipe (15) is joined to an outlet side of the throttle passage (45) in the engine compartment (1), and

at least a portion of the temperature-type expansion valve (17) in the periphery of the first pressure chamber (56) is covered with a heat-insulating material (24).

2. A refrigerating cycle device for vehicle use according to claim 1, wherein a portion of the pipe (20) for connecting the outlet side of the throttle passage (45) to the inlet side of the evaporator (5), the portion being located in the engine compartment (1), is covered with a heat-insulating material (25).

3. A refrigerating cycle device for vehicle use according to claim 1, wherein the pipe (20) for connecting the outlet side of the throttle passage (45) to the inlet side of the evaporator (5) and the outlet side pipe (21) of the evaporator (20) are made to come into contact with each other so that a portion of the pipe (20) for connecting the outlet side of the throttle passage (45) to the inlet side of the evaporator (5), the portion being located in the engine compartment (1), can be covered with a portion of the outlet side pipe (21) of the evaporator (5), the portion being located in the engine compartment (1).

4. A refrigerating cycle device for vehicle use according to claim 1, wherein a portion of the pipe (20) for connecting the outlet side of the throttle passage (45) to the inlet side of the evaporator (5), the portion being located in the engine compartment (1), and a portion of the outlet side pipe (21) of the evaporator (5), the portion being located in the engine compartment (1), are composed of a double pipe structure, the pipe (20) on the evaporator inlet side is composed of an inner pipe of the double pipe structure, and the evaporator outlet side pipe (21) is composed of an outer pipe of the double pipe structure.

5. A refrigerating cycle device for vehicle use according to claim 1, wherein a joint portion (18) is provided in the temperature-type expansion valve (17) on the outlet side of the throttle passage (45), a

refrigerant passage (18a) for communicating the outlet side of the throttle passage (45) with the inlet side of the evaporator (5) is formed in the joint portion (18), and an outlet portion of the hot gas bypass pipe (15) is joined to the refrigerant passage (18a).

6. A refrigerating cycle device for vehicle use capable of changing over between a refrigerating cycle (C) for cooling in which a refrigerant discharged from a compressor (10) is returned to the compressor (10) via a high pressure side radiator (14), a decompressing device (17) for cooling and an evaporator (5), and a hot gas heater cycle (H) for heating in which the refrigerant discharged from the compressor (10) is directly introduced into the evaporator (5) by a hot gas bypass pipe (15) and returned to the compressor (10) so that the evaporator (5) can be activated as a radiator,

the decompressing device for cooling is a temperature-type expansion valve (17) including: a throttle passage (45) for decompressing and expanding the high pressure side refrigerant; a first pressure chamber (56), the pressure of which changes according to a temperature of the outlet refrigerant of the evaporator (5); a second pressure chamber (57) into which the refrigerant pressure of the evaporator (5) is introduced; a diaphragm (52) displaced by a pressure difference between the first pressure chamber (56) and the second pressure chamber (57); and a valve body (43) for adjusting the degree of opening of the throttle passage (45) according to a displacement of the diaphragm (52), wherein

the evaporator (5) is arranged in a passenger compartment (2), and the compressor (10), the high pressure side radiator (14) and the temperature-type expansion valve (17) are arranged in an engine compartment (1), and

an outlet side of the throttle passage (45) is connected to an inlet side of the evaporator (5), an outlet portion of the hot gas bypass pipe (15) is joined to an outlet side of the throttle passage (45) in the engine compartment (1).

7. A refrigerating cycle device for vehicle use according to claim 6, wherein a joint portion (18) is provided in the temperature-type expansion valve (17) on the outlet side of the throttle passage (45), a refrigerant passage (18a) for communicating the outlet side of the throttle passage (45) with the inlet side of the evaporator (5) is formed in the joint portion (18), and an outlet portion of the hot gas bypass pipe (15) is joined to the refrigerant passage (18a).

8. A refrigerating cycle device for vehicle use, the device being constructed and arranged substantially as herein described and shown in the drawings.

Application No: GB0412904.5 **Examiner:** Mr Brian A Woods

Claims searched: 1-8 **Date of search:** 3 November 2004

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
A		US2004/074246 A (DENSO) See whole document noting a vehicle refrigeration cycle for heating and cooling of a cabin space, including a valve device 14 located within the engine compartment 29. Note in fig 1 that the front evaporator 32 has an associated fixed throttle expansion valve 24 in the engine compartment.
A		US2004/129008 A (PARKER) See whole document noting a temperature compensated expansion valve which is resistant to temperature variations and thus suitable for use in an engine compartment.
A		US6397613 A (DENSO) See whole document noting a vehicle refrigeration cycle for heating or cooling of a cabin space, including a temperature sensing expansion valve device 16.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{W} :

F4H

Worldwide search of patent documents classified in the following areas of the IPC^{07}

B60H; F25B

The following online and other databases have been used in the preparation of this search report

WPI:EPODOC:JAPIO