WSM KX121-3,161-3

VI Optional Unit : Air Conditioner

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Mechanism Section

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A.Air Condition System

a. Introduction of air conditioner

(1) Principle of Air Conditioner

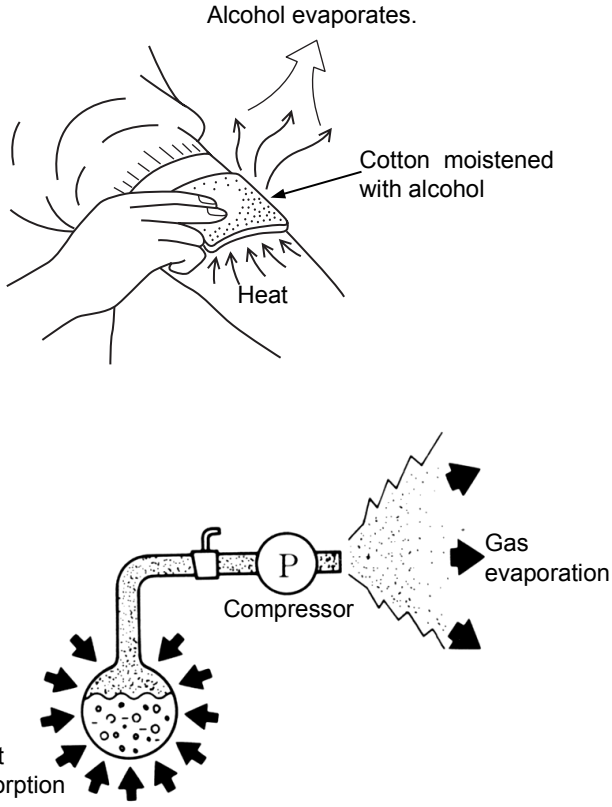
When your hand is wet and exposed to the wind or when you disinfect your hand with alcohol, you should feel your skin being cooled. This is because water or alcohol draws heat from your skin when it evaporates.

Air conditioners operate on this principle, using "Freon" as a refrigerant instead of water and alcohol.

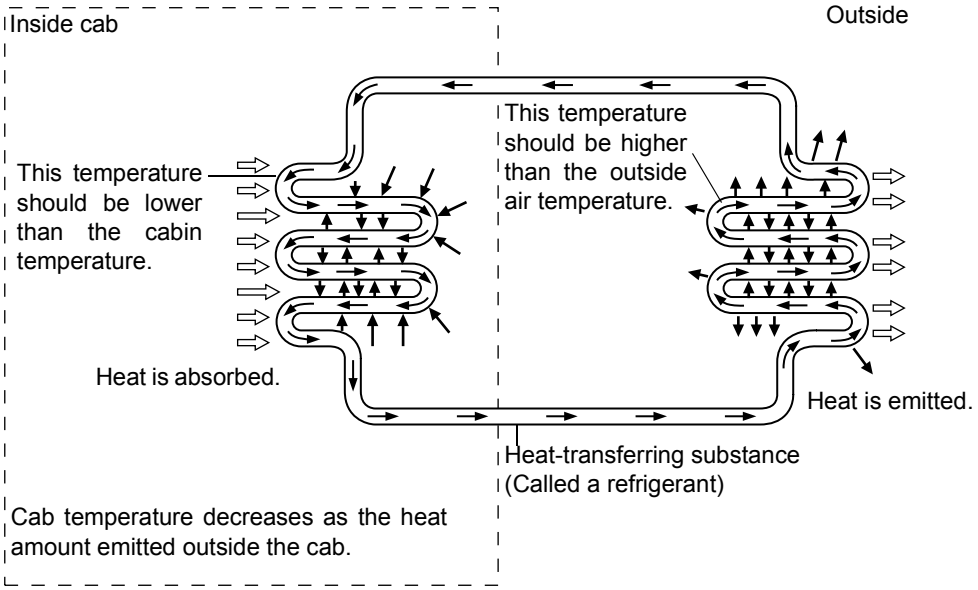
To cool the cabin of a vehicle in hot summer, the air conditioner of a vehicle is a device to absorb heat in the cabin and emit it out of the vehicle. Heat will transfer from high temperatures to low temperatures. In summer, inconveniently the temperature outside the vehicle is higher than the temperature of the cabin from which heat should be transferred. If the temperature outside the vehicle is lower, just opening the windows will emit heat out of the vehicle and cool the cabin immediately.

Trying to emit heat out of the vehicle in hot summer when the temperature outside the vehicle is higher than inside is to fight against the natural phenomenon. It seems that man likes to fight against nature and has been accumulating wisdom and expending enormous efforts to do so.

The air conditioner is the fruit of man's wisdom, which is a device that consumes important energy accordingly.



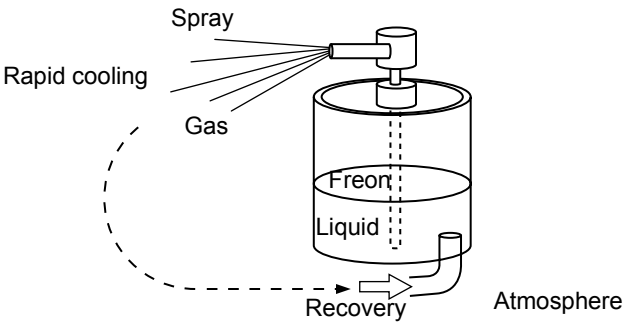
Cooling the cabin of the vehicle means emitting heat out of the vehicle. The air conditioner is a device to absorb heat in the cabin and emit it out of the vehicle.



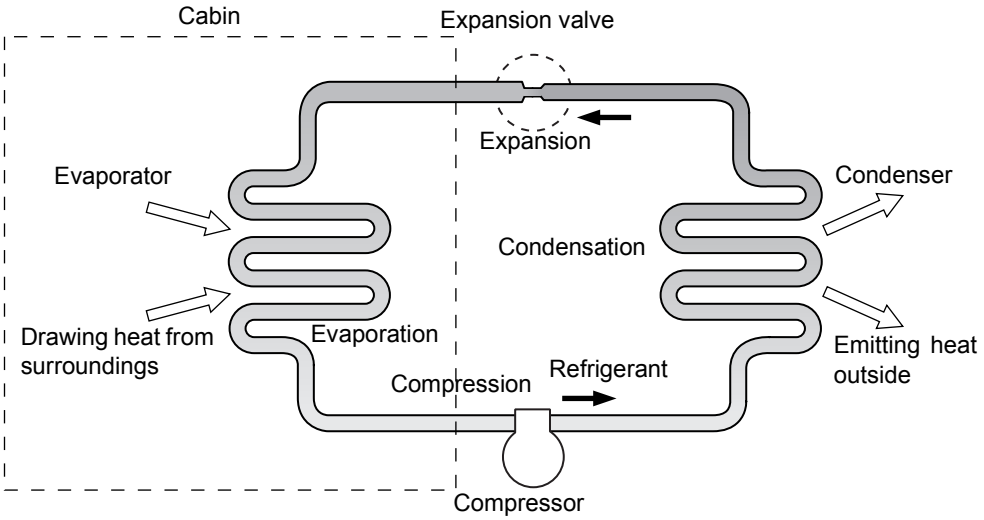
The figure in the left shows the principle of the air conditioning system to lower the temperature of the cabin by emitting heat out of the vehicle. Because heat transfers from high temperatures to low temperatures, the temperature in the piping should be lower than the cabin temperature inside the vehicle and higher than the atmospheric temperature outside the vehicle.

(2) Change of State of Refrigerant

The concept of the air conditioning system is as follows. When liquid Freon is sprayed, it expands and turns into very cold gas. It is so cold that it freezes and looks snow-white (even under atmospheric pressure). If the sprayed Freon is left as it is, it will be lost. It should be therefore recovered and reused. Freon continues to carry out a cooling function while changing its state from liquid to gas and vice versa.

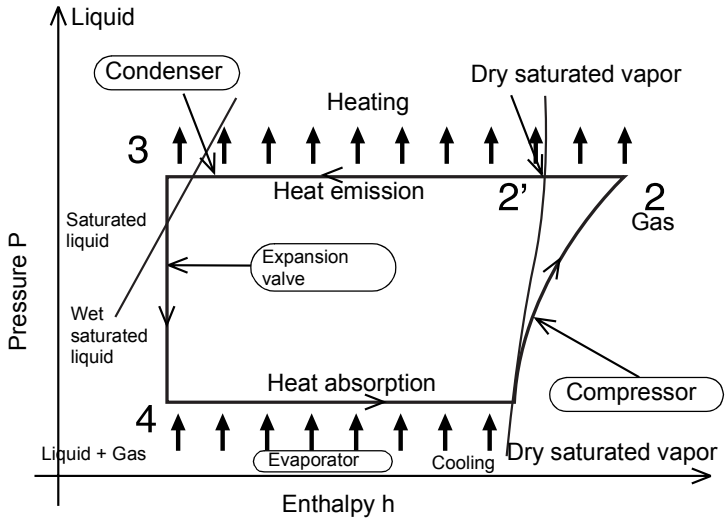


The temperature of the refrigerant should be lower than the cabin temperature inside the vehicle and higher than the atmospheric temperature outside the vehicle. As a refrigerant (heat-exchanging medium), Freon is used which makes it possible to provide such temperature changes relatively easily.



The principle of the air conditioner is as follows. By means of the expansion valve, the refrigerant in liquid form is rapidly expanded and turned into low-temperature gas. This low-temperature gas is passed through the evaporator, which is so designed that heat in the cabin can be absorbed effectively, and the cabin is cooled. Then the refrigerant in gaseous form, which has absorbed heat in the cabin and increased its temperature a little, is compressed by the compressor and becomes high-pressure and high-temperature gas. By means of the condenser, this high-pressure and high-temperature gas is air-cooled and turned back into liquid. At this time, the refrigerant emits into the atmosphere the heat absorbed from the cabin. This circulating system is called "Refrigerant Cycle".

The following p-H diagram describes each state of refrigerant.



- 1: Dry vapor
  1→2: Adiabatic compression by means of compressor
- 2: Superheated vapor
  2→2'→3: Isobaric change by means of condenser (condensation through heat emission)
- 3: Saturated liquid
  3→4: Isoentropic change by means of expansion valve (restriction phenomenon)
- 4: Wet vapor
  4→1: Isobaric and isothermal change by means of evaporator (evaporation through heat absorption)

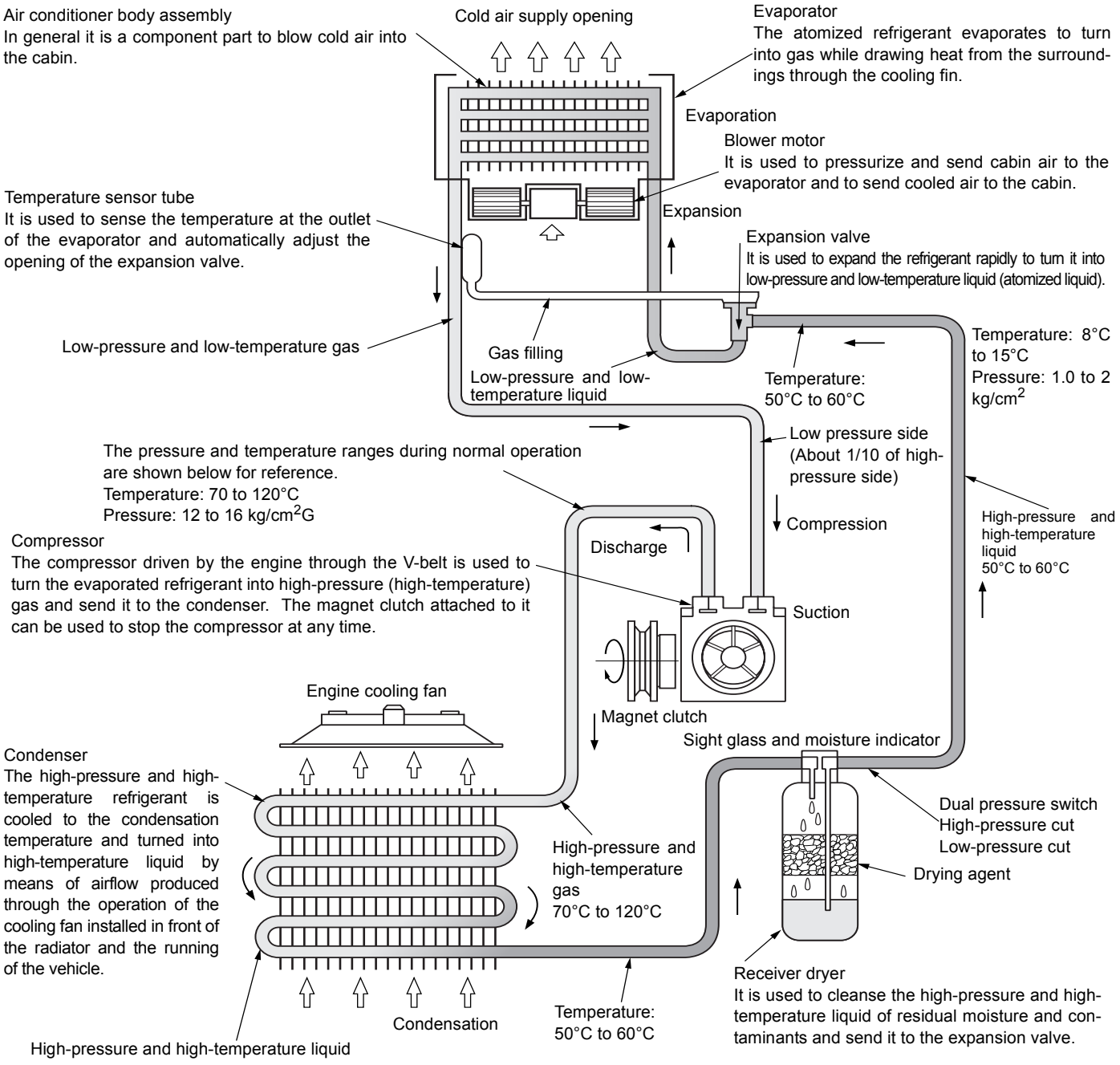
The cycle is thus completed.

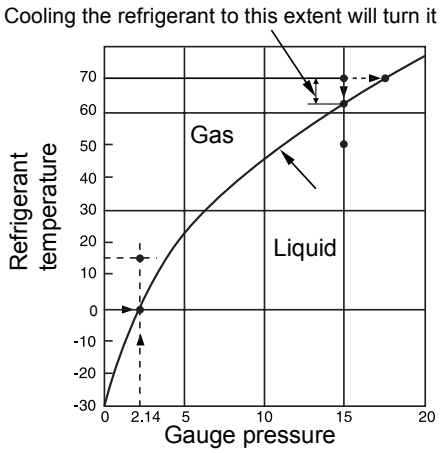
Function of expansion valve

- Sending a proper amount of refrigerant in liquid form from the high-pressure condenser side to the low-pressure evaporator side (flow control)
- Turning high-pressure refrigerant into low-temperature and low-pressure wet vapor

(3) Function and Construction

Note : Values of temperature and pressure in below Fig. are not specifications but just sample data.





The characteristics of the refrigerant used so far are as follows. When the gasified refrigerant is compressed to 15 kg/cm^2 , its temperature becomes 70ºC. Then, when the refrigerant is cooled to less than 60ºC (which means the refrigerant emits 10ºC or more of heat), it turns into liquid. When the pressure is reduced to less than 2.14 kg/cm^2 , it turns back into gas at 0ºC.

(4) Refrigerant Cycle

(1) Evaporation

The refrigerant changes from liquid (wet vapor) to gas (superheated vapor) in the evaporator. The atomized refrigerant sent to the evaporator evaporates actively. At this time, the liquid (wet vapor) keeps on evaporating while drawing heat necessary for evaporation (latent heat) from air around the cooling fin (cabin air). The air cooled as a result of losing heat is used to cool the cabin through the operation of the blower.

In the evaporator, the liquid (wet vapor) sent from the expansion valve and the evaporation gas (superheated vapor) coexist and a change of state from liquid to gas is performed. During this change of state, there is a certain relation between the pressure (evaporating pressure) and temperature (evaporating temperature); if the pressure is determined, the temperature is also determined. In other words, this relation is one between saturation pressure and saturation temperature.

In order to allow evaporation at a lower temperature in this change of state from liquid to gas, it is necessary to lower the pressure in the evaporator accordingly. The evaporation gas (superheated vapor) is therefore discharged rapidly from the evaporator with the compressor sucking it.

(2) Compression

The compressor compresses the refrigerant to a state in which the refrigerant can be easily liquefied at ordinary temperature (outside air temperature).

The gas generated through evaporation in the evaporator (superheated vapor) is sucked into the compressor. This operation is intended to keep the evaporating pressure in the evaporator at a low level so that the refrigerant in liquid form can evaporate even at low temperatures around 0°C. The gas (superheated vapor) sucked into the compressor is compressed in the vane chamber and becomes such high-pressure and high-temperature gas as can be easily liquefied by being cooled with outside air at ordinary temperature.

(3) Condensation

The refrigerant is cooled with outside air in the condenser and changes from gas to liquid.

The high-pressure and high-temperature gas coming out of the compressor is cooled with outside air, liquefied and stored in the receiver. The heat emitted from the high-pressure and high-temperature gas coming out of the compressor is called heat of condensation.

This heat of condensation is equal to the sum of the heat drawn from the cabin (evaporation heat) by the refrigerant in the evaporator and the energy used for compression (converted to heat quantity).

In the case of condensation, like the case of evaporation, there is a certain relation between the pressure (condensing pressure) and temperature (condensing temperature) during a state of change from gas to liquid performed with vapor and liquid coexisting. (Note that the pressure varies depending on the type of refrigerant and the condensing temperature.)

(4) Expansion

The expansion valve reduces the pressure of the refrigerant in liquid form to a state in which the refrigerant can be easily evaporated.

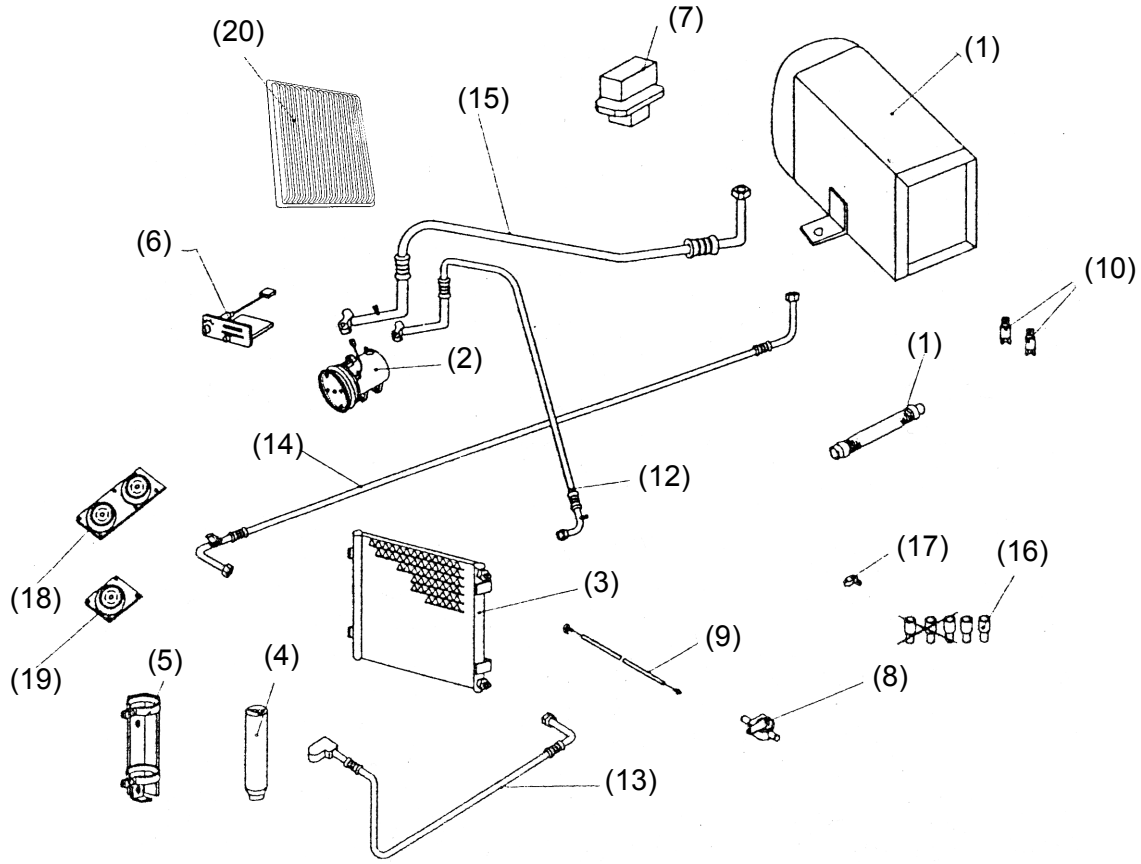
Before the liquefied refrigerant is sent to the evaporator, its pressure is reduced to a state in which it can be easily evaporated, which is called an expansion process. The expansion valve used for this process performs flow control of the refrigerant as well as pressure reduction.

The amount of refrigerant to be evaporated in the evaporator is determined by the heat quantity to be removed (cooling load) at a given evaporating temperature (evaporating pressure). It is important to catch it correctly and feed a proper amount of refrigerant.

The refrigerant circulates through the cooling system while going through the above-mentioned four processes. As a result, it transfers heat from the cabin to the outside air, that is, from low temperatures to high temperatures.

b. Components and location

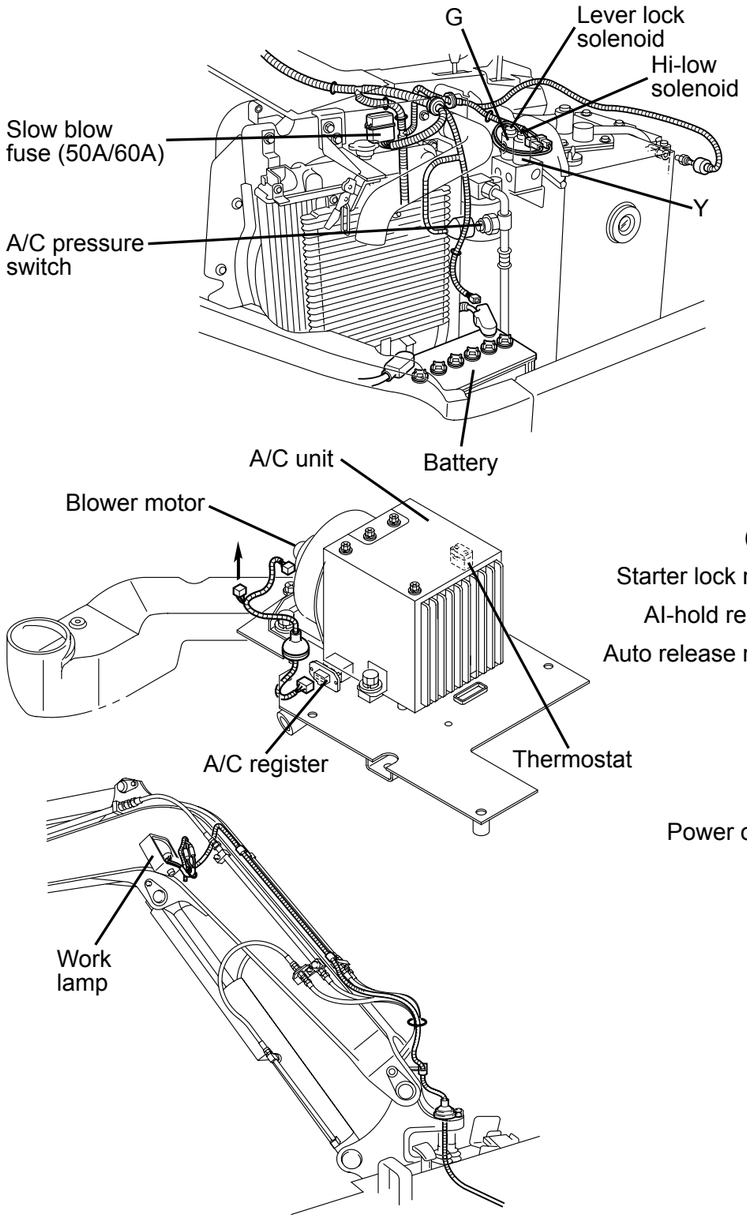
(1) Air conditioner & accessory assy

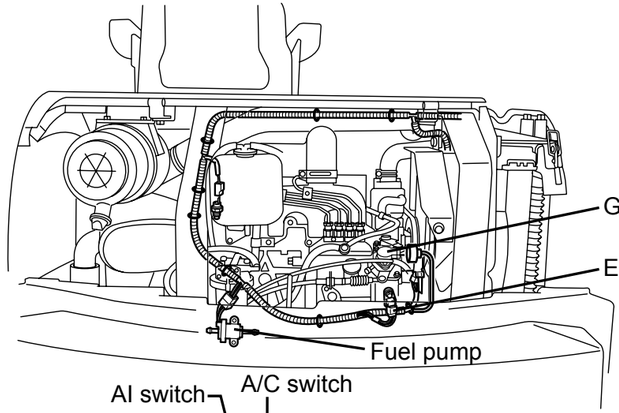


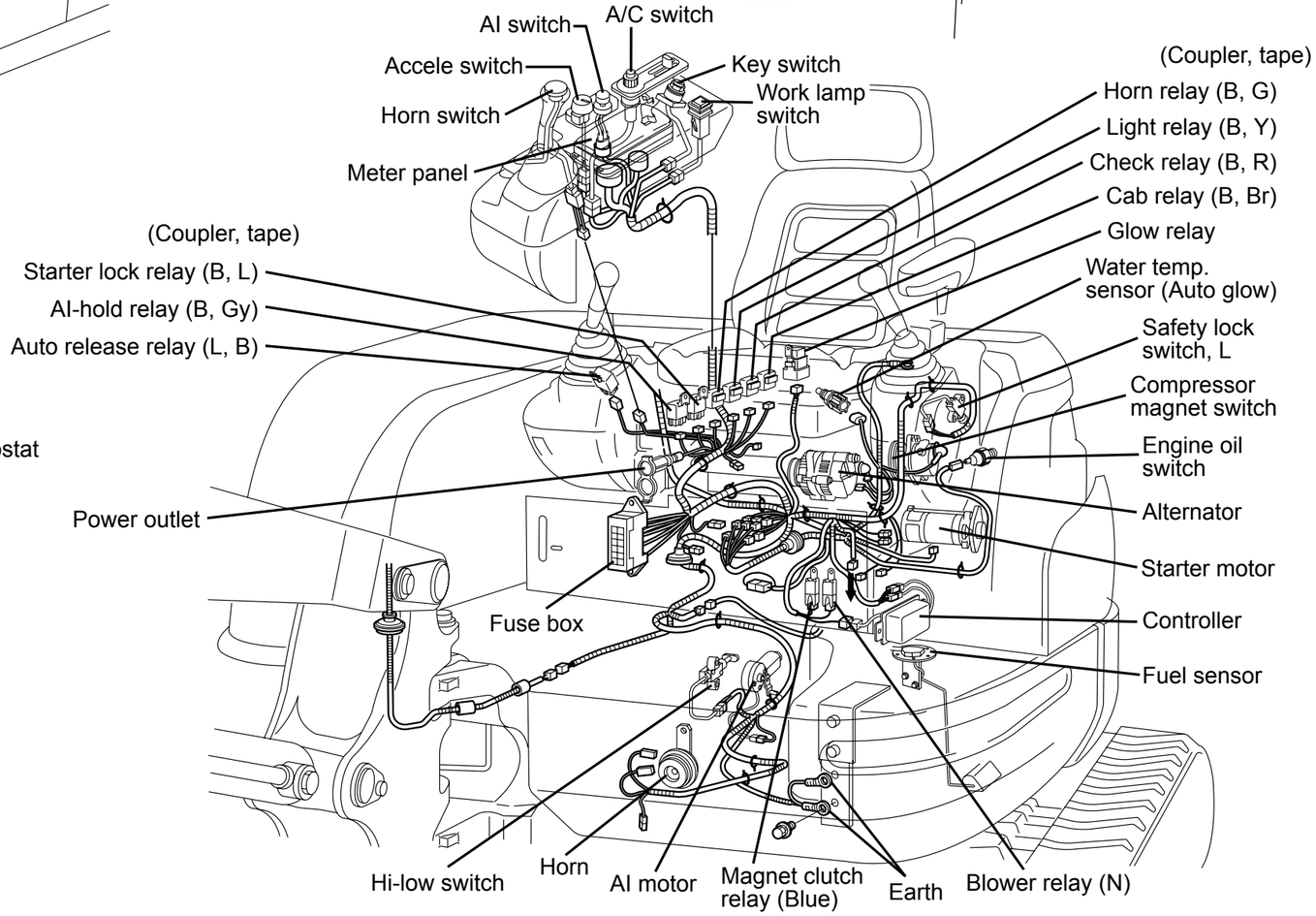
Kit No. RD118-53501

(1)A/C unit assy ; RD118-53701
(2)Compressor assy ; T2055-72252
(3)Condenser ; T1065-72221
(4)Receiver tank ; T0070-79271
(5)Receiver holder ; T0070-79281
(6)A/C control lever assy ; RD118-53611
(7)Blower resister ; T1065-72181
(8)Water valve assy ; T0270-67501
(9)Control cable ; RD118-47451
(10)Relay ; T1155-72151
(11)Receiver joint ; T0270-87171
(12)Discharge hose ; RD118-47511
(13)Liquid hose ; RD411-47541
(14)A/C hose accessory ; RD118-47531
(15)Suction hose ; RD118-47621
(16)Drain connector ; 6A671-71691
(17)Defroster hose ; RB419-49282
(18)Grill assy, air outlet ; 3G710-50291
(19)Grill assy, air outlet ; RD118-47231
(20)Filter subassy ; 6A671-75091

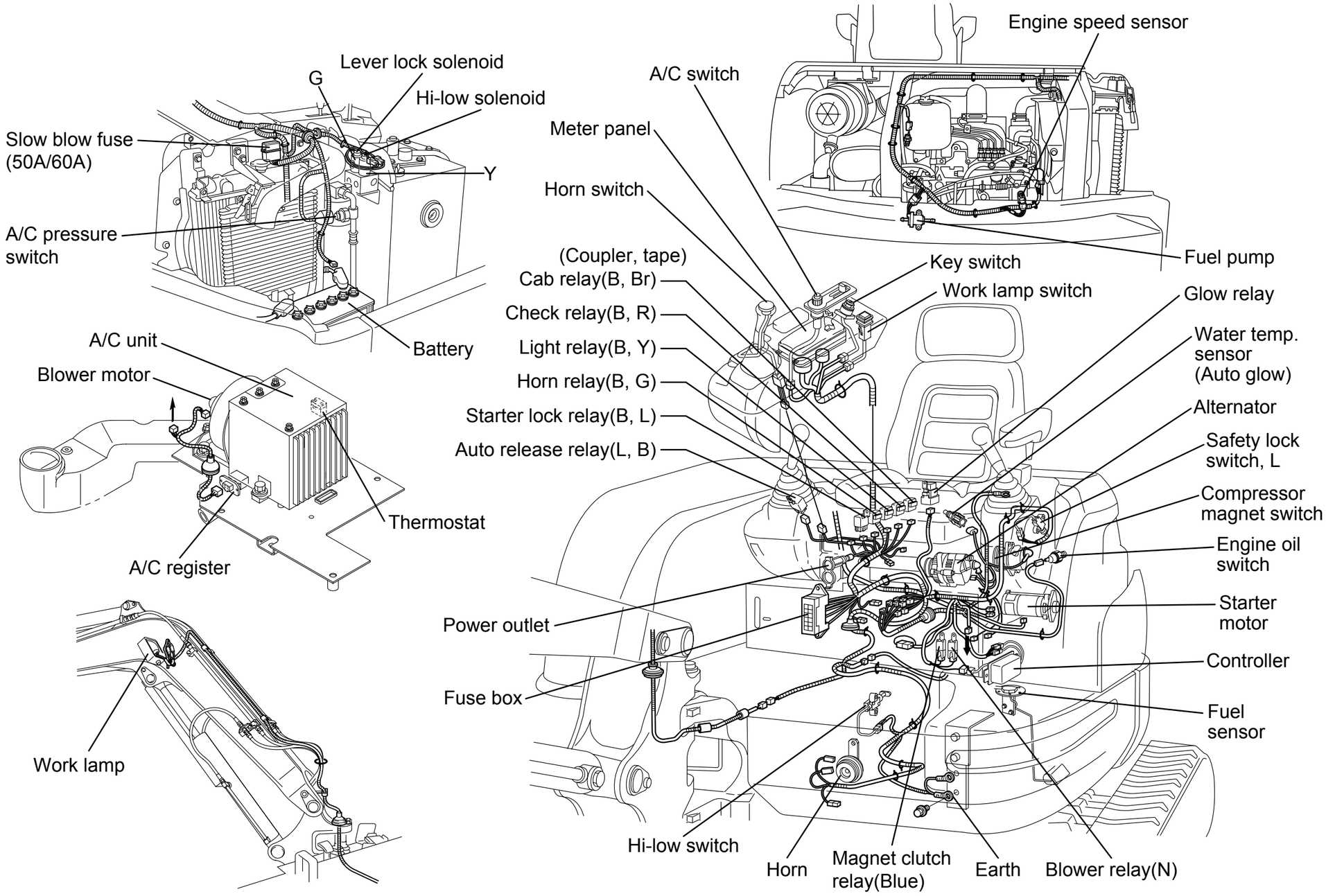
(2) Layout of A/C components : AI-version



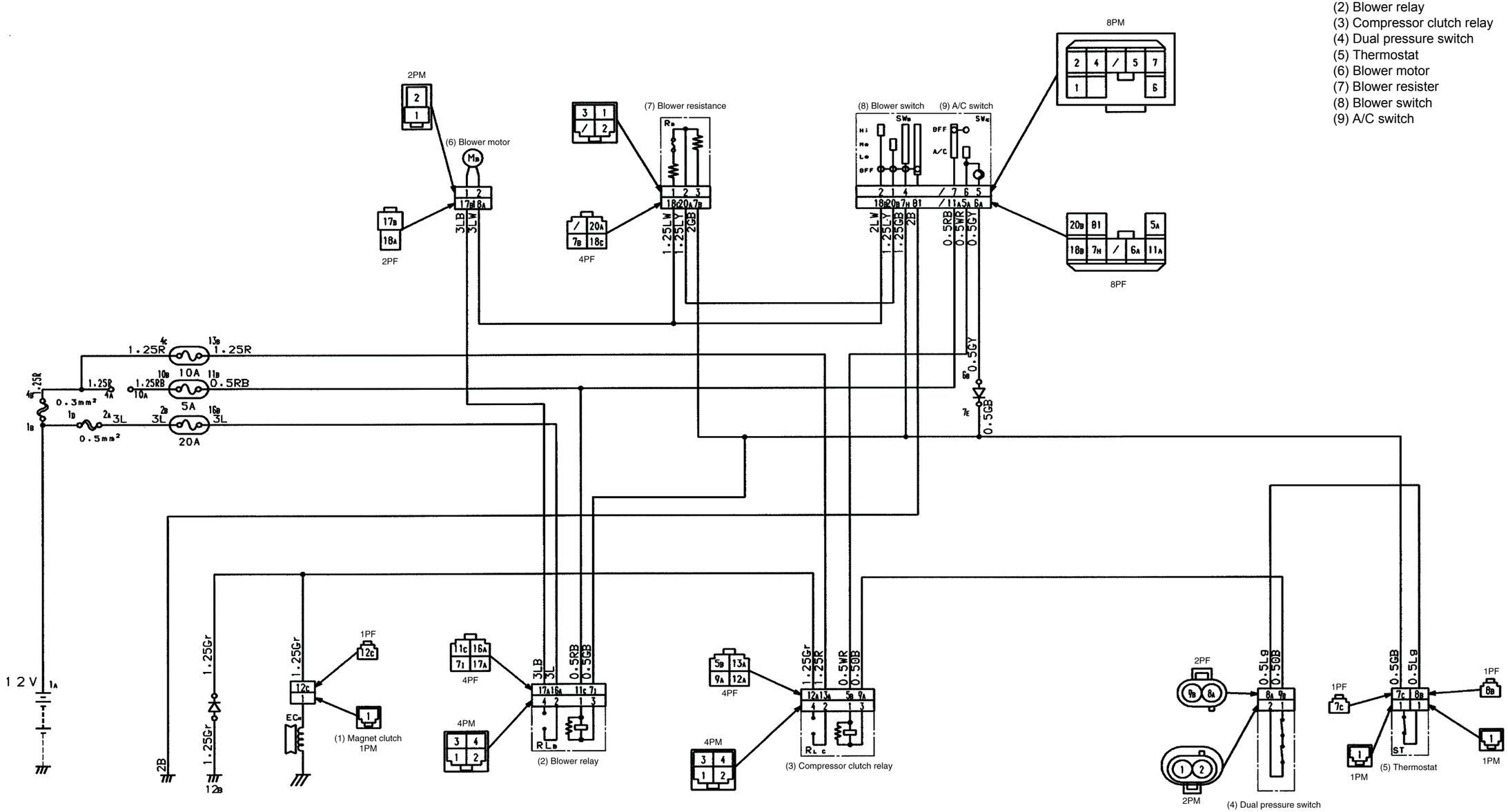




(3) Layout of A/C components : Non AI-version

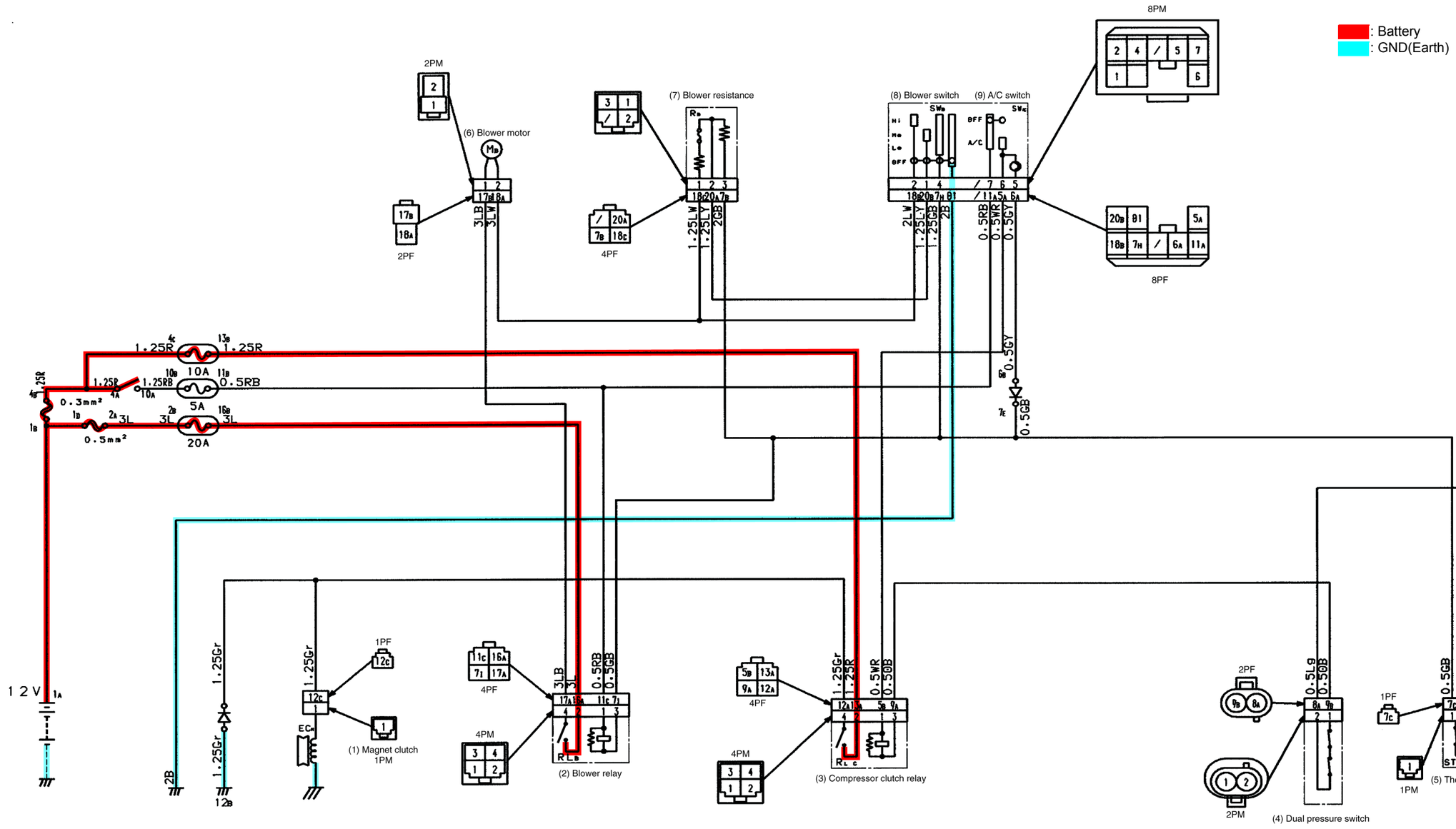


c. A/C system, electric circuit diagram



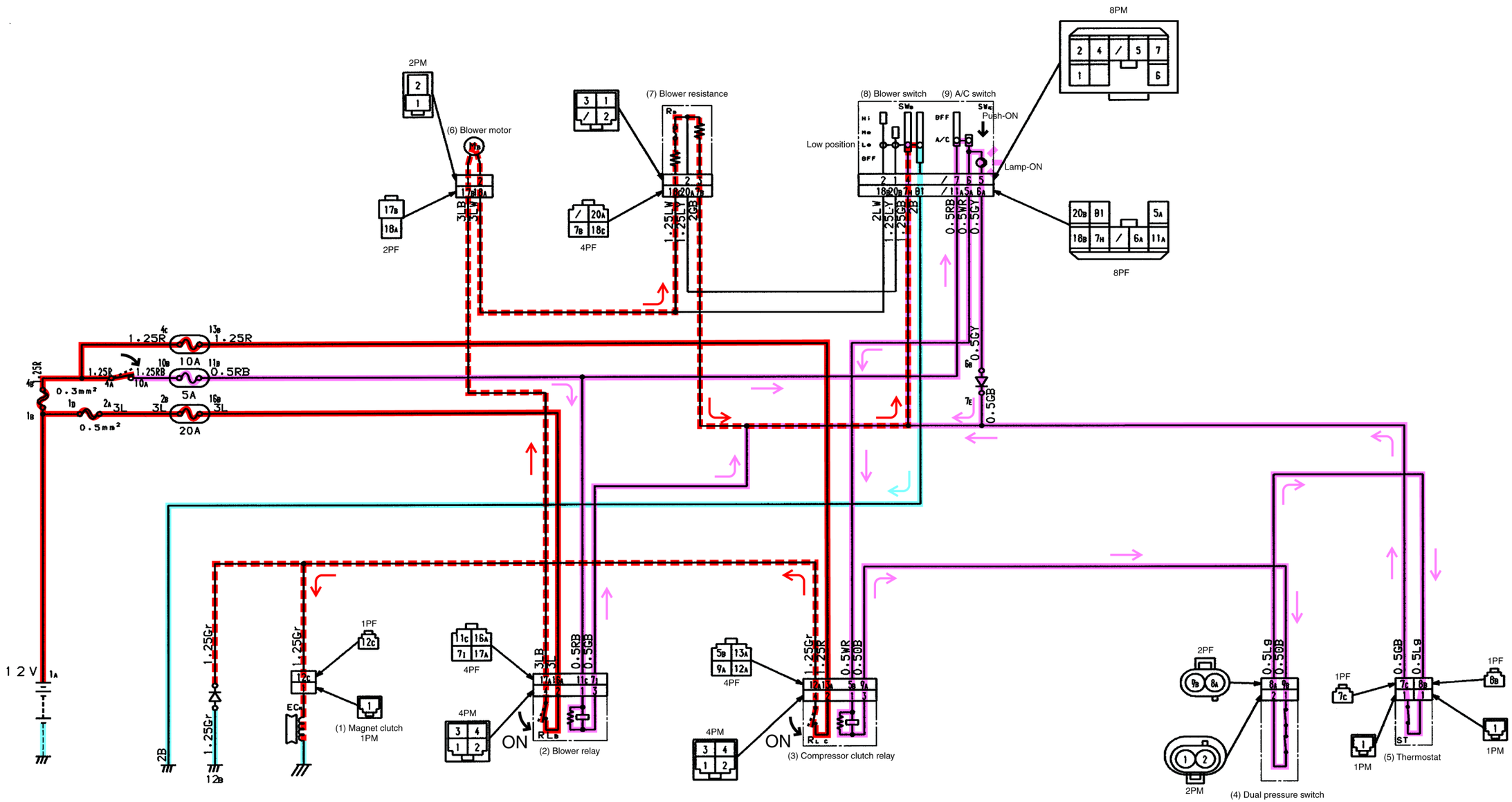
(1) Magnet clutch
(2) Blower relay
(3) Compressor clutch relay
(4) Dual pressure switch
(5) Thermostat
(6) Blower motor
(7) Blower resister
(8) Blower switch
(9) A/C switch

(1) Key-Off condition

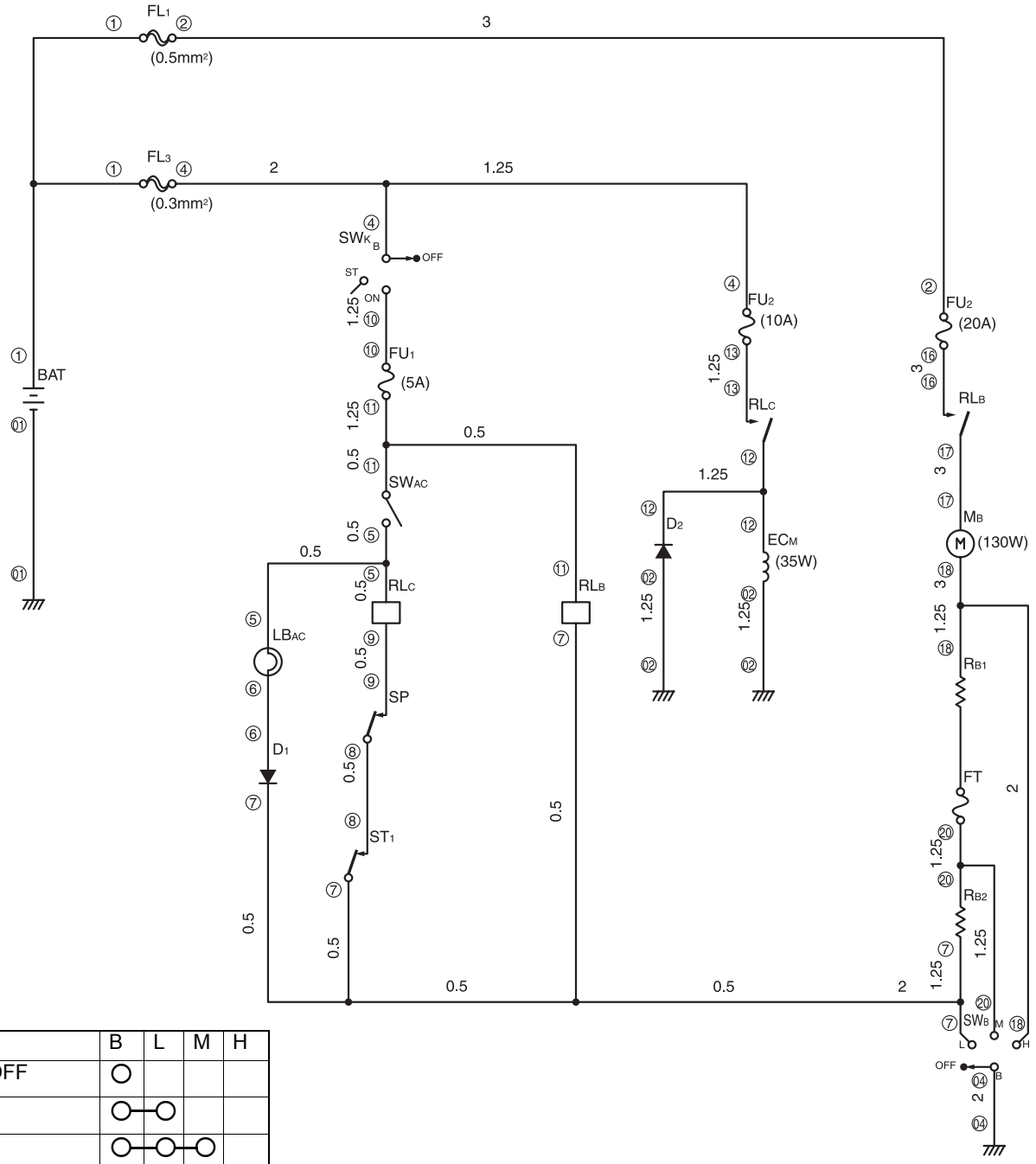


(2) Key-ON(AC) condition

A/C switch-ON
Blower SW-Low



(3) A/C electric circuit diagram(DENSO A/C)



SWB

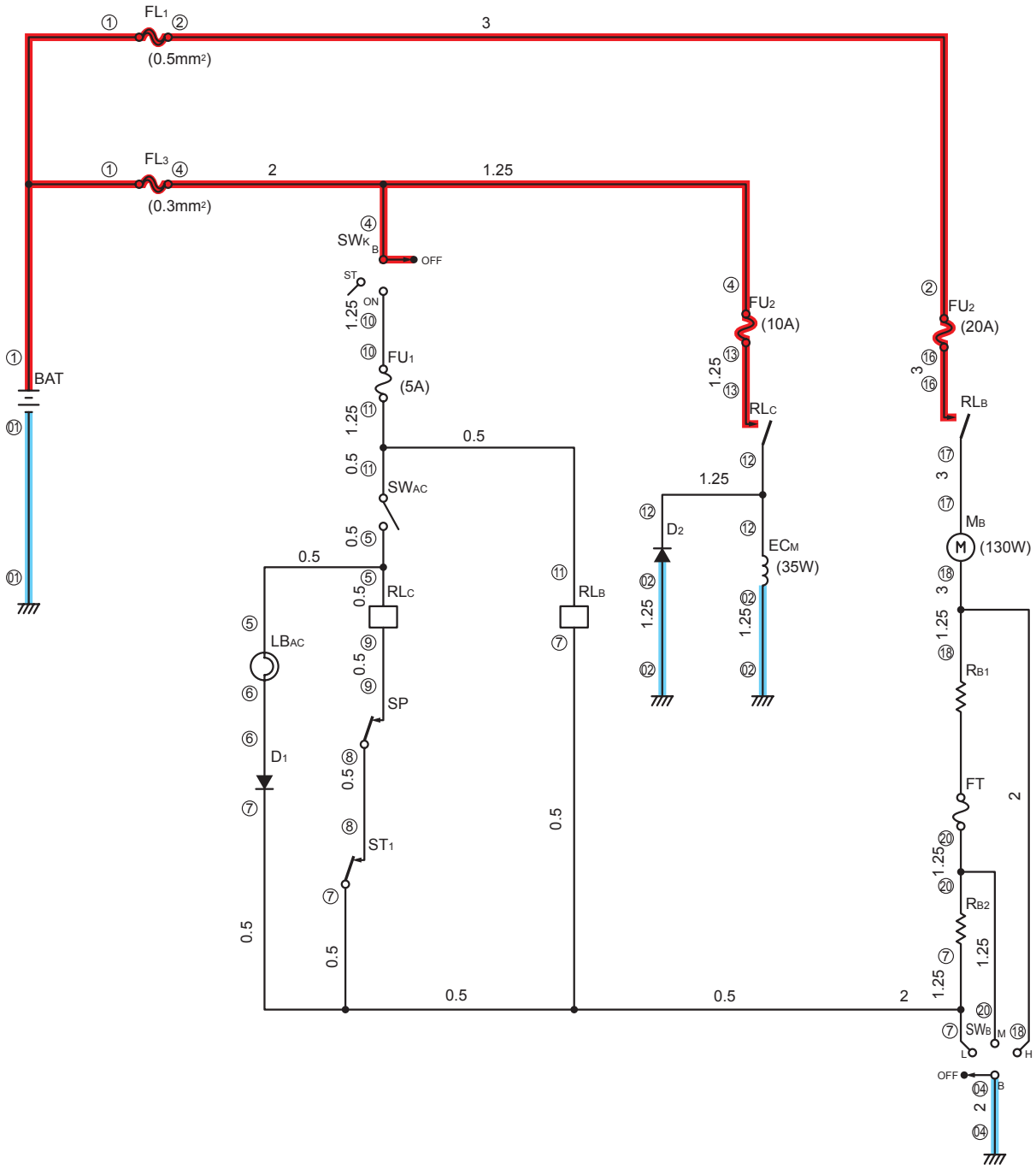
	B	L	M	H
OFF	○			
1	○—○			
2	○—○—○			
3	○—○—○—○			

⑫	1.25	⑨	0.5
⑬	1.25	⑩	1.25
⑭	2	⑪	0.5, 1.25
②	3	⑫	1.245
④	2, 1.25	⑬	1.25
⑤	0.5	⑯	3
⑥	0.5	⑰	3
⑦	0.5, 2, 1.25	⑱	2, 1.25
⑧	0.5	⑳	1.25

BAT: Battery
D_1 : Diode 1
D_2 : Diode 2
EC_M : Magnet clutch
FL_1 : Fusible link 1
FL_2 : Fusible link 2
FT : Resister, thermo fuse
FV_1 : Control Fuse
FV_2 : Control Fuse
FV_4 : Blower Fuse
LB_{AC} : A/C unit lamp

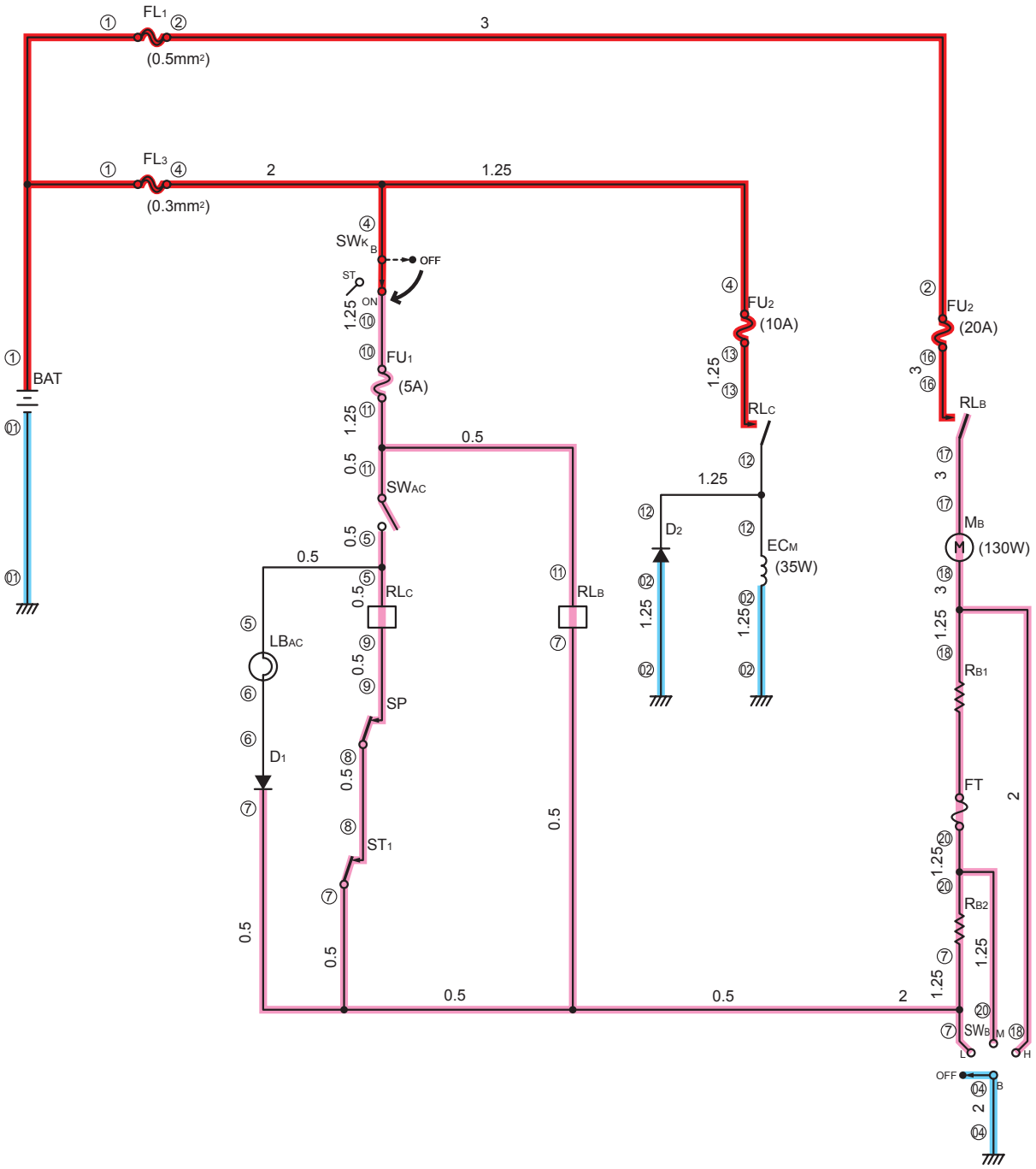
MB : Blower motor
R_{B1} : Blower resister 1
R_{B2} : Blower resister 2
RL_B : Blower relay
RL_C : Compressor clutch relay
SP : Dual pressure switch
ST_1 : Thermostat
SW_{AC} : A/C switch
SW_B : Blower switch
SW_K : Main key switch

(4) Key-Off condition



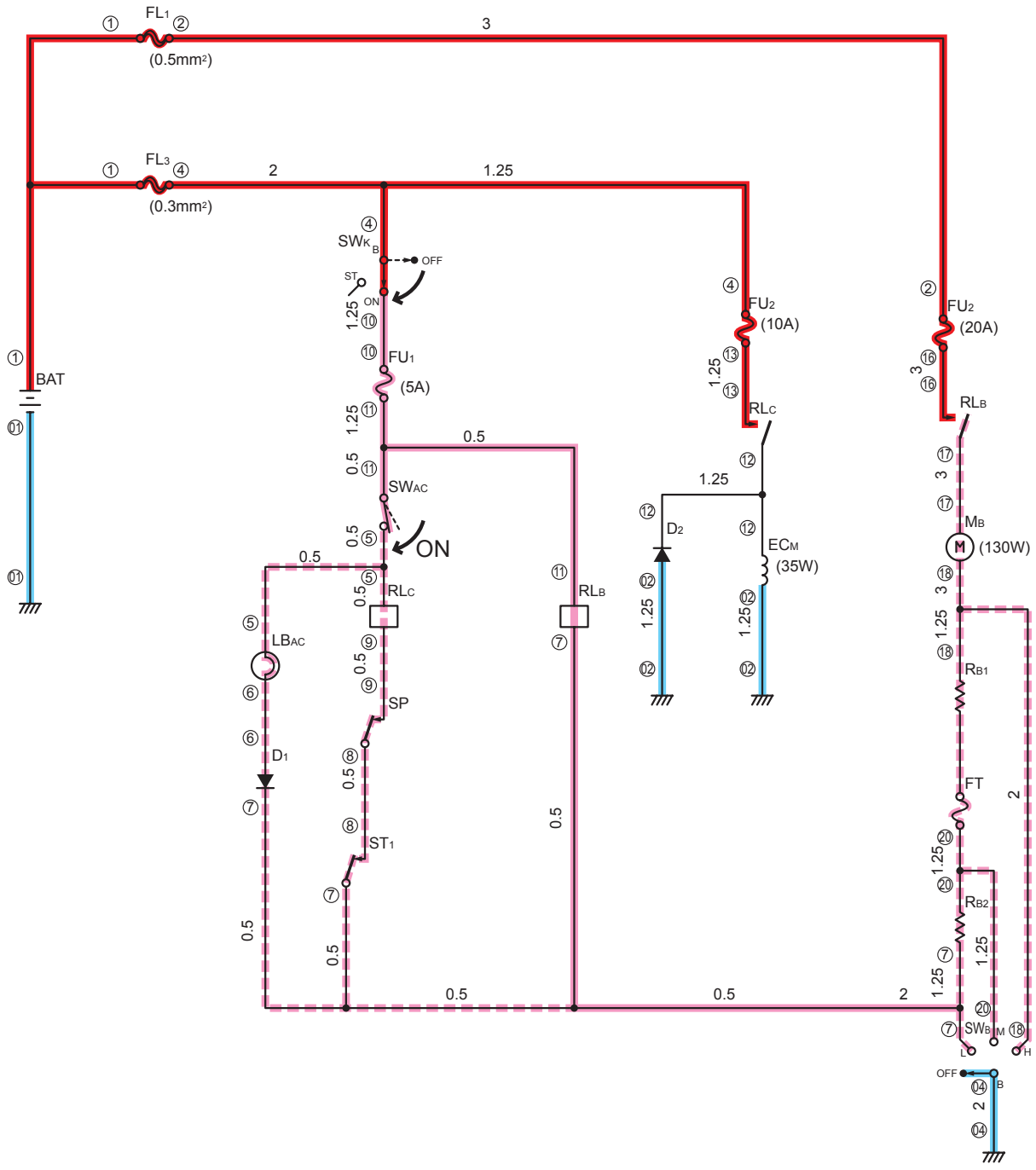
Function : Battery voltage is always reached to magnet clutch relay and blower relay control points.

(5) Key-ON (A/C) Conditions



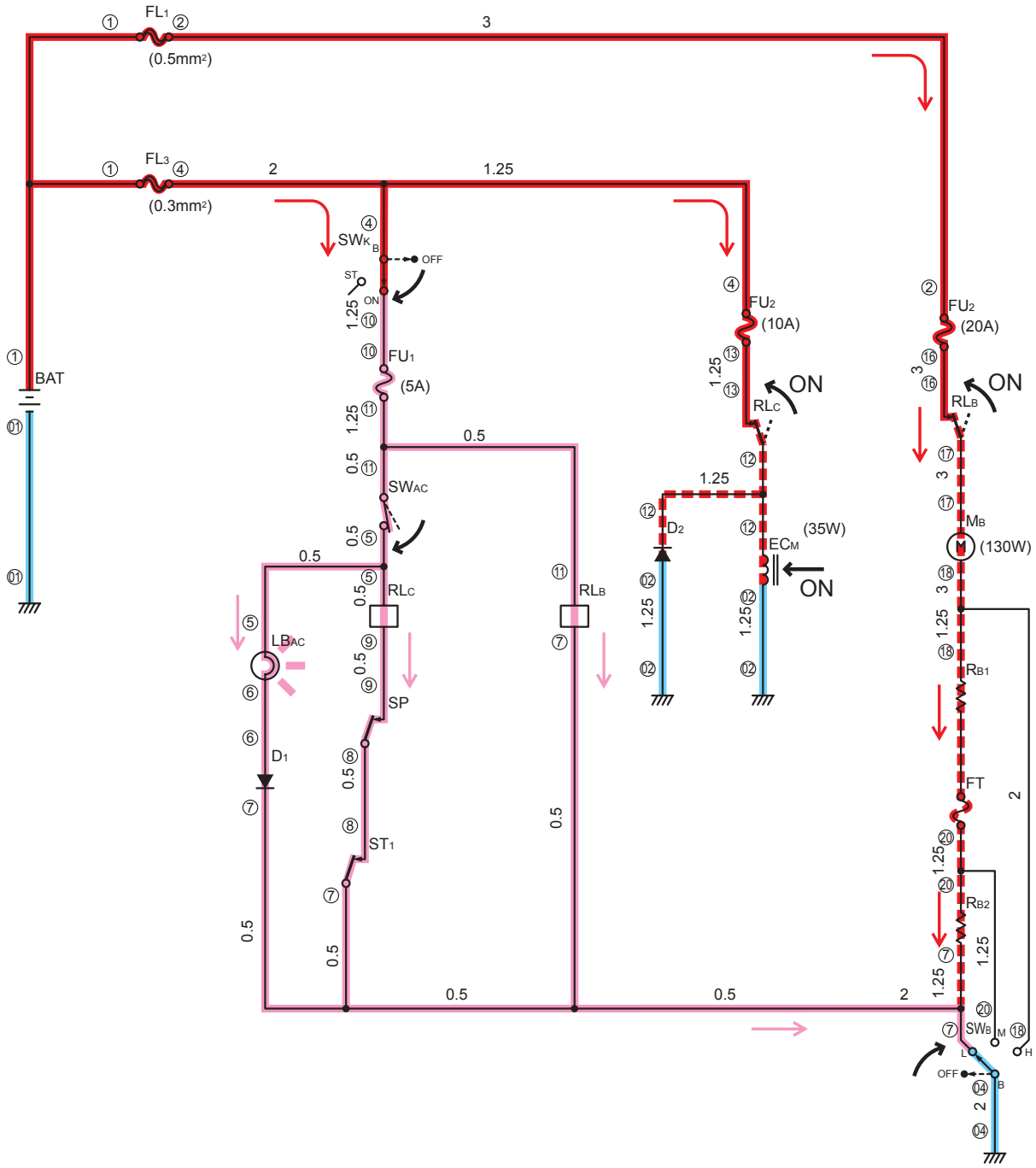
Function : When key switch is turned ON, battery current flows to blower relay coil. But as long as blower switch is off, current doesn't flow. So relay won't be magnetized and stays off. Still battery voltage can be detected on all connecting lines.

(6) Key-ON (A/C) + A/C SW-ON Condition



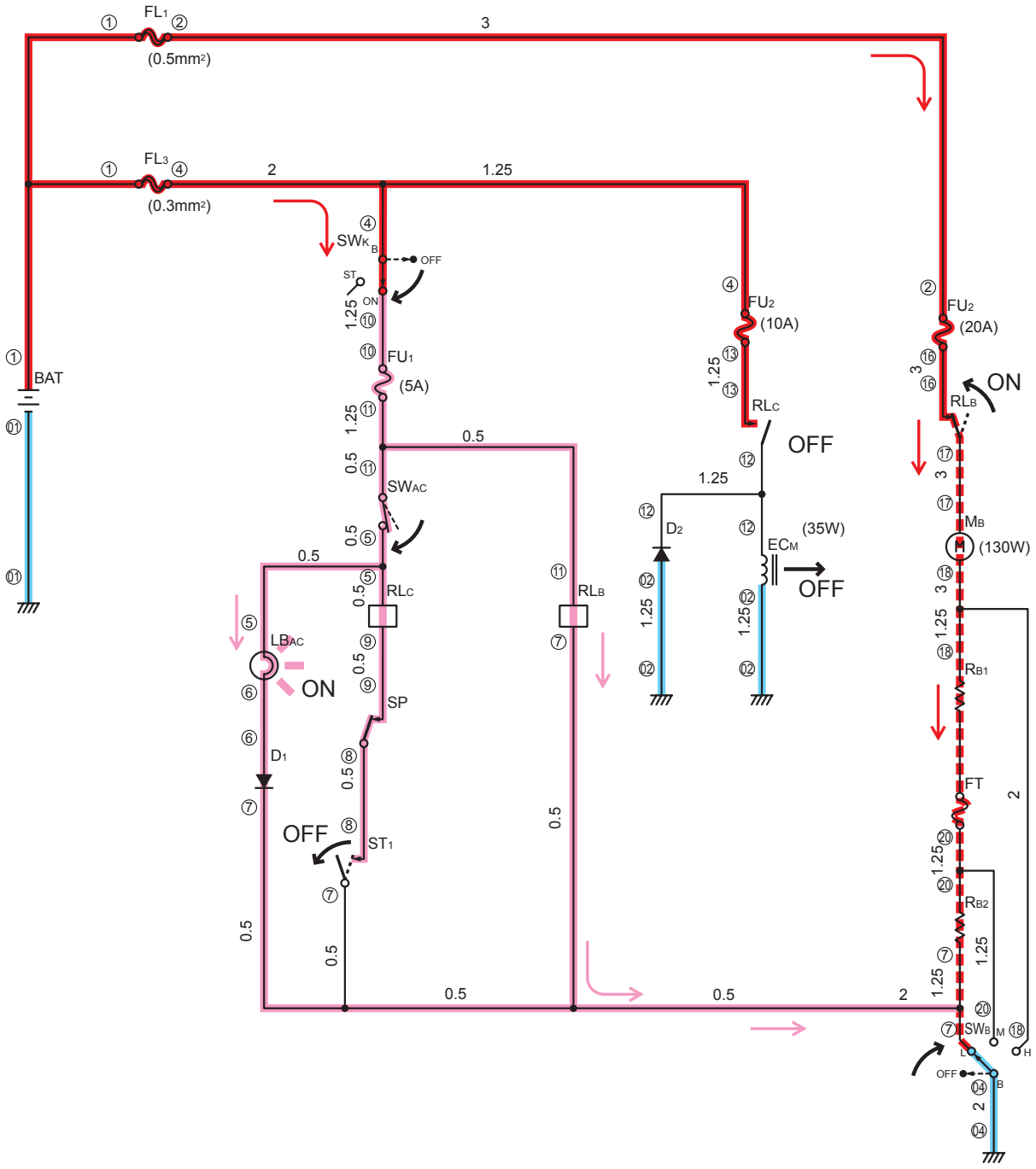
Function : Even when A/C switch is pushed on, as long as blower switch is off, current doesn't flow. So both clutch and blower relays stay off condition.

(7) Key-ON (A/C) + A/C SW-ON + Blower SW-Low Condition



Function : When blower switch is turned to low position, electric system current flows as shown in Fig. Both magnetic clutch and blower relays are turned on. Then compressor magnetic clutch is engaged. Blower motor current flows from battery through two resisters. In case of medium position, current flows through one resister. In high, it flows in no resister.

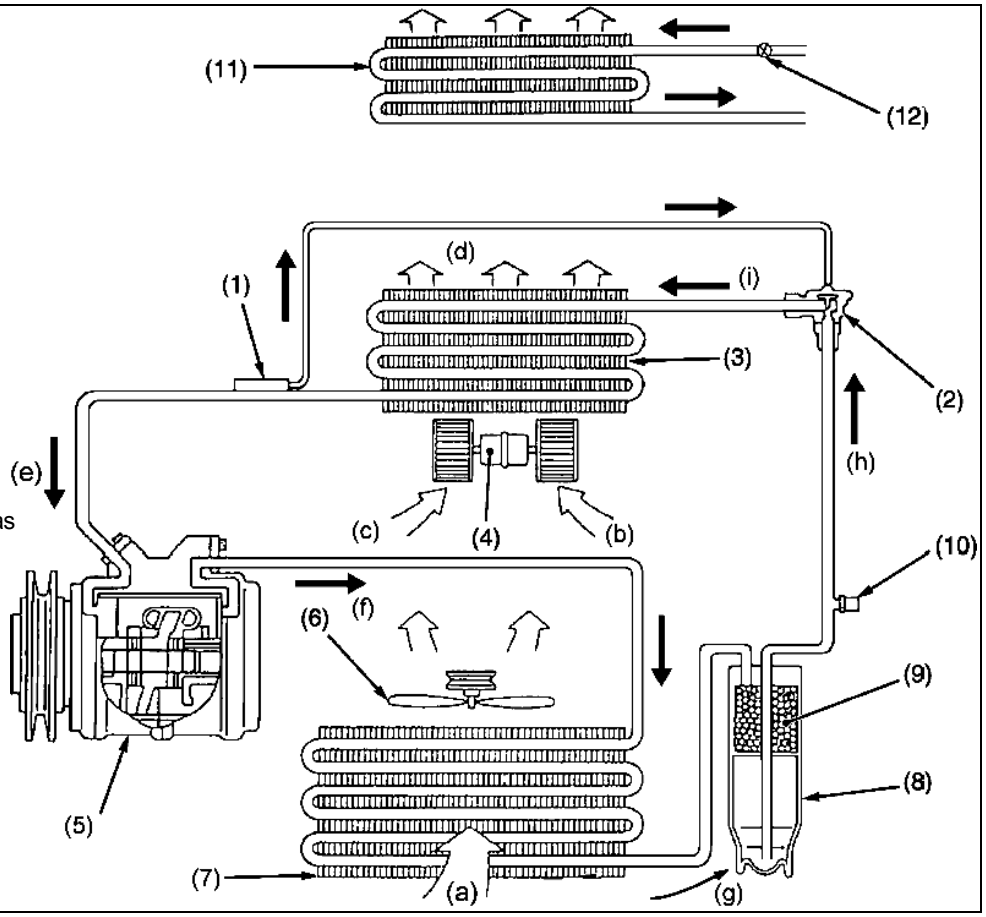
(8) Key-ON (A/C) + A/C SW-ON + Blower SW-Low + thrmostat-OFF Condition



Function : When room temperature is cooled down to pre-set level, thermostat turns off. Then clutch relay turns off and magnet clutch is disengaged. When dual pressure switch is turned off, also magnet clutch is disengaged.

B.Function and structure

(1) Heat Sensitizing Tube
(2) Expansion Valve
(3) Evaporator
(4) Blower Motor
(5) Compressor
(6) Engine Cooling Fan
(7) Condenser
(8) Receiver
(9) Desiccant
(10) Pressure Switch(Dual type)
(11) Heater Core
(12) Water Valve
(a) Hot air
(b) Cab Interior Air
(c) Cab External Air
(d) Colded Air
(e)Low Press, low-temp. gas
(f)High Pressure, High Temperature Gas
(g)High Pressure, High temp. liquid
(h)Liquid refrigerant
(i)Low Pressure, Low Temperature Liquid



The refrigerant cycle of air conditioning system is as follows.

1) The gaseous refrigerant evaporated through the evaporator (3) is compressed in the compressor (5) to approx. 1.47Mpa (15kgf/cm2, 213 psi) and is also raised in temperature to approx. 70ºC (158ºF) and delivered to the condenser (7).
2) The gaseous refrigerant is cooled down through the condenser (7) to approx. 50ºC (122ºF) and delivered to the receiver (8) in the liquid state. At this time, heat removed from the cabin interior is extracted by means of the condenser (7).
3) The liquid refrigerant is collected in the receiver (8) for a certain period. At this time moisture are removed from the refrigerant by desiccant (9).
4) The liquid refrigerant after removing moisture and dust is jetted out of the small hole of the expansion valve (2) into the evaporator (3) as if it were distributed by an atomizer. Thus, the refrigerant is reduced in both pressure and temperature, and becomes easy to evaporate.
5) The refrigerant evaporates at 0ºC (32ºF) vigorously, taking heat from the surface of the pipes in the evaporator (3).
6) At this time, warm air in a cabin is drawn into the evaporator (3) by the blower motor and is passed over those pipes, transferring its heat to the refrigerant for evaporation. The air thus cooled is distributed to the cabin. (That is, heat in a cabin is taken by the evaporator.)

Reference

Since warm air in a cabin is cooled suddenly, water in the air is liquefied and removed, which means dehumidification is also performed.

7) The gaseous refrigerant from the evaporator (3) after having performed the cooling action is returned to the compressor (5), and is compressed to liquefy it (high pressure and high temperature). This cycle is repeated.

a. Compressor

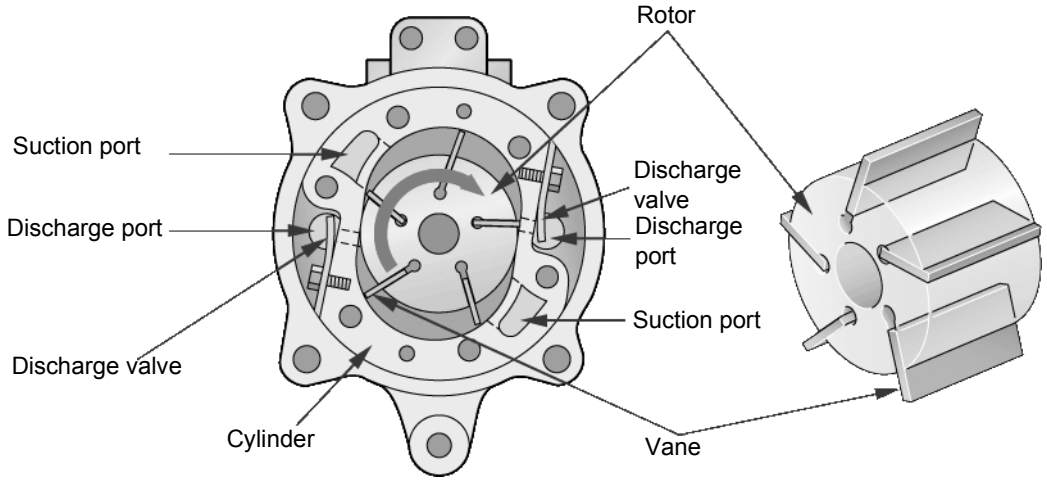
The compressor is installed on the engine and is driven by crank pulley through a belt.
The compressor is a pump designed to raise the pressure of refrigerant. Raising the pressure means raising the temperature. High temperature refrigerant vapor will condense rapidly in the condenser by releasing heat to the surrounding.

Compressors are classified as follows:

- Reciprocationg type
  - Swash plate type(6,10 cylinders) . . . . . 10P,10PA type
  - Wobble plate type(6 sylinders) . . . . . 6C, 6CA type
  - Variable capacity type . . . . . 7SB16 type
  - Crank shaft type(1 to 6 cylinders)
- Rotary type
  - Through vane type . . . . . TV type
  - Sliding vane type. . . . . SV type
  - Scroll type . . . . . SC type

(1) Outline of sliding-vane type compressor (SV07 type) : **KX121-3, 161-3**

This compressor consists of the following main parts: rotor with built-in five vanes and cylinder, two discharge valves, side plates on the front and back. As the rotor turns, the five vanes also turn pressed into contact with the inner surface of the cylinder by the centrifugal force and the back pressure of the vanes themselves.



(2) Feature

1) The rotor, cylinder and other major parts are made of aluminum for tremendous drop in weight.
2) The vanes are used to make the compressor compact.
3) Compared to conventional swash-plate compressors, the SV07 is compact with smaller cylinder capacity. Thanks to the better volumetric efficiency, however, the SV07 proves as powerful as the 10P08.

(3) Main specifications

Type	Displacement	Max.RPM	Lib. oil	Type of magnet clutch
SV07	70cm^3	6000rpm	ND OIL8	K-20

(4) Structure & Function

The basic internal construction of sliding-vane type compressor consists of a rotor fitted with five vanes, and a cylinder.

Although its internal construction partially differs from that of the through-vane type compressor, the function is identical. Its basic operation is to effect the suction, the compression, and the discharge of refrigerant gas by rotating the rotor, pushing the vanes to the cylinder inner wall, and allowing the vanes to rotate while sliding along the cylinder wall.

Similar to the through-vane type compressor, the sliding-vane type compressor uses the ND-OIL8 for the compressor oil.

1 Construction

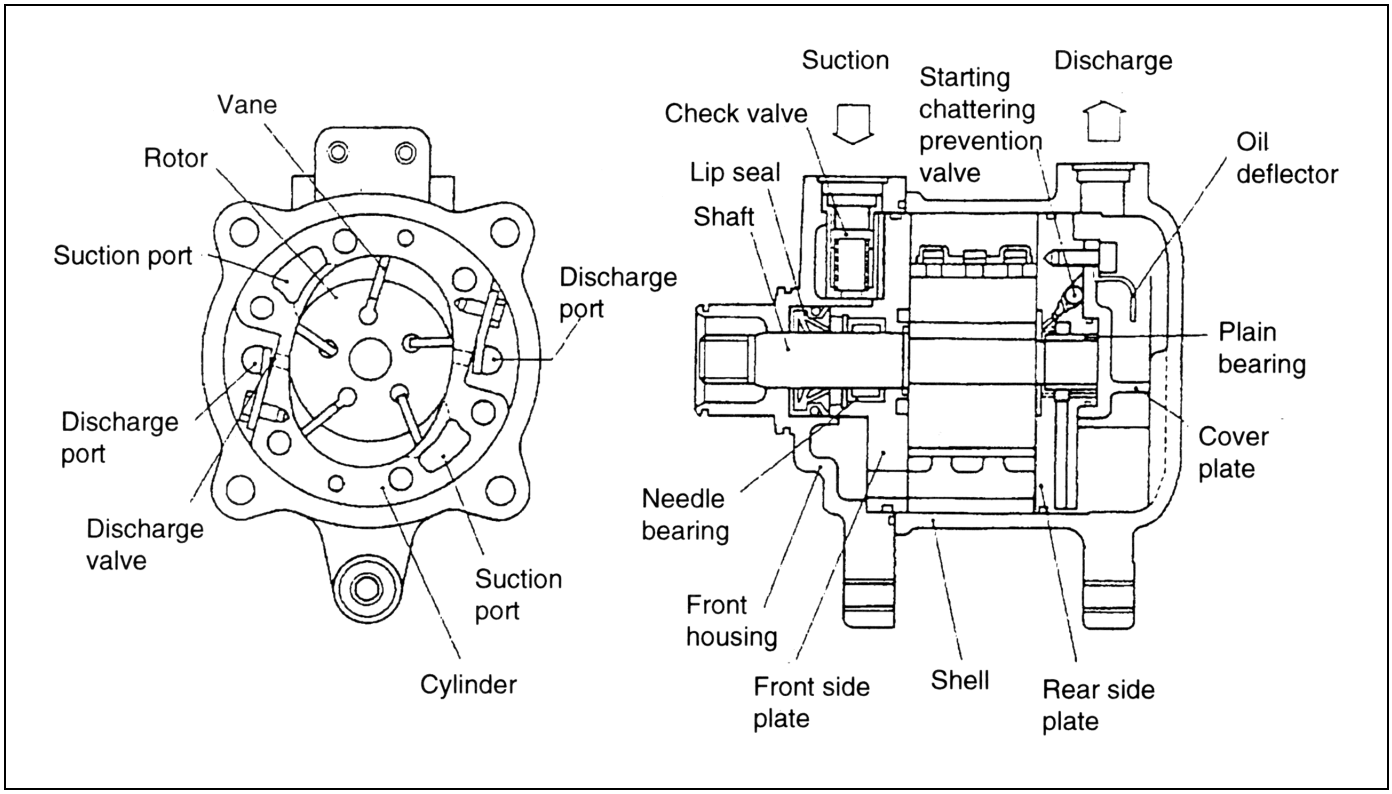


Fig. Construction of Sliding-vane Type Compressor (1)

1) **Cylinder Internal Construction**

Internally, the cylinder consists of a rotor fitted with five vanes. These vanes slide in contact with the inner cylinder wall to effect the suction, the compression, and the discharge of refrigerant gas.

2) **Shaft**

The shaft is integrated with the rotor. The front of the shaft is supported by the needle bearing which is fitted in the front side plate. The rear is supported by plain bearing which is fitted in the rear side bearing.

The end of the shaft is provided with splines, and the magnetic clutch (K type) that mates to the spline shaft is secured by a bolt (M6), in the same way as in the through-vane type compressor.

3) **Rear Side Plate**

The rear side plate is equipped with a valve that prevents the vanes from chattering during starting.

4) **Front Side Plate**
The front side plate is equipped with a suction port. The vanes pass by the suction port to draw in the refrigerant gas.

5) **Front Housing**
Internally, the front housing has a low-pressure chamber. In addition, a check valve is provided in the area where the suction hoses is connected.

6) **Shaft Seal**
A lip seal is used for sealing the shaft.

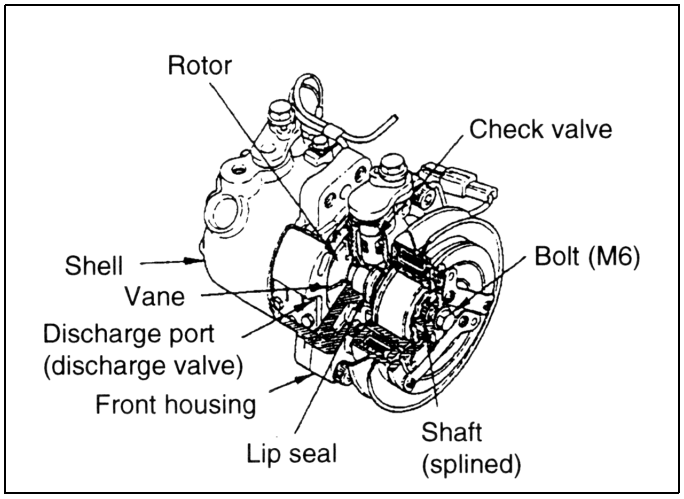
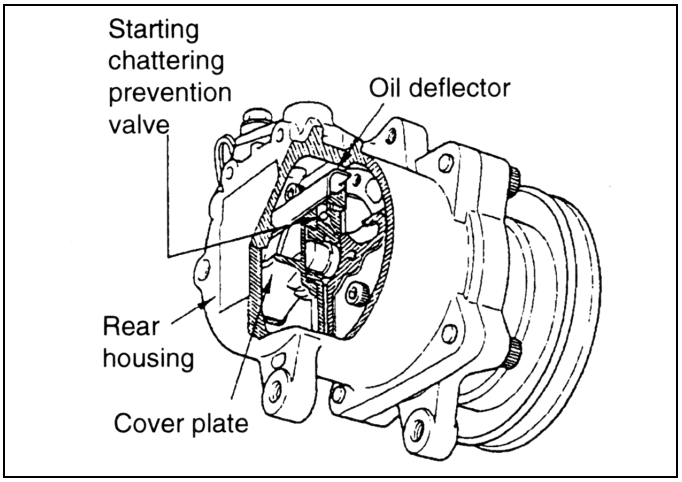


Fig. Construction of Sliding-vane type Compressor

7) **Rear housing (shell)**
The rear housing contains an oil separator chamber.
The discharged high pressure refrigerant gas becomes separated here into refrigerant and oil.



2 Operation

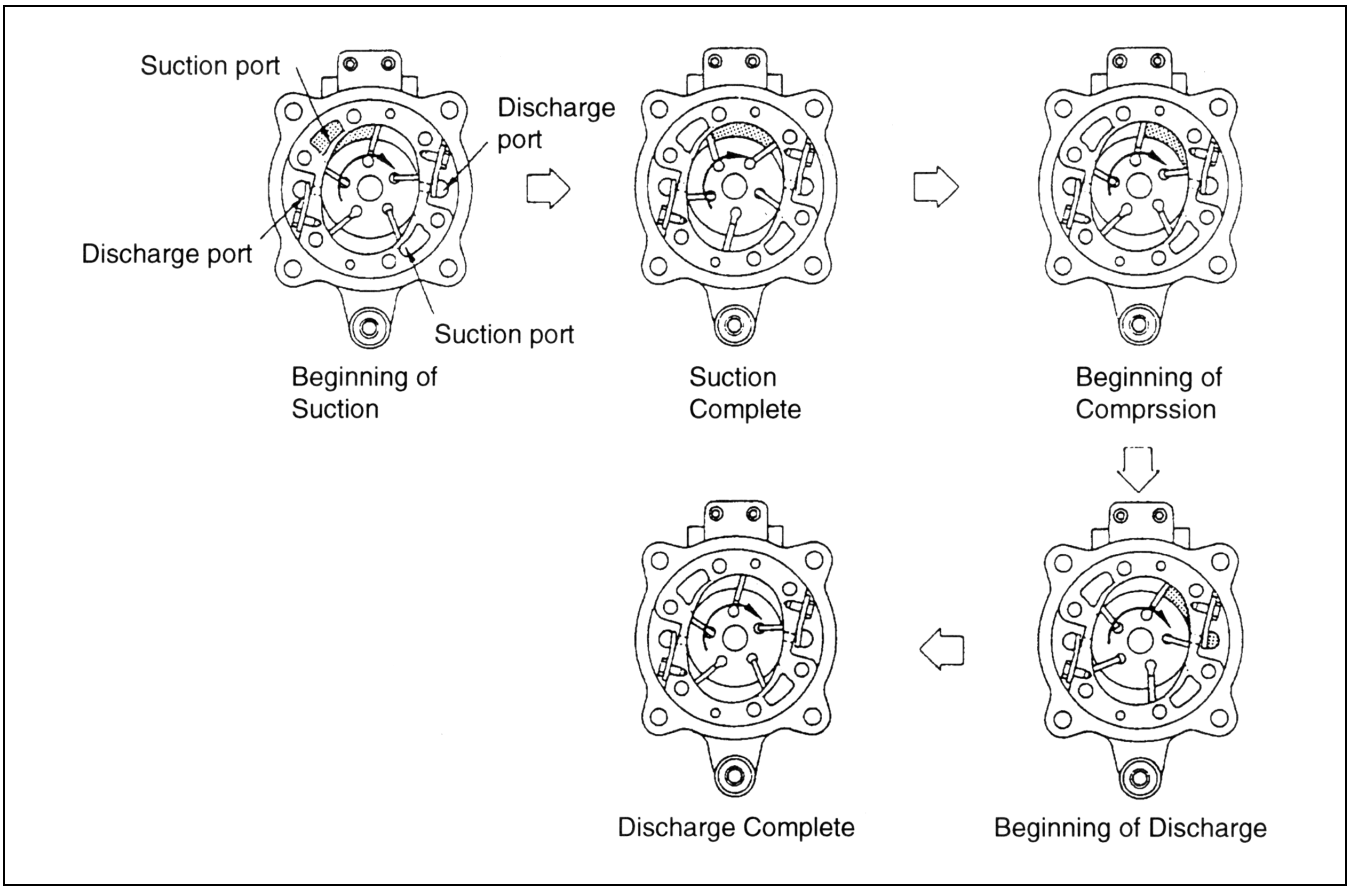


Fig. Operation of Sliding-vane Type Compressor

1) **Suction**
The refrigerant gas exits from the evaporator by the operation of the compressor, enters the compressor's low-pressure chamber. As the rotor turns together with the vanes, the refrigerant gas is drawn from the suction port into the cylinder.

2) **Compression**
After completing suction, the refrigerant gas, which is sealed by the vanes in the cylinder, becomes compressed as the vanes rotate. At this time, the sealing between the tip of the vanes and the cylinder wall is ensured by the compressor oil.

3) **Discharge**
At the compression continues and the refrigerant pressure in the cylinder increases to the point that it becomes higher than that of the high-pressure chamber, the refrigerant gas is discharged.
Even when the pressure in cylinder because the high-pressure chamber pressure maintains the discharge valve closed.
The compressor repeats the cycle described above to enable the five chambers, which are partitioned by the vanes in the cylinder, to perform suction, compression, and discharge twice for each rotation of the rotor.

3 Function of the Compressor

1) **Separating the Refrigerant Gas and Oil in the High-Pressure Chamber**
The refrigerant gas that is discharged from the cylinder is actually mixed with the compressor oil found in the cycle. Because it is important to minimize the outflow of oil into the cycle in order to achieve efficient refrigeration, the refrigerant gas and the oil are separated in the compressor.The sliding-vane type compressor separates the compressor oil from the discharged refrigerant gas as described below.
(a) The refrigerant gas (which is mixed with oil) that is discharged from the cylinder collides with the oil deflector that is provided on the rear side plate. Because the oil is heavier, the oil flows downward, via the cover plate, and settles in the bottom of the shell.
(b) After the oil thus separated, the refrigerant gas is discharged from the top of the shell.
(c) The cover plate functions as a barrier to prevent the oil (which foams when the compressor is first started) from discharging together with the refrigerant gas.

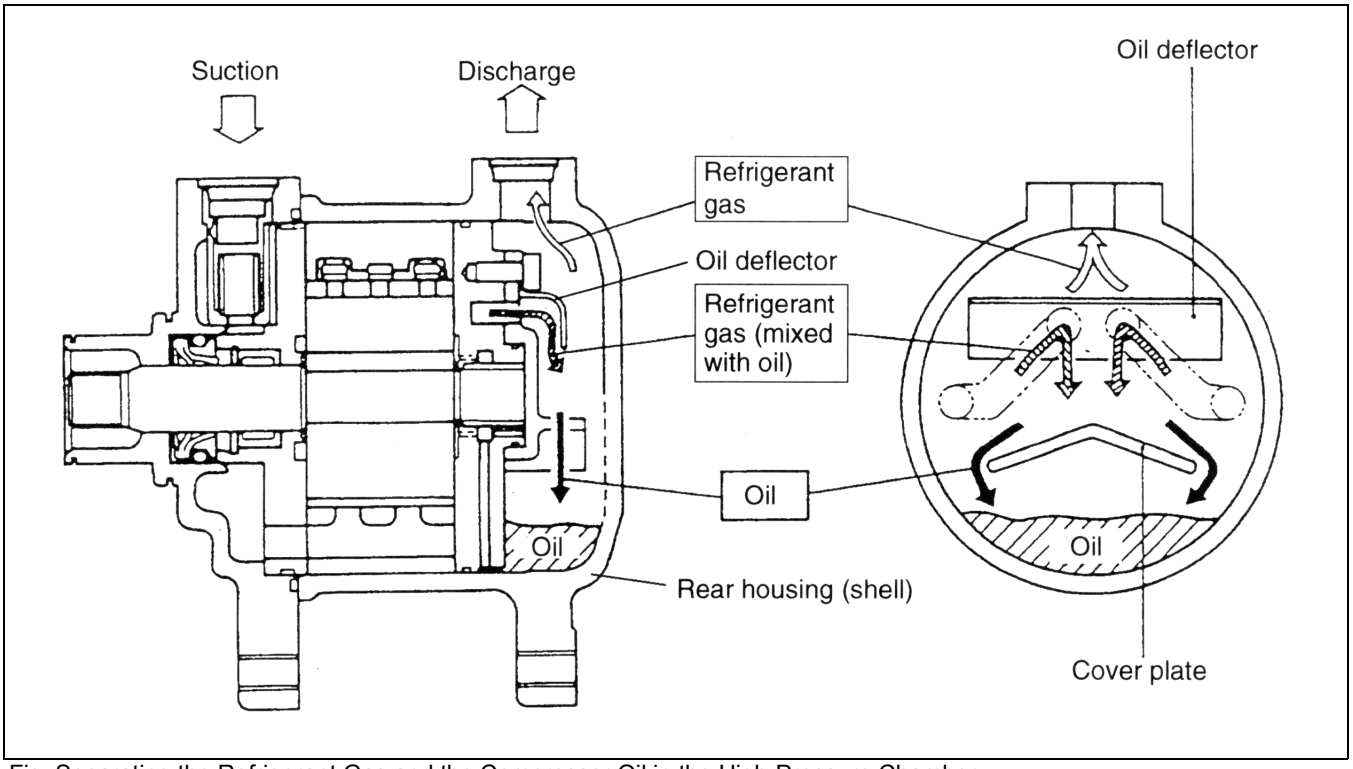
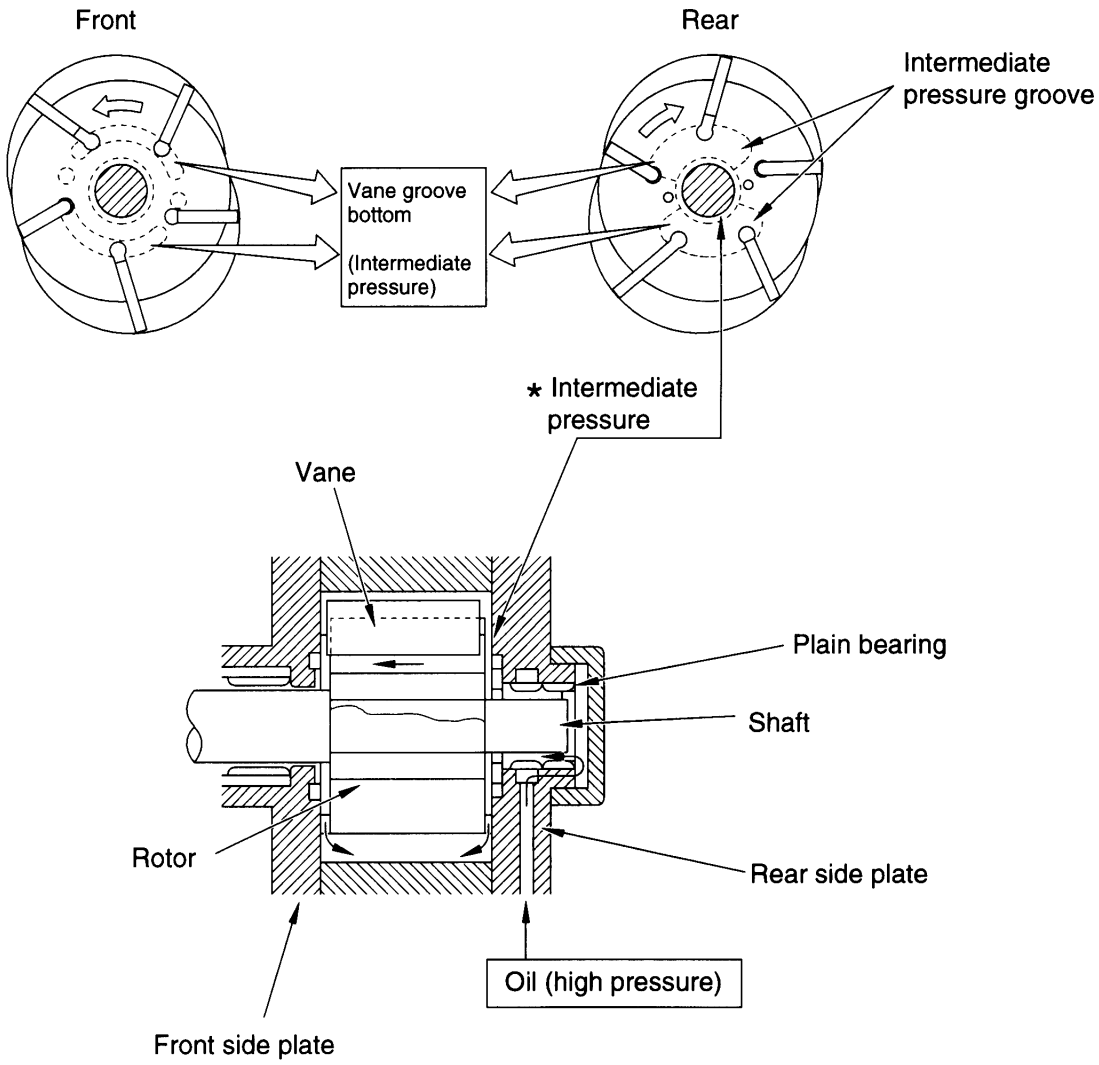


Fig. Separating the Refrigerant Gas and the Compressor Oil in the High-Pressure Chamber.

2) **Lubricating the Vanes and Plain Bearings**

The oil, which settles in the bottom of the shell, is pushed by the pressure from the high-pressure chamber to pass through the passage in the rear side plate and lubricates the plain bearings on the shaft, thus preventing wear.

After passing through the clearance between the shaft and the plain bearings, the decompressed oil passes through the intermediate pressure groove in the rear plate and settles in the vane groove to lubricate the vanes and the rotor.



*Intermediate pressure: The high-pressure oil, which is drawn up from bottom of the shell, travels through the passage in the rear side plate, and becomes decompressed as it passes through the clearance between the shaft and plain bearings. As a result, the pressure of the oil assumes an intermediate pressure between the discharge and suction pressures.

Fig. Vane and Plain Bearing Lubrication

3) **Vane Back-Pressure System**

To ensure that the vanes of sliding-vane type compressor slide in continuous contact with the cylinder wall, it is necessary to apply a force to push the vanes outward, without relying solely on the centrifugal force that is generated by the rotation of the rotor.

The sliding-vane type compressor uses the oil pressure (under intermediate pressure) that is deposited in the bottom of the rotor's vane grooves, to push the vanes outward.

<Concept of back pressure>

The relationship between the stresses that are applied should ideally be the following:
vane back pressure + vane centrifugal force = vane pushing force
vane outward force = retraction force associated with vane compression

A greater "vane outward force" increases friction at the vane nose, which leads to a loss in consumable horsepower. A small "vane pushing force" causes the vanes to chatter. The sliding-vane type compressor uses plain bearings to reduce the pressure of the high-pressure oil and delivers the oil to the back-pressure chamber so that both forces are in balance.

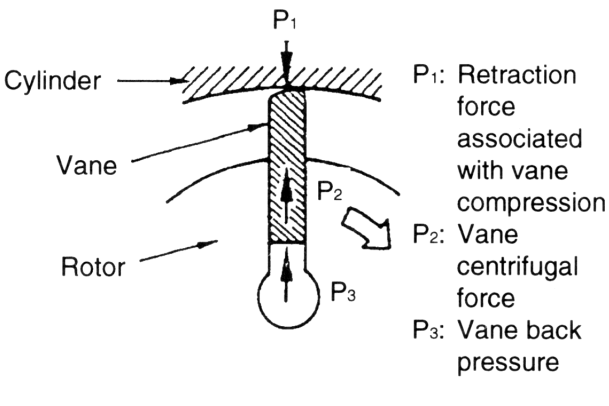


Fig. Vane Back Pressure

4) **Chattering Prevention Valve**

When the compressor is first started, the vanes are likely to chatter because the back pressure that is applied to the vanes has not reached a prescribed level.

For this reason, a chattering prevention valve is provided in the rear side plate. When the compressor is first started, the chattering prevention valve delivers the refrigerant gas from the high-pressure chamber directly to the back-pressure grooves of the vanes, thus preventing the vanes from chattering.

(a) Stopped compressor

The force of the spring maintains the valve open. (The pressure in the compressor is constant.)

(b) Starting the compressor

Immediately after the compressor begins its rotation, the refrigerant gas from the high-pressure chamber passes through the open valve to apply pressure directly onto the back of the vanes. As a result, the vanes are pushed outward, thus preventing them from chattering.

(c) Normal compressor operation

The discharge pressure rises, overcomes the spring force, and closes the valve (in approximately 3 seconds of operation). After the valves closes, the vanes are pushed outward by the vane back-pressure and the vanes' centrifugal force.

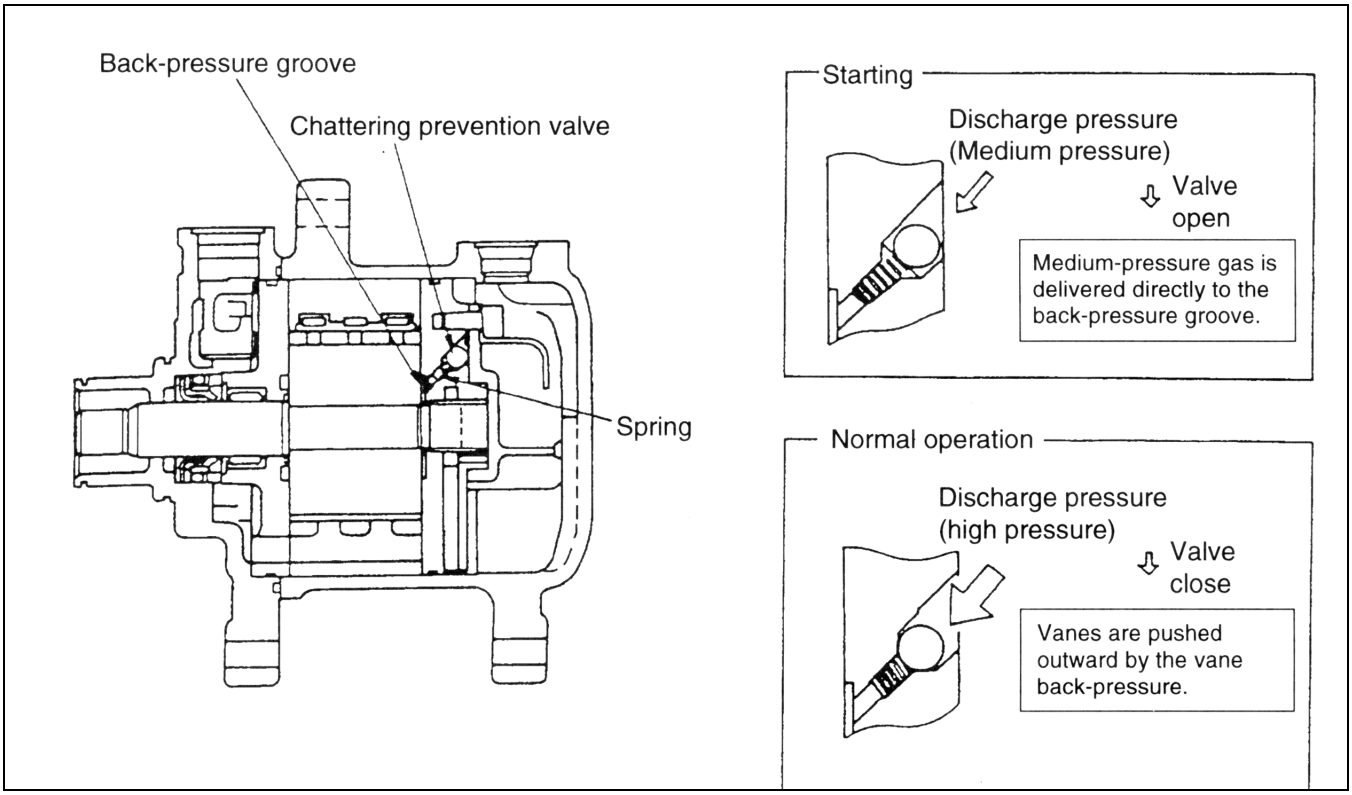


Fig. Operation of Chattering Prevention Valve

5) **Check Valve**

Immediately after the sliding-vane type compressor stops, if there is a great difference in pressure between the discharge and suction pressure owing to the construction of the compressor, the compressor could rotate backwards and cause the refrigerant gas to flow back into the evaporator.

To prevent the refrigerant gas from flowing back, a check valve is provided at the inlet of the suction valve in the front housing.

Immediately after the compressor stops, the high-pressure gas pushes the spool upward to close the passage to the suction side pipe, thus preventing the refrigerant gas from flowing back.

<Regarding the Check Valve>

Although the check valve is made of nylon (both the spool and the case), it has the strength to withstand the pressure even if it is subjected to liquid compression.

Furthermore, the check valve does not pose any problems in terms of heat resistance because its melting point is 225°C.

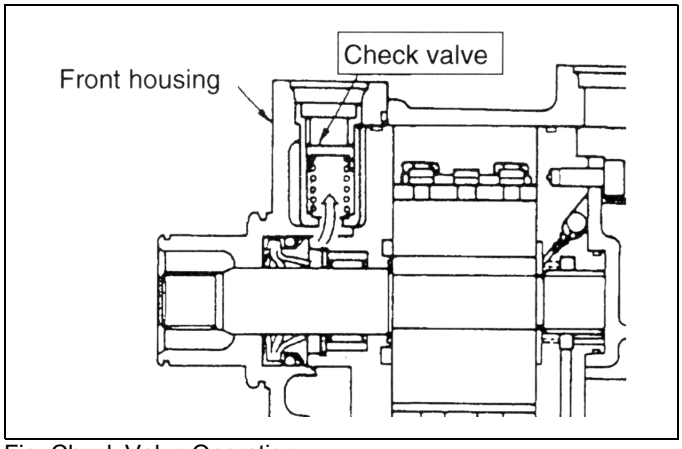


Fig. Check Valve Operation

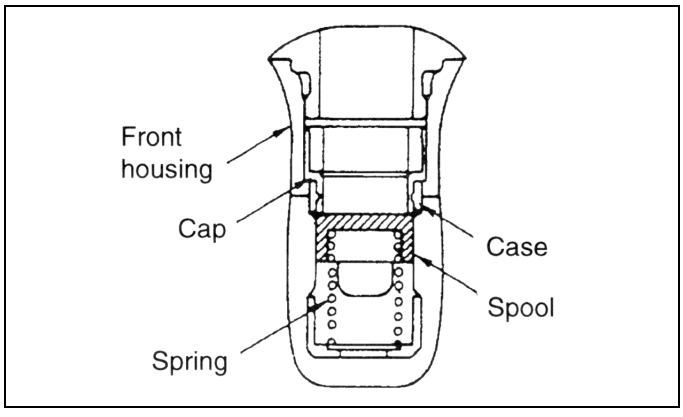


Fig. Check Valve Construction

6) **Shaft Seal**

A lip seal is used to seal the shaft.

Because the lip seal is located in the low-pressure chamber, it is cooled by the refrigerant gas that is constantly drawn into the chamber. At the same time, the lip seal is lubricated by oil.

In the event that oil leaks through the lip seal, the leaked oil is drained downward and becomes absorbed by the oil felt that is provided in the pool chamber. This prevents the oil from adhering onto the magnetic clutch surface, which could cause the magnetic clutch to slip.

Note : This lip seal is not interchangeable with the lip seal that is used in the swash-plate type or in the through-vane type compressor.

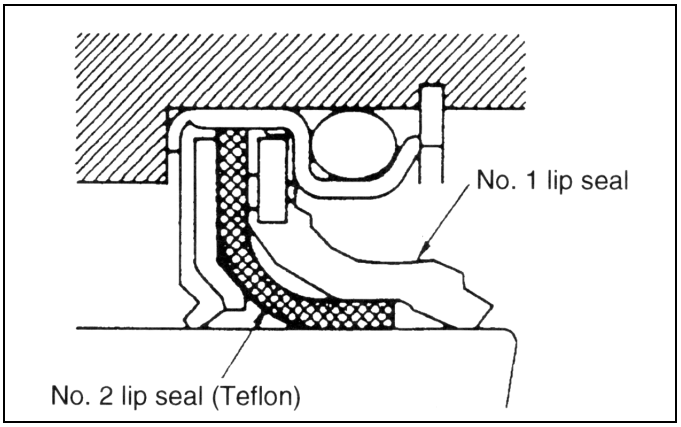


Fig. Shaft Seal Construction

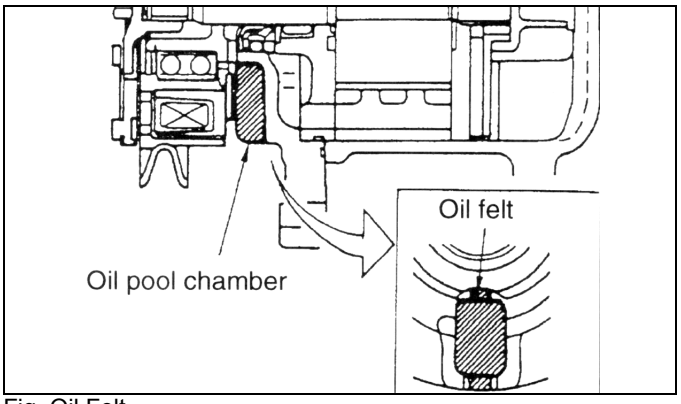


Fig. Oil Felt

FYI - (For your information)

(1) Scroll Type Compressor (SC-type : Kubota Agricultural Tractor)

The scroll type compressor chamber consists of a pair of spiral-shaped scrolls; a fixed scroll and a rotating scroll.

The fixed scroll is integrated with the housing. The rotating scroll revolves (while its revolution on its axis is restrained) along with the rotation of the eccentric shaft. Therefore, the volume changes in the compression chamber, which is partitioned by both scrolls. This results in effecting the suction and compression of refrigerant.

(1) Fixed scroll
(2) Rotating scroll
(3) Suction port
(4) Discharge port

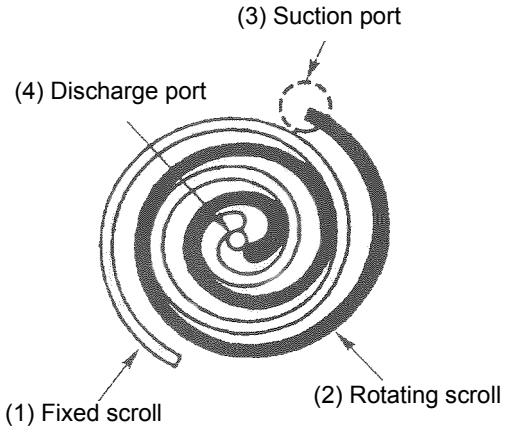
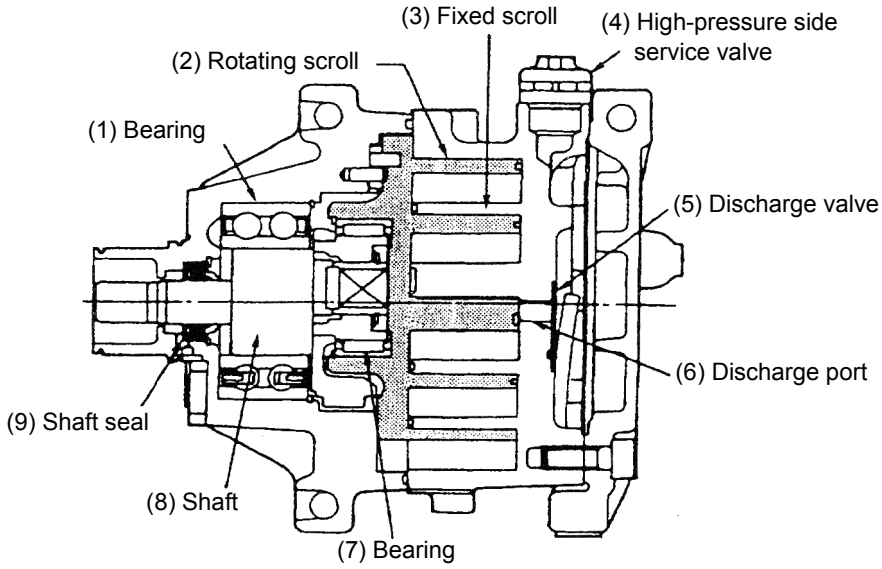
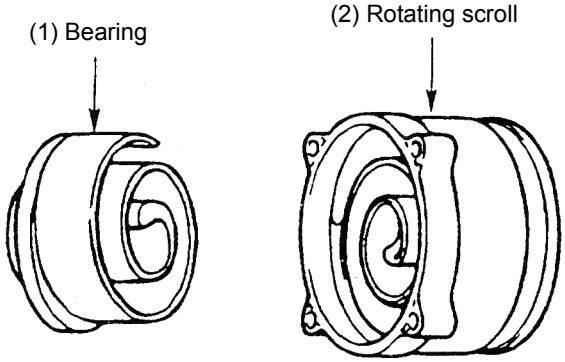


Fig. Contruction of Scroll-type Compressor(1)



(1) Bearing
(2) Rotating scroll
(3) Fixed scroll
(4) High-pressure side service valve
(5) Discharge valve
(6) Discharge port
(7) Bearing
(8) Shaft
(9) Shaft seal



(1) Bearing
(2) Rotating scroll

FYI - continued

(2) Drive Mechanism

A crankshaft driving mechanism is needed in order to enable the rotating scroll to move smoothly in the prescribed revolution radius.
The crankshaft is provided with a rectangle eccentric shaft, and is joined to the bushing, which is integrated with a counterweight for balancing purposes.
The bushing and the rotating scroll move while they automatically regulate their revolution radius.

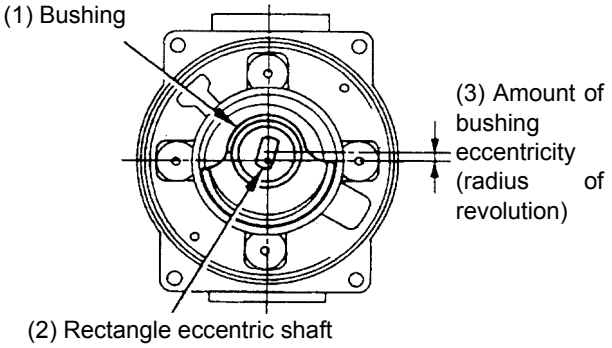


Fig. Drive Mechanism (1)

(1) Bushing
(2) Rectangle eccentric shaft
(3) Amount of bushing eccentricity (radius of revolution)

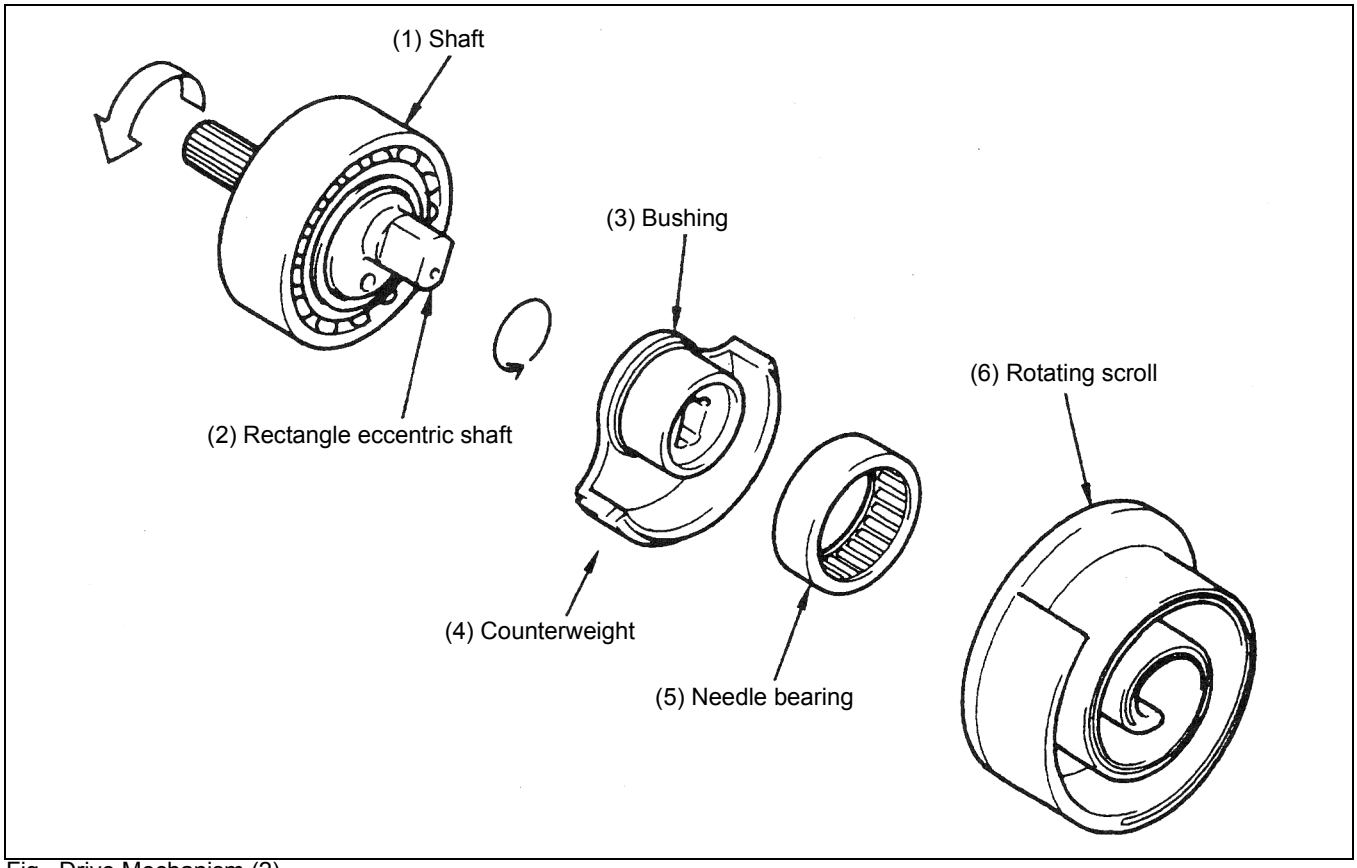


Fig. Drive Mechanism (2)

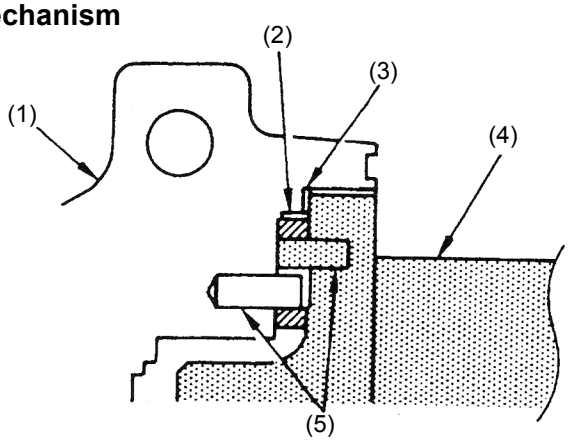
(1) Shaft
(2) Rectangle eccentric shaft
(3) Bushing
(4) Counterweight
(5) Needle bearing
(6) Rotating scroll

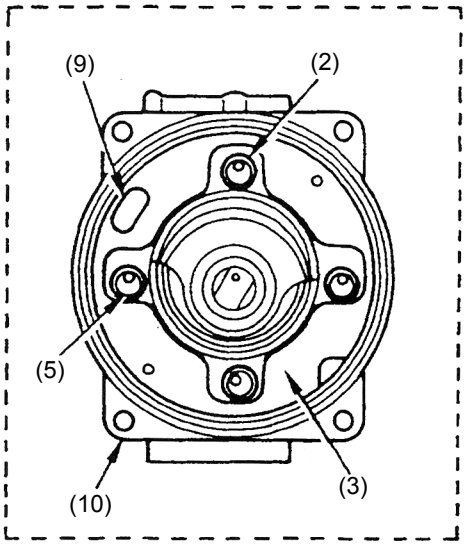
FYI - continued

(3) Rotating Mechanism

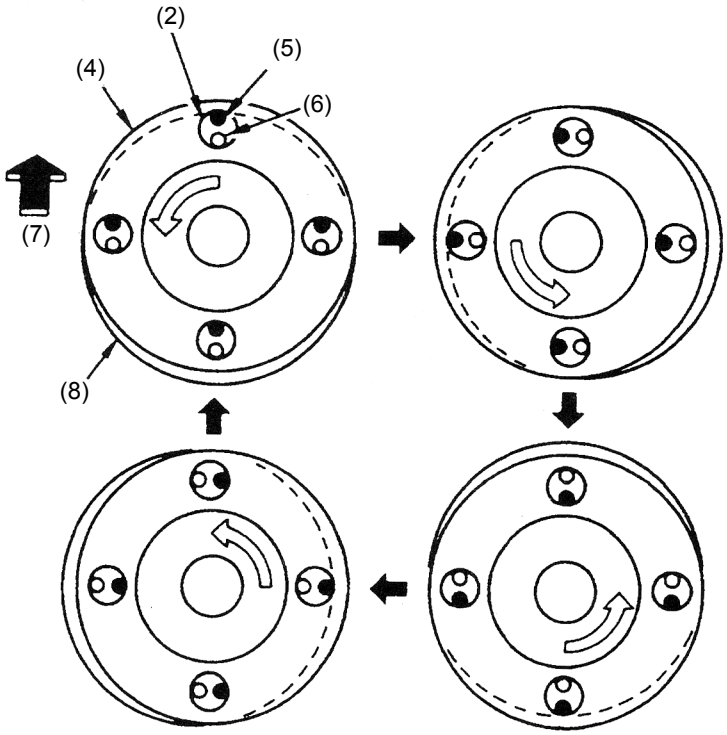
When the rotating scroll effects a smooth movement along the revolution radius through the use of the crankshaft driving mechanism, the rotating mechanism prevents the rotating scroll from revolving on its own axis, thus causing the movement locus to travel around the axis.
Revolving prevention pins and retainers are positioned at four locations at 90º intervals. Each of these maintains their prescribed revolution radius and performs a rotating movement as illustrated below.

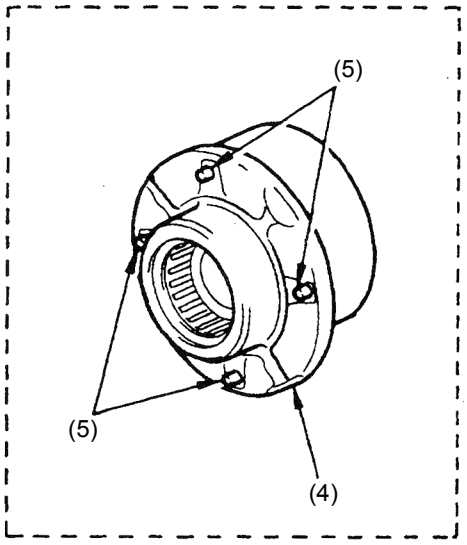
Rotating Mechanism





Rotating Mechanism Diagram





(1) Front housing
(2) Retainer
(3) Plate
(4) Rotating scroll
(5) Rotating scroll side pin
(6) Housing side pin
(7) Front of vehcle
(8) Front housing (Fixed)
(9) Suction port
(10) Housing

FYI - continued

(4) Compression Mechanism

1 Suction and Compression

Along with the revolving movement of the rotating scroll, the refrigerant is drawn in from the suction port when the volume between the rotating scroll and the fixed scroll increases.

The compression chamber consists of a fixed scroll and rotating scroll, with their respective teeth meshing against each other. The fixed scroll has spiral-shaped teeth and is fixed to the housing. The rotating scroll has similar spiral-shaped teeth, and is assembled at a phase that is staggered 180º from the fixed scroll.

The rotating scroll is off set 180º in the radial direction only for the amount of the bushing eccentricity and meshes against the fixed scroll. As a result, both scrolls form a crescent-shaped compression chamber through multiple contact points (indicated by the "▼" in the illustration). Illustrations (b), (c), and (d) show the state in which the revolution angle is advanced 90º, 180º, and 270º, respectively, from that of illustration (a).

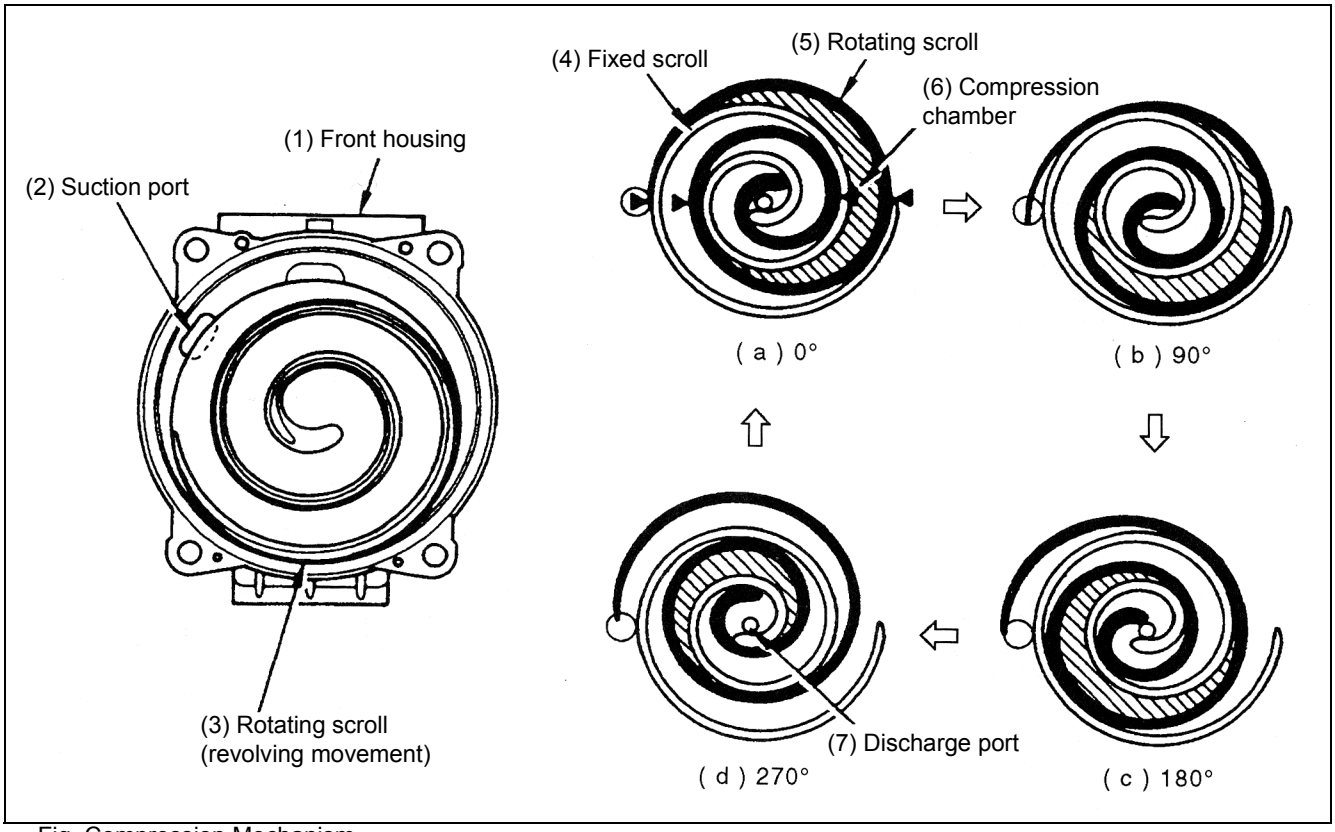


Fig. Compression Mechanism

(1) Front housing
(2) Suction port
(3) Rotating scroll (revolving movement)
(4) Fixed scroll
(5) Rotating scroll
(6) Compression chamber
(7) Discharge port

FYI - continued

2 Discharge

The crescent-shaped compression chamber decreases its volume, as the rotating movement advances, and moves the refrigerant gradually towards the center, while compressing the refrigerant.

The compression if the refrigerant gas is completed after approximately 2.5 rotations. Then, the refrigerant gas pushes the discharge valve to open and exits through the discharge port that is provided in the center of the fixed scroll.

The refrigerant gas is discharged once after each revolution of the compressor shaft.

(1) Raer housing
(2) Discharge port
(3) Valve stopper
(4) Discharge valve

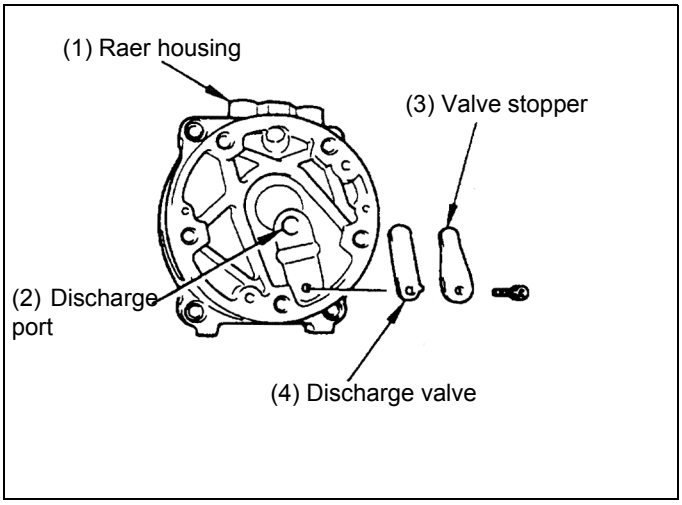


Fig. Discharge Valve

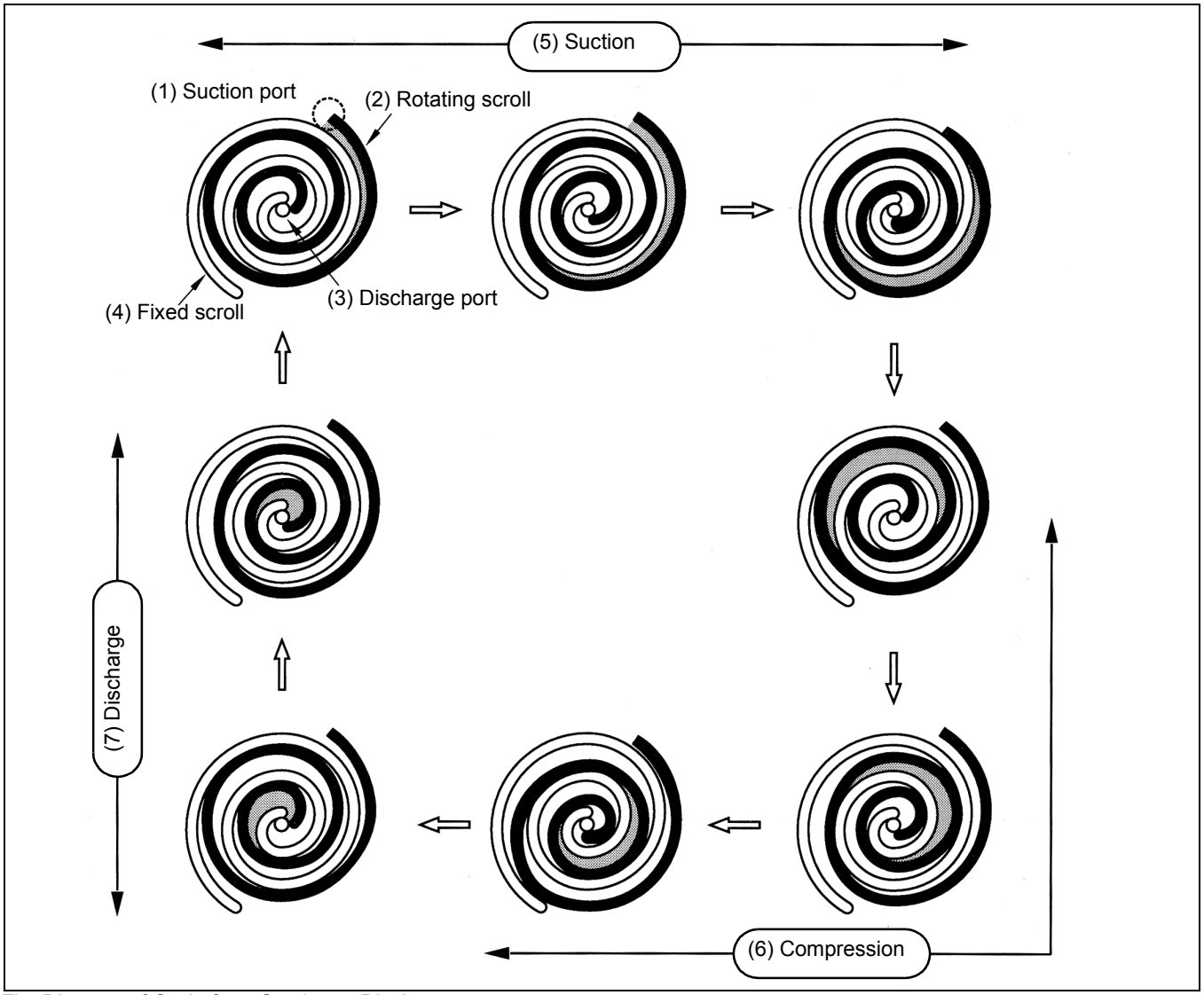


Fig. Diagram of Cycle from Suction to Discharge

(1) Suction port
(2) Rotating scroll
(3) Discharge port
(4) Fixed scroll
(5) Suction
(6) Compression
(7) Discharge

FYI - continued

(5) Seal Mechanism

1 Shaft Seal

A lip seal is used to seal the shaft.

Because the lip seal is located in the low-pressure chamber, it is cooled by the refrigerant gas that is constantly drawn into the chamber. At the same time, the lip seal is lubricated by oil.

In the event that oil leaks through the lip seal, the leaked oil is drained downward and becomes absorbed by the felt that is provided in the oil pool chamber. This prevents the oil from adhering onto the magnetic clutch surface, which could cause the clutch to slip.

(1) Shaft seal
(2) Shaft
(3) Oil felt
(4) Lip seal (Teflon)
(5) Lip seal (rubber)

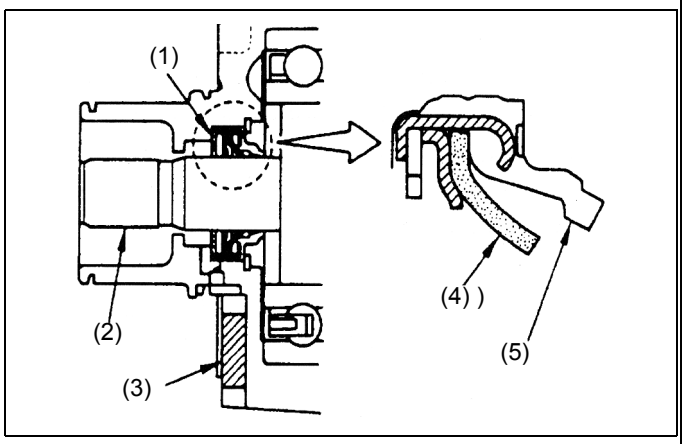


Fig. Shaft Seal

2 Tip Seal

Tip seal are provided at the tips of the fixed scroll and of the rotating scroll in order to prevent the pressure from leaking out of the compression chamber.

(1) Tip seal
(2) Fixed scroll
(3) Rotating scroll

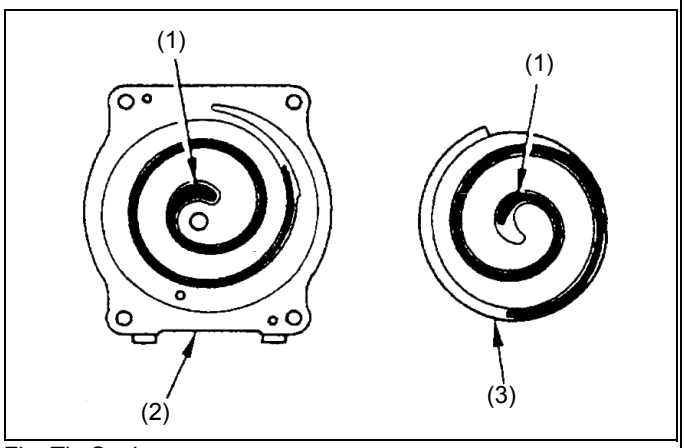


Fig. Tip Seal

3 Wall-to-Wall Clearance Seal

The eccentric shaft is set with an angle that ensures that the tooth of the moving scroll is pushed (by the high-low pressure difference in the compression chamber) against the fixed scroll tooth. As a result, the wall-to-wall clearance is sealed automatically.

(1)Low-pressure chamber
(2) High-pressure chamber
(3) Wall-to-Wall clearance
(4) The difference between the high and low pressures cause the rotating scroll to move.

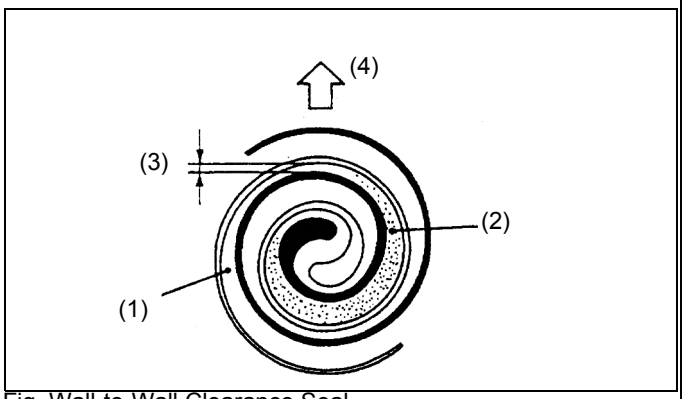


Fig. Wall-to-Wall Clearance Seal

(7) Oil Replenishment upon Function Part Replacement (for the HFC134a System)

1 Compressor Oil Quantity

When the air conditioning system is operating, compressor oil is discharged together with the refrigerant from the compressor and circulates within the refrigeration cycle.

As a result, an amount of oil is always found inside the condenser, the evaporator, the receiver drier and other parts.

A specified amount of oil must circulate inside the refrigeration cycle.

If the amount is larger or smaller than the specified amount, problems will occur in the refrigeration cycle as follows:

1) If the amount of oil is larger than the specifications;
   A larger amount of oil remains inside the condenser and evaporator, and then prevents proper heat exchange, thus decreasing the cooling capacity.
2) If the amount of oil is smaller than the specifications;
   A small amount of oil inside the compressor may cause premature wear, overheating and eventually seizure of internal parts.

2 When the evaporator or condenser is replaced;

Since a certain amount of compressor oil always stays inside the functional part, when the defective evaporator or condenser is replaced with the new one, the following amount of oil needs to be added into the refrigeration cycle.

<Compressor oil replenishment amounts>

	Replacement part		
	Compressor	Condenser	Evaporator
Compressor oil replenishment amounts	Refer to below explanation	40cc	40cc
Compressor oil	•ND-OIL 8		

3 When the compressor is replaced;

The amount of oil needed for the cycle is filled in the new compressor. Therefore, when replacing the compressor, remove excess oil as shown in Fig.

(1) New compressor
(2) Compressor to be replaced
(3) Remove the excess oil (A-B)

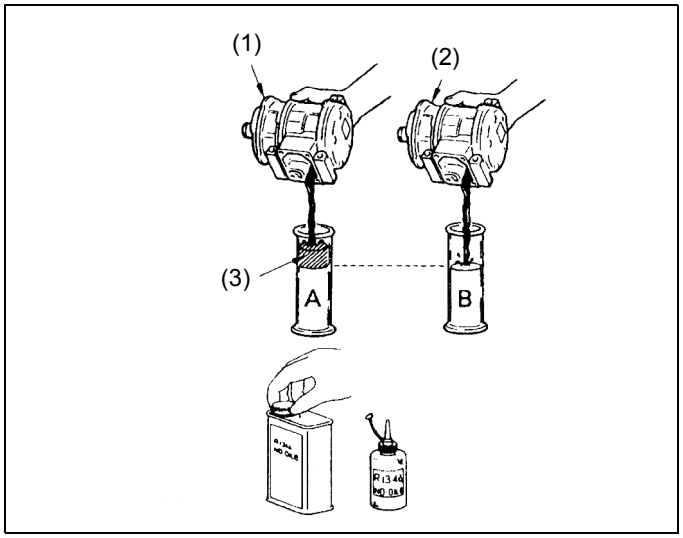


Fig. Oil Replenishment

⚠ Caution

1. **HFC134a oil easily absorbs moisture. Keep the oil container sealed at all times.**
2. **HFC134a oil reacts with some plastics.Keep it stored in metal container.(Plastic bottle should only be used for O-ring lubrication)**
3. **Care should be taken not to spill the HFC134a oil on paint work, and plastics. If this is accidentally done, wipe immediately.**
4. **Clearly identify the oils when transferred to a different container.**

Note : The amount of oil contained in the new part of compressor is 140 ±10 cc.

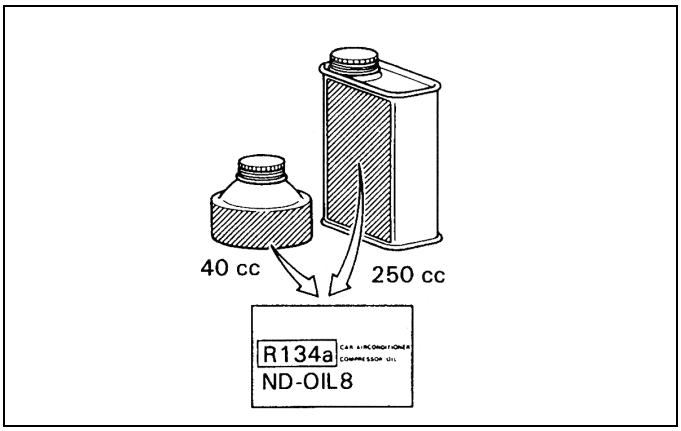
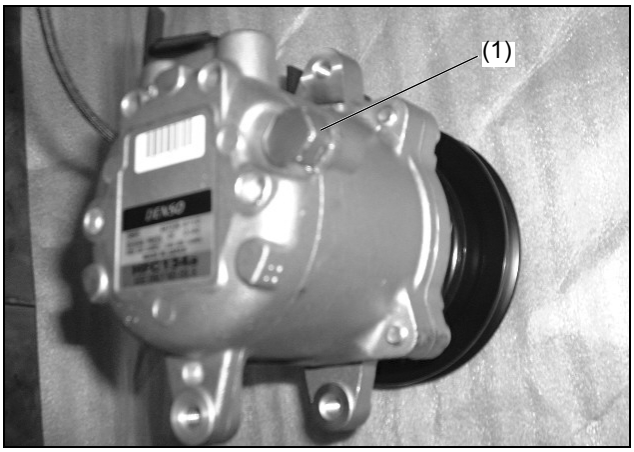
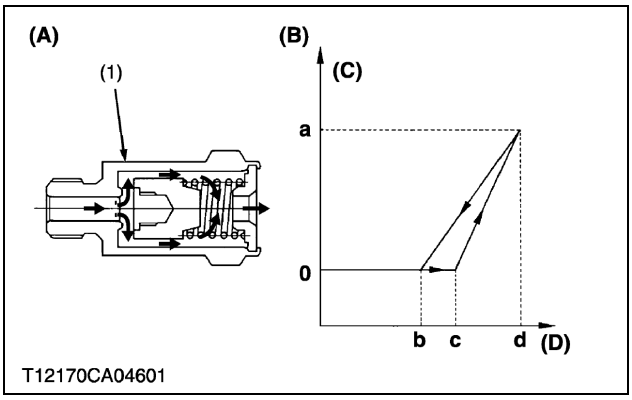
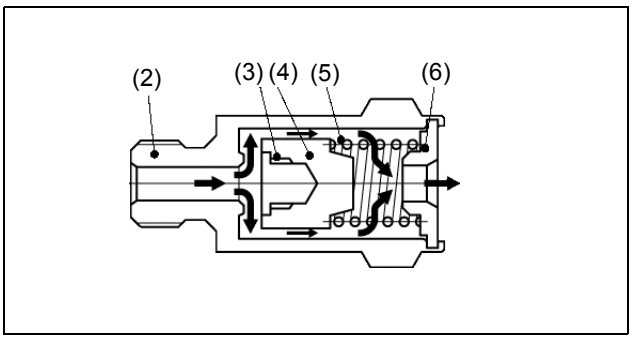


Fig. Compressor Oil Container

b. High pressure relief valve







If the high pressure is abnormally high, the pressure relief valve open, and the refrigerant is released into the atmosphere, and the system is maintained. At that time, some of the refrigerant in the system is released into the atmosphere. Even in the worst case, the outflow of refrigerant is stopped at the minimum limit.

(Reference)

In normal operation, the high pressure switch is triggered first and the compressor stops, so the pressure relief valve is not triggered so easily.

(1) Pressure Relief Valve

(a) 113L/min., 27.2 U.S.gals./min., 24.86 Imp.gals/min.
(b) 2.75 Mpa, 28.1 kgf/cm2, 399.7 psi
(c) 3.43 Mpa, 35.0 kgf/cm2, 497.8 psi
(d) 4.14 Mpa, 42.4 kgf/cm2, 603.1 psi

(A) Gas Ejection Route When Operating
(B) Operating Characteristic
(C) Leakage Quantity
(D) Pressure

(2) Body
(3) Seal
(4) Poppet
(5) Spring
(6) Stopper

c. MAGNETIC CLUTCH

A magnetic clutch is used to connect and disconnect the compressor from the engine.
The main components are the stator, rotor, and pressure plate.

(1) Principle

When the current is supplied to the coil, magnetic forces are generated in the iron II and attracts the iron I.

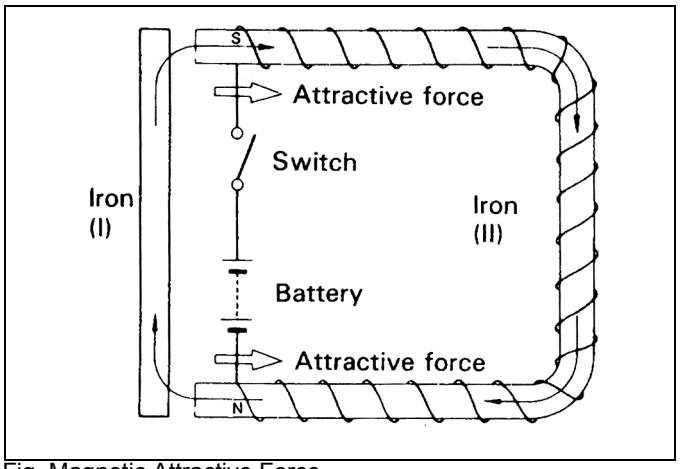
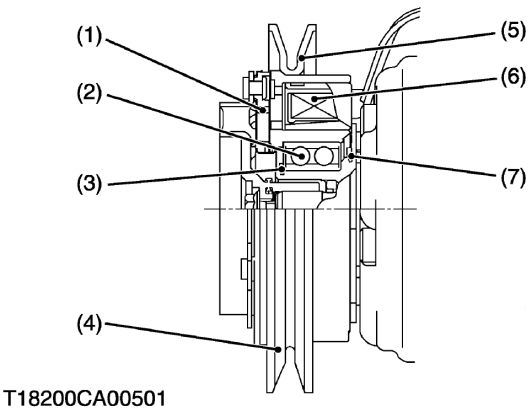


Fig. Magnetic Attractive Force

(2) Magnetic Clutch

A magnetic clutch is used to engage and disengage the compressor from the engine. Main components are stator (6) and rotor with pulley (5), and pressure plate (1) to engage the drive pulley (4) and compressor magnetically.
The stator is fixed on the compressor housing, and pressure plate is attached to the compressor shaft.
Two ball bearings are used between the inner surface of the rotor and the front housing of the compressor.

(1) Pressure Plate
(2) Ball Bearing
(3) Snap Ring
(4) Pulley
(5) Rotor with Pulley
(6) Stator
(7) Snap Ring



(3) Operation

Whenever the engine is operating, the pulley is rotating since it is connected to the crankshaft by a drive belt, but the compressor does not operate until the magnetic clutch is energized. When the air conditioning system is switched on, the system supplies current to the stator coil. Then the electromagnetic field attracts the pressure plate and pulls the plate against the friction facings on the pulley. The friction between the facings on the pulley and pressure plate causes the magnetic clutch assembly to rotate as a unit, and drive the compressor.

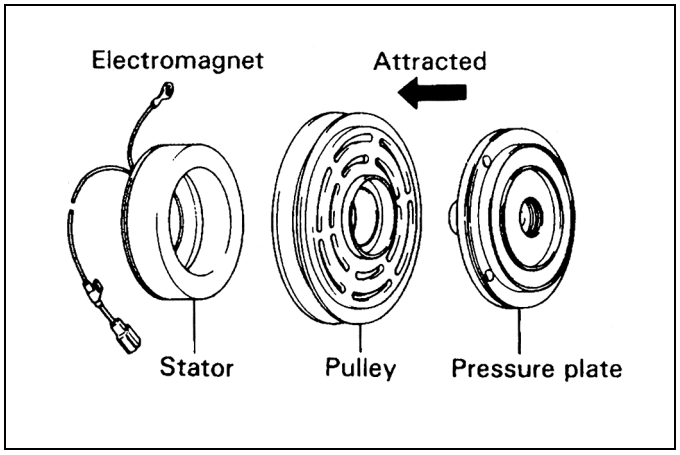


Fig. Operation

d. CONDENSER

(1) Description

The condenser is used to cool down the high temperature and high pressure gas refrigerant and change it to a liquid refrigerant.

The greater the amount of the heat released off into the air through the condenser, the greater will be the cooling effect obtained by the evaporator.

Therefore, the condenser is installed at the front end of the vehicle to get forcible cooling by the machine when moving.

There are some models which are equipped with a fan exclusively for the condenser.

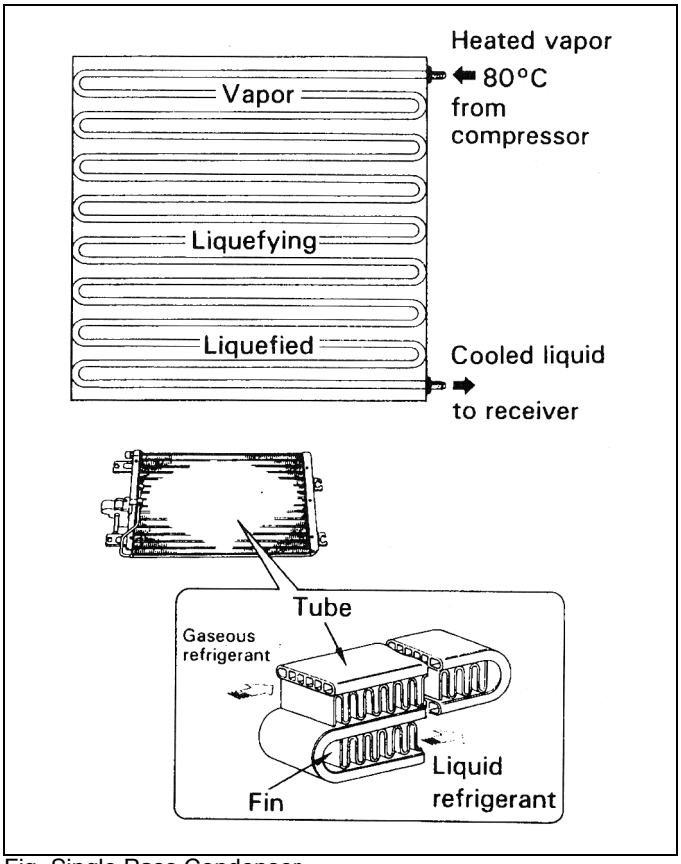


Fig. Single Pass Condenser

(2) Type of Condenser

To improve the cooling performance and decrease the weight and size of condenser, new types of condenser have been developed as follows:

1) Single Pass Type (Conventional type)
   As shown in Fig, the refrigerant gas flows only in one passage.
2) Two Pass (Passage) Type
   This condenser has the refrigerant passages in two directions to improve cooling performance.
3) Three Pass (Passage) Type
   This condenser has the refrigerant passages in three directions to improve cooling performance.
4) Multi Pass (Passage) Type
   This condenser has been developed to decrease its weight and size especially for HFC134a, new refrigeration cycle.

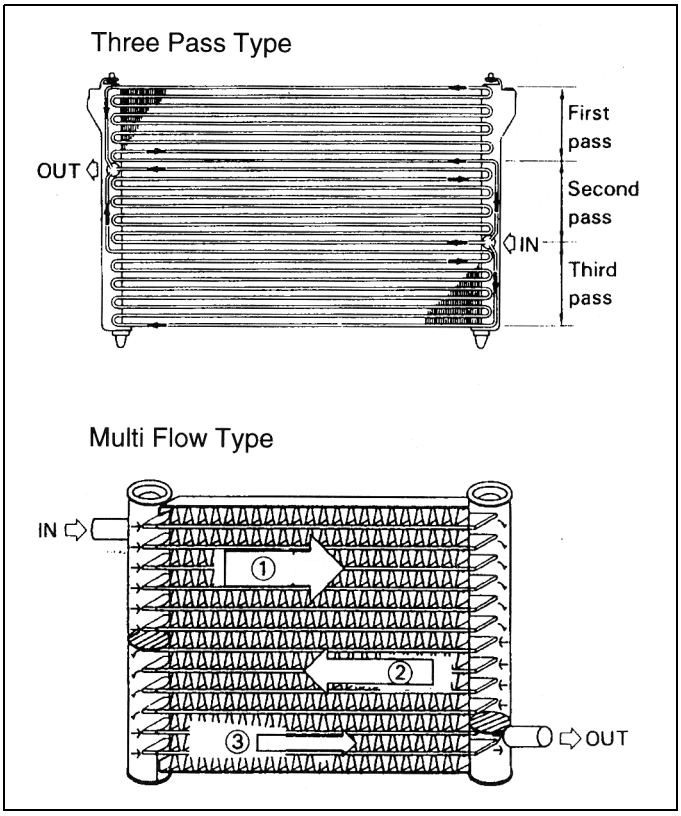
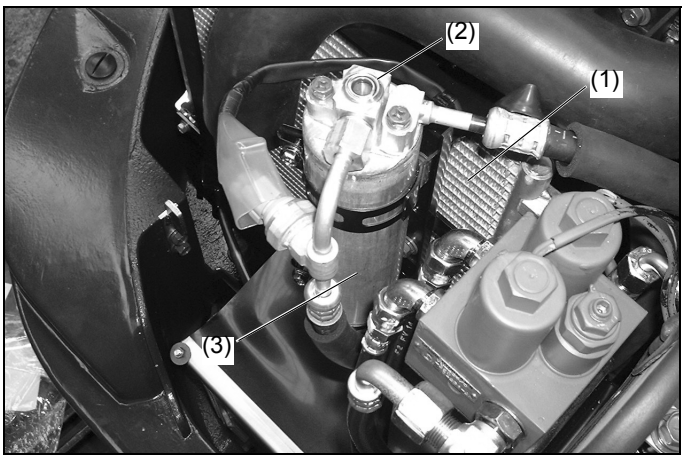
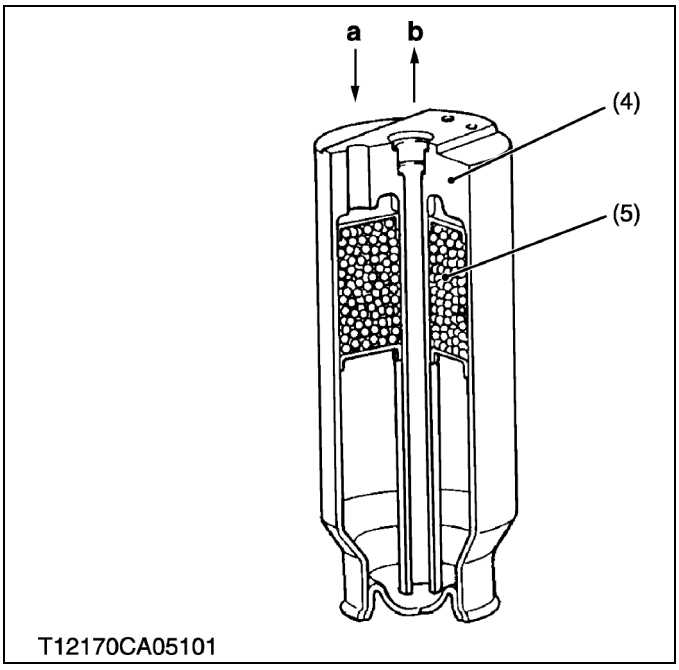


Fig. Three Pass Type and Multi Pass Type Condensers

e. Receiver





The receiver (3) serves the purpose of storing the liquid refrigerant. The amount of the liquid refrigerant flowing through the system varies with the operating condition of the air conditioner. To be accurate, the receiver stores excess amount of refrigerant when the heat load is lowered. It also releases stored refrigerant when additional cooling is needed, thus, maintaining the optimum flow of refrigerant within the system.

The receiver includes a desiccant (5). It has the job of removing moisture as the refrigerant circulates within the system.

The sight glass (2) is installed on the top of receiver. Amount of refrigerant to be charged is very important for the efficiency of air conditioner. The sight glass is used to check the amount of refrigerant. If large flow of bubbles can be seen in the sight glass, there is insufficient refrigerant charged. If so, replenish the refrigerant to the proper level.

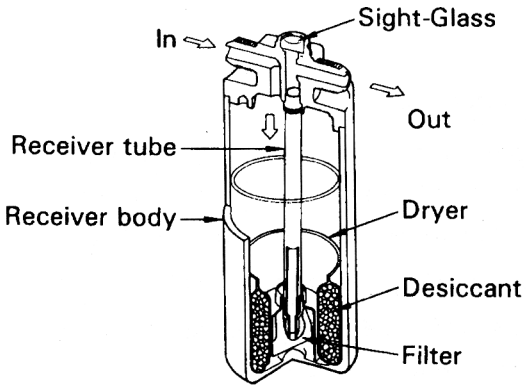
(1) Condenser
(2) Sight Glass
(3) Receiver
(4) Receiver Body
(5) Desiccant (silicagel → zeolite)

a : IN
b : OUT

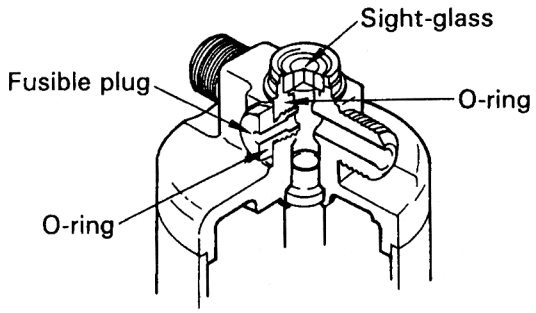
Desiccant changed from silicagel to zeolite for HFC134a type.

FYI (For your information)

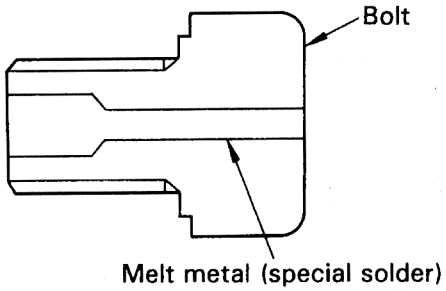
For the receiver/dryer of CFC12 air conditioning, the silicagel is used as a desiccant and its structure is slightly different from HFC134a receiver.
Also, a fusible plug was used to protect the system from abnormally high pressure, which may cause the damage to the other parts in the system.
However, as an environmental concern, the fusible plug has been discontinued.
Instead of this, a pressure relief valve has been employed on the compressor.



Receiver for CFC12



Sight-glass and Fusible Plug for CFC12



Fusible Plug

f. DUAL PRESSURE SWITCH

(1) Location & structure

The pressure switch is installed on the liquid tube between the receiver and the expansion valve. It detects abnormally high and low pressure of the refrigerant and switches off the magnetic clutch. Then the compressor operation is stopped, preventing potential trouble with the system.

(1) Dual pressure switch

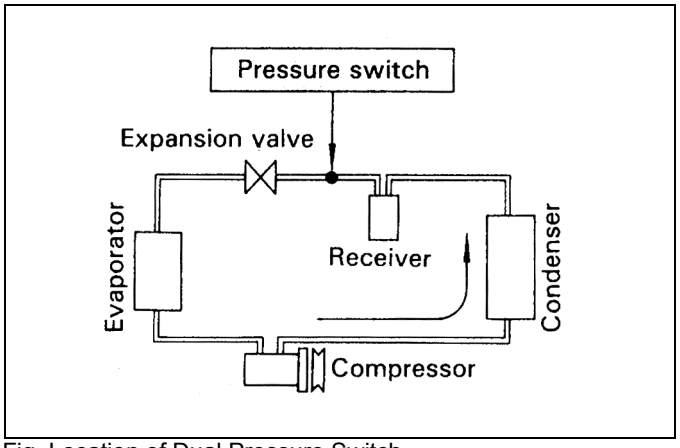


Fig. Location of Dual Pressure Switch

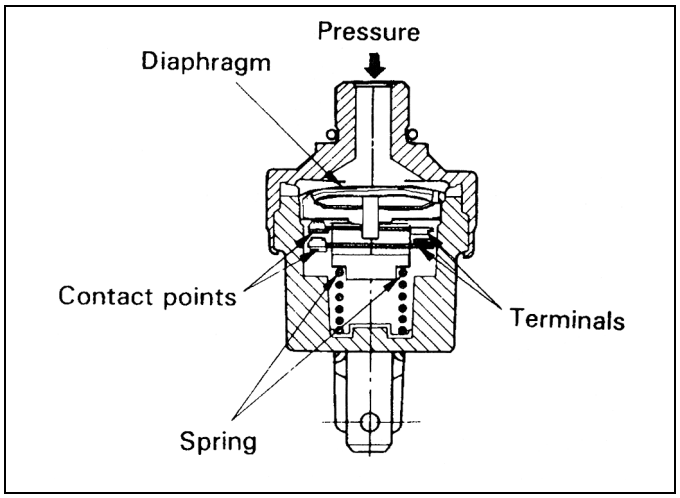


Fig. Dual Pressure Switch

(2) When the Pressure is Abnormally High

When the pressure in the refrigeration cycle becomes abnormally high, it may cause damage to various components.

When it detects abnormally high pressure, generally about 32 kg/cm^2 (3.14 MPa) the switch turns off. This turns the magnetic clutch off and stops the compressor (27 kg/cm2 for CFC12).

(3) When the Pressure is Abnormally Low

When there is insufficient refrigerant and the pressure drops to 2.0 kg/cm^2 (0.20 MPa) or lower, the pressure switch turns off. This turns the magnetic clutch off and stops the compressor.

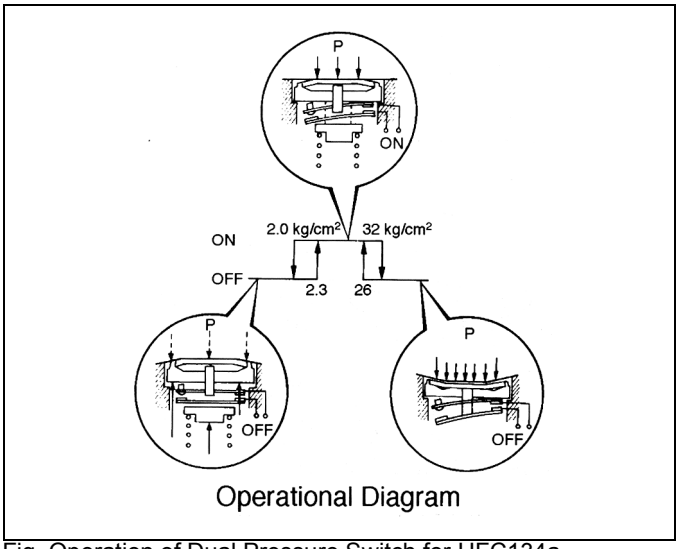
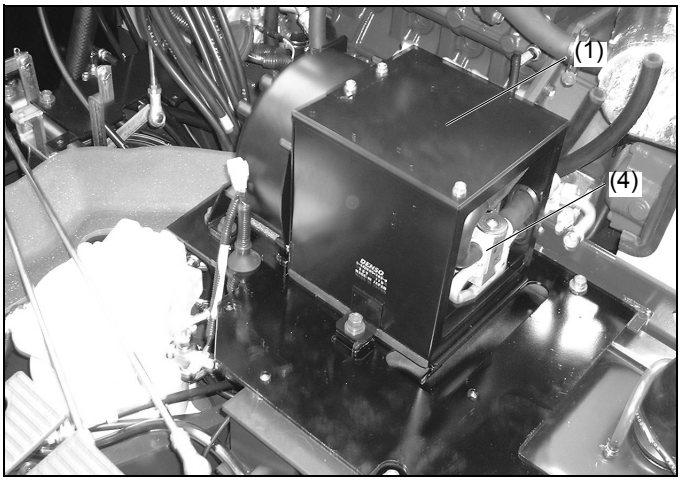


Fig. Operation of Dual Pressure Switch for HFC134a.

g. Air Conditioner Unit

Air conditioner unit (1) consists of evaporator (3), expansion valve (4), heater core (2), blower (5), etc..

(1) Air Conditioner Unit
(2) Heater Core
(3) Evaporator
(4) Expansion Valve
(5) Blower



(1) Outline

The cooling unit consists of the following three main parts.

1) Expansion Valve
2) Evaporator
3) Drain Pan

The drain pan collects the water condensed on the evaporator and drains it to the outside of the machine.

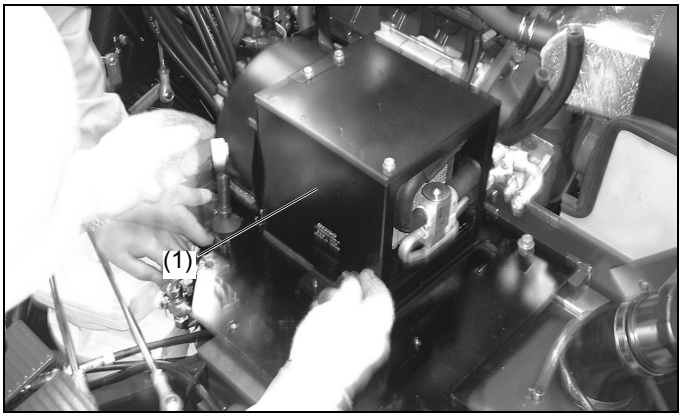
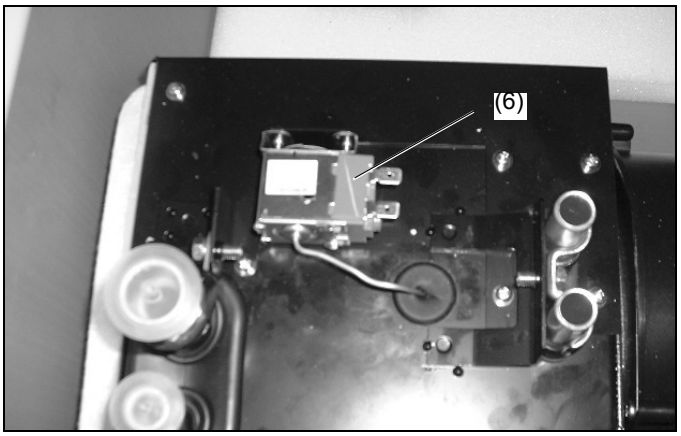
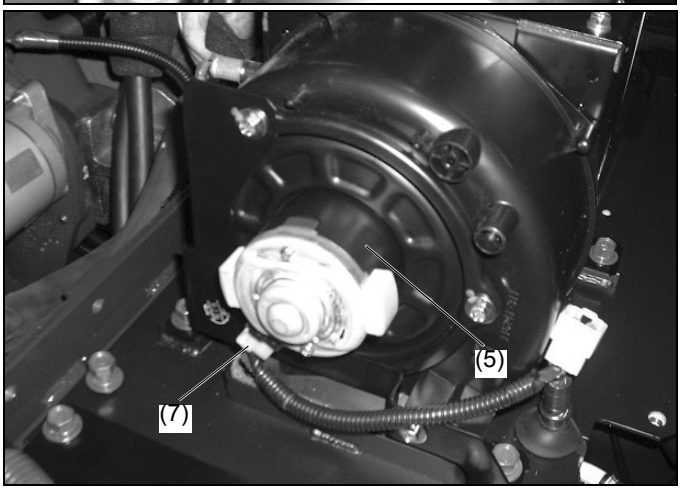


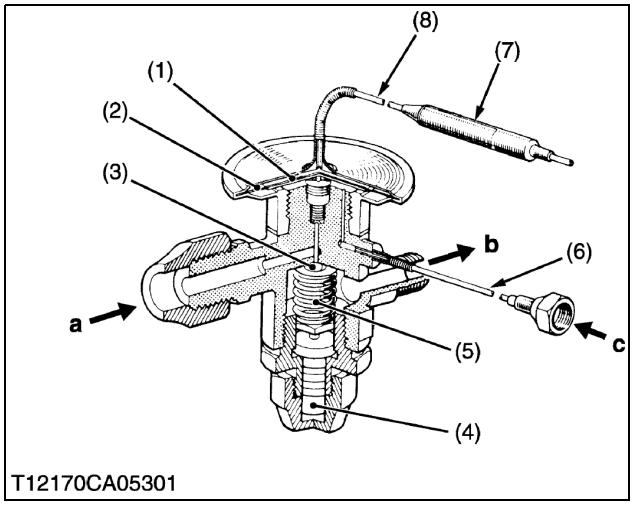
Fig. Cooling Unit for CFC12

(6) Thermostat



(5) Blower
(7) Coupler





(2) Expansion Valve

The expansion valve restricts the flow of liquid refrigerant as it passes through the expansion valve and delivers sprayed refrigerant to the evaporator for facilitating refrigerant evaporation.

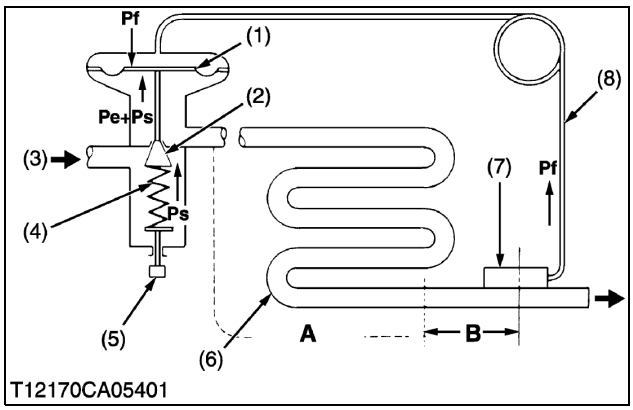
The cabin interior will not be cooled sufficiently if the expansion valve outlet is too small. If it is too wide, frost will be produced on the evaporator, decreasing cooling efficiency. Thus the size of this small spray hole has to be controlled according to various conditions.

(1) Diaphragm Chamber
(2) Diaphragm
(3) Needle
(4) Adjusting screw
(5) Pressure Spring
(6) Tube
(7) Heat Sensitizing Tube
(8) Capillary Tube

a : From Receiver
b : To Evaporator
c : From Evaporator

When the vapor pressure of the operating system is stable, Pf = Pe + Ps condition will prevail. The needle valve opening at this time will be stationary and constant refrigerant flow will be maintained.

In the evaporator installing expansion valve, the refrigerant in the outlet is always in superheated vapor form for certain length (part B in the figure). If the cooling load increases (inlet air temperature of evaporator becomes high), the refrigerant will vaporize faster and cause the length of the superheated vapor part (B) to become longer. Thus, the pressure in the heat sensitizing tube (7) rises and increases needle valve opening, resulting in larger flow of the refrigerant into evaporator. Conversely, if the amount of refrigerant in evaporator becomes greater, the length of the superheated vapor part (B) will become shorter. The pressure in the heat sensitizing tube will drop and decrease the needle valve (2) opening.



(1) Diaphragm
(2) Needle Valve
(3) Refrigerant Inlet
(4) Spring
(5) Adjusting Screw
(6) Evaporator Tube
(7) Heat Sensitizing Tube
(8) Capillary Tube

A : Saturated Vapor Part
B : Superheated Vapor Part
Pf : Gas pressure in sensitizing tube
Ps : Spring pressure
Pe : Vapor pressure in evaporator

FYI (For your information)

There are internally equalized and externally equalized types of thermal expansion valves depending on where the refrigerant gas pressure within the evaporator is taken. But both are identical in principle.

1) Internally Equalized Type Thermal Expansion Valve
When the refrigerant gas pressure in the evaporator is stable, pressure Pf is balanced with the sum of the pressure Pe and Ps. The valve opening will be stationary and constant refrigerant in the evaporator outlet is always in super-heated vapor form (completely evaporated) for certain length (part L in diagram). If the amount of the refrigerant in the evaporator becomes less, the refrigerant will vaporize faster and cause the super-heated part L to become longer. Therefore, the temperature of the outlet increases. The pressure in the temperature sensing bulb increases and opens the valve more, resulting in large flow of the refrigerant into the evaporator.
Conversely if the amount of the refrigerant in the evaporator becomes large, the super-heated part L will become shorter. The pressure in the temperature sensing bulb will drop and decrease the valve opening.

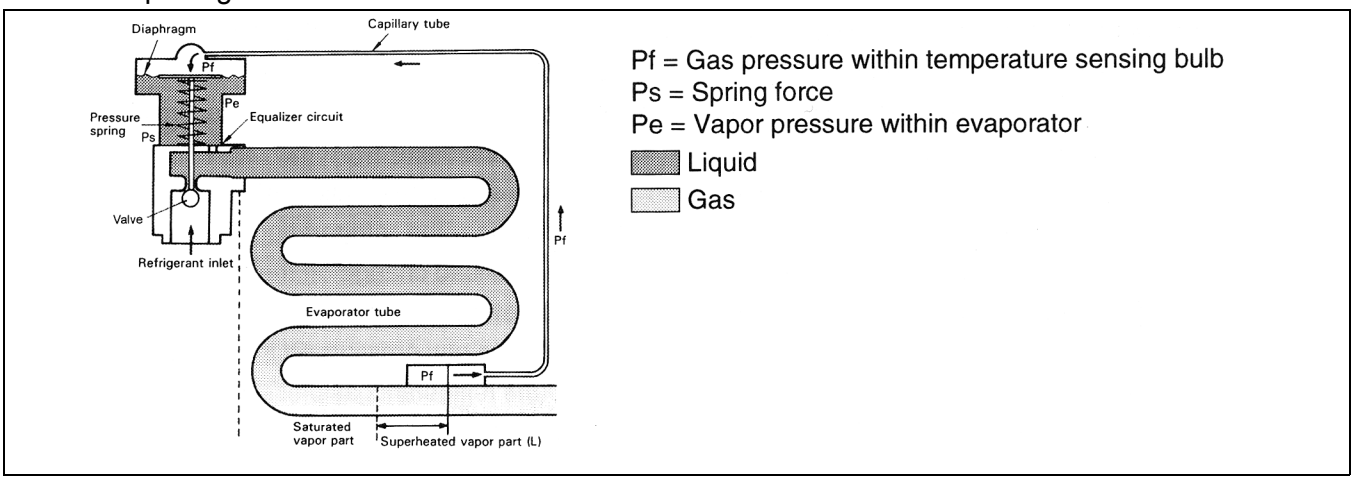


Fig. Operation of Internally Equalized Type Thermal Expansion Valve

2) Externally Equalized Type Thermal Expansion Valve
In the case of an internally equalized type thermal expansion valve, if there is a pressure drop between the evaporator inlet and outlet due to a blockage, a large degree of superheat will be required to open the valve.
In the externally equalized type expansion valve, this problem is overcome by taking the pressure near the end of the evaporator, instead of the evaporator inlet pressure. This pressure is applied to the underside of the diaphragm.

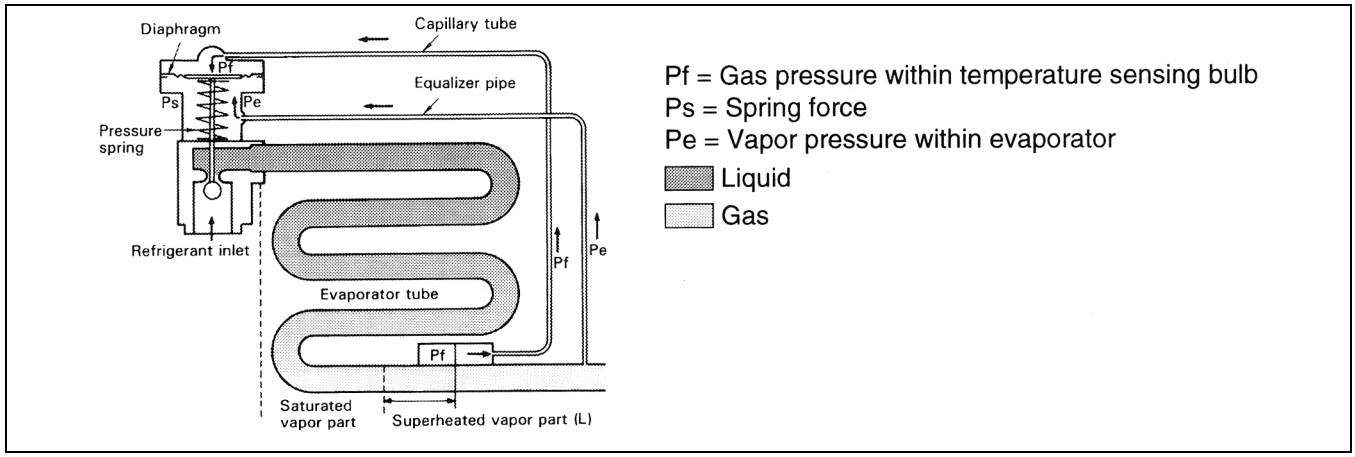


Fig. Operation of Externally Equalized Type Thermal Expansion Valve

3) Box Type Expansion Valve

Some recent vehicle models use a box-type expansion valve. This expansion valve features an internal temperature sensing rod (equivalent to the temperature sensing bulb found in the conventional expansion valve, which makes the use of the conventional capillary tube.). This capillary tube is not necessary for the box type. In addition, the box-type construction, in which the refrigerant pressure at the evaporator outlet is applied directly to the temperature sensing rod side of the diaphragm, makes the use of the conventional equalizer pipe unnecessary.

In operation, the temperature sensing rod senses the temperature at the evaporator outlet and transmits to the diaphragm, causing the pressure of the gas that is contained in the diaphragm chamber to vary. As a result, the diaphragm moves, thereby controlling the opening and closing of the valve.

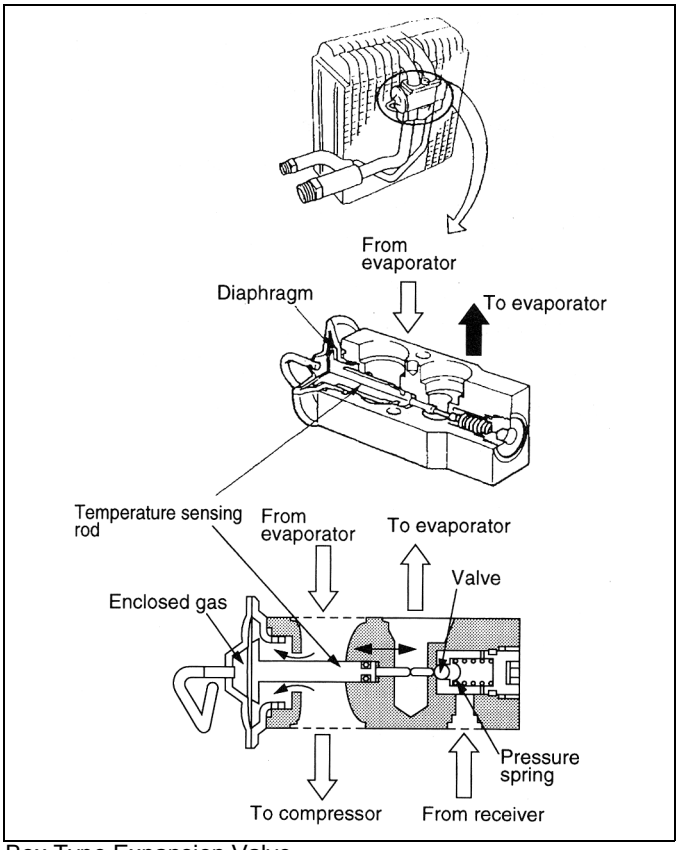


Fig. Box Type Expansion Valve

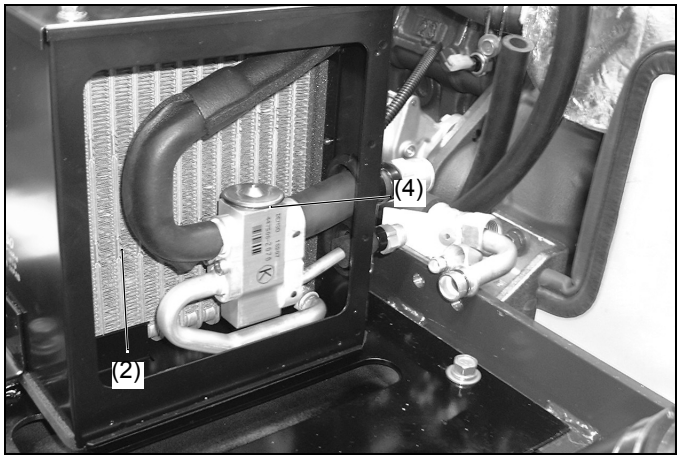
(3) Evaporator

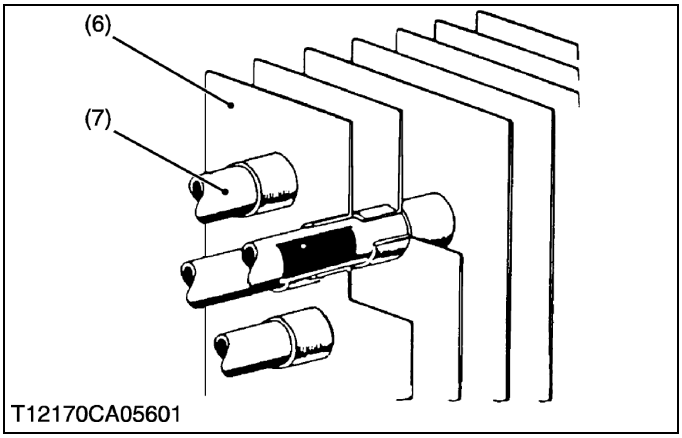
The purpose of evaporator (2) is just opposite to that of the condenser. The state of refrigerant immediately after the expansion valve (4) is 100% liquid. As soon as the liquid pressure drops, it starts to boil, and in doing so, absorbs heat. This heat is removed from the air passing over the cooling fins of the evaporator and causes the air to cool.

If too much refrigerant is sent into the evaporator, it will not boil away so easily. Also, the evaporator filled with liquid refrigerant eliminates a place for the refrigerant to properly vaporize, which is necessary in order to take on heat. A flooding condition of the evaporator will allow an excess of liquid refrigerant to leave the evaporator and may cause serious damage to the compressor.

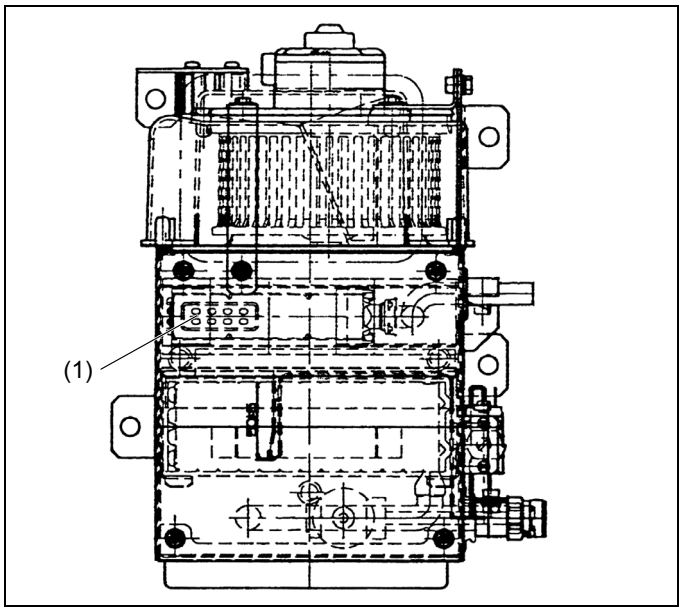
If too little refrigerant is sent into the evaporator, again the evaporator will not cool because the refrigerant will vaporize, or boil off, long before it passes through the evaporator.

Refrigerant properly metered into the evaporator should allow for 100 % liquid just after the expansion valve, and 100 % gas at the outlet.





(1) Pressure Switch
(2) Evaporator
(3) Capillary Tube
(4) Expansion Valve
(5) Thermostat
(6) Fin
(7) Tube



(4) Heater Core

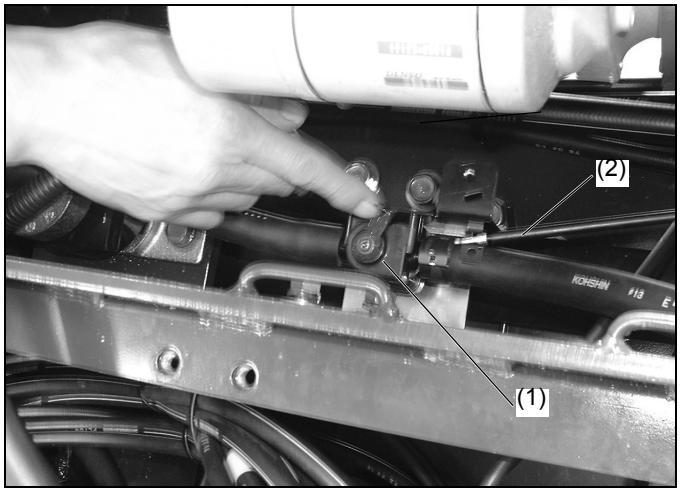
The heater-source of heater utilizes coolant which becomes high temperature by heat of engine.

The inlet port heater core is connected to the delivery side of engine water pump by a rubber hose, and the water valve is installed on the inlet port of heater core.

Also, the outlet port of heater core is connected to the engine cylinder block.

The heater core (1) is one of the heat exchangers like evaporator or condenser, and heat is exchanged between heated coolant passing through the core and air in the cabin or fresh outdoor air. Thus, air is heated.

(1) Heater Core



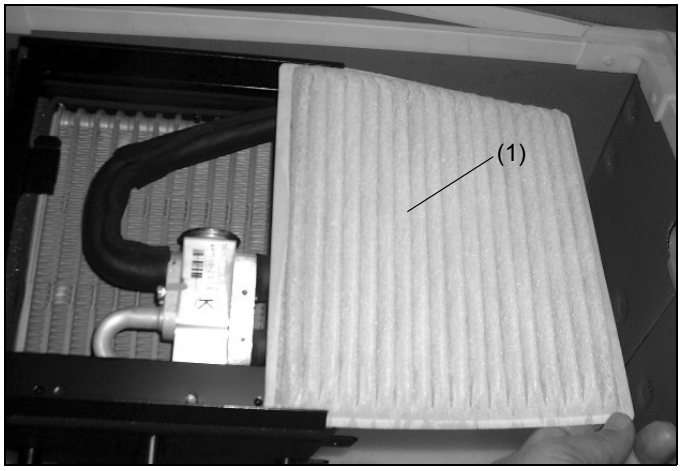
(5) Water Valve

The hot water valve (1) is connected with the got water valve cable (2) and controlled with the temperature control lever on the control panel. This lever is used to adjust the flow rate of hot water going into the heater.

Set the temperature control lever to the COOL position and the hot water valve gets closed, allowing no hot water flow. The hot water valve is built in at the right-hand top of the center pillar.

(1) Hot Water Valve

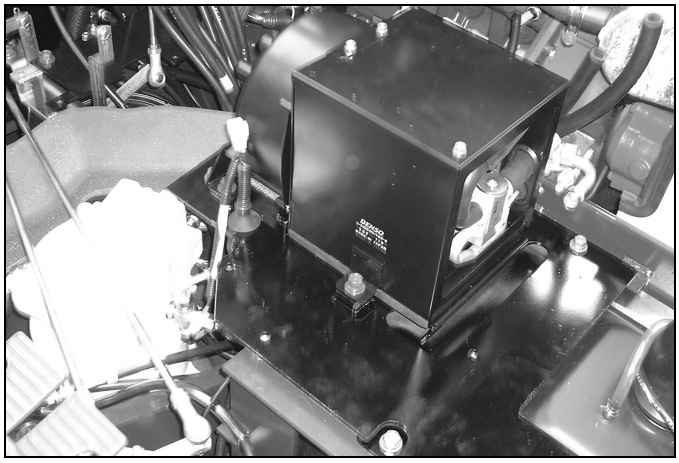
(2) Hot Water Valve Cable

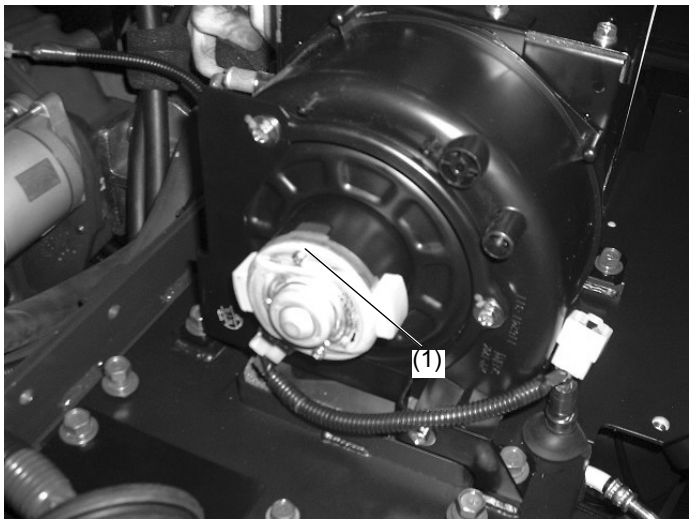


(6) Air filter

1. Percolation area : 0.057 m^2
2. Rated air filter : 300 m^3/h
3. Clearing efficiency : 45% or more at 150 m^3/h

(1) Air filter





(7) A/C Blower

The blower is incorporated in the right-hand space of the air conditioner unit. It blows cool, warm of fresh air via the front and side blow ports into the cabin.

The speed of the blower motor (1) can be adjusted in 3 steps by the resistor (2).

The blower fan (3) is centrifugal type. The air being sucked in parallel with the rotary shaft is blown in the centrifugal direction; in other words, perpendicular to the rotary shaft.

(1) Blower Motor
(2) Resistor
(3) Blower Fan

(1) Blower Motor

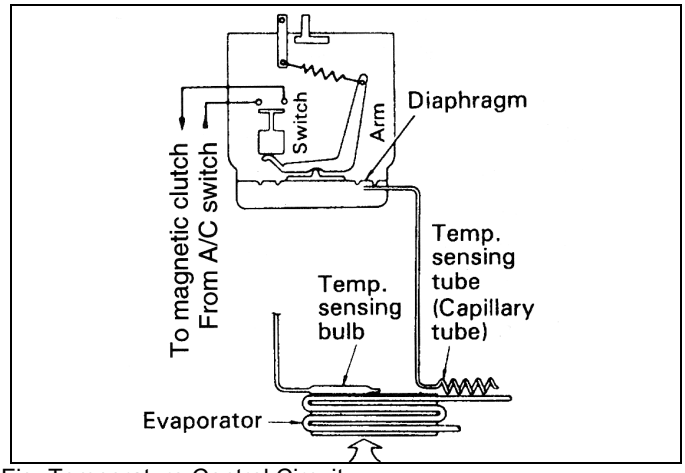


Fig. Temperature Control Circuit

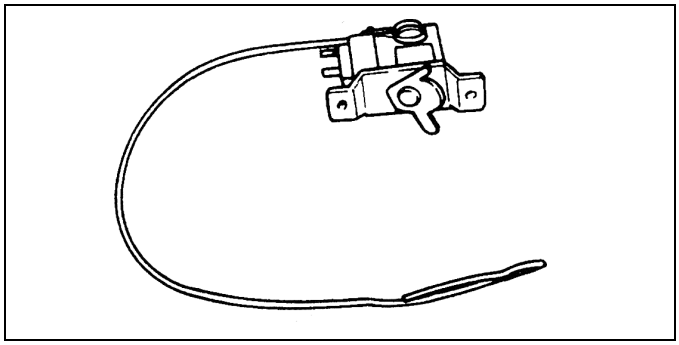


Fig. Gas Type Thermostat

(8) Gas Type Thermostat

The gas type thermostat consists of a capillary tube, diaphragm and microswitch..

The capillary tube is filled with a special gas.

The capillary tube is fitted on the tube of the evaporator outlet. The gas pressure in the capillary tube changes depending on the temperature change of refrigerant gas.

When the temperature of refrigerant at the evaporator outlet increases, the pressure in the capillary tube increases, thus closing the contact point (ON) of the microswitch.

Conversely when the temperature of the refrigerant decreases, the pressure in the capillary tube decreases and opens the contact point (OFF) of the microswitch.

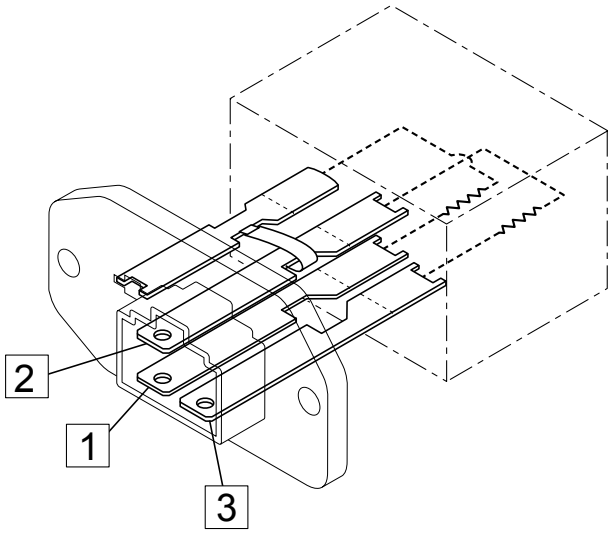
As a result, the magnetic clutch is turned on and off, depending on the temperature of evaporator outlet. This controls the temperature in the cab.

(9) A/C blower resistor

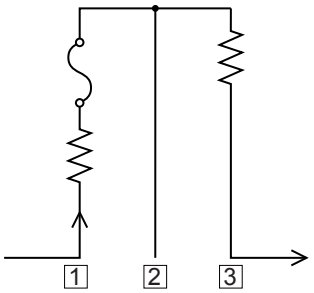
1 Main functions are ;

1. Two resistors regulate the blower speed according to the A/C blower switch speed range.
2. Fuse prevents the blower from burning out.

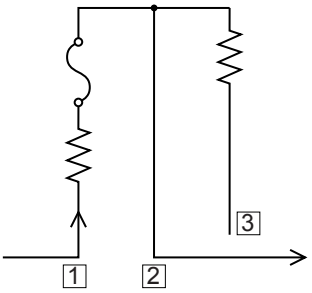
2 Structure



3 Current flow

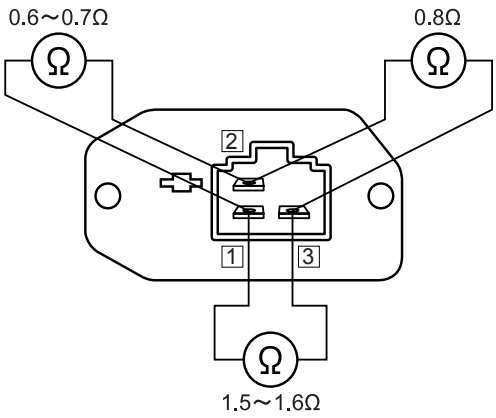


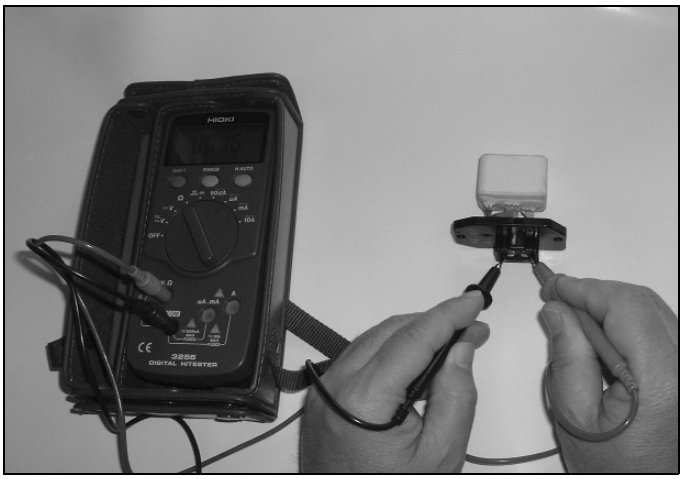
Low position



Medium position

4 Testing





h. Refrigerant

(1) Refrigerant R134a

Important

- **The air conditioning system operates using R134a refrigerant. This substance does not contain any chlorine atoms, so it does not have a detrimental effect on the ozone in the Earth's atmosphere.**
- **Even so, the refrigerant must never be discharged straight into the air. It must be trapped in a recycling machine.**
  Refrigerant stored in a recycling unit may be re-used at any time.
- **The recycling machine used to do this must be of a type suitable for handling R134a refrigerant.**
- **R134a has a corrosive effect on copper as well as various seals and components used in the R12 system. For this reason, never use R134a refrigerant in a system that has previously used R12. Before replacing any component, it is vital to check whether it is compatible with the type of refrigerant used.**

(2) Refrigerant Properties

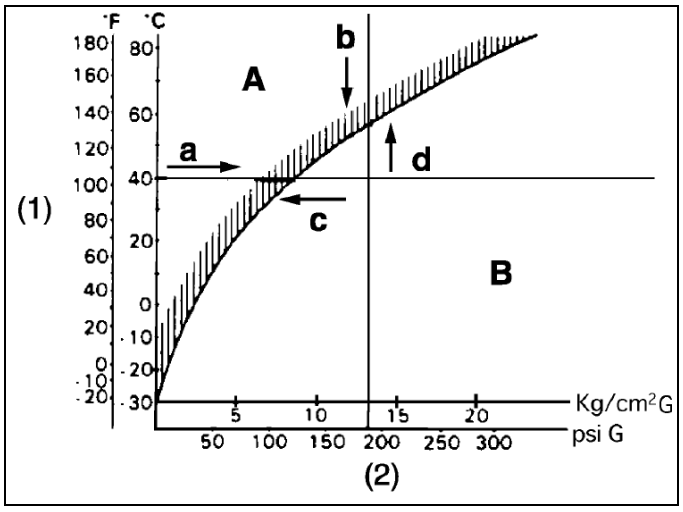
Water boils at 100 °C (212 °F) under atmospheric pressure, but R134a boils at -26.5°C (-15.7 °F) and its freezing points is -101°C (-149.8 °F) below zero under atmospheric pressure.

If R134a were exposed and released to the air under normal room temperature and atmospheric pressure, it would absorb the heat from the surrounding air and boil immediately changing into liquid under the pressurized condition by removing heat from it.

The characteristic curve of R134a which expresses the relation between the temperature and pressure is shown in the figure left. The graph itself indicates the boiling point of R134a under each temperature and pressure. On the graph, the upper portion above the curve is gaseous state of R134a and the lower portion below the curves liquid state of R134a. The gaseous refrigerant can be converted into liquid refrigerant by raising the pressure without changing the temperature or decreasing the temperature without changing the pressure. (See (a) and (b) in the figure.) Conversely, the liquid refrigerant by lowering the pressure without changing the temperature, or by raising the temperature without changing the pressure. (See (c) and (d).)

A : GAS
B : LIQUID

(1) Temperature
(2) Gauge Pressure



A : GAS
B : LIQUID

FYI (For your information)

Type of Refrigerant

The characteristics of representative refrigerants used in vapor compression cooling machines familiar to the public are shown in the table below. Their characteristics stand out as compared with water. Because their boiling point is very low, they boil instantaneously at ordinary temperature, rapidly drawing heat from the surroundings.

The lower the boiling point of a refrigerant used is, the higher the pressure becomes, which allows the use of a low-capacity compressor. HCFC-22 is therefore used in room coolers. In the case of air conditioners for construction machines, because it is absolutely necessary to use a rubber hose as the refrigerant pipe in order to absorb vibration of the compressor attached to the engine, CFC-12 that will not cause rubber to deteriorate has been used. Recently, in order to address the problem of ozone layer destruction, CFC-12 has been replaced with HFC-134a that has almost the same thermal characteristics as CFC-12.

Characteristics of representative refrigerants

Refrigerant	Chemical formula	Boiling point (1atm)°C	Pressure (0°C)MPa	Latent heat (0°C)kj/kg	Remarks
HCFC-22	CHC	-40.75	0.50	205.3	Causing rubber to deteriorate
CFC-12	CCF2	-29.65	0.31	151.4	Promoting ozone layer destruction
HFC-134a	CH2FCF3	-26.07	0.29	198.7	
<Reference> Water	H2O	100.0	0.0006	2,502.8	

Freon name

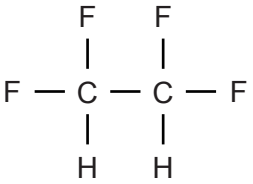
How to understand a Freon name

Example HFC-134a (CH_2FCF_2)

HFC − 1 3 4 a

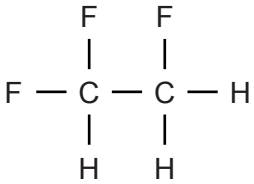
- HFC: Hydro Fluoro Carbon
- 1: Number of carbon atoms minus 1
- 3: Number of hydrogen atom plus 1
- 4: Number of fluorine atoms
- a: Symbol indicating symmetry

HFC−134



Symmetric

HFC−134a



Asymmetric

No symbol, a, b, c...are suffixed in order of symmetry.

As compared with CFC-12, HFC-134a has the following unfavorable characteristics.
(1) Bad compatibility with the conventional compressor oil (mineral oil)
(2) High water solubility (Absorbing moisture easily)
(3) High swelling-property and permeability for sealing materials and hose materials
It is therefore necessary to select materials suited to HFC-134a. The problems with HFC-134a and the changes to be made to cope with them are summed up in the figure below.

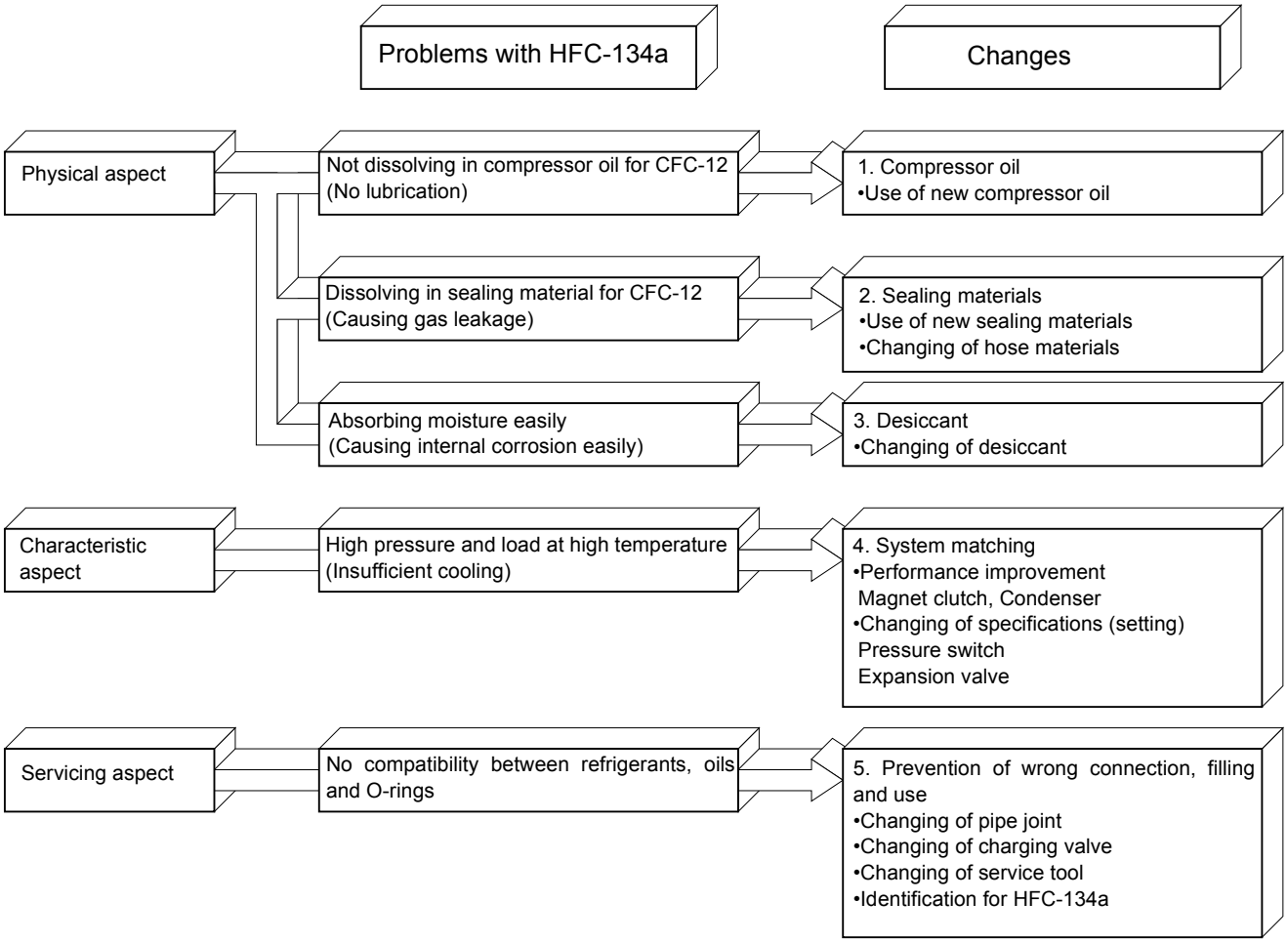
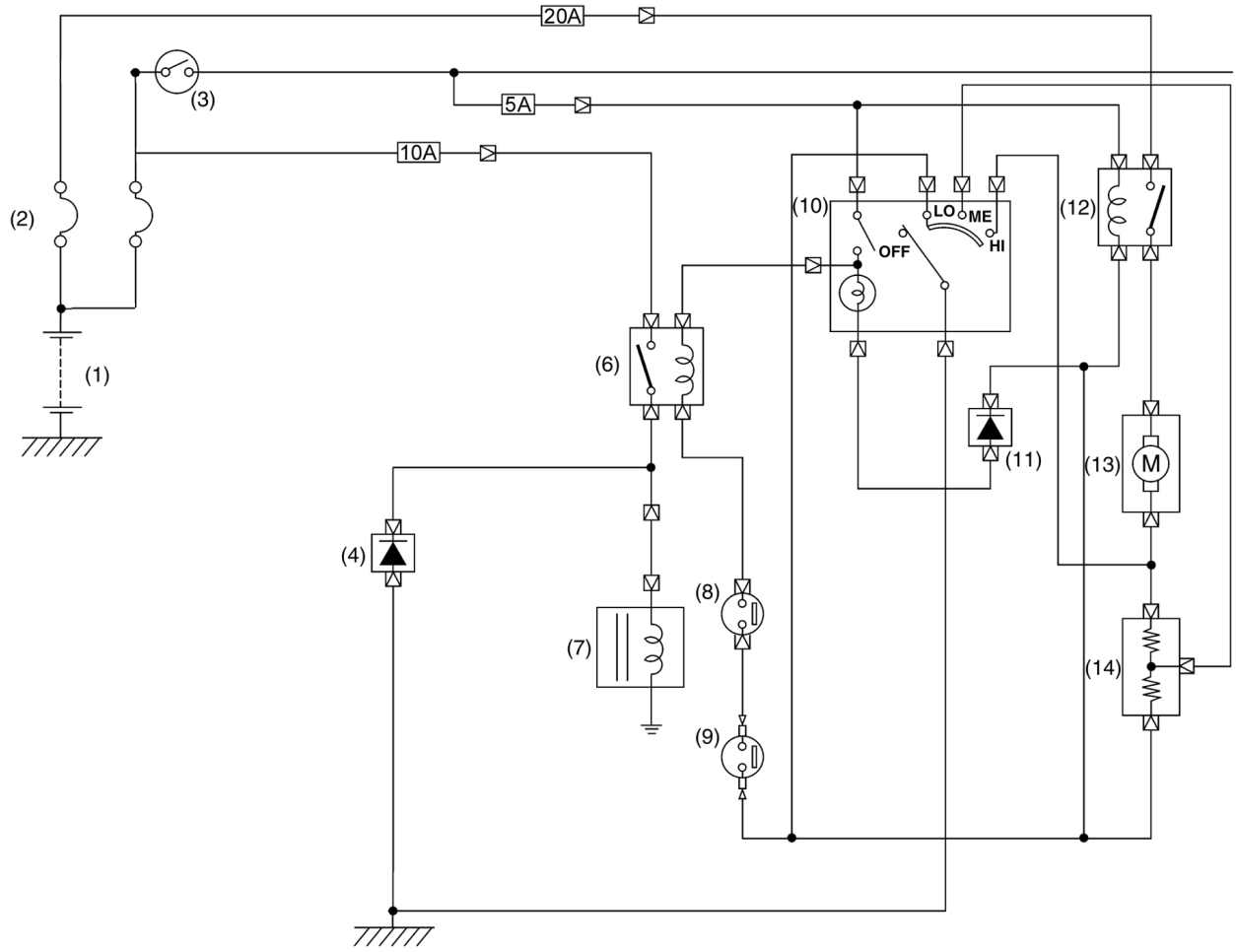


Fig Problems with HFC-134a and changes to be made to cope with them

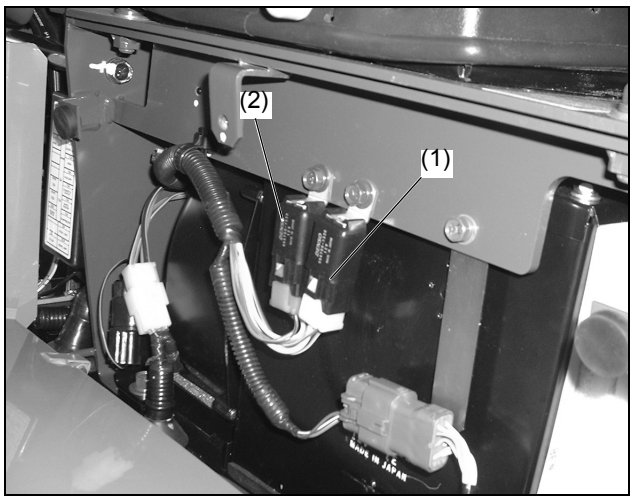
C.Electrical System

a. Electrical Circuit



(1) Battery
(2) Slow Blow Fuse
(3) Main Switch
(4) Diode
(5) Joint Connector
(6) Compressor Relay
(7) Compressor
(8) Pressure Switch(Dual type)
(9) Thermostat
(10) A/C Blower Switch
(11) Diode
(12) A/C Blower Relay
(13) A/C Blower Motor
(14) A/C Blower Resistor

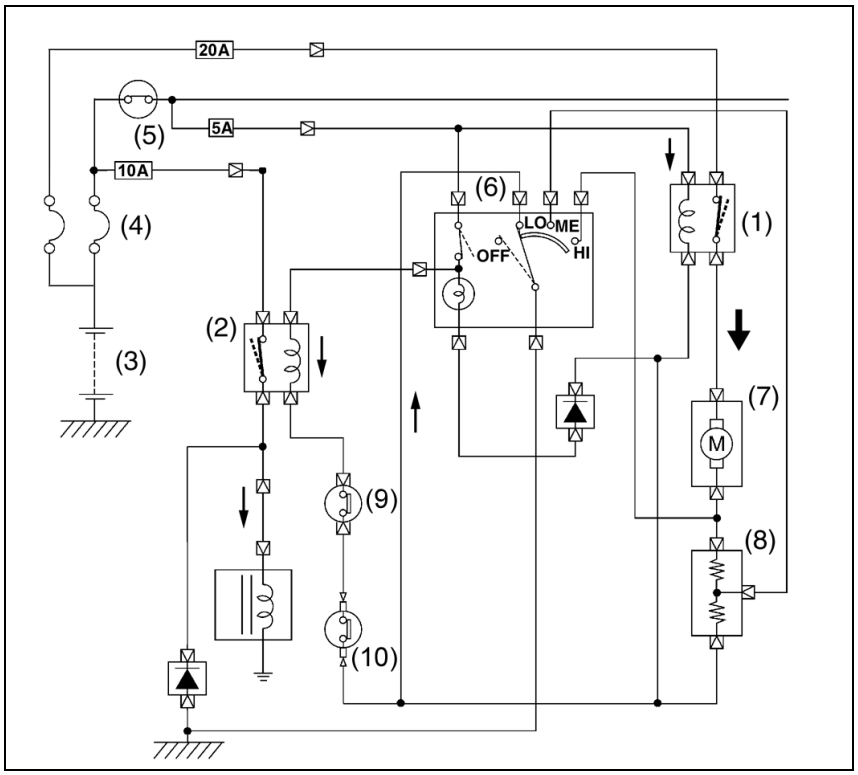
The process of magnetic clutch being engaged is shown below.
Main Switch (3) ON → A/C Switch (10) ON → Compressor Relay Coil (6) → Thermo Switch (9) ON (the thermostat temperature is more than 4 °C (39.2 °F)) → Pressure Switch (8) ON (if refrigerant pressure is between 0.196 MPa (2.0 kgf/cm^2, 28.4 psi) and 3.14 MPa (32 kgf/cm^2, 445 psi) → Blower Switch (10) ON (Low, Medium or High) → Ground.
Then Compressor Relay Contact (6) → Magnetic Clutch of Compressor (7) engaged.



Open the cover of A/C and the relays are visible at the foot center of the cabin : blower relay (1) and compressor relay (2). When the blower fan is adjusted for the air flow rate, the blower relay (1) is activated by a signal from the fan switch on the control panel.

Among the air conditioner components, current flows to the blower motor (7) and magnetic clutch. If all of these current were to be passed through the main switch (5) and supplied, the current would be too large for the main switch (5) so that there will be danger or burning out the main switch contact. If the current were to be passed directly from the battery (3), forgetting to turn off the blower motor (7) could result in a discharged battery (3).

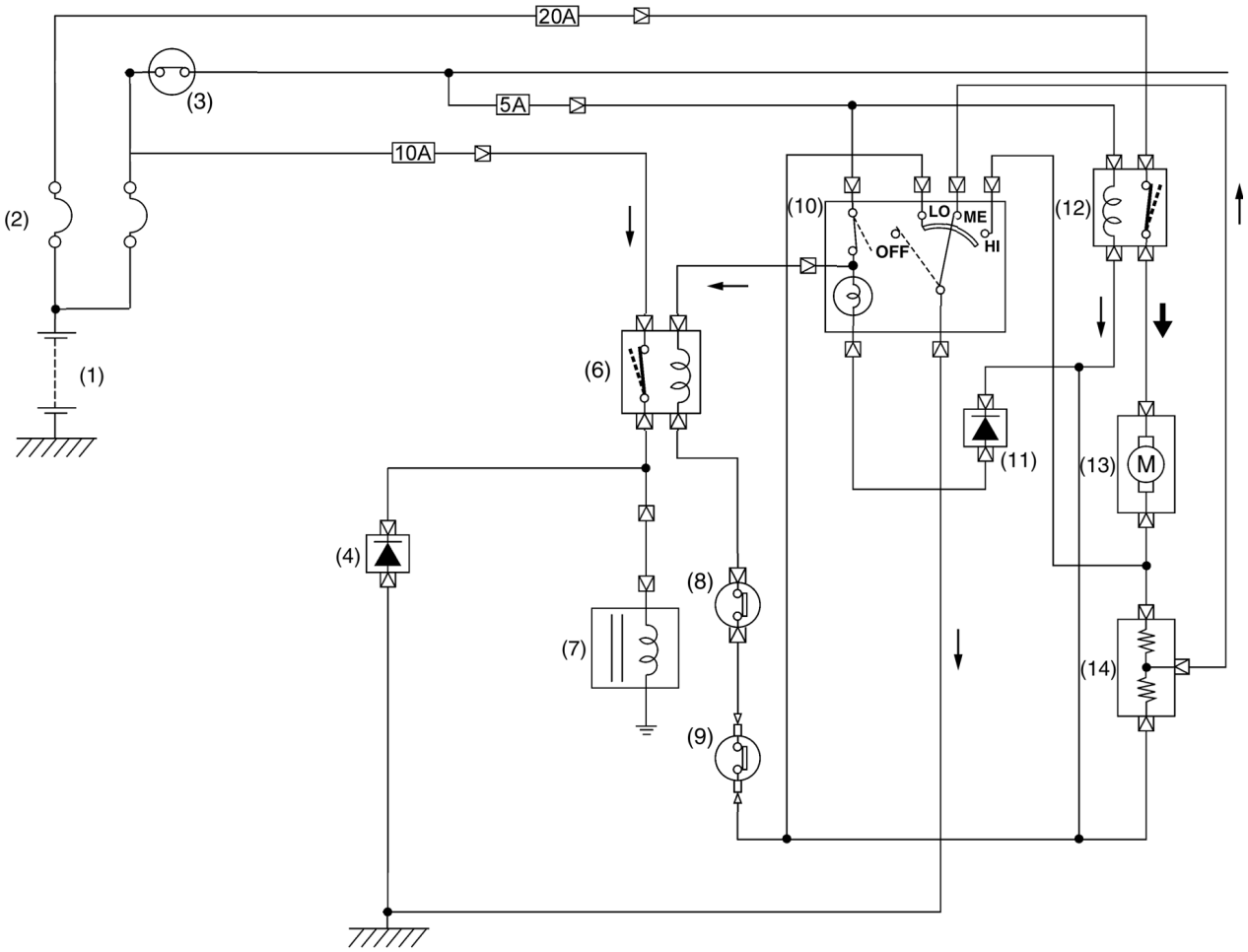
To protect against such trouble, relays have been provided. These relays have been made so that when current flows through its coil, the contact close to supply the power from the battery (3). By employing these relays, the current flowing through the main switch (5) has been decreased as only a small current is required to actuate the relay. Thus there will be no danger of burning out the switch contact, and when the main switch (5) is opened, the relay contact will open at the same time. This action stops the current flow in the air conditioner circuit so that there will also be no chance of the battery discharging.



(1) A/C Blower Relay
(2) Compressor Relay
(3) Battery
(4) Slow Blow Fuse
(5) Main Switch
(6) A/C Blower Switch
(7) A/C Blower Motor
(8) A/C Blower Resistor
(9) Dual pressure switch
(10) Thermostat

c. Air Conditioner Blower Switch

When Blower Switch is in ·(Low), • (Medium) or●(High) Position



(1) Battery
(2) Slow Blow Fuse
(3) Main Switch
(4) Diode
(5) Joint Connector
(6) Compressor Relay
(7) Compressor (Magnet clutch)
(8) Pressure Switch
(9) Thermostat
(10) A/C Blower Switch
(11) Diode
(12) A/C Blower Relay
(13) A/C Blower Motor
(14) A/C Blower Resistor

When the Main Switch is turned ON, the current flows from battery to A/C Blower Relay Coil and A/C relay is turned ON. As the A/C relay is turned ON, the current from battery flows to A/C Blower Switch through the A/C Blower Motors as follows.

"·"(Low) Position

Battery (1) → Slow Blow Fuse (2) → Main Switch (3) → Fuse → A/C Blower Relay Coil (12) → A/C Blower Switch LO Position (10) → Ground.

Then, A/C Blower Relay is turned ON and battery current flows to A/C Blower Motor.

Battery(1) → Slow Blow Fuse(2) → Fuse → A/C Blower Relay Contact(12) → Blower Motor(13) → Blower Resister(14) → A/C Blower Switch LO Position (10) → Ground.

"•"(Medium) Position

Battery (1) → Slow Blow Fuse (2) → Main Switch (3) → Fuse → A/C Blower Relay Coil (12) → A/C Blower Switch LO Position (10) → Ground.

Then, A/C Blower Relay is turned ON and battery current flows to A/C Blower Motor(13), A/C Blower Resistor(14), A/C Blower Switch ME Position(10) and ground.

"●"(High) Position

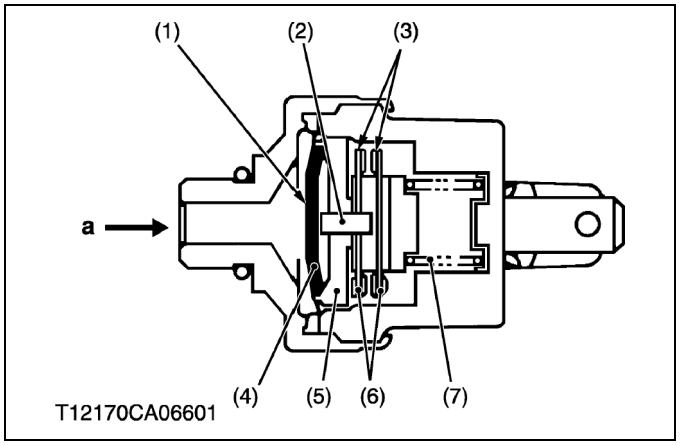
Battery (1) → Slow Blow Fuse (2) → Main Switch (3) → Fuse → A/C Blower Relay Coil (12) → A/C Blower Switch LO Position (10) → Ground.

Then, A/C Blower Relay is turned ON and battery current flows to A/C Blower Motor(13), A/C Blower Switch HI Position (10) and ground.

d. Dual Pressure Switch

The pressure switch detects the pressure in the refrigerant cycle, and when something is wrong, turns off the magnetic clutch to prevent the component from troubling. This system has dual type pressure switch (2), and this switch controls low pressure cut and high pressure cut.

(1) A/C Unit
(2) Pressure Switch

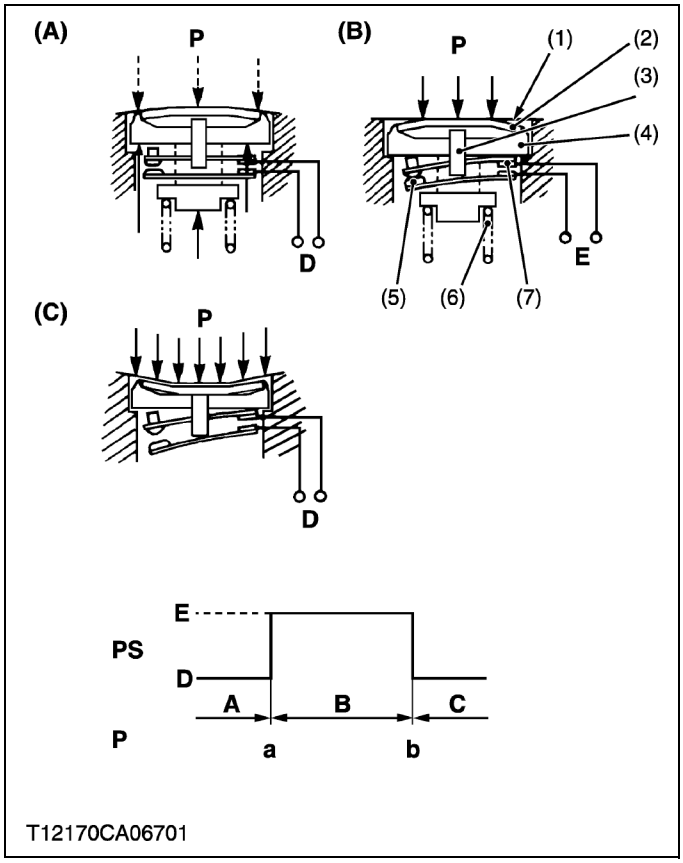


(1) Pressure Switch (Dual Type)

The pressure switch is installed in inlet line (liquid line) between receiver and expansion valve. The contact of pressure switch is normally open type.

(1) Diaphragm
(2) Pin
(3) Terminal
(4) Belleville Spring
(5) Plate
(6) Movable Contact
(7) Spring

a : Pressure



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OFF Position

(A : When the Refrigerant Pressure is Low)

The pressure switch detects the pressure drop when the refrigerant leaks from the system causing compressor seizure. When pressure of refrigerant is less than specified pressure, the switch is turned OFF and disengages magnetic clutch.

ON Position

(B : When the Refrigerant Pressure is Normal)

When the pressure in the inlet line is between 0.196 MPa (2.0 kgf/cm^2, 28.4 psi) and 3.14 MPa (32.kgf/cm^2, 455 psi), the switch is turned ON (the pressure is normal condition), and engages magnetic clutch.

OFF Position

(C : When the Refrigerant Pressure is High)

When the pressure in the inlet line is higher than specified pressure, the switch is turned OFF, and disengages magnetic clutch.

Reference

Setting pressure

OFF (Low pressure side) :

Less than approx. 0.196 MPa (2.0 kgf/cm^2, 28.4 psi)

ON (Normal pressure) :

Between approx. 0.196 MPa (2.0 kgf/cm^2, 28.4 psi), to 3.14 MPa (32 kgf/cm^2, 455 psi)

OFF (High pressure side)

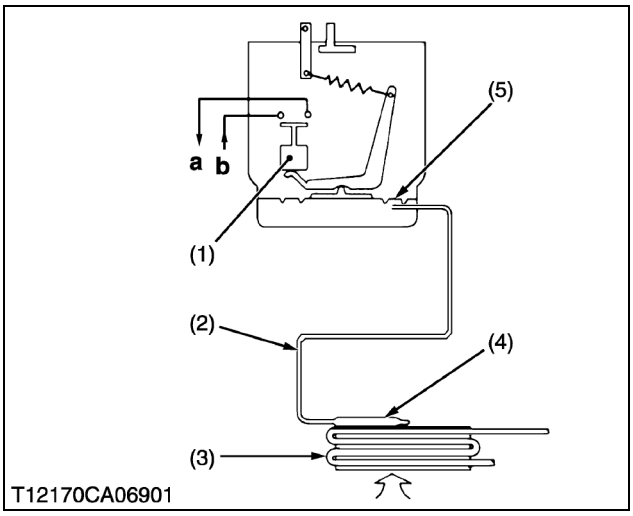
More than approx. 3.14 MPa (32 kgf/cm^2, 455 psi)

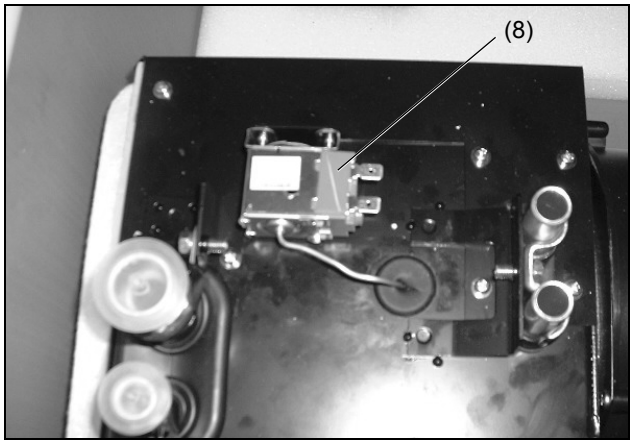
(1) Diaphragm
(2) Bellville Spring
(3) Pin
(4) Plate
(5) Terminal
(6) Spring
(7) Contact

A : Refrigerant Pressure is Low
B : Refrigerant Pressure is Normal
C : Refrigerant Pressure is High
D : OFF
E : ON
P : Pressure
PS : Pressure Switch

a : 0.196 MPa (2.0 kgf/cm^2, 28.4 psi)
b : 3.14 MPa (32 kgf/cm^2, 455 psi)

e. Thermostat





If the evaporator fin temperature, that is, refrigerant vaporizing temperature, drops below 0°C (32°F), frost or ice will form on the fins, causing a decrease in air flow and lowering cooling capacity. To prevent such frosting, and also to allow setting cabin interior to desired temperature, a thermostat has been installed.

In this system, gas type thermostat is used.

The gas type thermostat has a capillary tube which is filled with special gas. The capillary tube is connected to the diaphragm chamber. The tip of the capillary tube is positioned on the evaporator fins.

When the evaporator fins temperature is high, the micro switch in the thermostat is turned **ON** by increasing the pressure in the diaphragm chamber. When the evaporator fins temperature is low, such as in winter season, the micro switch is turned **OFF** because of the pressure in the diaphragm chamber and spring tension drops, thus turning **OFF** the magnetic clutch to prevent the evaporator from frosting.

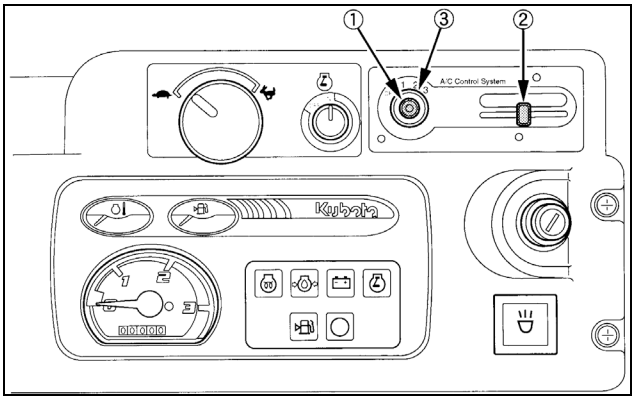
(Reference)

Thermostat setting temperature
OFFApprox 1°C (34°F)
ONApprox 4.5°C (40.1°F)

(1) Micro Switch
(2) Capillary Tube
(3) Evaporator
(4) Heat Sensitizing Tube
(5) Diaphragm
(6) Thermo Switch
(7) Expansion Valve
(8) Thermo sensor

a : To Magnetic Clutch
b : From A/C Switch

f. Control Panel



(1) Air conditioner switch with indicator light
(2) Temperature control lever
(3) Blower switch

Air Conditioner Switch with Indicator Light
Push this switch to activate the air conditioner. An indicator light will light up when the switch is set "ON".
Push switch again to turn air conditioner off, in which case the indicator light will be off.

Temperature Cintrol Lever
Set this lever at the desired position to obtain the desired air temperature. Move the lever to the right to obtain cooler air. Move it to the left to obtain warmer air.

Blower Switch
Air volume can be changed in three steps. At the "3" position, the largest air volume is obtained.

Operation

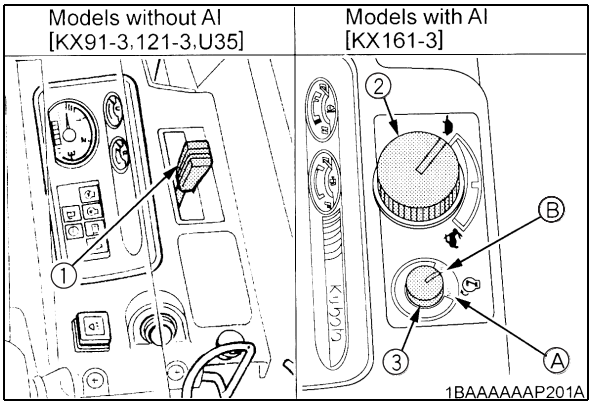
Heating

1) Adjust the blower (1/2/3) switch and the temperature control lever to achieve the desired temperature level.

Note : In summer when the heater is not used, keep the temperature control lever ar the "COOL" (rightmost) position. Otherwise, hot air will raise the temperature in the CAB.

Dehumidifying-heating

1) Press and turn on the air-conditioner switch.
2) Turn on the blower (1/2/3) switch.
3) Adjust the temperature control lever to "COOL" or an intermediate position to achieve the desired temperature level.



(1) Throttle lever
(2) Throttle potentiometer
(3) Switch for Auto Idle control
(A) "ON"
(B) "OFF"

Note : Be sure to close the door while the air conditioner is ON.

Cooling

1) Press and turn the air-conditioner switch.
2) Turn on the blower (1/2/3) swich.
3) Adjust the temperature control lever to the "COOL" or an intermediate position to achieve the desired temperature level.

Note : Be sure to close the door while the air conditioner is ON.

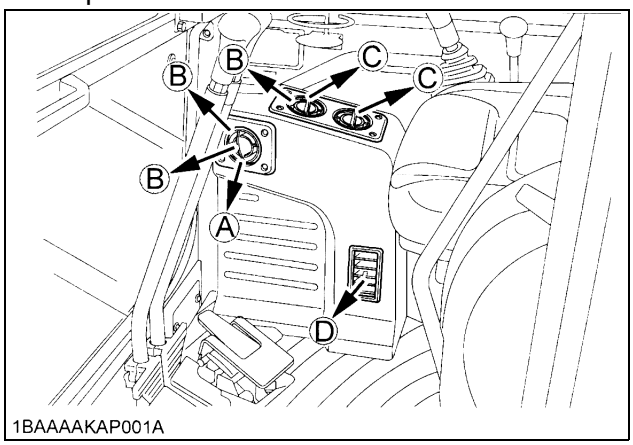
Defrosting or demisting

To defrost oe demist the windshield. take the following steps.

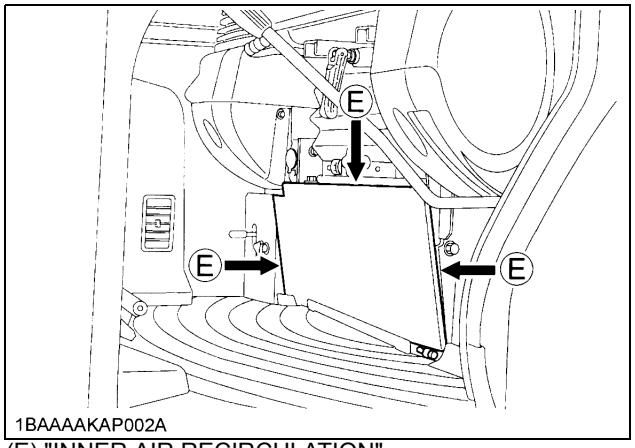
1) Open the front air outlet and direct it to the windshield.
2) Set the blower switch and the temperature control lever to the "3" and "WARM" (leftmost) positions, respectively.

g. Air Flow

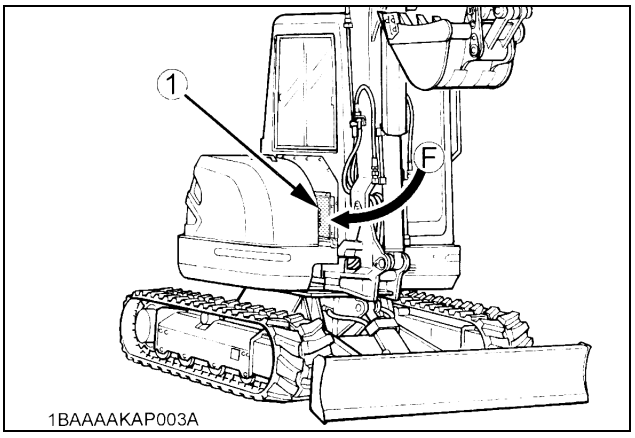
Air in the CAB and fresh air introduced into the CAB flow as shown in the figure. Adjust the 4 air outlet ports to obtain the desired condition.



(A) "DOOR WINDOW"
(B) "WIND SHIELD"
(C) "CHEST AREA"
(D) "FOOT AREA"



(E) "INNER AIR RECIRCULATION"



(1) Fresh air filter
(F) "FRESH AIR INLET"

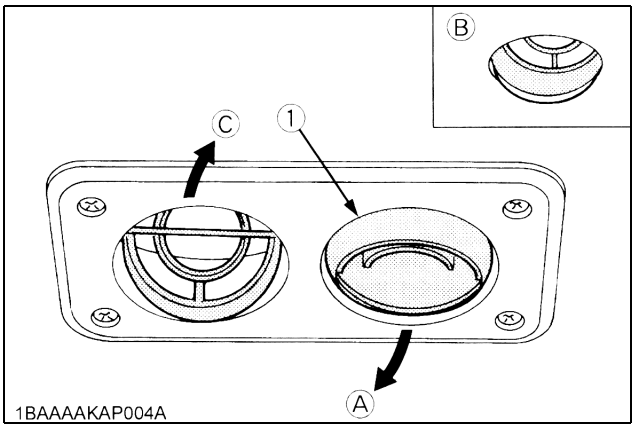
IMPORTANT

Do not allow water to enter the fresh air port while washing the excavator.

Air Control Vent

Front air outlet

The front air outlets can be independently adjusted as required. To defrost the windshield, rotate the outlets toward the windshield.



(1) Front air outlet
(A) "WINDSHIELD"
(B) "CLOSED"
(C) "CHEST AREA"

⚠ CAUTION

To avoid personal injury;

- **Replace the water hoses every two years.**
- **Inspect daily.**
- **Have the excavator repaired immediately if any of the following defects are discovered.**
  (Such defects may cause burns or injury. They may also cause engine failure by serious damage.)
  - **Scratches, cracks or swelling in water hoses**
  - **Water leaks at joints or connecting points.**
  - **Missing or damaged water hose protective sleeve or grommet.**
  - **Loose mounting bolt, damaged bracket**
- **Do not touch the water hoses or the heater with your hand. You may get burned.**
- **If the window fails to defrost in extreme conditions or becomes cloudy when dehumidifying the CAB, remove moisture with soft cloth.**
- **Do not block all the air outlets of the air conditioner. A trouble may result.**

D. Technical Terms

a. Heat

Heat is one form of energy.
1 kcal heat quantity changes the temperature of 1 kg of liquid water by 1°C

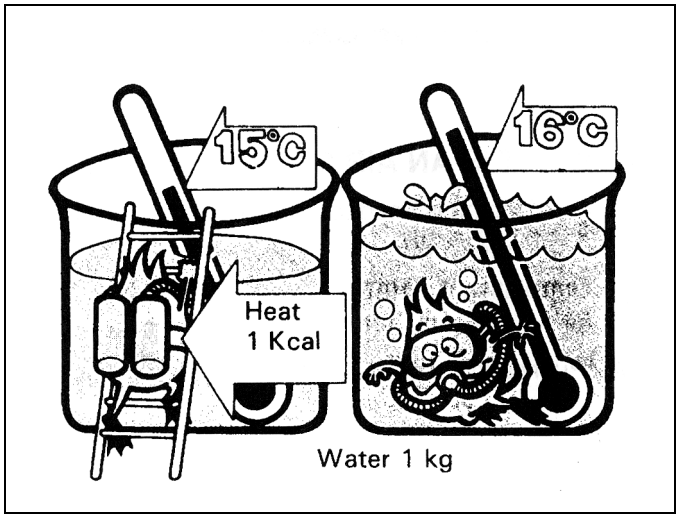


Fig. Heat Quantity

(1) Specific Heat

Specific heat is heat quantity required to CHANGE THE TEMPERATURE of an object 1°C

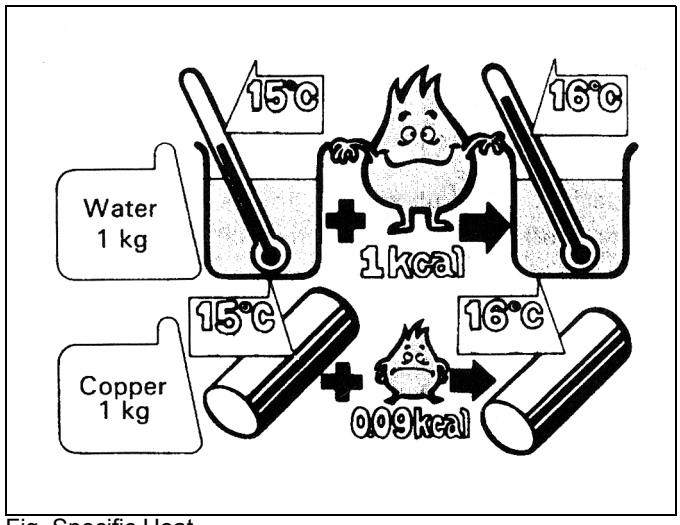


Fig. Specific Heat

b. Temperature

(1) Temperature Scales

Temperature is degree of heat coldness of an object. The unit generally used to express it is "Centigrade degree (°C)" or "Fahrenheit degree (°F)".
In the Celsius scale, the freezing point (solid point) of pure water is taken as 0°C, and the distance between the freezing point and boiling point is divided into 100 parts. And each part designated as 1°C.
In the Fahrenheit scale, the freezing point of pure water is taken as 32°F, and the distance between the freezing point and boiling point is divided into 180 parts, and each part designated as 1°F.

$$°C = \frac{5}{9}(°F - 32)$$

$$°F = \frac{9}{5}(°C + 32)$$

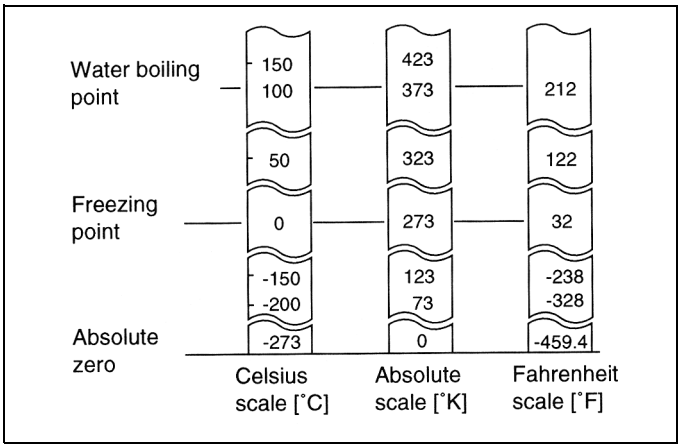


Fig. Temperature Scales

(2) Wet Bulb and Dry Bulb Thermometers

[WET BULB THERMOMETER]

The bulb (heat sensitizing part) of a glass tube thermometer is wrapped with a gauze or other rough mesh cloth. One end of the cloth is immersed in a water container to allow the water to be drawn up by a capillary action and to moisten the heat sensitizing part. The water in the cloth surface near the heat sensitizing part evaporates and robs the latent heat of evaporation from surrounding air, causing the air temperature around the heat sensitizing parts to drop. The temperature registered by the thermometer at this time is called the wet bulb temperature.

This is used to find out humidity in combination with the dry bulb temperature.

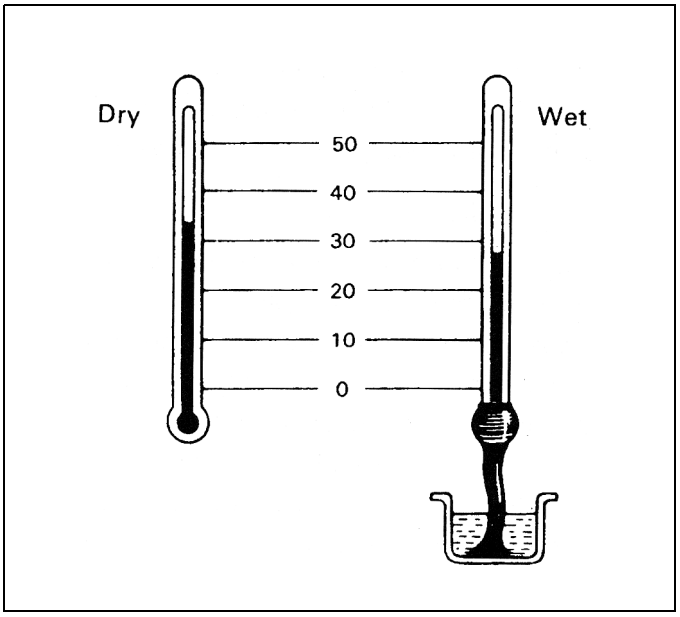


Fig. Thermometer

(3) Dew Point Temperature

When the air surrounding us is cooled, the air temperature drops, and when the humidity becomes 100%, that is, when the dry bulb and wet bulb temperature become the same, the water vapor contained in the air will be in a saturated state.

On further cooling, the water vapor reaches a condition where it cannot remain in a vapor state so that a part condenses and becomes dew. The temperature at which the humidity becomes 100% and dew is formed is called dew point temperature.

c. Humidity

(1) What is Humidity ?

Humidity is the term used to express the wetness or dryness of air.

The air around us is composed of air containing no vapor (dry air) and air containing water vapor, all mixed together. The amount of water vapor in the air is called "humidity".

In general, human beings feel uncomfortable when the humidity is high, and comfortable when the humidity is low.

(2) Relative Humidity

There are two ways of measuring humidity: "relative humidity" and "absolute humidity".

The most common measurement of humidity is relative humidity. Relative humidity is the amount (by weight) of water vapor which the air actually contains, compared with the amount (weight) of vapor which the air could hold at a given temperature. Thus, if the relative humidity is 50%, the air could twice as much vapor as it actually does at that temperature.

The amount (weight) of vapor that the air could hold changes according to the temperture of the air. If the temperture of the air rises, the amount of vapor which the air could hold also rises.

So, if the temperature of the air rises, and the amount of vapor that the air contains remains unchanged, the relative humidity will decrease.

(3) Absolute Humidity

Absolute humidity is amount (by weight) of vapor which the air contains, compared with the amount of dry air.

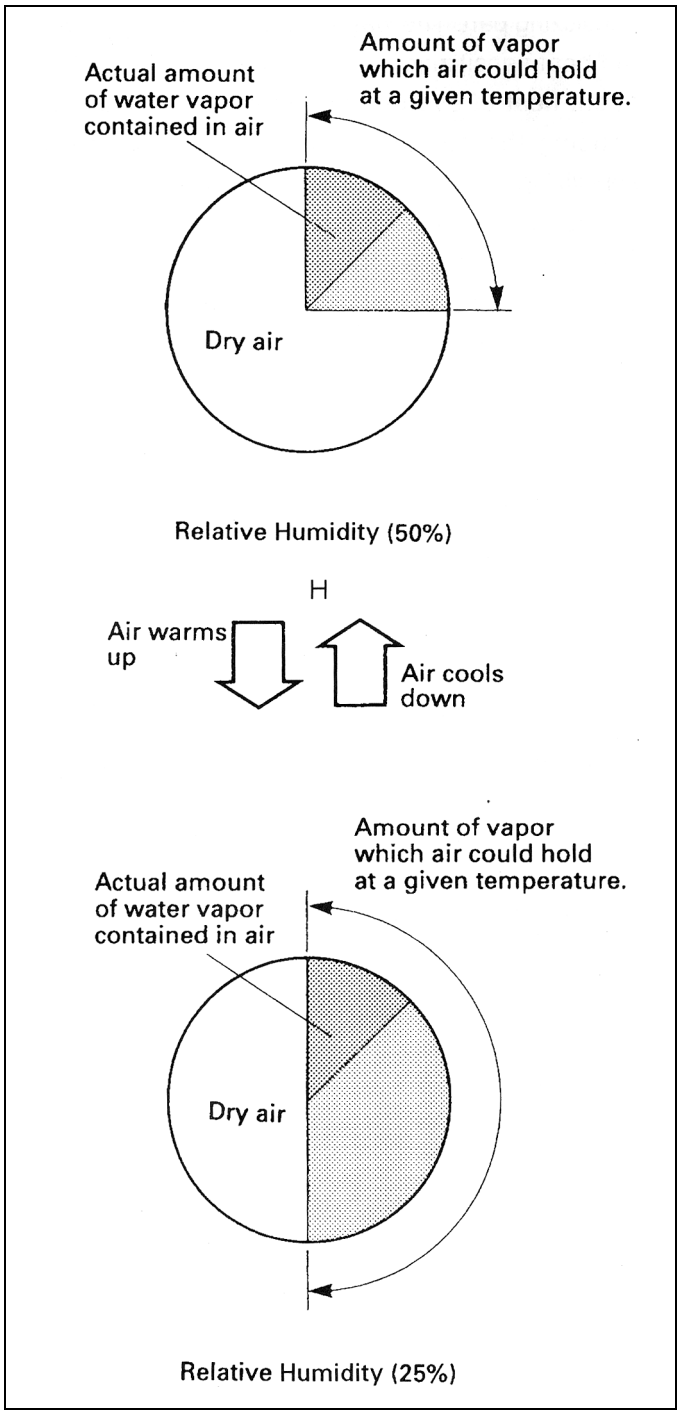


Fig. Relative Humidity

(4) Check Performance of Air Conditioning System

1) Calculate the relative humidity from the psychrometric graph by comparing the wet- and dry-bulb readings of the psychrometer at the air inlet.

HOW TO READ THE GRAPH:
After measuring the temperatures of wet- and dry-bulb thermometers at the evaporator air inlet, relative humidity (%) can be obtained.
Example: Supposing dry- and wet- bulb temperatures at the evaporator air inlet are 25°C (77°F) and 19.5°C (67°F) respectively. The point of intersection of the dotted lines in the graph is 60%.

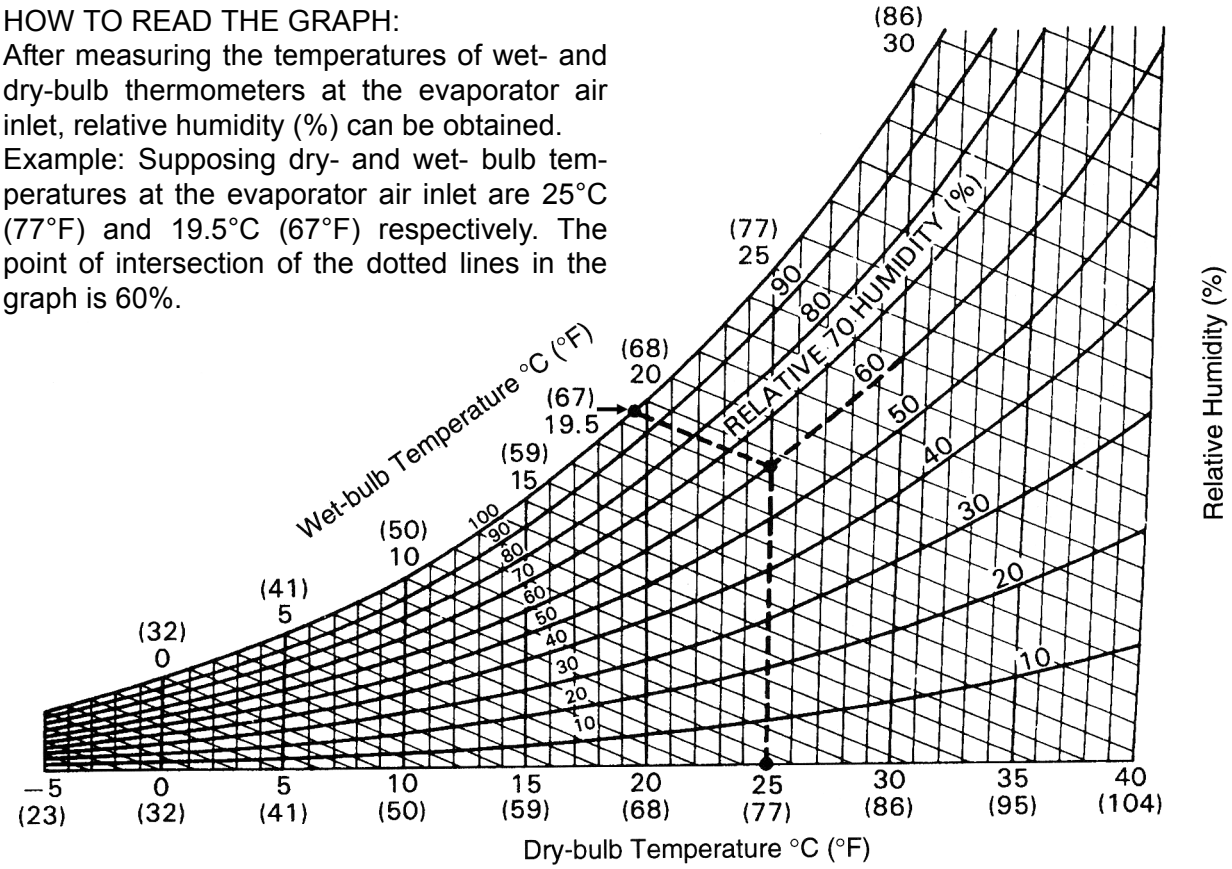


Fig. Psychrometric Graph

2) Measure the dry-bulb temperature at the cool air outlet, and calculate the difference between the inlet dry-bulb and outlet dry-bulb temperatures.
   In this case ;
   inlet dry-bulb = 25°C
   outlet dry-bulb = 8°C
   Then, temp. difference = 17°C
3) Check that the intersection of the relative humidity and temperature difference is above the line.
   If the intersection is within a line A and a line B, cooling performance is satisfactory.

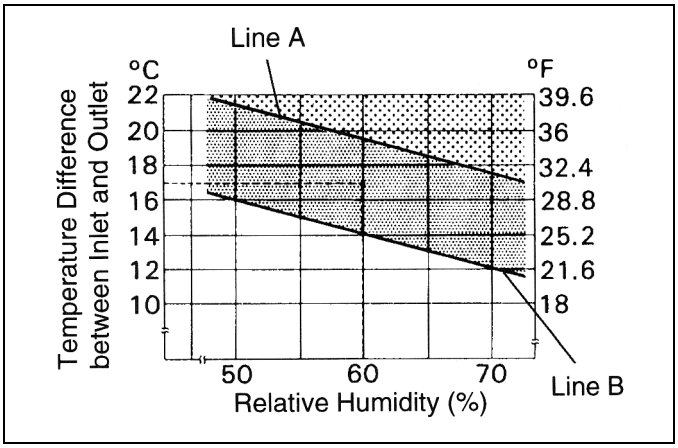


Fig. Relative Humidity Graph

d. Pressure

Pressure is defined as the vertical force applied on an unit area of a solid, liquid or gas. The unit of measurement is "kg/cm^2".
However, instead of "kg/cm^2", Pascal is used as a international unit of measurement.

1 kPa (Pascal) = 1.01972 x 10^{-2} kg/cm^2
1 kg/cm^2 = 98.06 kPa
1 MPa = 10.1972 kg/cm^2

For blower performance, mmAq (Water Column) is generally used.
For pressure below atmospheric (Vacuum), mmHg (Mercury Column) is used.

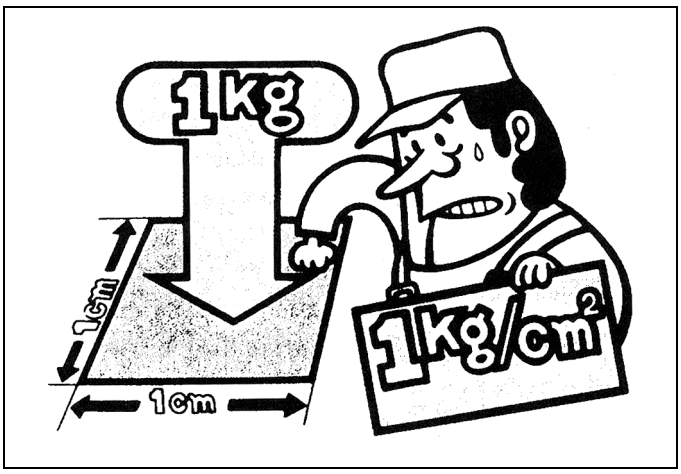


Fig. Pressure

(1) Atmospheric Pressure

This is the pressure acting on all object on earth. This pressure is the weight of air surrounding everyone and is equal to 1.03 kg/cm^2 (1 atmosphere).
At this pressure, the mercury column will be 760 mmHg.

1 atm = 1.03 kg/cm^2 = 760 mmHg

Practically all pressure gauges are made to indicate atmospheric pressure as 0.

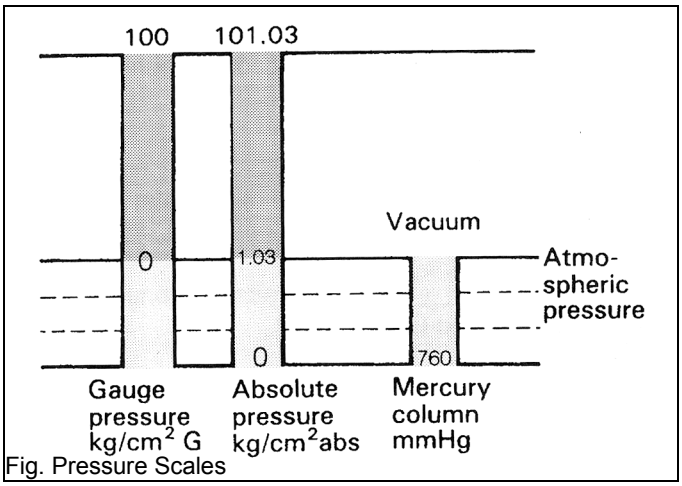


Fig. Pressure Scales

(2) Absolute Pressure

Absolute pressure is when perfect vacuum is taken as 0 kg/cm^2. Therefore, the atmospheric pressure is 1.03 kg/cm^2 in terms of absolute pressure.
To distinguish from absolute pressure, the pressure measured with a gauge is called a gauge pressure.
For identification, absolute pressure is indicated by kg/cm^{2}abs and gauge pressure by kg/cm^{2}G.
The relationship between absolute pressure and gauge pressure is as fellows:

Absolute press. (kg/cm^{2}abs) = Gauge press. (kg/cm^{2}G) + 1.03 kg/cm^2

e. Change of State

(1) Stage Change of Water

Now, we will consider how ice changes its state when we add heat to it. We will use water as example as it is the easiest matter to understand heat and state change.

It we add heat to ice until the temperature of ice reaches 0 degree centigrade (32°F), ice melts into water, and while the ice is melting, the temperature of ice and water remains at 0 degree centigrade.

After the ice has melted, the temperature of water begins to rise.

When the temperature of water reaches 100°C (212°F), water begins to become steam. Until all the water becomes steam, the temperature of water remains 100°C (212°F).

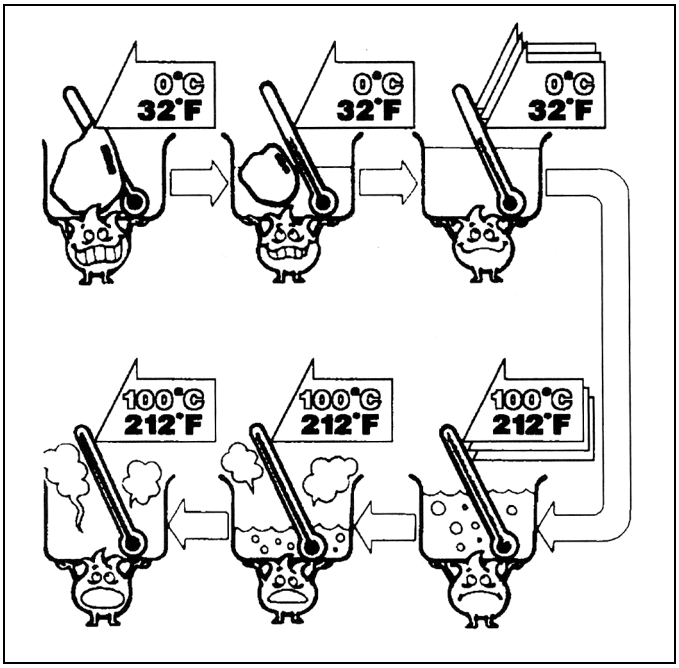


Fig. State Change of Water

(2) Sensible Heat and Latent Heat

Fig. shows the relation between heat and temperature. There are two kinds of heat called sensible heat and latent heat.

THE SENSIBLE HEAT can changes the temperature of water but cannot change the state of water.

Therefore, the sensible heat raises or lowers the temperature of water.

In the case of water, 1 kg of water at 0°C must absorb 100 kcal of sensible heat to change to 1kg of water at 100°C.

THE LATENT HEAT can change the state of water, but cannot change the temperature of water. Ice melts into water by adding latent heat and water evaporates into steam by adding latent heat. In the case of water, 1kg of ice at 0 degree must absorb 80 kcal of latent heat to change to 1 kg of water at 0 degree, and 1 kg of water at 100 degrees must absorb 539 kcal of latent heat to change to 1 kg of steam.

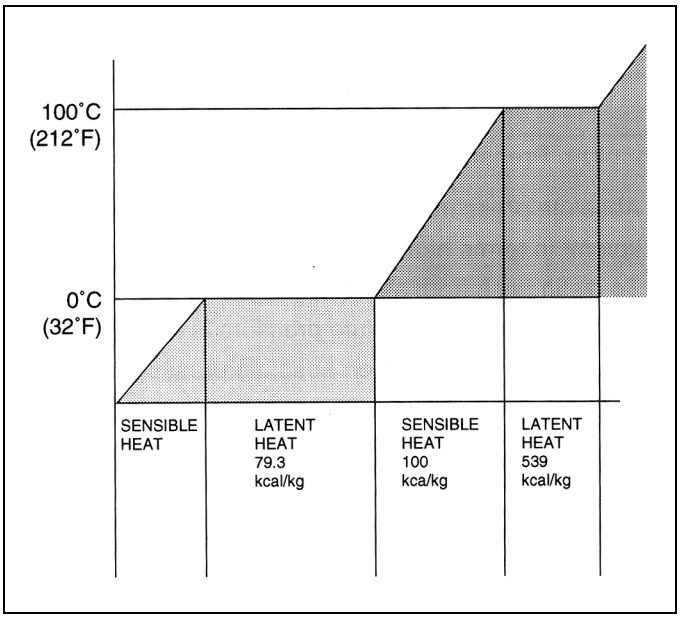


Fig. Sensible Heat and Latent Heat

(3) Three States of Matter

As you know, matter exists in three states; solid, liquid and gas. In the case of water, the solid state is ice, the liquid state is water, and the gas state is steam.

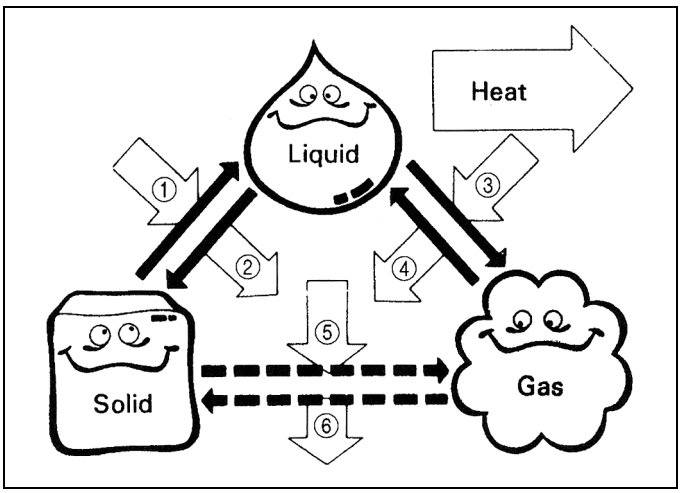


Fig. Three States of Matter

1. Fusion
   When solid melts into liquid, heat is absorbed from the surrounding matter.
   In the case of water, when 1 kg of ice melts into 1 kg of water, under atmospheric pressure, 80 kcal of heat is absorbed from the surrounding.
2. Solidification
   In the opposite situation, when liquid changes into a solid, heat is released to the surrounding matter.
3. Evaporation
   When liquid evaporates into gas, heat is absorbed from the surrounding matter.
4. Condensation
   In the opposite situation, heat is released to the surrounding matter.
   In the case of water, when 1 kg of water evaporates into 1kg of steam, 539 kcal of heat is absorbed from the surrounding matter.
   In the opposite situation, 539 kcal of heat is released to the surrounding matter.
5. Sublimation
   In rare case such as dry ice (solid carbon dioxide) and napthaline, heating causes the solid to directly turn into gas.
6. Adhesion
   The reverse process is called adhesion.

f. What is a Heater?

There are various types of heaters, which include a hot water heater, combustion heater and exhaust heater, but generally a hot water heater used in automobiles.

(1) Principle

In a hot water heater system, engine coolant is circulated through the heater core to make it hot. Cold air passes through the hot heater core, being blown by the blower fan. Through heat transfer, the air is warmed up.

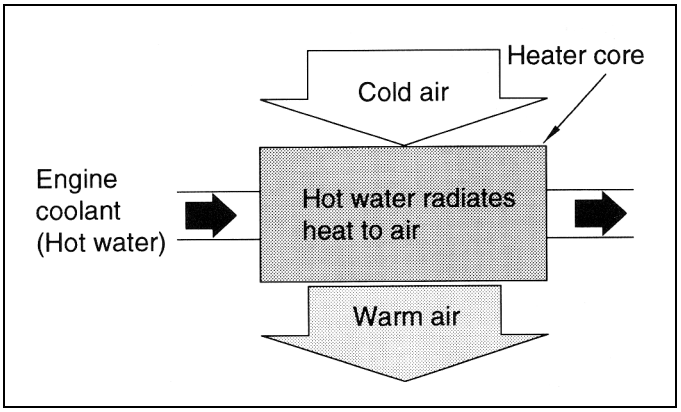


Fig. Principle of Heater

(2) Temperature Control

To control the air temperature, an air mix type control is used. This type uses the air mix control door which changes the air temperature by adjusting the proportion of cold air passing through the hot heater core and the proportion of air not passing through the heater core.

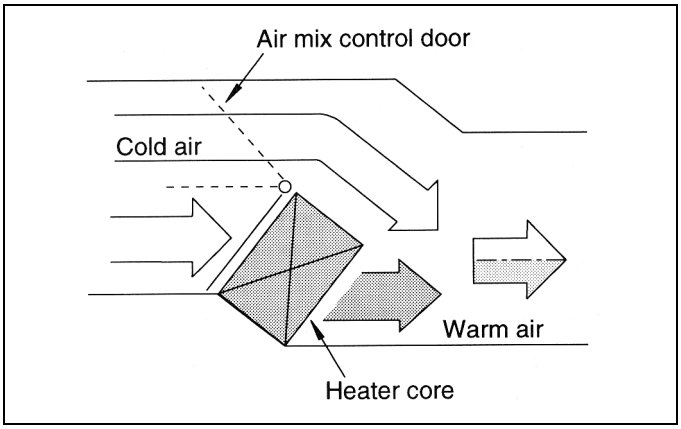


Fig. Temperature Control of Heater

g. Principle of Cooling

A cooler cools and dehumidifies the air inside the car or fresh air from outside the car so as produce comfortable cooling.

(1) Basic Theory of Cooling

After swimming on a hot day we feel a little cold. This is because the water remaining on our body eventually vaporizes. Whilst vaporizing, this is drawing heat from our body.

For the same reason, we feel cool when we apply alcohol to our skin. The alcohol is placed as a liquid on our skin. After a short time the liquid starts to change into a gas (vaporize).

In this process heat is drawn from our skin (our skin feels cold). Using this principle we can apply it to an air conditioning system. i.e.: Heat being drawn when a liquid vaporizes to a gas.

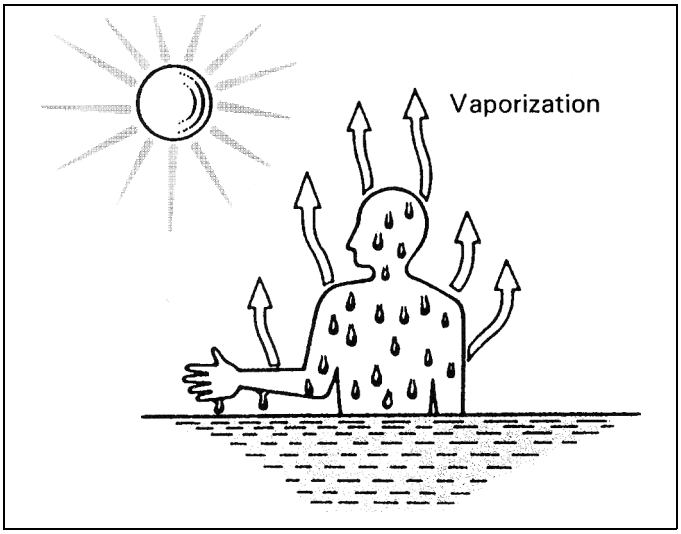


Fig. Vaporization

(2) Refrigerant

Refrigerant is a substance that serves as a moving fluid in a refrigerator and circulates through functional parts to produce the cooling effect by absorbing heat through the expansion valve and evaporator. The refrigerant used in new vehicles today is now HFC134a, which has no-ozone-destroying properties (does not contain chlorine).
HFC stands for Hydro Fluoro Carbon

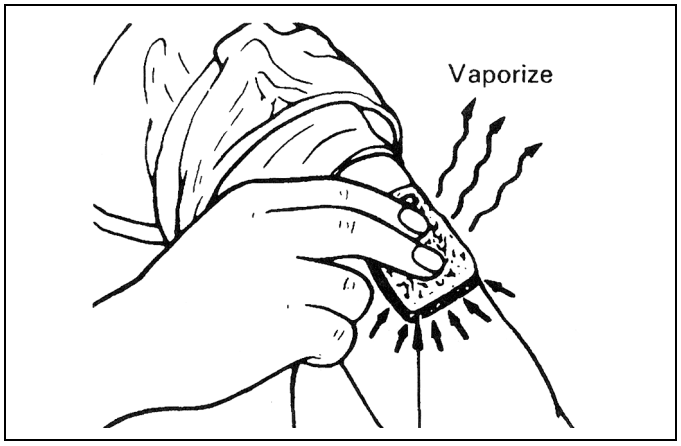


Fig. Basic Theory of Cooling

1 Characteristics of HFC134a

Water boils at 100°C (212°F) under atmospheric pressure, but HFC134a boils at -26.9°C (-16.4°F) under atmospheric pressure.
Water boils at 121°C (250°F) under 1 kg/cm^2 (98 kPa) of pressure, HFC134a boils at -10.6°C (-12.8°F) under 1 kg/cm^2 (98 kPa) of pressure.
If HFC134a were released to air under normal room temperature and atmospheric pressure, it will absorb the heat from the surrounding air and boil immediately, changing into a gas. HFC134a is also easily condensed back into a liquid under a pressurized conditions by removing the heat.

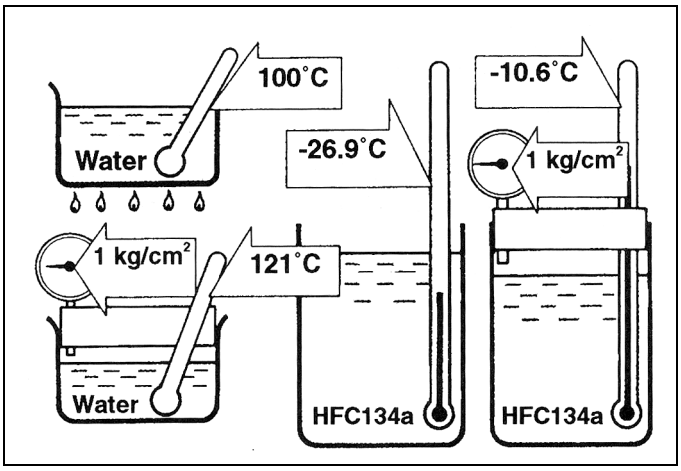


Fig. Characteristics of Refrigerant (HFC134a)

The graph shows the characteristic relationship between the temperature and pressure of HFC134a.
The curve in the graph indicates the boiling point of HFC134a under different temperatures and pressures. The upper portion above the curve is gaseous HFC134a and the lower portion is liquid HFC134a.

Example-1
The gaseous refrigerant can be converted into the liquid refrigerant by increasing the pressure without changing the temperature.

Example-2
The gaseous refrigerant can also be converted into a liquid by decreasing the temperature without changing the pressure.

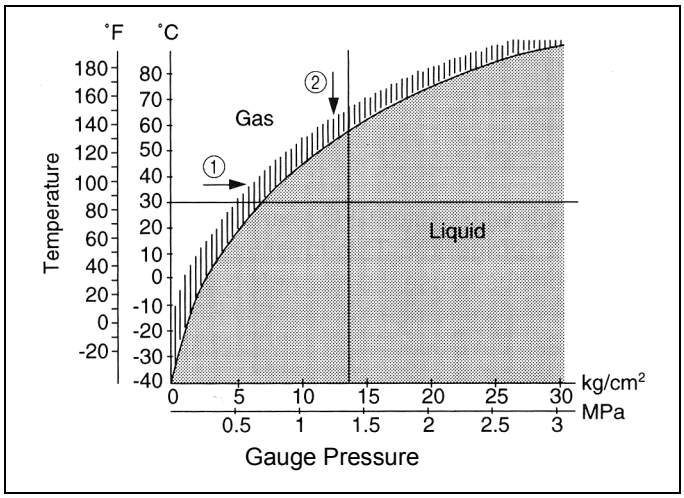


Fig. Refrigerant Saturating Curve

2 Conversely

Example-3
The liquid refrigerant can be converted into gas by decreasing the pressure without changing the temperature.

Example-4
The liquid refrigerant can be converted into a gas by the temperature without changing the pressure.

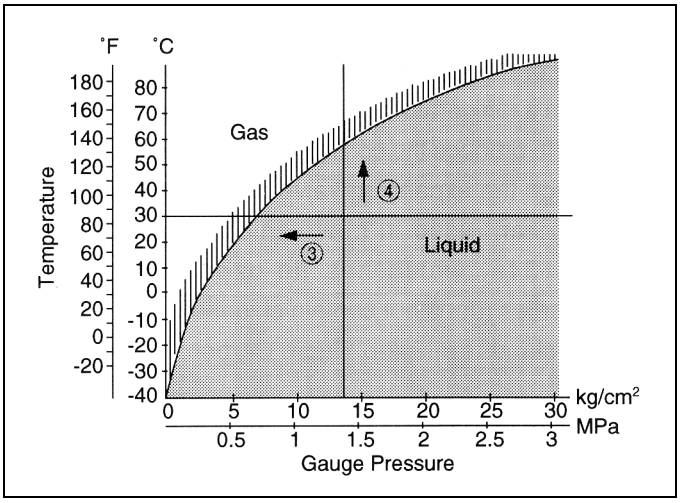


Fig. Refrigerant Saturating Curve

HFC134a has very good characteristics and properties to be used in air conditioning system. It is non-flammable, non-explosive, non-poisonous, non-corrosive, odorless and harmless to clothes and food.

h. Principle of Air Conditioning

(1) Expansion and Evaporation

In a air conditioning the air is cooled by the following method;

- The high temperature and high pressure liquid refrigerant is stored in the receiver.
- Then, the liquid refrigerant is released to the evaporator through a small hole, called the expansion valve. At this time, the temperature and pressure of the liquid refrigerant is decreased, and some of the liquid refrigerant changes to vapor.
- The low temperature and low pressure refrigerant flows into the evaporator.
  In the evaporator, the liquid refrigerant evaporates and takes heat from the surrounding air.

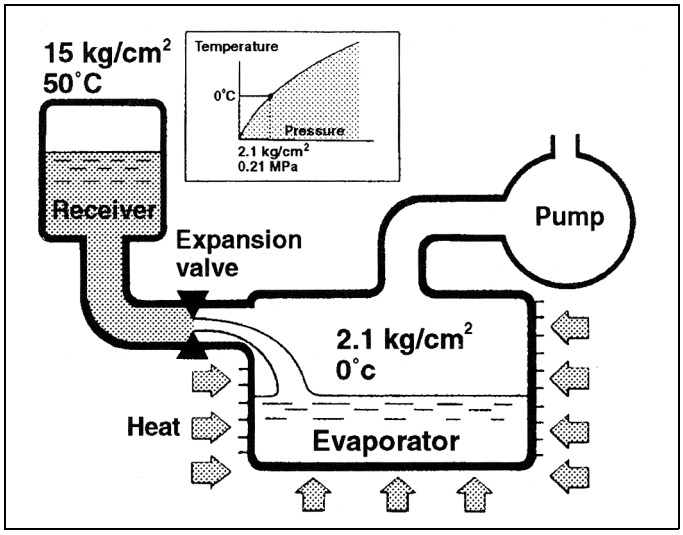


Fig. Expansion and Evaporation

(2) How to Condense Gaseous HFC134a into Liquid

The air conditioning system cannot cool the air when the liquid refrigerant is used up (i.e. changed to the gaseous refrigerant).

To change the gaseous refrigerant into a liquid refrigerant, a compressor is used in the air conditioning.

As you know, when gas is compressed in the compressor, both the temperature and pressure increase.

For example, when the gaseous refrigerant is compressed from 2.1 kg/cm^2 (0.21 Mpa) to 15 kg/cm^2 (1.47 MPa), the temperature also increases from 0°C to 80°C (32°F to 180°CF).

The boiling point of refrigerant at 15 kg/cm^2 (1.47 MPa) is 57°C (135°CF). The temperature (80°C, 176°F) of compressed gaseous refrigerant is higher than its boiling point (57°C) and also higher than the surrounding air. The refrigerant stays in gaseous state.

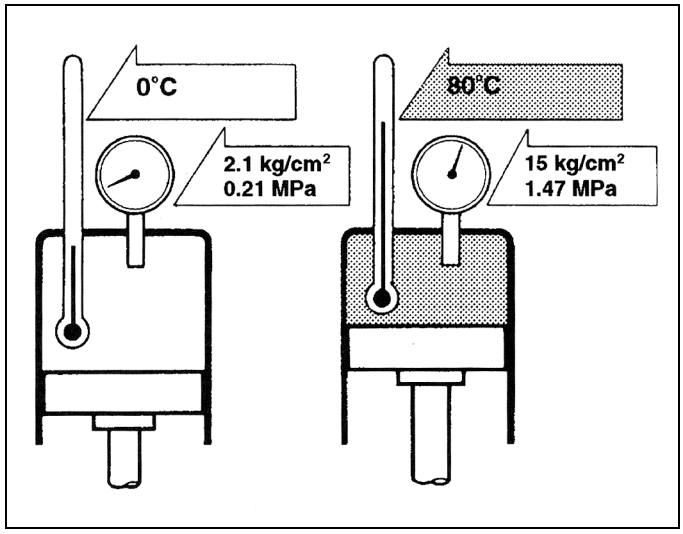


Fig. How to Condense HFC134a

(3) Condensing of the Gaseous HFC134a

In the air conditioning, the high pressure, high temperature gaseous refrigerant is transferred into a liquid by cooling it down at the condenser. By flowing through the condenser, the compressed gaseous refrigerant releases heat to the surrounding air and is condensed back into a liquid. At this time, the refrigerant temperature becomes lower than the boiling point (around 57°C). The liquid refrigerant then returns to the receiver.

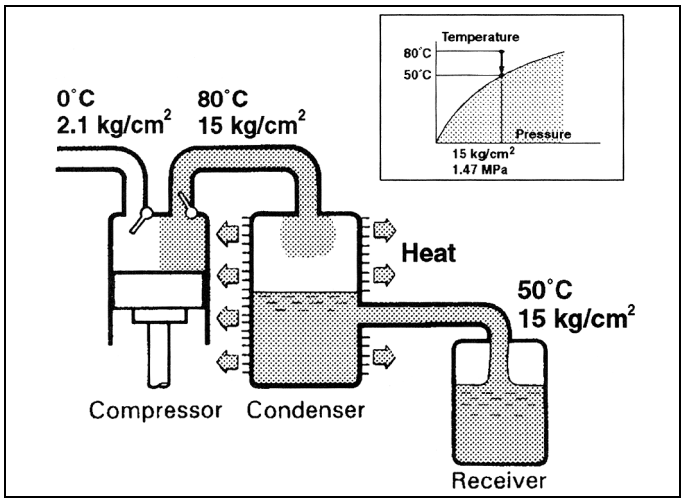
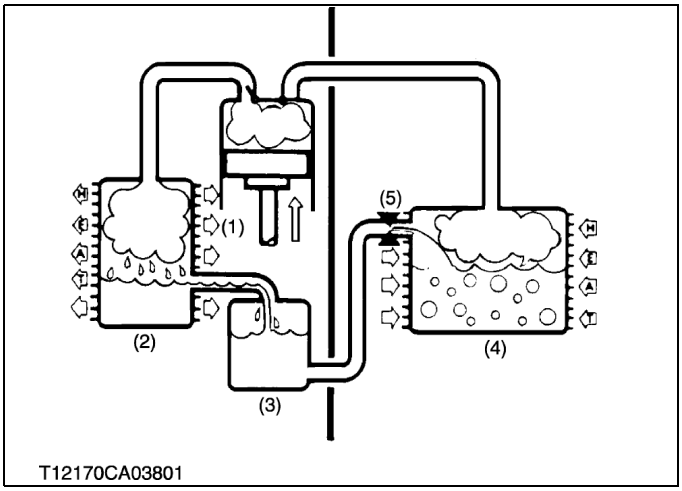


Fig. Condensing the Gaseous HFC134a

i Refrigeration Cycle



1) The compressor (1) discharges high temperature and high pressure refrigerant that contains the heat absorbed from the evaporator (4) plus the heat created by the compressor in a discharge stroke.
2) This gaseous refrigerant flows into the condenser (2).
   In the condenser, the gaseous refrigerant condenses into liquid refrigerant.
3) This liquid refrigerant flows into the receiver (3) which stores and filters the liquid refrigerant changes into low temperature, low pressure liquid and gaseous mixture.
4) By the expansion valve (5), the liquid refrigerant till the evaporator requires the refrigerant.
5) This cold and foggy refrigerant flows to evaporator. Vaporizing the liquid in the evaporator, the heat from the warm air steam passing through the evaporator core is transferred to the refrigerant.
   All the liquid will change into gaseous refrigerant in the evaporator and only heat-laden gaseous refrigerant is drawn into the compressor. Then the process is repeated again.

(1) Compressor
(2) Condenser
(3) Receiver
(4) Evaporator
(5) Expansion Valve

j. Practical Control of Air Conditioner

(1) Concept of control

In order to operate the cooling cycle efficiently, it is necessary to control the heat exchanger outlet optimally. It is desirable to perform control so that the following is realized.

- Evaporation of refrigerant is just completed at the evaporator outlet.
- Condensation of refrigerant is just completed at the condenser outlet.

1 Evaporator outlet control = Temperature-type expansion valve

As shown in the figure below, the refrigerant flow is controlled by feeding back the outlet temperature (point a') so that evaporation is completed at the evaporator outlet and slightly overheated gas is provided.

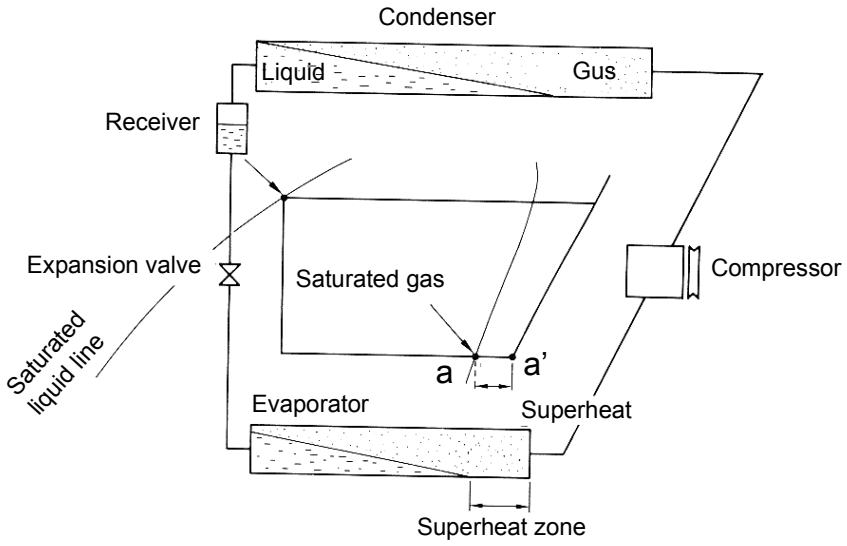


Fig. Control point for receiver and temperature-type expansion valve

Though superheating the refrigerant in gaseous form at this point will increase the refrigerant temperature at the evaporator outlet and therefore may not be the best way, superheat is necessary for feedback.

In view of the characteristics of the temperature-type expansion valve, controlling to 5 to 10°C is usually performed.

2 Condenser outlet control = Receiver

As shown in the figure above, the receiver provided at the condenser outlet is used for controlling so that condensation is completed at the condenser outlet.

(2) Principle of control

1 Controlling of evaporator outlet superheat by means of temperature-type expansion valve

The construction of the temperature-type expansion valve is shown in the figure below.

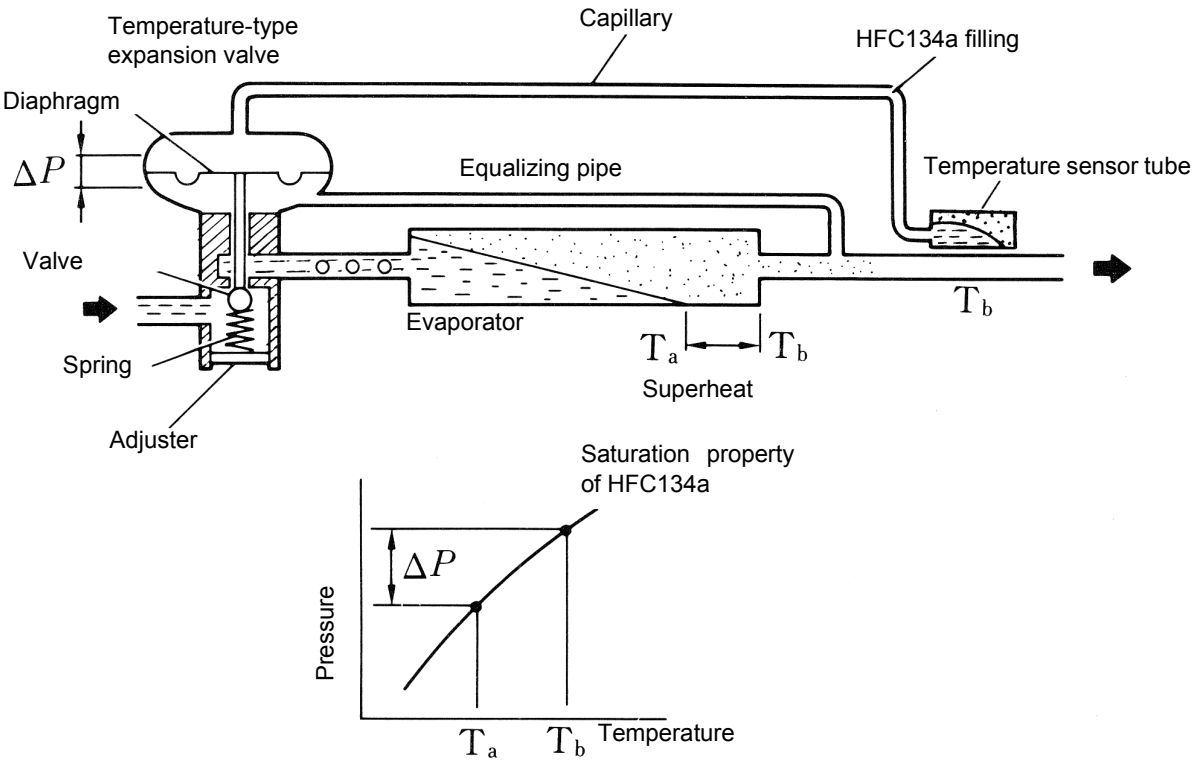


Fig. Principle of control by means of temperature-type expansion valve

The part above the diaphragm is sealed and filled with working medium. Usually this working medium is the same as the refrigerant used in the cooling cycle. In the case of a air-conditioner, this part is filled with HFC-134a.

This part is connected through the capillary tube to the temperature sensor tube attached to the evaporator outlet. In the temperature sensor tube, a saturation state is maintained with liquid and gas coexisting. The pressure in the temperature sensor tube, that is, in the part above the diaphragm is the saturation pressure at temperature T_b. On the other hand, the pressure in the evaporator (saturation pressure at temperature T_a) is directly applied to the part below the diaphragm. Therefore there is pressure difference ΔP corresponding to superheat ($(T_b - T_a)$) between the upper and lower parts. The opening of the valve is determined by the balance between this pressure difference ΔP and the spring force.

The principle of control is instantiated below.

- When the superheat of the evaporator increases (T_b increases), the pressure in the part above the diaphragm increases to displace the diaphragm downward, which further opens the valve to increase the refrigerant flow, thus reducing the superheat.
- When the superheat of the evaporator decreases, the operation described above is reversed.
- When the rotating speed of the compressor increases due to fluctuation in engine revolution, the suction power increases to reduce the pressure in the evaporator. As a result, the pressure in the part below the diaphragm decreases to further open the valve, which immediately increases the refrigerant flow according to the suction power of the compressor. Then the temperature sensor tube feeds back the temperature so that the superheat is optimized with optimum valve opening.

2 Controlling of condenser outlet by means of receiver

The necessary amount of refrigerant changes due to sharp fluctuation in engine revolution and vehicle heat load. To cope with this, excess refrigerant is stored and separate into gas and liquid in the receiver and only refrigerant in liquid form is sent out from the receiver. Normally there is always a liquid level in the receiver in which saturated liquid and saturated gas coexist. The supercooling temperature of the refrigerant in liquid form in the receiver is about 0°C.

The control by means of the receiver can be explained as follows. If, for example, refrigerant in gaseous form is not condensed completely in the condenser due to fluctuation of some kind, lots of refrigerant in gaseous form flows into the receiver. The amount of refrigerant in liquid form flowing into the receiver decreased accordingly and therefore the liquid level moves down, which means a corresponding amount of refrigerant in liquid form shifts to the condenser (Fig. below).

On the other hand, if refrigerant in liquid form collects at the condenser outlet and is cooled further out of the supercooling temperature, bubbles (shown in the figure below) at the condenser outlet disappear and no gas is added to the receiver. As a result, the amount of gas in the receiver decreases and the liquid level moves up (Fig. below), which means excess refrigerant in liquid form in the condenser shifts to the receiver. Thus controlling is performed so that proper gas and liquid flows into the receiver.

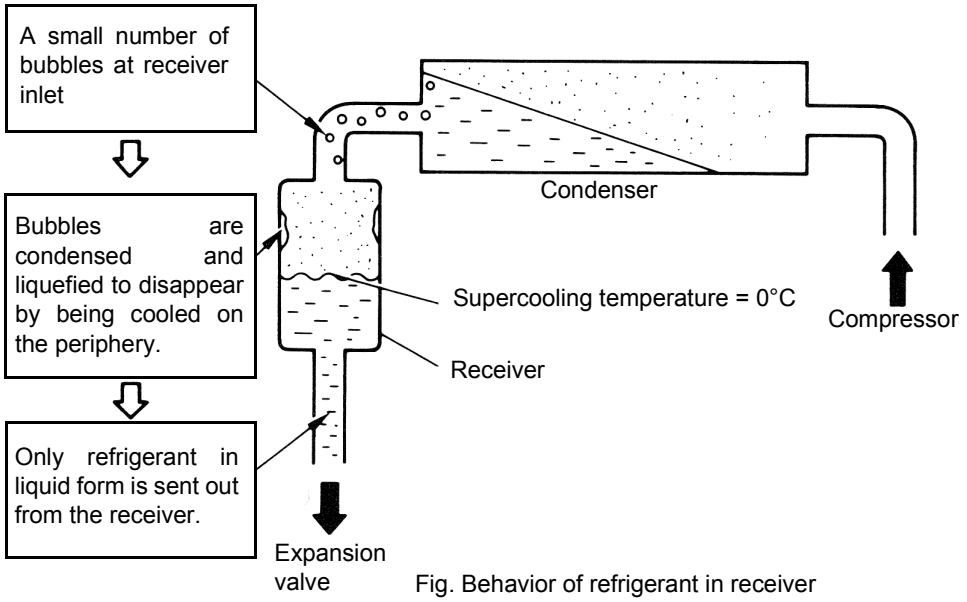


Fig. Behavior of refrigerant in receiver

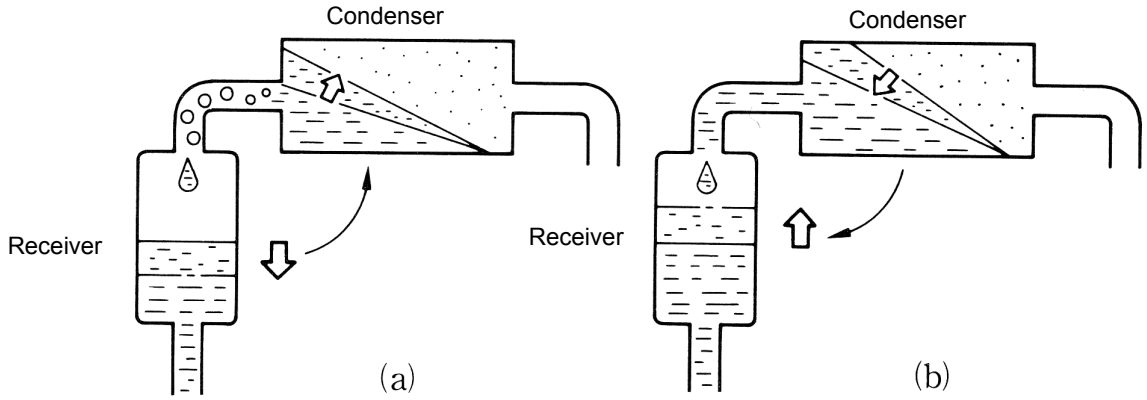


Fig. Behavior of liquid level in receiver

k. Mollier Diagram

The refrigerant in the cooling cycle is subjected to complicated thermodynamic changes such as increase and decrease in temperature, liquefaction and gasification, and changes in pressure. The Mollier diagram devised by Mollier is used to show such thermodynamic changes in a way easy to understand.

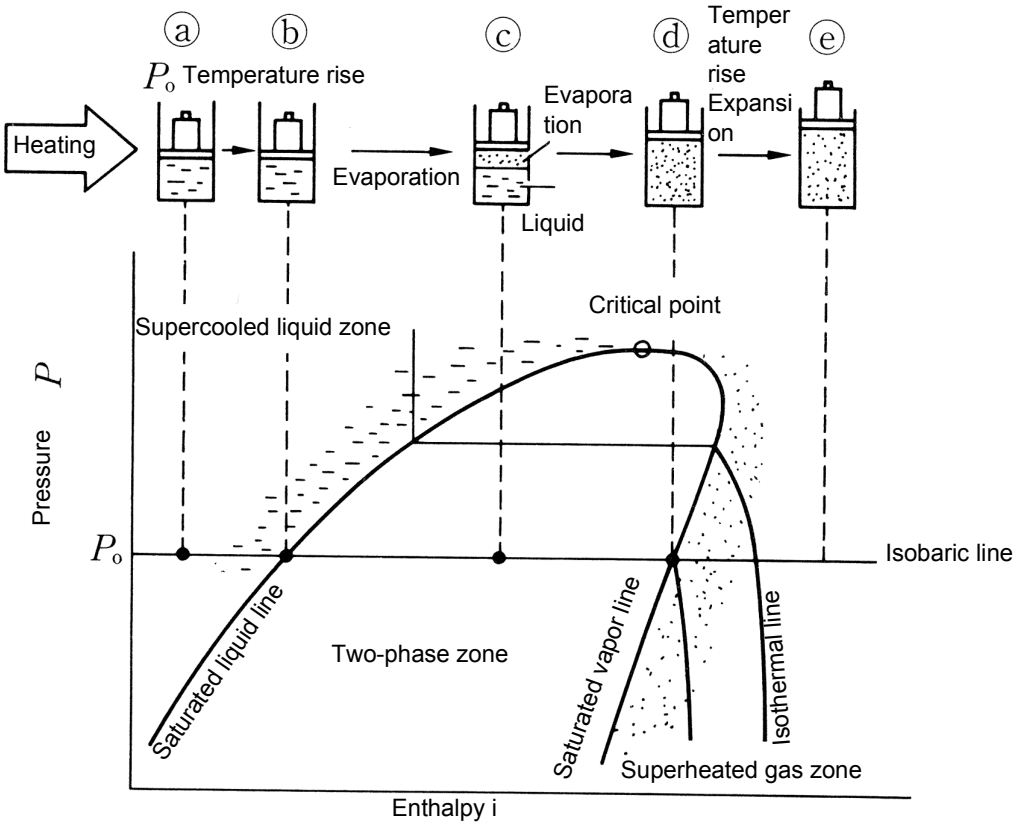


Fig Fundamentals of Mollier diagram

The configuration of the Mollier diagram is shown in the figure above. The vertical axis indicates the pressure of the refrigerant and the isobaric line is drawn horizontally. The horizontal axis indicates enthalpy i. Enthalpy i represents the total thermal energy of a substance. The quantity of heat and work externally given to the refrigerant is equal to the variation in enthalpy i, which is a very convenient index. For example, if a cylinder filled with liquid is heated at a constant pressure $P0$, the temperature of the liquid increases and the liquid becomes saturated (b). If heated further, the liquid starts to evaporate (c). While the liquid is boiling, the temperature of the liquid is kept constant. If heating is continued, all the liquid is gasified and a state of saturated gas is provided (d). If heated further, the temperature of the gas increases and the gas expands. When W kg of refrigerant is subjected to such enthalpy change Δi , heat quantity Q can be determined as follows:

$Q = \Delta i \cdot W$

In the Mollier diagram, the saturated liquid line shows at which stage evaporation is started in heating; the saturated vapor line shows at which stage condensation is started in cooling. The portion to the left of the saturated liquid line is a supercooled liquid zone; the portion to the right of the saturated vapor line is a superheated gas zone. The portion between these lines represents a state of saturation in which liquid and gas coexist. In this zone, the temperature and pressure are uniquely determined by the saturation pressure and temperature characteristics. Degree of dryness x shown in the figure below indicates the ratio of refrigerant in gaseous form. In the case of saturated liquid, $x = 0$. If 20% (on a weight basis) is gasified, $x = 0.2$.

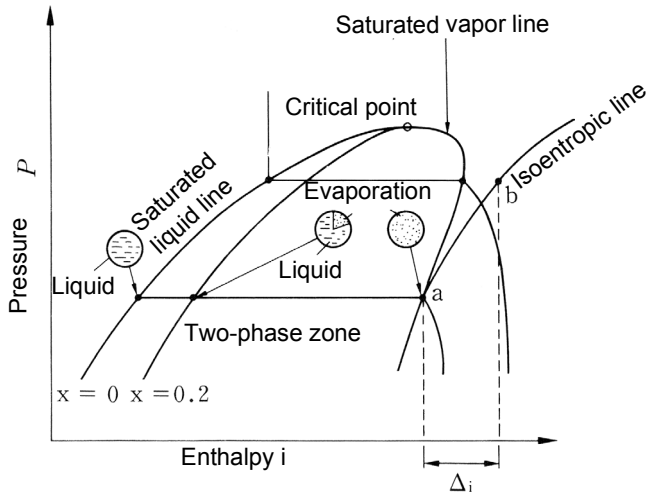


Fig Fundamentals of Mollier diagram

For compression, it is necessary to explain the isoentropic line. If ideal compression with no heat transfer or friction is realized, a change with constant enthalpy S (a→b in the figure above) occurs. At this time, the quantity of work per unit weight given to the refrigerant in gaseous form is equal to enthalpy difference Δi (kJ/kg) between a and b in the Mollier diagram above.

I. Basic Operation of Cooling Cycle

The basic operation of the cooling cycle is as shown in the figure below (Mollier diagram).

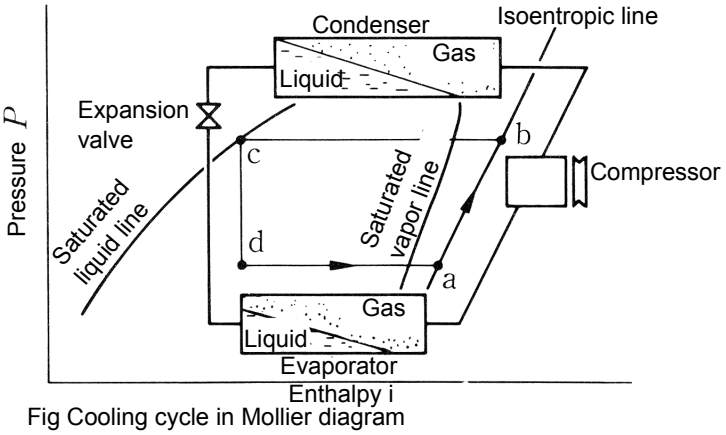


Fig Cooling cycle in Mollier diagram

1. The compressor sucks the gas generated through evaporation in the evaporator and compresses it. In the case of ideal adiabatic compression, as described above, a climbing change (point a→point b) occurs because isoentropic compression is performed. The pressure and enthalpy of the refrigerant in gaseous form increase in accordance with the quantity of work.
2. he refrigerant in gaseous form is cooled at a constant pressure in the condenser. The superheated gas is cooled to be saturated gas and then condensation starts. It is completely liquefied at the outlet.
3. Because no heat transfer is made in the expansion valve, a change from point c to point d occurs at a constant enthalpy. This hot refrigerant in liquid form is rapidly decompressed. Because the saturation temperature is low in the low-pressure side after decompression, it is necessary for the refrigerant to evaporate to lower the liquid temperature. Therefore, at point d at the inlet of the evaporator, a two-phase (gas and liquid) state with degree of dryness χ = 0.3 to 0.4 (refrigerant in gaseous form occupies 30 to 40%) is provided.
4. In the evaporator, the low-temperature and low-pressure refrigerant in liquid form (60 to 70%) draws heat from the surroundings at a constant pressure and evaporates. At the outlet of the evaporator, the refrigerant is completely gasified.

m. Calculation of Refrigeration Capacity and Power from Mollier Diagram

The points shown in the Mollier Diagram are values per unit weight of refrigerant. In order to calculate the refrigeration capacity and power, the flow of refrigerant actually circulating through the cooling system should be determined. Assuming that this flow of refrigerant is Gr (kg/h), refrigeration capacity Q_{er}, which is equal to the change in the enthalpy of the refrigerant achieved by the evaporator drawing heat from the surroundings, is calculated as follows:

$$Q_{er} = (i_a - i_d)G_r \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

- In the case of the compressor power, because the quantity of externally given work is equal to the increase in the enthalpy of the refrigerant, power L is calculated as follows:

$$Q_{er} = (i_a - i_d)G_r \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

- The quantity of heat radiation of the condenser, which is opposite to the case of the evaporator, is calculated as follows:

$$Q_{cr} = (i_b - i_c)G_r \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Because the sum of the quantity of heat drawn by the evaporator and the quantity of work added by the compressor is equal to the quantity of heat radiation performed by the condenser, the following equation holds.

$$Q_{cr} = (Q_{er} + L) \quad \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Shown below is COP (Coefficient of Performance) that is commonly used to indicate the efficiency of work for cooling. It shows a ratio of power L to refrigeration capacity Q_{er}.

$$\mathrm{COP} = \frac{Q_{er}}{L} \quad \ldots\ldots\ldots\ldots\ldots\ldots (5)$$

n. Calculation of Flow of Circulating Refrigerant

Flow of circulating refrigerant G_r is calculated from compressor suction capacity V_c (m^3/h) and specific volume bulk of gas υ_s (m^3/kg) as shown below.

$$G_r = \frac{V_c}{\upsilon_s} \text{ (kg/h)} \quad \ldots\ldots\ldots\ldots\ldots\ldots (6)$$

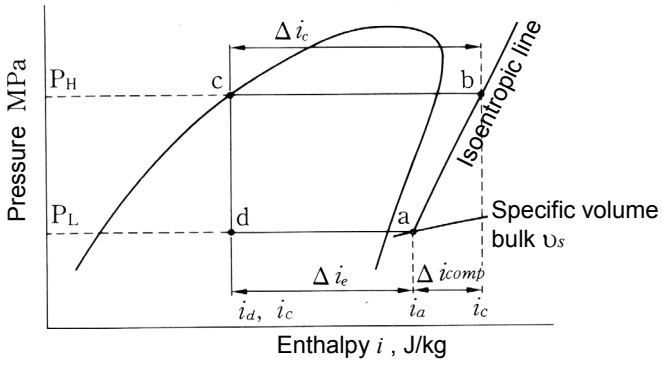


Fig Cooling cycle in Mollier diagram

Compressor suction capacity V_c is calculated as follows:

$$V_c = \frac{V_1 \times N \times 60}{10^6} \times \eta_\upsilon \quad \ldots\ldots\ldots\ldots\ldots\ldots (7)$$

V_1: Volume of compressor cylinder (cc)
N: Rotating speed of compressor (rpm)
η_υ: Volumetric efficiency

o. Theoretical Performance (Sample Calculation)

(1) Compressor out put ; L

Compressor displacement = 70 cm^3/rev
Compressor rotating speed = 1800 rpm
Compressor delivery refrigerant volume V_c ;

V_c = 70 $cm^3/rev \times 1800$ rpm $\times 60$ min $\times 0.65 \div 10^6$
= 4.914 m^3/h
η_v = volumetric efficiency = 0.65
υ_s = HFC134a specific volume at 10°C, 3 kgf/cm^2abs
= 0.075 m^3/kg

Compressor delivery refrigerant amount G_r ;

$G_r = 4.914 \div 0.075 = 65.52$ kg/h

Enthalpy increase by compressor $= i_b - i_a$
= 8kcal/kg (Example)

L = Compressor output = 8 kcal /kg $\times$ 65.52 kg/h
= 524.16 kcal/h

524.16 ÷ 860 = 0.609 kw (1 kwh = 860 kcal/h)

Engine input horse power = 0.609 ÷ 0.7 = 0.871 kw

0.871 kw ÷ 0.7355 =1.184 ps (1 ps = 0.7355kw)

Engine torque for compression T_r ;

$$T_r = \frac{ps \times 716.2}{N} = \frac{1.184 \times 716.2}{1800} = 0.47 kgfm$$

(2) Evaporator capacity Q_{er} ;

Enthalpy change in evaporator = $i_a - i_d$

$Q_{er} = (i_a - i_d) \times G_r$ = 32 kcal/kg $\times$ 65.52 kg/h
= 2096.64 kcal/h

2096.64 ÷ 860 = 2.438 kw

(3) Condenser capacity Q_{co} ;

Enthalpy change in condenser = $i_b - i_c$

$Q_{co} = (i_b - i_c) \times G_r$ = 40 kcal/kg $\times$ 65.52 kg/h
= 2620.8 kcal/h

2620.8 ÷ 860 = 3.047 kw

(4) Basically,

$Q_{co} = Q_{er} + L$ = 2096.64 + 524.16
= 2620.8 kcal/h

(5) Coefficient of Performance ;

$$COP = \frac{Q_{er}}{L} = \frac{2096.64}{524.16} = 4.0$$

Note : Above data are all for sample calculation purpose only.

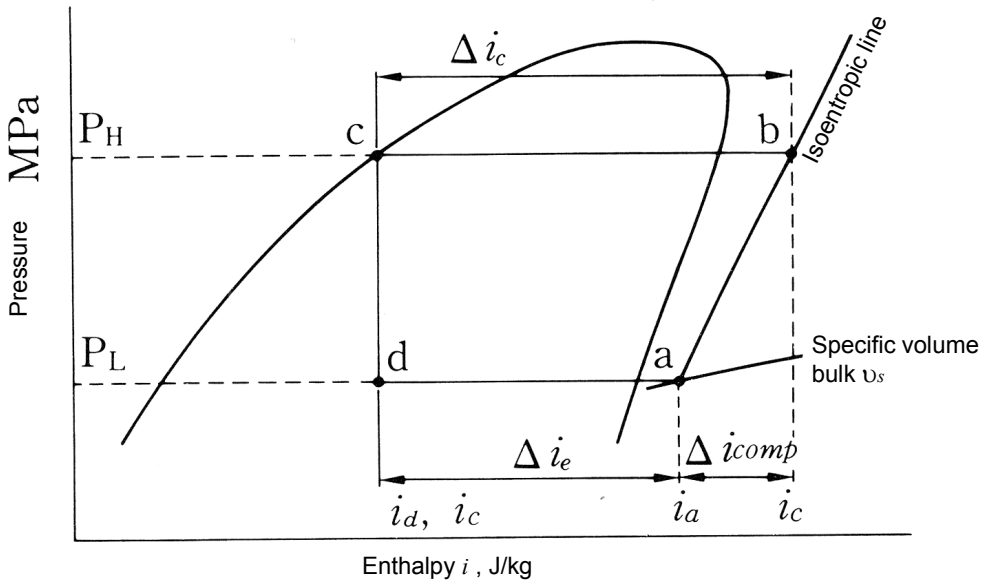
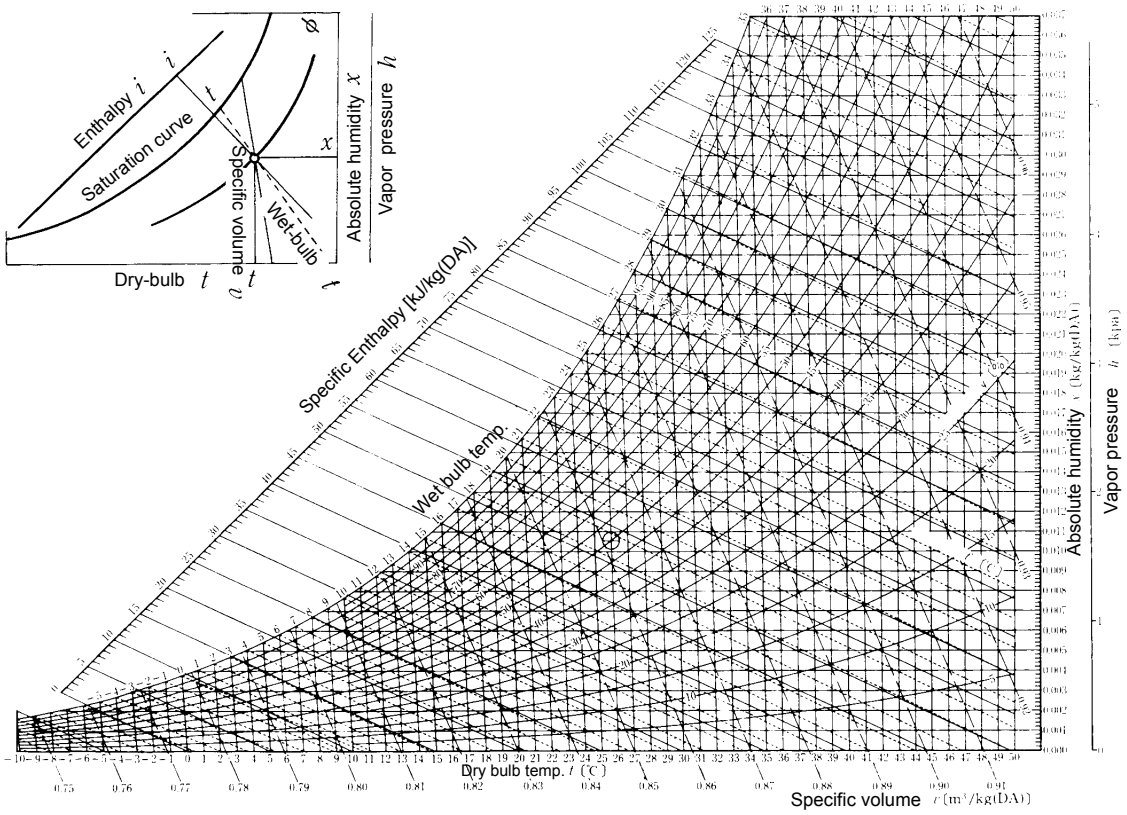


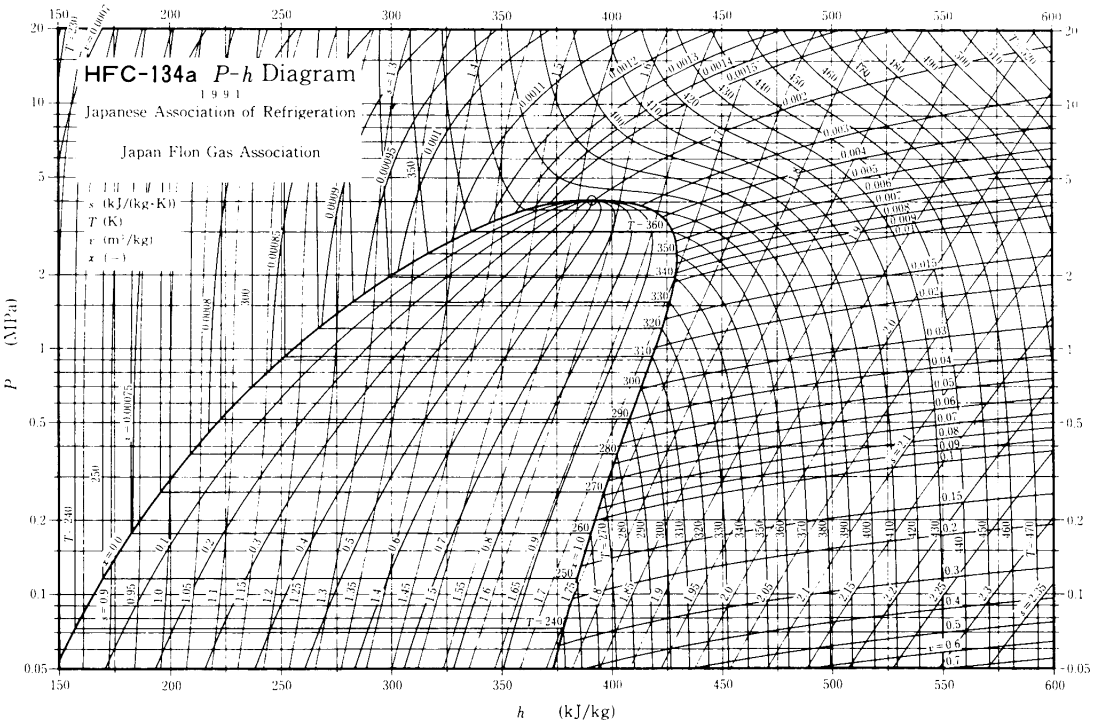
Fig. Cooling cycle in Mollier diagram

(6) Relevant diagram

1 Wet air diagram



2 Mollier diagram : HFC-134a



Service Section

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A.Troubleshooting

In order to find the cause of troubles as quickly as possible, it is necessary to conduct troubleshooting using a rational method and procedure. We will explain in the following:

Before starting troubleshooting, first confirm the symptoms as follows:

Start the engine and keep it idling. Then turn the blower switch and A/C switch on, and check the A/C working conditions.

You can check the blower operation, the magnetic clutch operation and A/C outlet air temperature very easily.

After confirmation of symptoms, conduct the following rational method of troubleshooting.

Visual and Audible Inspection
This can detect simple causes of troubles.

See next page VI-S-4 for details.

Preparation: (1) Install the manifold gauge to the refrigerant cycle.
(2) Prepare a multimeter and gas leak detector.

Check Manifold Gauge Pressure
Inspect the refrigeration cycle pressures - Low and High Side
Standards : Low side1.5 - 2.0 kg/cm2 (0.15 - 0.20 MPa)
(at 30 to 35 °C) High side13 - 17 kg/cm2 (1.27 -1.66 MPa)

See page VI-S-20 for details.

After the pressures to be okay, the remaining causes are on the electrical circuit and components.

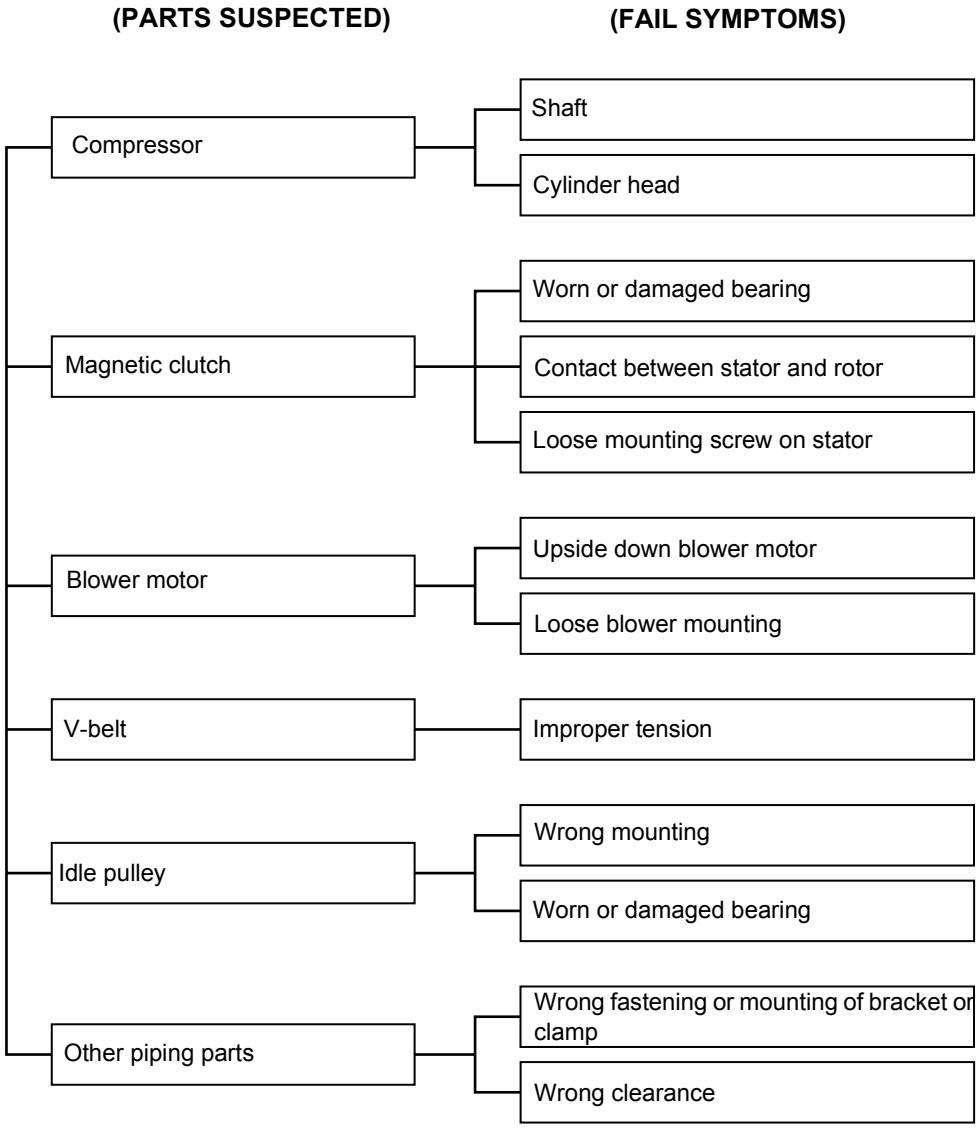
Troubleshooting Electrical Circuit
To make it easy, first start the blower circuit troubleshooting and continue to the cooler circuit troubleshooting.

See page VI-S-45 for details.

a. Visual and Audible Inspection

The simplest way to detect troubles is by looking and listening.

1. Is the drive belt loose?
2. Are the condenser fins covered with dirt and dust?
   In this case, the condenser cooling effect will be greatly reduced. As a result, the cooling capacity also will decrease.
3. Is the air filter clogged?
   A clogged air filter will reduce the air flow and lower the cooling capacity.
4. Can oil stains be seen in the refrigeration cycle connections and joints?
   A place that shows an oil stain indicates that the refrigerant is leaking from that place together with the compressor oil.
5. Check the quantity of refrigerant at the sight glass.
6. Abnormal noise



b. Components

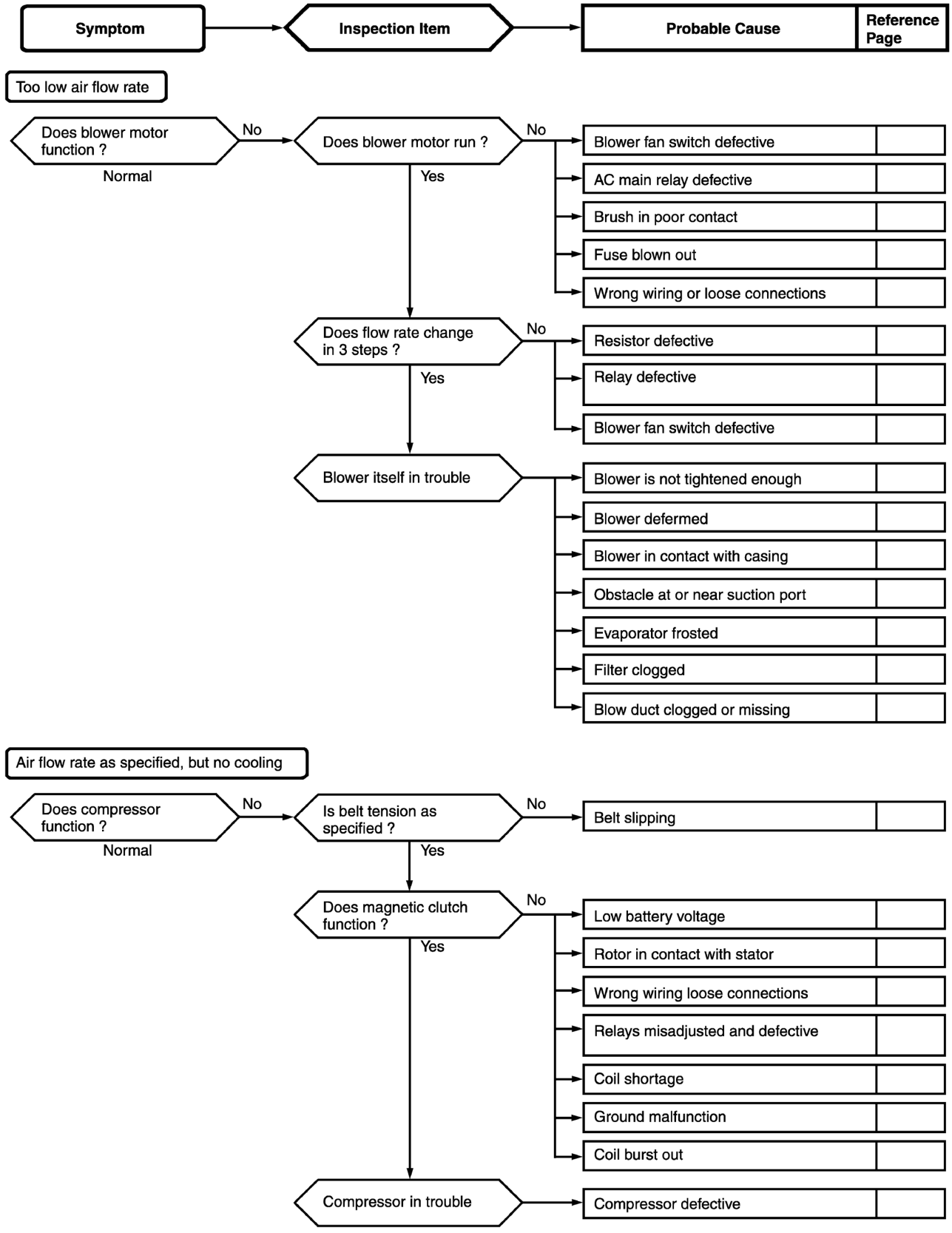
Air Conditioning System

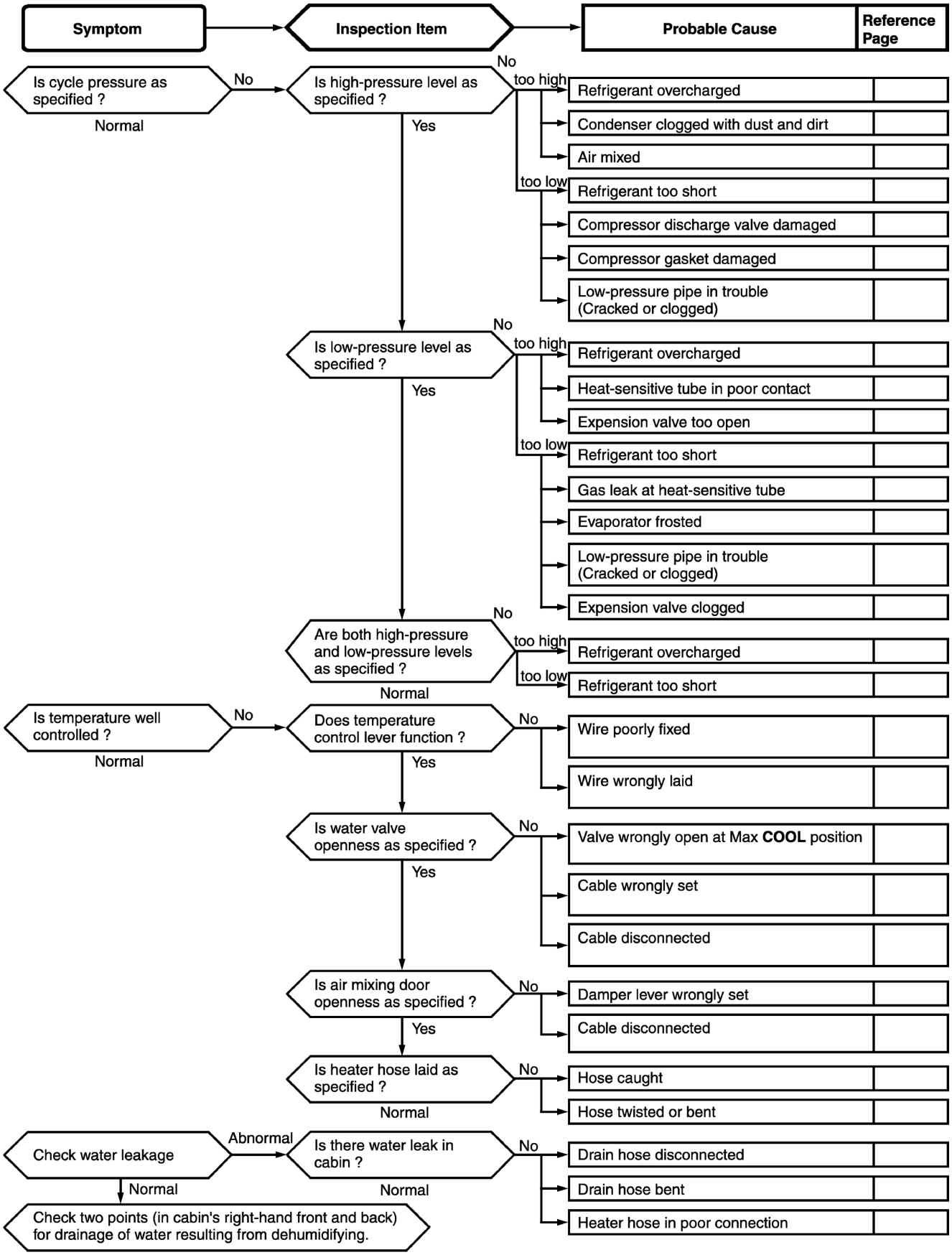
Symptom	Probable Cause	Solution	Reference Page
Does Not Cool (No Air Flow)	•Fuse blown •A/C main relay defective •Blower high relay detective •Blower motor defective •Blower switch defective •Wiring harness disconnected or improperly connected	Replace Repair or replace Replace Replace Replace Repair	
(Compressor Does Not Rotate)	•Fuse blown •Magnetic clutch defective •A/C switch defective •Pressure switch defective •Belt slipping	Replace Repair or replace Replace Replace Adjust or replace	
(Others)	•Insufficient refrigerant •Expansion valve defective •Compressor defective	Check with manifold gauge Replace Replace	
Insufficient Cooling (Insufficient Air Flow)	•Air filter clogged •Evaporator frosted •Blower motor defective •Blower resistor defective	Clean or replace Clean or replace thermo switch Replace Replace	
(Many Bubbles in Sight Glass)	•Insufficient refrigerant •Gas leaking from some place in refrigerating cycle •Air mixed in	Check with manifold gauge Repair and charge refrigerant Check with manifold gauge	
(No Bubbles in Sight Glass)	•Too much refrigerant	Check with manifold gauge	

Compressor

Symptom	Probable Cause	Solution	Reference Page
Insufficient Cooling (Compressor Does Not Rotate Properly)	•Belt slipping •Magnetic clutch defective •Compressor defective	Adjust or replace Repair or replace Replace	
(Others)	•Thermostat defective •Water valve defective •Condenser fin cogged with dust •Expansion valve defective	Replace Replace Clean Replace	
Insufficient Heating	•Water valve defective •Air mix door malfunctioning •Insufficient coolant	Replace Adjust control cable Replenish	
Insufficient Cooling (Compressor Does Not Rotate Properly)	•Belt slipping •Magnetic clutch defective •Compressor defective	Adjust or replace Repair or replace Replace	
(Others)	•Cndenser fin clogged with dust •Expansion valve defective	Clean Replace	
Abnormal noise	•Excessive refrigerant •Internal damage	Discharge gas to specified amount. Replace	
Noisy (Compressor ON)	•Bearing of compressor worn or damaged •Valves in compressor damaged •Belt slipping •Compressor bracket mounting screws loosen •Piping resonant	Replace Replace Adjust or replace Tighten Tighten or add clamp	
(Compressor OFF)	•Blower defective •Bearings of magnetic clutch, idle pulley or crank pulley worn or damaged	Repair or replace Replace	

c. Diagnosis flow chart




Symptom
Inspection Item
Probable Cause
Reference Page
Is cycle pressure as specified ?
No
Normal
Is high-pressure level as specified ?
No
too high
Refrigerant overcharged
Condenser clogged with dust and dirt
Air mixed
too low
Refrigerant too short
Compressor discharge valve damaged
Compressor gasket damaged
Low-pressure pipe in trouble (Cracked or clogged)
Yes
Is low-pressure level as specified ?
No
too high
Refrigerant overcharged
Heat-sensitive tube in poor contact
Expension valve too open
too low
Refrigerant too short
Gas leak at heat-sensitive tube
Evaporator frosted
Low-pressure pipe in trouble (Cracked or clogged)
Expension valve clogged
Yes
Are both high-pressure and low-pressure levels as specified ?
No
too high
Refrigerant overcharged
too low
Refrigerant too short
Normal
Is temperature well controlled ?
No
Normal
Does temperature control lever function ?
No
Wire poorly fixed
Wire wrongly laid
Yes
Is water valve openness as specified ?
No
Valve wrongly open at Max COOL position
Cable wrongly set
Cable disconnected
Yes
Is air mixing door openness as specified ?
No
Damper lever wrongly set
Cable disconnected
Yes
Is heater hose laid as specified ?
No
Hose caught
Hose twisted or bent
Normal
Check water leakage
Abnormal
Is there water leak in cabin ?
No
Drain hose disconnected
Drain hose bent
Heater hose in poor connection
Normal
Normal
Check two points (in cabin's right-hand front and back) for drainage of water resulting from dehumidifying.

d. Troubleshooting from Problem Symptoms (Except Refrigeration Cycle Troubles)

You will find the troubles easily using the table below. For details, refer to each troubleshooting chart.

No.	Problem	Main Inspection Areas						Refer to page
		Fuses	Connectors	Wire harness	Body ground	*1 Sensor circuit	Others	
1	Fuse is blown out easily	○	○	○	○			
2	No blower operation	○	○	○	○		Blower motor, Blower resistor, Blower switch	
3	Blower speed does not change	○	○	○	○		Blower resistor Blower switch	
5	No compressor operation	○	○	○	○		Magnetic clutch & relay Compressor A/C switch	
6	A/C lamp does not light	○	○	○	○		A/C switch	
7	A/C lamp flashes. (only for compressor with lock sensor)	○	○	○		○	Compressor, V-ribbed belt Magnetic clutch	
8	No A/C operation (No cool air comes out)	○	○	○	○			
9	Room temp. does not decrease (insufficient cooling)	○	○	○	○	○		
10	No warm air comes out						Engine coolant volume, A/C temp. control lever Heater radiator	

Note : *1 : Sensors are thermistor, pressure switch and water temp. switch.

B.Servicing Specifications

a. Specifications of A/C system and components

	Item			Specifications	Remarks
Performance	Cooler		Capacity	2.8kW ±10%	Outside air: 35ºC •Inside air: 27ºC, 50% •Rotating speed of Comp: 1800 rpm •Terminal voltage of blower motor: 13.5 V •Vehicle duct resistance: 310 Pa (including air supply grille)
			Airflow	280m^3/h ±10%	
			Power consumption	150W ±10%	
	Heater		Capacity	3.6kW ±10%	•Difference between air and water temperatures: 65ºC •Hot water flow: 6 L/min •Terminal voltage of blower motor: 13.5 V •Vehicle duct resistance: 460 Pa (including air supply grille)
			Air flow	250m^3/h ±10%	
			Power consumption	140W ±10%	
Component	Compressor assembly	Compressor	Model	SV07E	
			Piston displacement	70cm^3	
			Rotating speed	700~6000rpm	
			Lubricant	ND-0il 8 140 ±10cm^3	
		Magnet clutch	Model	K20	
			Drive belt	Single HM,33.5inch	Deflection : 12 - 15 mm at 6~7 kgf
			Pulley efficacy	dia. 108	Nut tightening torque = 19.6 N·m (200 kgf·cm)
			Power consumption	35W or less	
		Weight		2.82kg	
	Condenser	Specifications of core	Dimensions (mm)	Height 264.2 Width 325 Thickness 16.1	
			Fin type	Corrugated fin, 3.6 mm (With louver)	
		Weight		1.1kg	
	Cooler unit	Specifications of core (cooler)	Dimensions (mm)	Height 165 Width 163.5 Thickness 58	
			Fin type Pitch	Corrugated fin, 4 mm	
		Specifications of core (heater)	Dimensions (mm)	Height 140 Width 122.5 Thickness 21	
			Fin type Pitch	Corrugated fin, 1.8 mm	
		Motor	Motor type	dia.70 ferrite motor	
			Rotating speed	3350rpm ±10%	12V
			Current	12A or less	
		Weight		6.9kg	
	Receiver	Actual capacity		370cm^3	Inner gas = N_2
		Moisture absorption capacity		32g	60ºC, 90% in air (Desiccant: 290 g)

	Item		Specifications		Remarks
Component	Pressure switch	High-pressure relief	Opening pressure	3.43~4.1MPa	Installed in the compressor
			Closing pressure	2.75 MPa or more	
		High-pressure OFF	3.14MPa(DIFF 0.59MPa)		High-pressure cut
		Low-pressure OFF	0.196MPa(DIFF 0.02MPa)		Low-pressure cut (prevention of operation without gas)
Refrigerant used			HFC134a		
Engine pulley			ø140		Code No. : RD411-55161
Compressor pulley			ø120, w =11.7, θ= 36		

b. Performance Specifications

Item		Specifications	Remarks
Noise level at ear point db(A)		80, 82>	
Duct sealing capacity	Air flow speed out of grille A (m/s)	17.0, 17.0<	Engine : MAx., Blower : MAX. All outlet except A are closed.
Heater capacity	Air temp. out of grille A (°C)	45.0, 45.0 5 min. later	Engine : Max. Blower : Max. A/C switch : OFF, 4 outlets : Open Measuring point : 20 - 30 mm lower from grille A.
Cooler capacity	Air temp. out of grille A (°C)	10.0> at ambient temp.<=35 °C within 10 min.	Engine : Max. Blower : Max. A/C switch : ON, 4 outlets : Open Measuring point : 20 - 30mm lower from grille A.
		15.0> at ambient temp.> 35 °C within 10 min.	

c. Adjustment and Testing

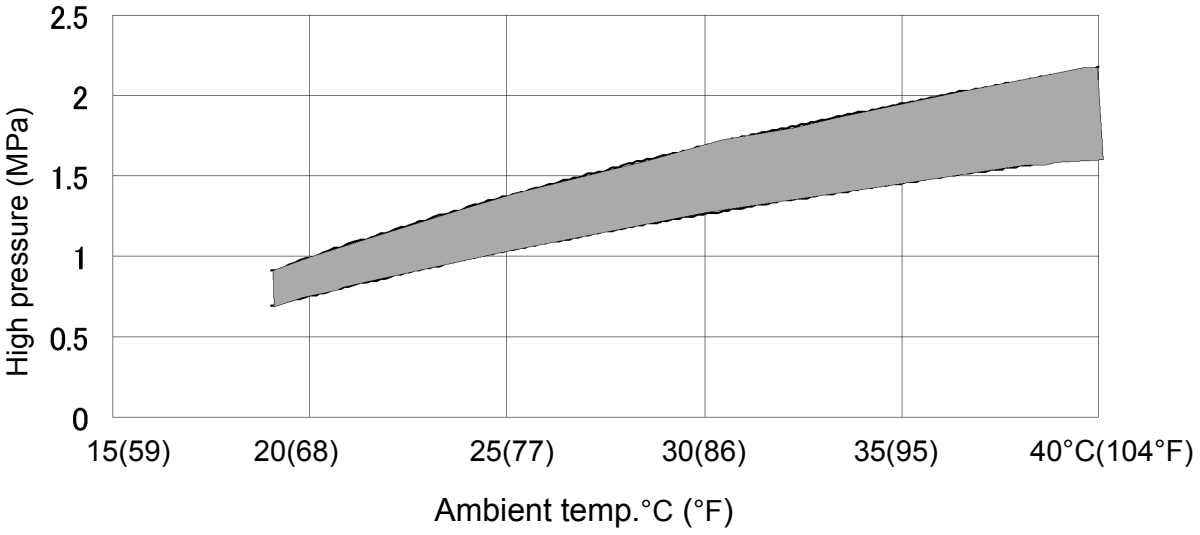
Item		Factory Specification	Allowable Limit
Refrigerant amount	Type : R134a	800 ± 50 g 1.76 ± 0.11 lbs	
Lub. oil amount in total system	Type : ND-Oil 8	140 ± 10 cc 0.037 ± 0.003 us gal	In new compressor
Air-gap of A/C Compressor Magnet Clutch	Swash Plate Type Compressor Scroll Type Compressor	0.25 to 0.50 mm 0.010 to 0.020 in. 0.35 to 0.65 mm 0.014 to 0.022 in.	
Refrigerating Cycle (Refrigerating Cycle is Normal Operating) Condition •Engine Speed : Approx. 1500 min-1 (rpm) •Ambient Temperature : 30 to 35 °C 86 to 95 °F •Blower Switch : High position	Pressure (**LO** Pressure Side) Pressure (**HI** Pressure Side)	0.15 to 0.20 MPa 1.5 to 2.0 kgf/cm^2 21 to 28 psi 1.27 to 1.66 MPa 13 to 17 kgf/cm^2 185 to 242 psi	
Pressure Switch (Dual Type) (When pressure switch is turned **OFF**)	Setting Pressure (**LO** Pressure Side) Setting Pressure (**HI** Pressure Side)	Less than Approx. 0.196 MPa 2.0kgf/cm^2 28.4psi More than approx. 3.14 MPa 32 kgf/cm^2 455 psi	
Air Conditioner Drive Belt	Tension	12 to15 mm (0.47 to 0.59 in.) deflection at 58.8~68.6 N (6~7 kgf, 13.2~15.4 lbs) of force	

d. Ambient Temperature vs Normal High-Low Pressure Range

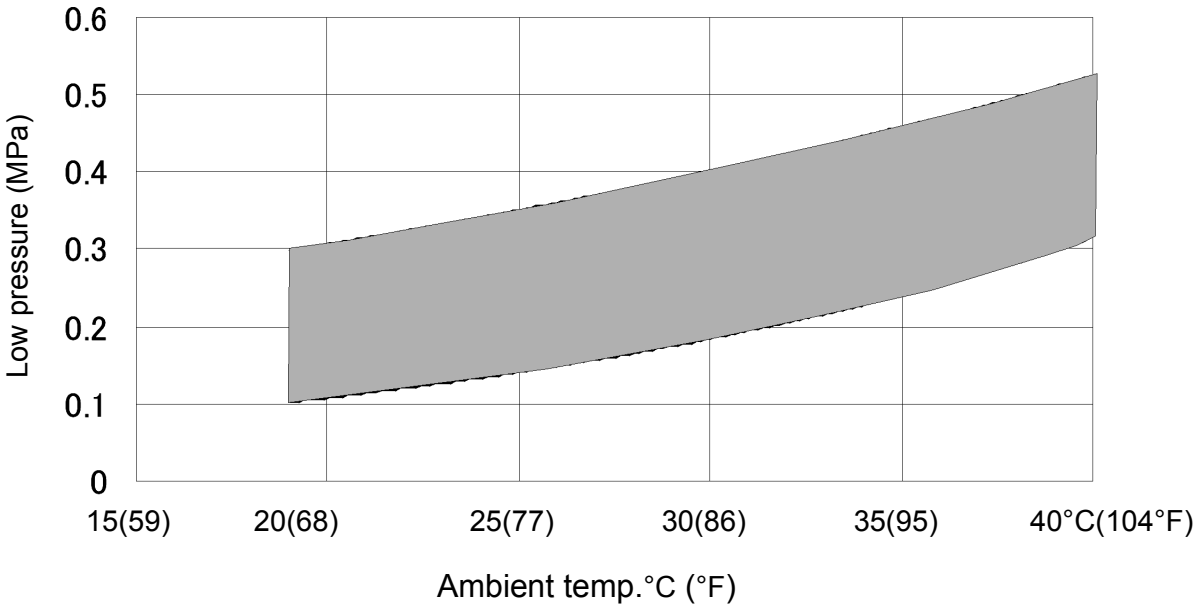
Conditions :

Door	; open
Blower	; High range
Temp. control	; Max. cool
Engine speed	; 1500 rpm

Normal high pressure range



Normal low pressure range



1 MPa = 10.2 kgf/cm^2 = 145 psi

e. Tightening Torques

Tightening torques of screws, bolts and nuts on the table below are especially specified.
(For general use screws, bolts, and nuts : See page G-11.)

Item	N•m	kgf•m	ft-lbs
Cabin mounting nuts			
M14 nut	107.9 to 125.5	11.0 to 12.8	79.6 to 92.6
M16 nut	166.7 to 191.2	17.0 to 19.5	123.0 to 141.0
Compressor mounting screw, M8 bolt	16.7 to 19.9	1.7 to 2.0	12.3 to 14.5
Compressor bracket mounting screws			
Screws M12	77.5 to 90.2	7.9 to 9.2	57.1 to 66.5
Screw M8	16.7 to 19.6	1.7 to 2.0	12.3 to 14.5
Receiver mounting bolt (M6)	3.9 to 6.9	0.4 to 0.7	
Clutch mounting screw (Slide vane type compressor)	10.8 to 16.2	1.10 to 1.65	8.0 to 11.9
High pressure pipe screw and retainer nut			
between compressor and condenser (High pressure pipe 1)			
screw	7.8 to 11.8	0.8 to 1.2	5.8 to 8.7
retaining nut, M22 x 1.5	19.6 to 24.5	2.0 to 2.5	14.5 to 18.1
between condenser and receiver			
screw, M6 bolt	3.9 to 6.9	0.4 to 0.7	2.9 to 5.1
retaining nut, M16 x 1.5	11.8 to 14.7	1.2 to 1.5	8.7 to 10.8
between receiver and A/C unit (High pressure pipe 2)			
retaining nut, M16 x 1.5	11.8 to 14.7	1.2 to 1.5	8.7 to 10.8
Low pressure pipe			
between A/C unit and compressor			
screw, M6 bolt	7.8 to 11.8	0.8 to 1.2	5.8 to 8.7
retaining nut, M24 x 1.5	29.4 to 34.3	3.0 to 3.5	21.7 to 25.3
A/C unit mounting screws (M6)	3.9 to 6.9	0.4 to 0.7	2.9 to 5.1
A/C unit mounting screws (M8)	9.8 to 15.7	1.0 to 1.6	7.23 to 11.6

Reference: Lub.oil

Replacing Parts	Approx Replenish Quantity	Brand Name
Condenser	20 cc 0.021 U.S.qts. 0.018 Imp.qts.	ND-OIL 8 <PAG* oil>
Evaporator	20 cc 0.021 U.S.qts. 0.018 Imp.qts.	
Receiver	10 cc 0.011 U.S.qts. 0.009 Imp.qts.	

* PAG : Polyalkyleneglycol (Synthetic oil)

C.Regular Check and Service Points

a. Maintenance interval ; Air conditioner

No.	Items	Period	Indication on hour meter							Since then	Reference No.	
			50	100	150	200	250	300	350			
1	Inner air filter	clean				○				every 200 hrs	1	*2
		replace								every 1000hrs	1	*2
2	Outer air filter	clean				○				every 200 hrs	1	*2
		replace								every 1000 hrs	1	*2
3	Air conditioner condenser	clean				○				every 200 hrs	2	
4	Air conditioner drive belt	check				○				every 200 hrs	3	
5	Air conditioner pipes and hoses	check								every 1 year		
		replace								every 2 years		
6	Refrigerant (gas)	check								Service as required		

No.	Items	Period	Indication on hour meter							Since then	Reference No.	
			400	450	500	550	600	650	700			
1	Inner air filter	clean	○				○			every 200 hrs	1	*2
		replace								every 1000hrs	1	*2
2	Outer air filter	clean	○				○			every 200 hrs	1	*2
		replace								every 1000 hrs	1	*2
3	Air conditioner condenser	clean	○				○			every 200 hrs	2	
4	Air conditioner drive belt	check	○				○			every 200 hrs	3	
5	Air conditioner pipes and hoses	check								every 1 year		
		replace								every 2 years		
6	Refrigerant (gas)	check								Service as required		

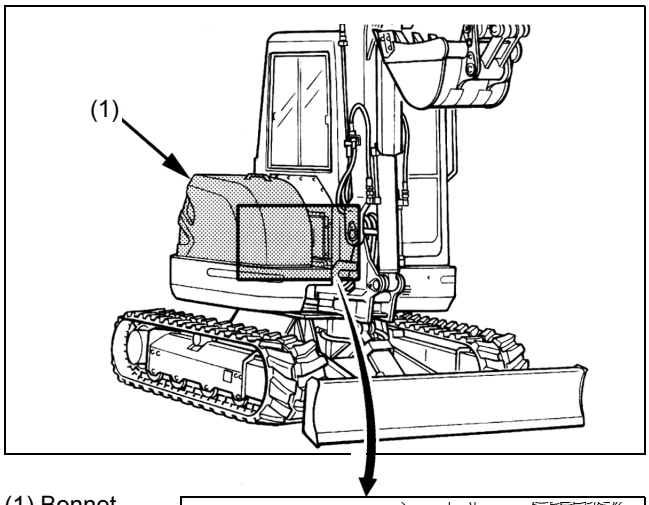
Important

*2 Clean and replace the air filter more frequently if used under dusty conditions. By heavy soiling, replace the filter.

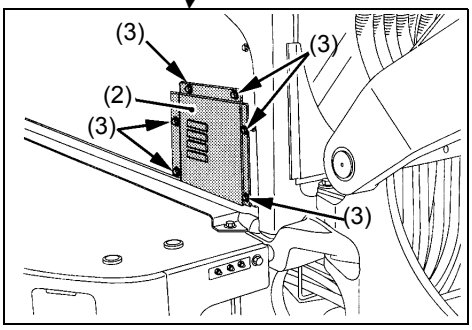
b. Regular Service Points

1. Cleaning Air Filter

   Remove the bonnet, and then remove the bolts and pull out filter.



(1) Bonnet
(2) Cover
(3) Bolt



Note:

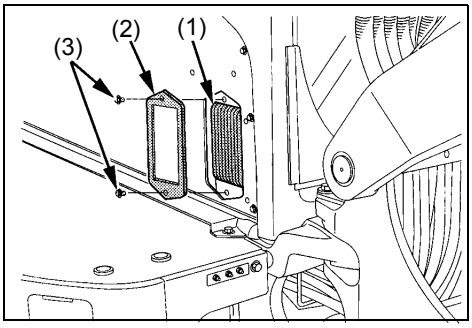
- Attach the filter, plate and cover as illustration.
- ◆ **Claening the air filter**
- Normal use

  Blow air from the opposite direction to the filter's normal air flow.

IMPORTANT :

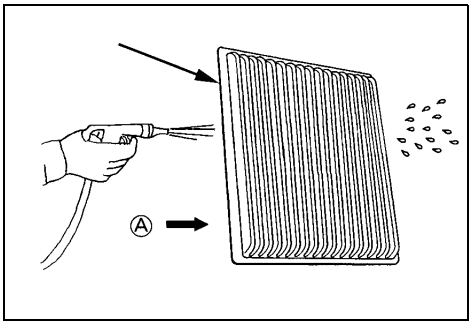
- Do not hit the filter. If thefilter becomes deformed, dust may enter into the air-conditioner, which may cause damage and malfunction.

(1) Outer air filter
(2) Plate
(3) Bolt



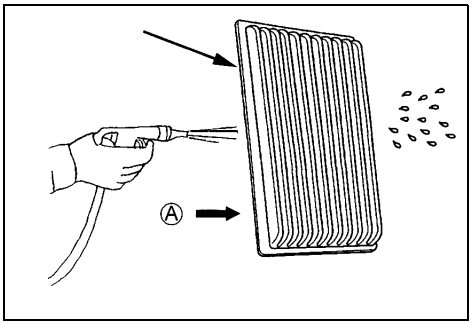
(1) Inner filter

Ⓐ "AIR CONDITIONER AIR FLOW"



(2) Outer filter

Ⓐ "AIR CONDITIONER AIR FLOW"

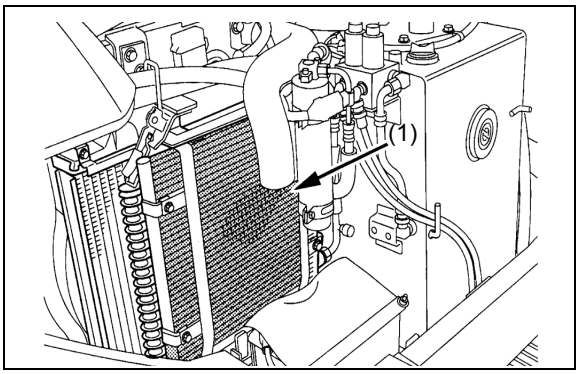


Note:

- If the filter is very dirty, replace the air filter.

2. Checking Air-Conditioner Condenser

Check air conditioner condenser to be sure it is clean from debris.



(1) Air conditioner condenser

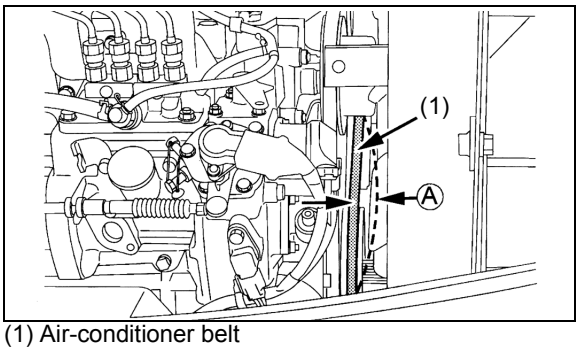
3. Checking Air-Conditioner Belt Tension

⚠ Caution

To avoid personal injury :

- **First stop the engine and remove the key.**
- **After servicing, make sure to replace the belt cover in its original position.**

Push on the belt between the pulleys with a finger. A deflection of 12 to 15 mm (0.5 to 0.6 in.) under a 7 kg-f load is appropriate.



(1) Air-conditioner belt

Ⓐ 10 to 15mm

Note:

- If the air-conditioner belt is too loose, consult your local KUBOTA Dealer for this service

Important

- **Charge only with R134a not R12 refrigerant (gas).**

Servicing As Required

[Air conditioner type]

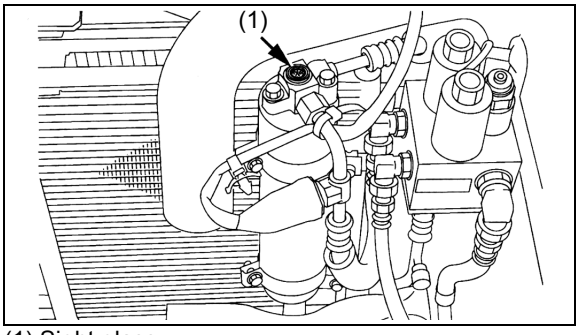
4. Checking Amount of Refrigerant (gas)

⚠ Warning

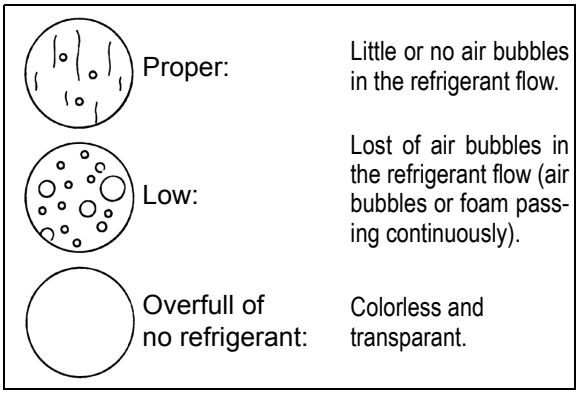
To avoid personal injury :

- **Liquid contact with eyes or skin may cause frostbite.**
- **In the event of a leakage, wear safety goggles. Escaping refrigerant can cause severe injuries to eyes.**
- **In contact with a flame, R134a refrugerant gives a toxic gas.**
- **Do not disconnect any part of the refrigeration circuit of air cinditioning system. Consult your local KUBOTA Dealer for assistance and service.**

A shortage of refrigerant impairs the air-conditioner performance. Check the following points. If it is indicated that the amount of refrigerant is extremely low, ask your dealer to inspect and charge.



(1) Sight glass



Checking procedure

1. Run the air-conditioner in the following conditions.
   - Engine speed : About 1500 rpm
   - Temperature control lever : Maxmum cooling position (rightmost)
   - Fan switch : Highest blow (3)
   - Air-conditioner switch : ON
2. Look into the sight glass to see if the refrigerant is flowing through its circuit.

D.Precautions at Repairing Refrigerant Cycle

When checking or repairing the air conditioning system, the following precautions and rules must be observed. And it is of first importance that no other personnel than a well-trained serviceman should be allowed to handle the refrigerant.

⚠ CAUTION

- **Since direct contact of the liquid refrigerant with your skin will cause frostbite, always be careful when handling the refrigerant. Always wear goggles to protect your eyes when working around the system.**
- **The refrigerant service container has a safe strength. However, if handled incorrectly, it will explode.**
- **Therefore, always follow the instructions on the label. In particular, never heat the refrigerant container above 40°C (104°F) or drop it from a high height.**
- **Do not steam clean on the system, especially condenser since excessively high pressure will build up in the system, resulting in explosion of the system.**
- **If you improperly connect the hose or handling the valve, be sure to check the high pressure side or low pressure side.**
- **In case the refrigerant is charged while the compressor is operated, do open the high pressure valve of the gauge manifold.**
- **Beware of the toxicity of the gas. The gas is harmless and nontoxic in its original state, however it produces a toxic substance when it comes in contact with high temperature parts and decomposes.**
- **Do not heat the service can unless necessary. When it has to be heated, use warm water of 40°C (104°F) or lower. Do not heat using boiling water.**

IMPORTANT

- **If the refrigerant, O-rings, etc. for R12 are used in the R134a air conditioner system, problems such as refrigerant leakage or cloudiness in the sight glass may occur. Therefore, in order to prevent charging of refrigerant or erroneous connections, the shapes of the piping joint as well as the shapes of the service valve and the service tools have been changed.**
- **Always keep the working place clean and dry and free from dirt and dust. Wipe off water from the line fittings with a clean cloth before disconnecting.**
- **Use only for R134a refrigerant service tool.**
- **Use for R134a refrigerant recovery and recycling machine when discharging the refrigerant.**
- **Before attaching the charging hose to the can tap valve of the refrigerant container, check each packing for clogging.**
- **When disconnecting the charging hose from the charging valve of compressor and receiver, remove it as quick as possible so that gas leakage can be minimized.**
- **Be sure to charge the specified amount of refrigerant, but not excessively, Over-charging of the refrigerant in particular may cause insufficient cooling, etc..**
- **Since the charging hose can be connected to can tap valve by hand, do not use a pliers for tightening it.**
- **Keep refrigerant containers in a cool and dark place avoiding such place which are subject to strong sunlight or high temperature.**
- **R134a compressor oil absorbs moisture easily, so that be sure to seal after disconnecting the each parts.**
- **Do not use old-type refrigerant R12a or compressor oil for old-type refrigerant.**
- **When replacing the condenser, evaporator and receiver, etc., replenish the compressor oil to compressor according to the table below.**

Observance of laws and regulations

- **Refrigerant is the subject of global environmental protection issue.**
  Therefore, when handling the refrigerant cycle, we are subjected to abide the laws and regulations.

E.Precaution for Installation and Maintenance

Important service points for high quality and long life.

<table>
<tr><th>Item</th><th>Description</th><th>Possible problem in case of control failure</th></tr>
<tr><td>1. Storage place of A/C parts (all)</td><td>Store them in an indoor place not exposed to rain water.</td><td>Water or dust entry into circuit
↓
Circuit clogged</td></tr>
<tr><td>2. Plugs</td><td>●Do not remove them until connecting.
Limit the receiver's open time to shorter than 3 minutes (because of the desiccant inside).
●Be sure to put in the plugs if you have to leave the spot during connecting.</td><td>↑</td></tr>
<tr><td rowspan="3">3. Pipe connections</td><td>Tightening torque of pipe fixture nuts and bolts
<table>
<tr><th>Connection</th><th>Tube size or bolt size</th><th>Tightening torque N•m</th></tr>
<tr><td rowspan="3">Nut type</td><td>+B pipe (liquid pipe)</td><td>11.8~14.7</td></tr>
<tr><td>D1/2 pipe (discharger pipe)</td><td>19.6~24.5</td></tr>
<tr><td>D5/6 pipe (suction pipe)</td><td>29.4~34.3</td></tr>
<tr><td rowspan="2">Block joint</td><td>Receiver's M6 bolt (4T)</td><td>3.92~6.86</td></tr>
<tr><td>Other M6 bolts (6T)</td><td>7.65~11..8</td></tr>
</table></td><td>Gas leak</td></tr>
<tr><td>Pipe connections
Tighten up the pipe unions and nuts by applying two wrenches at once.</td><td>Cracks in brazed spot
↓
Gas leak</td></tr>
<tr><td>Oil application on O rings
Apply the ND-OIL8 new refrigerant compressor oil to the O rings. Be sure to use the ND-OIL8 oil, not any other such as ND-OIL6, 7, and Suniso.</td><td>Refrigerant cloudiness</td></tr>
<tr><td>4. Pipe clamps</td><td>Use clamps that match the diameters of hoses and tubes. Make sure the pipe connections withstand possible vibrations.</td><td>Pipe damage, hose wear-out
↓
Gas leak</td></tr>
<tr><td>5. Vacuum buildup</td><td>• Use the high-/low-pressure service valve.
• Continue for 10 minutes or longer at -101 kPa, (- 1.03 kgf/cm2), - 14.6 psi</td><td>Poor removal of water and air from circuit
↓
Poor cooling, circuit clogged</td></tr>
<tr><td>6. Drain hose connection</td><td>Connect the drain hose below the unit drain pan. Make sure there is no air trap.</td><td>Drain water leak</td></tr>
<tr><td rowspan="2">7. Refrigerant charging</td><td>(1) Gas charging (during cycle operation)
1) Feed through the high-pressure side without cycle operation. (Never feed through the low-pressure side, nor keep on the cycle operation.)
2) Then add through the low-pressure side during cycle operation.</td><td>Liquid compression
↓
Compressor failure</td></tr>
<tr><td>(2) Liquid charging (without cycle operation)
Be sure to feed through the high-pressure side (never through the low-pressure side).</td><td>↑</td></tr>
</table>

<table>
<tr><th>Item</th><th>Description</th><th>Possible problem in case of control failure</th></tr>
<tr><td>8. Refrigerant charge amount</td><td>Maintain the refrigerant amount of 800±50 g. (Refrigerant amount with no more bubble sight glass + 150 g)
Determine with the following factors in mind.
(Engine rpm, idling, temperature regulator, cooling power, blower, Lo - Hi)</td><td><Too much refrigerant>
Pressure switch activated, resulting in poor cooling
↓
<Too short refrigerant>
Poor cooling, compressor failure</td></tr>
<tr><td>9. Oil control</td><td>(1)Immediately wipe oil off the metallic parts, as required.
(2)Do not use if the acrylic and ABS resin parts (amorphous thermoplastic resin) get stained with oil.</td><td>Preventing the other parts from rust and degrading due to the ND-OIL8.</td></tr>
<tr><td>10. Tightening torque of A/C unit mounting bolts and nuts</td><td>M8 parts: 9.8-15.68 N-m</td><td>Loose mounting nut, damaged mounting bolt</td></tr>
<tr><td>11. A/C running-in</td><td>Keep the A/C running in for 10 minutes or longer (under the following conditions).<table><tr><th>Engine run</th><th>Idling</th></tr><tr><td>Key switch</td><td>ON</td></tr><tr><td>Blower switch</td><td>ON, High position</td></tr><tr><td>A/C switch</td><td>ON</td></tr></table>Preferably run at temperatures higher than 20°C.</td><td>Short compressor service life</td></tr>
<tr><td>12. A/C run after long-term shutdown</td><td>When the vehicle has not been used for a long time (1 week or longer) and the A/C gets restarted, be sure to idle-run the engine and turn on the A/C switch to protect the compressor.</td><td>↑</td></tr>
</table>

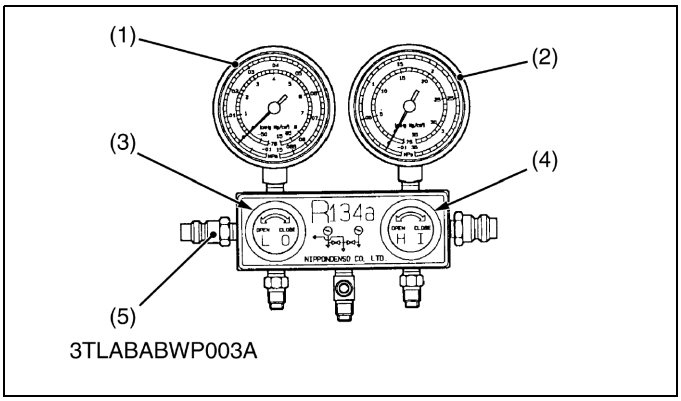
F. Checking and Charging Refrigerant Cycle

a. Handling Of Service Tools

(1) Manifold Gauge Set

The hand valves on the manifold gauge set are used to open and close the valve. The hand valve inscribed **LO** is for the low pressure side valve (3) and **HI** is for the high pressure side valve (4). By opening or closing the high and low pressure hand valves, the following circuits are established.

(1)LO Pressure Gauge
(2)HI Pressure Gauge
(3)LO Pressure Side Valve
(4)HI Pressure Side Valve
(5)Schrader Valve



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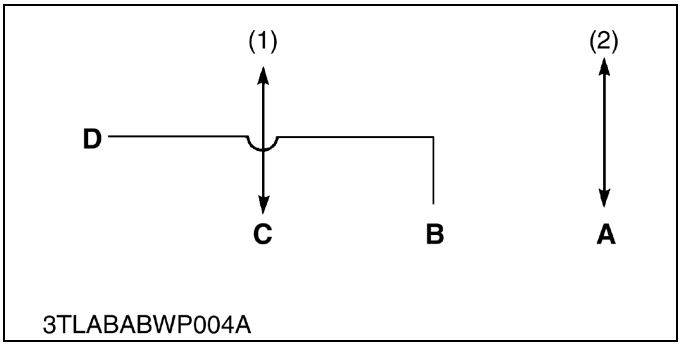
When LO Pressure Side Valve and HI Pressure Side Valve are Closed
Two circuits are established.
Port (**C**) → **LO** pressure gauge (1)
Port (**A**) → **HI** pressure gauge (2)

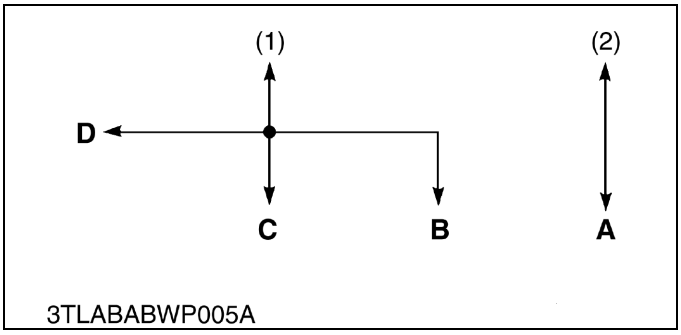
Note : Schrader valve (D) must be opened.



3TLABABWP004A

When LO Valve is Opened and HI Valve is Closed
Two circuits are established.
Port (**C**) → **LO** pressure gauge (1)
→ Port (**B**)
→ Port (**D**)
Port (**A**) → HI pressure gauge (2)

Note : Schrader valve (D) must be opened.



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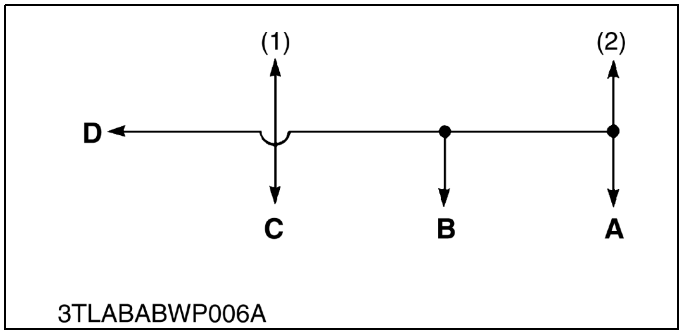
When LO Valve is Closed and HI Valve is Opened
Two circuits are established.
Port (**C**) → **HI** pressure gauge (2)
→ Port (**B**)
→ Port (**D**) (Schrader valve must be opened)
Port (**A**) → **LO** pressure gauge (1)

Note : Schrader valve (D) must be opened.



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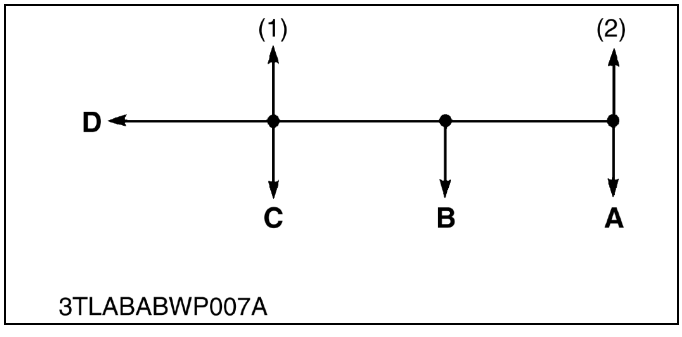
When LO and HI Valve are Opened
Circuits are established.
Port (**A**) → **HI** pressure gauge (2)
→ **LO** pressure gauge (1)
→ Port (**B**)
→ Port (**C**)
→ Port (**D**) (Schrader valve must be opened)

Note : Schrader valve (D) must be opened.



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(2) Refrigerant Charging Hose

The charging hoses are classified into three colors. Each charging hose must be handled as follows :

- The air conditioner manufacture recommends that the blue hose (3) is used for the **LO** pressure side (suction side), the green hose (5) for refrigeration side (center connecting port) and the red hose (4) for **HI** pressure side (discharged side).

(When connecting)

- Push the quick disconnect adaptor (6) into the charging valve, and push on part **A** until a click is heard.

Note :

- **When connecting, push carefully so the pipe doesn't bend.**
- **When connecting the quick disconnect connector, should the sleeve (7) move before the quick link connector can be connected to the charging valve, move the quick sleeve to its original position and try again.**
- **When some refrigerant remains in the charging hose at the time of connections, it may be difficult to connect the quick link connector. In this case, perform the operation after removing any residual pressure in the hose. (Remove the residual pressure by pushing the pusher (8).)**

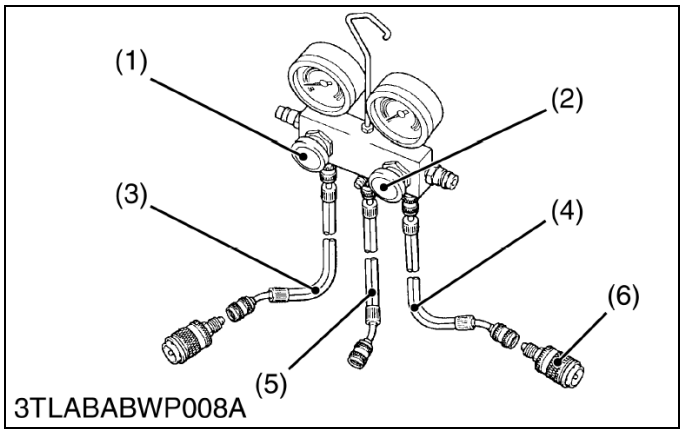
(When reassembling)

- While holding on to part **A** of the quick disconnect adaptor, slide part **B** up.

Note : After removing the adaptor, ensure to cap the quick disconnect adaptor service valve.

(1)LO Pressure Side Valve
(2)HI Pressure Side Valve
(3)Blue Hose
(4)Red Hose
(5)Green Hose
(6)Quick Disconnect Adaptor
(7)Sleeve
(8)Pusher
(9)Sleeve

a : CLICK



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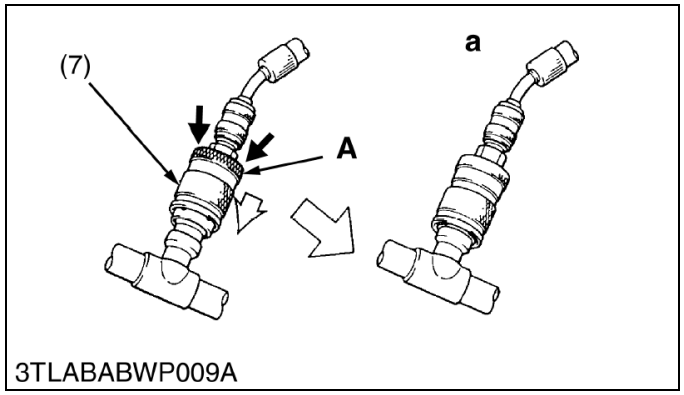

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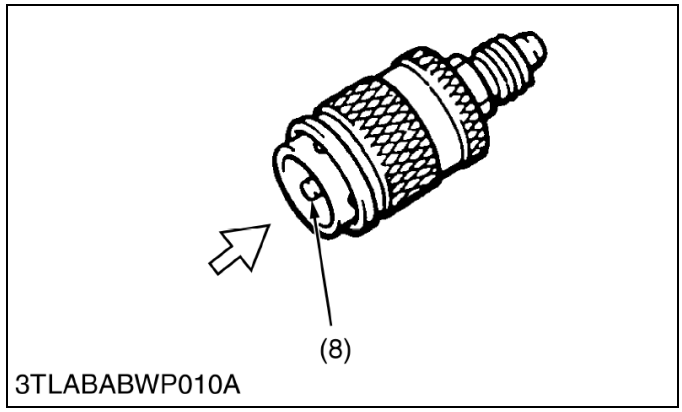

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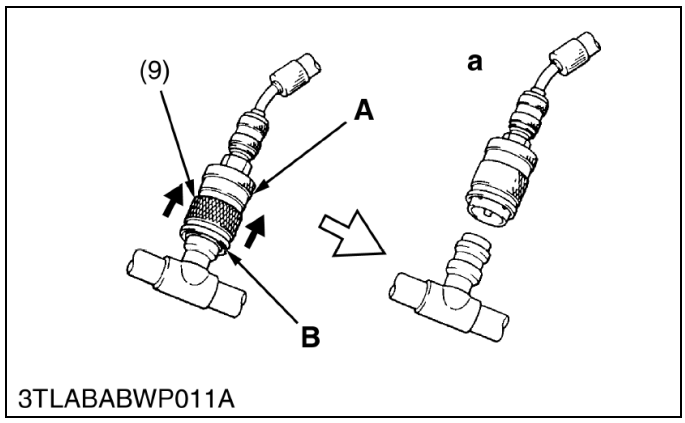

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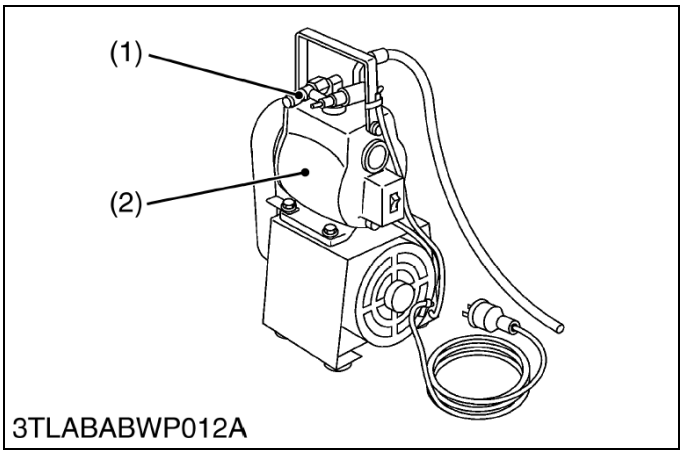
(3) Vacuum Pump Adaptor

Objective of the Vacuum Pump Adaptor

1) After vacuum has been created in the air conditioning cycle, when the vacuum pump is stopped, since there is vacuum in hoses within the gauge manifold, the vacuum pump oil flows back into the charging hose. If the refrigerant is refilled with the system still in this state, the vacuum pump oil left in the charging hose enters the air conditioner cycle together with the refrigerant. Vacuum pump adaptor with a solenoid valve is used to prevent this back-flow of oil from the vacuum pump. The role of the solenoid valve is that when the current passes through the solenoid valve, the valve closes to keep out the outside air and allow the vacuum to build up, but when the current stops, the valve opens to allow in air and end the vacuum.
2) Attaching this adaptor to the R12 vacuum pump currently being used allows the pump to be used with both R134a and R12.

(1) Vacuum Pump Adaptor
(2) Vacuum Pump
(3) Magnetic Valve
(4) Blind Cap
(5) Air
(6) For R134a
(7) For R12



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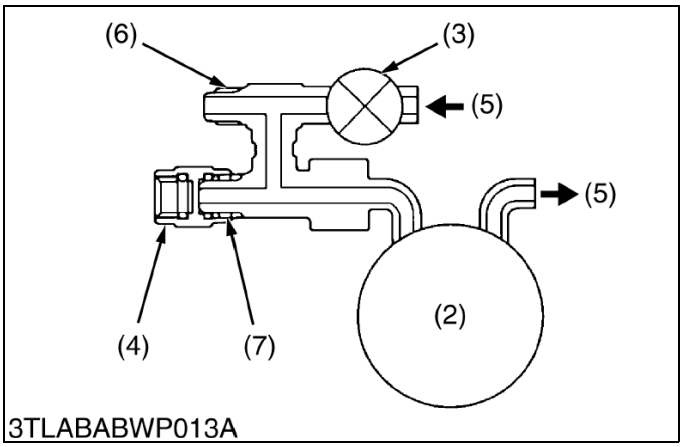


3TLABABWP013A

(4) Electric Gas Leak Tester

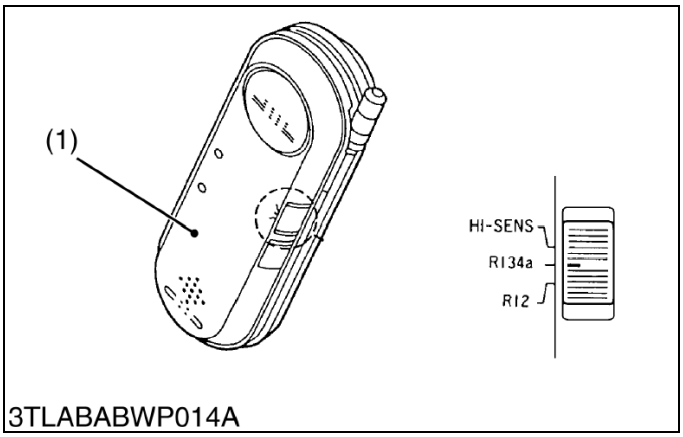
The current R12 gas leak tester has poor sensitivity for R134a and cannot be used. Therefore, a new electric gas leak tester with greater sensitivity has been designed and can be used with both R134a and R12.

Reference

Leak tester with halide torch

- Since the reaction with chlorine within the refrigerant is used to detect gas leaks, R134a, which contains no chlorine, cannot be detected.

(1) Electric Gas Leak Tester



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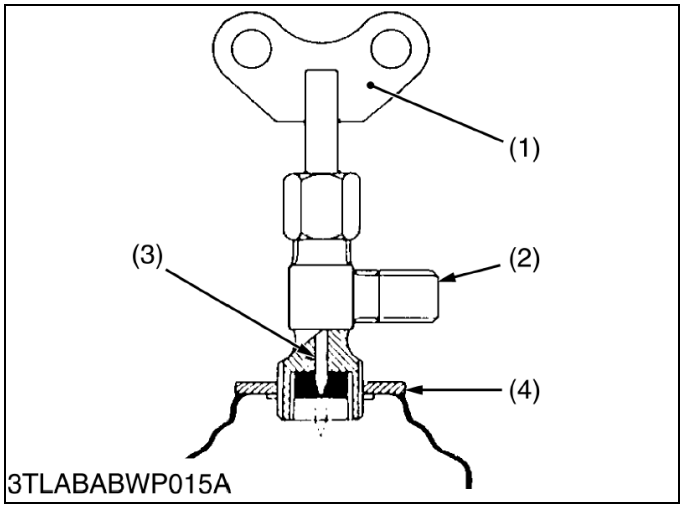
(5) Can Tap Valve

The can tap valve that is used to charge the refrigerant into the air conditioning system, should be used as follows :

1) Before putting the can tap valve on the refrigerant container, turn the handle (1) counterclockwise till the valve needle is fully retracted.
2) Turn the plate nut (disc) (4) counterclockwise till it reaches its highest position, then screw down the can tap valve into the sealed tap.



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3) Turn the place nut clockwise fully, and fix the center charging hose to the valve.
4) Tighten the place nut firmly by hand.
5) Turn the handle (1) clockwise, thus making a hole in the sealed tap.
6) To charge the refrigerant into the system, turn the handle (1) counterclockwise. To stop charging, turn it clockwise.

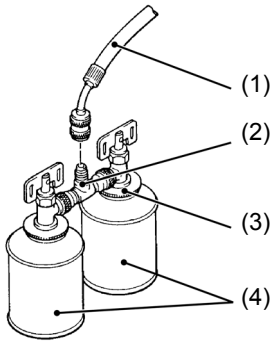
(1) Butterfly Handle
(2) Connection
(3) Needle
(4) Disc

(6) T-joint

T-joint (2) is used to increase efficiency of gas charging using two refrigerant containers (4) at a time.

1) Install two refrigerant container service valves to T-joint (2) sides and connect the charging hose (1) to it.

(1) Charging Hose (Green)
(2) T-joint
(3) Can Tap Valve
(4) Refrigerant Container



(7) R134a Refrigerant Recovery and Recycling Machine

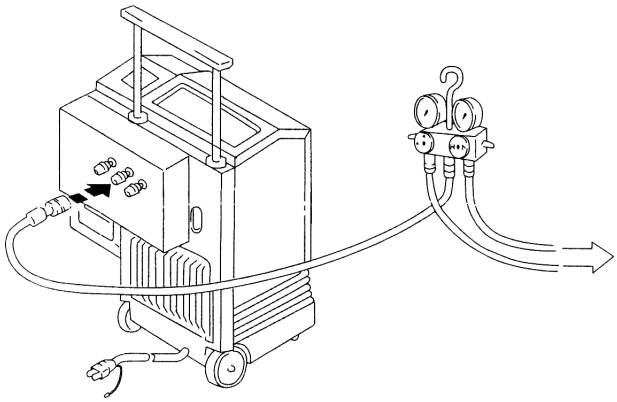
When there is necessity of discharging the refrigerant on repairing the air conditioning system, it should use recovery and recycling machine. (Don't release the refrigerant into the atmosphere.)

IMPORTANT

- **Use only R134a refrigerant recovery and recycling machine, eliminate mixing R134a equipment, refrigerant and refrigerant oils with R12 systems to prevent compressor damage.**

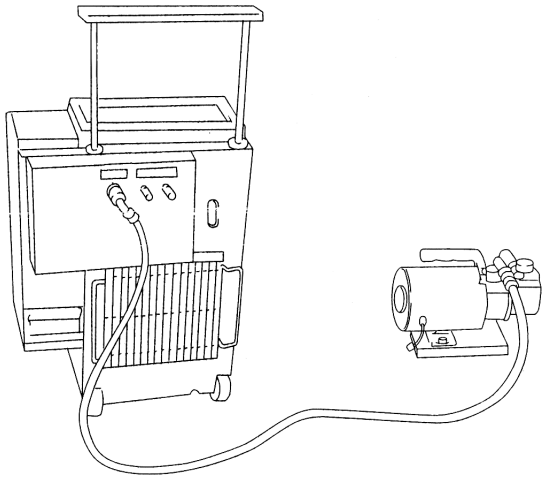
When recovering the refrigerant

(1) Refrigerant recovery port
(2) Charging hose (center)
(3) For HFC134a
(4) Vehicle



When vacuuming the system

(5) Vacuum buildup port
(6) Vacuum pump
(7) Charging hose



Machine unit

Type : ESR-20ACR
Rated : AC 100V 50/60Hz 400/460W
Tank type : HFC134a - ESR-20T
Size : 450 (W) I399(D) I672(H) mm
Weight : 43 kgf
Maker : DENSO

(8) Special tools

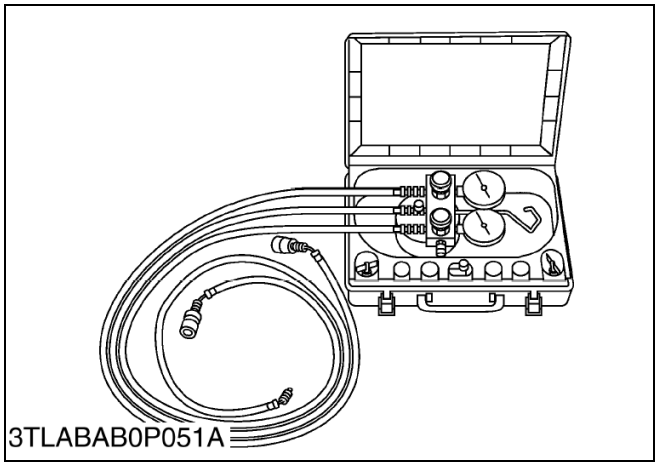
Special tools for R134a refrigerant air conditioning system introduced below are available from NIPPONDENSO CO. LTD.

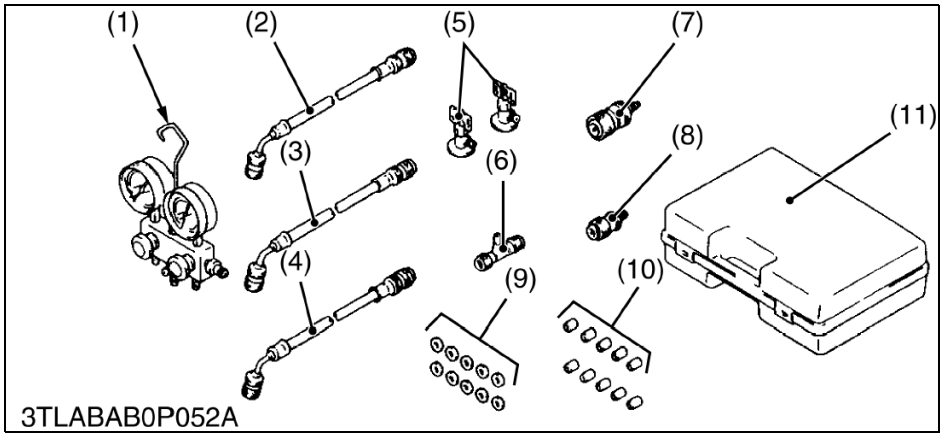
Air Conditioner Service Tool

Code No: NIPPONDENSO 95048-00061

Application: Use for charging, testing or discharging the air conditioning system.

(1) Manifold Gauge Assembly	95048-10090
(2) Charging Hose(Red : HI)	95948-10270
(3) Charging Hose (Blue : LO)	95948-10280
(4) Charging Hose (Green)	95048-10260
(5) Can Tap Valve	95048-10150
(6) T Joint	95048-10160
(7) Quick Coupler (HI)	95048-10130
(8) Quick Coupler (LO)	95906-10140
(9) Service Valve Packing	95906-10310
(10)Charging Hose Packing	95949-10300
(11)Tool Case	95949-10610

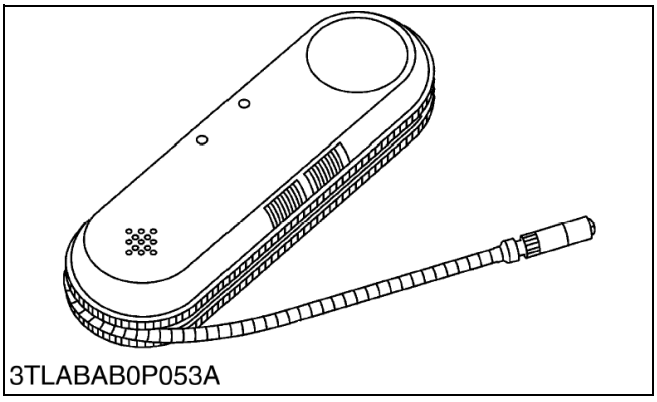




Electric Gas Leak Tester

Code No: NIPPONDENSO 95146-00060

Application: Use for gas leak testing the air conditioning system.

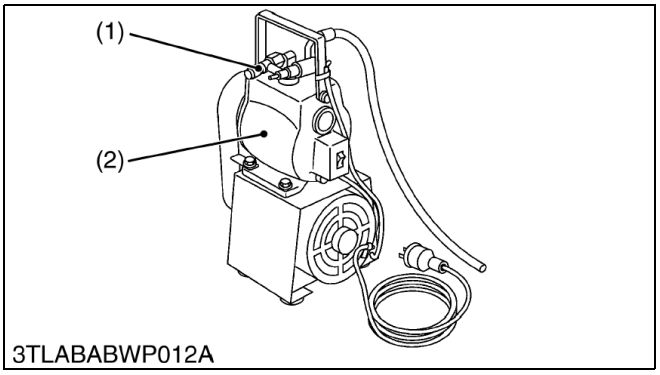


Vacuum Pump

Code No: NIPPONDENSO 95046-00040 (AC220V)
95046-00050 (AC240V)

Application: Use for gas leak testing the air conditioning system.

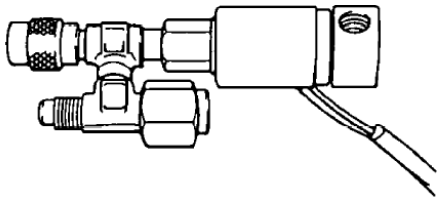
(1) Adaptor (For 134a) (2) Vacuum Pump



Adaptor (For R134a)

Code No: NIPPONDENSO 95048-10190 (AC220V)
95048-10200 (AC240V)

Application: Use for evacuating the air conditioning system.



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b. Checking with Manifold Gauge

IMPORTANT

The gauge indications described in the following testing are those taken under the same condition, so it should be noted that the gauge readings will differs somewhat with the ambient conditions.

Condition

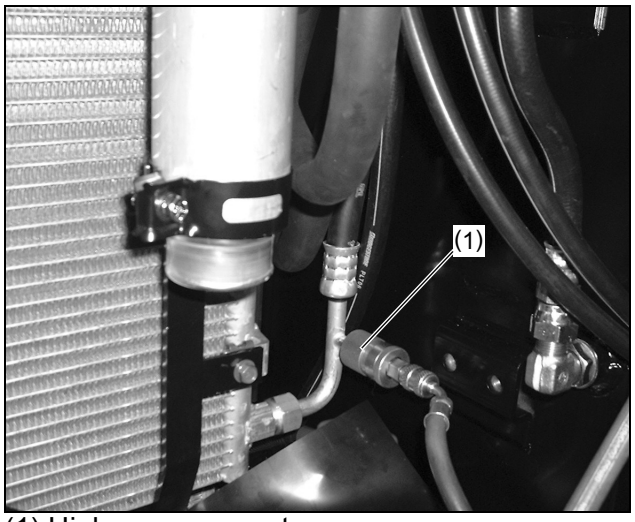
- Ambient temperature : **30 to 35 °C (86 to 95 °F)**
- Engine speed : Approx. **1500 min^{-1}(rpm)**
- Temperature control lever : **Maximum cooling position**
- Air-Conditioner switch : **ON**
- Blower switch : **HI** position

Manifold Gauge Connecting and Test Preparation

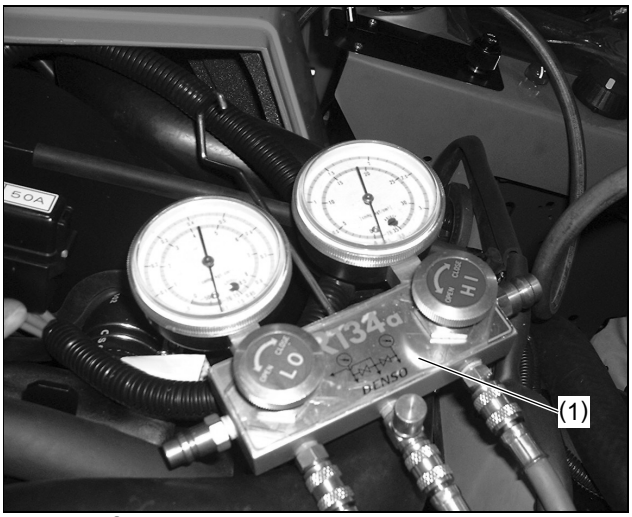
1) Close the manifold gauge **HI** and **LO** pressure side valve (7), (6) tightly.
2) Connect the charging hose (1) (red) to the **HI** pressure side charging valve (2) and connect the charging hose (4) (blue) to the **LO** pressure side charging valve (3).

Note : Be sure to drive out the air in the charging hoses at the manifold gauge connection end by utilizing the refrigerant pressure in the refrigerating cycle.

3) Start the engine and set at approx. 1500 min-1(rpm).
4) Turn on the A/C switch and set the temperature control lever to **maximum cooling** position.
5) Set the blower switch to **HI** position.



(1) High pressure port



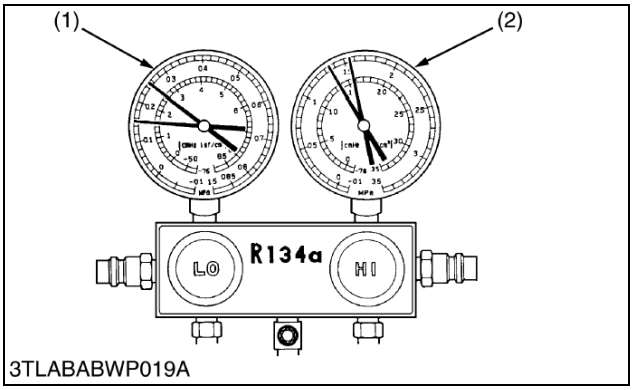
(1) Manifold gauge

(1) Low pressure port

Normal Operating

If the refrigerating cycle is operating normally, the reading at the **LO** pressure side (1) should be generally by around 0.15 to 0.2 MPa (1.5 to 2.0 kgf/cm^2, 21 to 28 psi) and that at the **HI** pressure side (2) around 1.27 to 1.66 MPa (13 to 17 kgf/cm^2, 185 to 242 psi).

Gas pressure	Factory spec.	Low pressure side	0.15 to 0.20 MPa 1.5 to 2.0 kgf/cm^2 21 to 28 psi
		High pressure side	1.27 to 1.66 MPa 13 to 17 kgf/cm^2 185 to 242 psi



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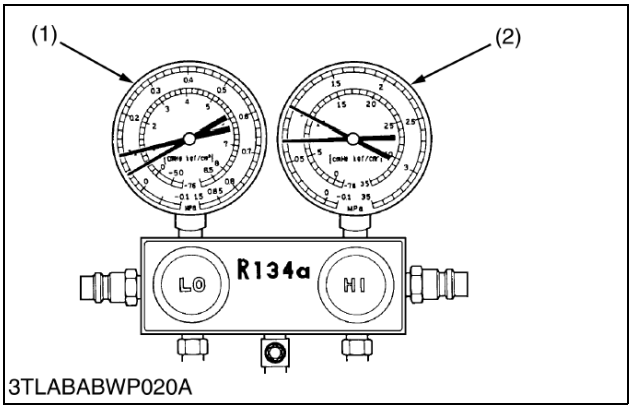
(1) **LO** Pressure Side (2) **HI** Pressure Side

Insufficient Refrigerant

1) Symptoms seen in refrigerating cycle
   Both **LO** and **HI** pressure side (1), (2) pressures too low.
   LO pressure side (1) : 0.05 to 0.1 MPa
   (0.5 to 1.0 kgf/cm^2, 7.1 to 14.2 psi)
   HI pressure side (2) : 0.69 to 0.98 MPa
   (7 to 10 kgf/cm^2, 99.6 to 142.2 psi)
   Bubbles seen in sight glass.
   Air discharged from air conditioner slightly cold.
2) Probable cause
   Gas leaking from some place in refrigerant cycle.
3) Solution
   Check for leakage with electric gas leak tester and repair.
   Recharge refrigerant to the proper level.



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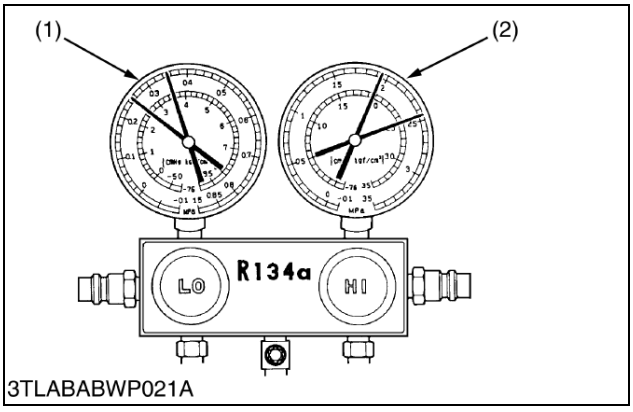
(1) **LO** Pressure Side (2) **HI** Pressure Side

Excessive Refrigerant or Insufficient Condenser Cooling

1) Symptoms seen in refrigerating cycle
   Both **LO** and **HI** pressure side (1), (2) pressures too high.
   LO pressure side (1) : 0.2 to 0.35 MPa
   (2.0 to 3.5 kgf/cm^2, 28 to 49.8 psi)
   HI pressure side (2) : 1.96 to 2.45 MPa
   (20 to 25 kgf/cm^2, 284.5 to 355.6 psi)
2) Probable cause
   Overcharging refrigerant into cycle.
   Condenser cooling faulty.
3) Solution
   Clean condenser.
   Adjust air conditioner belt to proper tension.
   If the above two items are in normal condition, check refrigerant quantity.

Note : If excessive refrigerant is to be discharged, loosen manifold gauge LO pressure side valve and vent out slowly.



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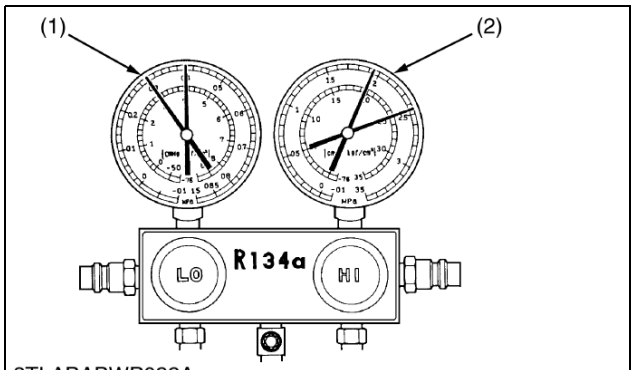
(1) **LO** Pressure Side (2) **HI** Pressure Side

Air Entered in the Cycle

1) Symptoms seen in refrigerating cycle
   Both **LO** and **HI** pressure side (1), (2) pressures too high.
   LO pressure side (1) : 0.2 to 0.35 MPa
   (2.0 to 3.5 kgf/cm^2, 28 to 49.8 psi)
   HI pressure side (2) : 1.96 to 2.45 MPa
   (20 to 25 kgf/cm^2, 284.5 to 355.6 psi)
   LO pressure side (1) piping not cold when touched.
2) Probable cause
   Air entered in refrigerating cycle.
3) Solution
   Replace receiver.
   Check compressor oil contamination and quantity.
   Evacuate and recharge new refrigerant.

Note : The above cycle can be seen when the cycle is charged without evacuation.



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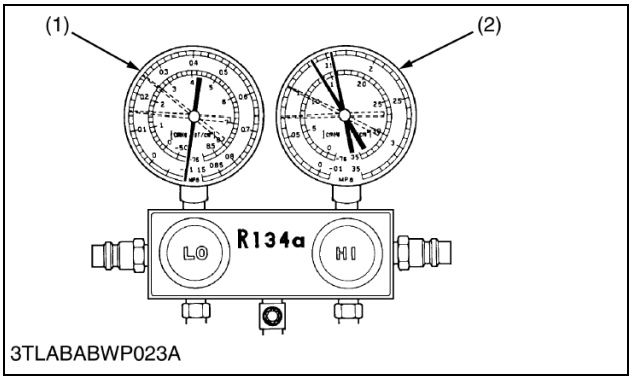
(1) **LO** Pressure Side (2) **HI** Pressure Side

Moisture Entered in the Cycle

1) Symptoms seen in refrigerating cycle
   The air conditioner operates normally at the beginning, but over time, **LO** pressure side (1) pressure is vacuum and **HI** pressure side (2) is low pressure.
   LO pressure side (1) : Vacuum
   HI pressure side (2) : 0.69 to 0.98 MPa
   (7 to 10 kgf/cm^2, 99.6 to 142.2 psi)
2) Probable cause
   The moisture in the refrigerating cycle freezes in the expansion valve orifice and causes temporary blocking. After a time, the ice melts and condition returns to normal.
3) Solution
   Replace receiver.
   Remove moisture in cycle by means of repeated evacuation.
   Recharge new refrigerant to the proper level.



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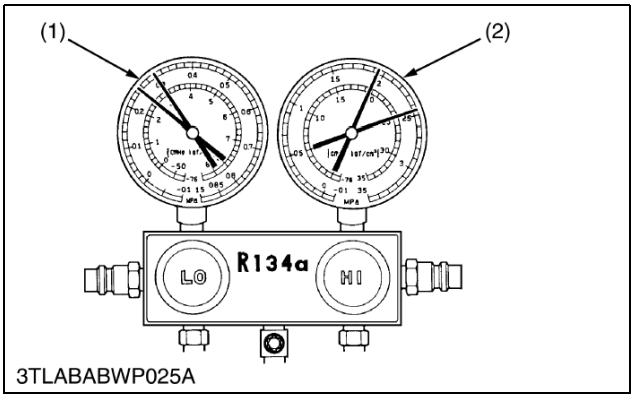
(1) **LO** Pressure Side (2) **HI** Pressure Side

Refrigerant Fails to Circulate

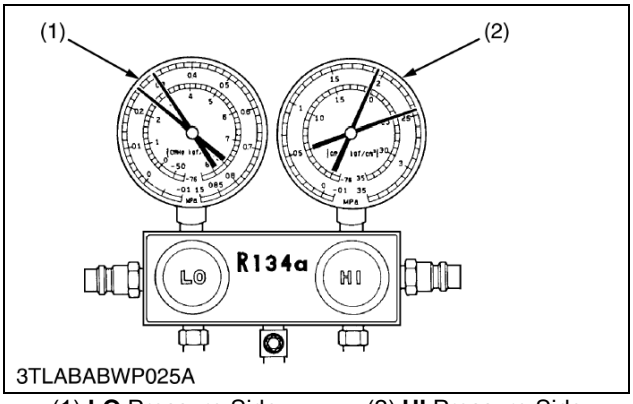
1) Symptoms seen in refrigerating cycle
   LO pressure side (1) pressure is vacuum and, **HI** pressure side (2) is low pressure.
   LO pressure side (1) : Vacuum
   HI pressure side (2) : 0.49 to 0.59 MPa
   (5 to 6 kgf/cm^2, 71.2 to 85.3 psi)
   Frost or dew formed on piping at front and rear sides of expansion valve or receiver.
2) Probable cause
   Refrigerant flow obstructed by moisture or dirt in the refrigerating cycle freezing or sticking on the expansion valve orifice.
3) Solution
   Allow to stand for same time and then resume operation to decide whether the plugging is due to moisture or dirt.
   If caused by moisture, correct by referring to instructions in previous.
   If caused by dirt, remove the expansion valve and blow out the dirt with compressed air.
   If unable to remove the dirt, replace the expansion valve. Replace the receiver. Evacuate and charge in proper amount of new refrigerant.
   If caused by gas leakage in heat sensitizing tube, replace the expansion valve.



(1) **LO** Pressure Side (2) **HI** Pressure Side

Expansion Valve Opens Too Far or Improper Installation of Heat Sensitizing Tube

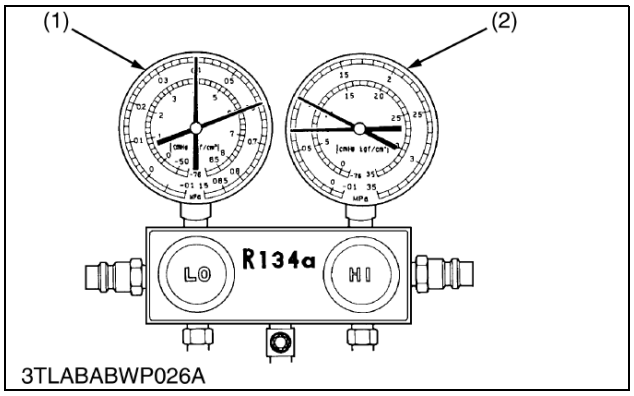
1) Symptoms seen in refrigerating cycle
   Both **LO** and **HI** pressure side (1), (2) pressures too high.
   LO pressure side (1) : 0.29 to 0.39 MPa
   (3.0 to 4.0 kgf/cm^2, 42.71 to 56.9 psi)
   HI pressure side (2) : 1.96 to 2.45 MPa
   (20 to 25 kgf/cm^2, 284.5 to 355.6 psi)
2) Probable cause
   Expansion valve trouble or heat sensitizing tube improperly installed.
   Flow adjustment not properly done.
3) Solution
   Check installed condition of heat sensitizing tube.
   If installation of heat sensitizing tube is correct, replace the expansion valve.



(1) **LO** Pressure Side (2) **HI** Pressure Side

Faulty Compression of Compressor

1) Symptoms seen in refrigerating cycle
   Both **LO** and **HI** pressure side (1), (2) pressures too high.
   LO pressure side (1) : pressure too high :
   0.39 to 0.59 MPa (4 to 6 kgf/cm^2, 56.9 to 85.3 psi)
   HI pressure side (2) : pressure too low :
   0.69 to 0.98 MPa (7 to 10 kgf/cm^2, 99.6 to 142.2 psi)
2) Probable cause
   Leak in compressor.
3) Solution
   Replace compressor. (See page 10-S39.)



(1) **LO** Pressure Side (2) **HI** Pressure Side

Note : Manifold gauge indications (left side figure) at faulty compressing by compressor.

c. Discharging, Evacuating and Charging

IMPORTANT

When discharging, evacuating or charging the refrigerating system, be sure to observe the "Precaution at Repairing Refrigerant Cycle".

(1) Discharging the System

Prepare for the R134a refrigerant recovery and recycling machine.

1) Connect low pressure side hose (blue) from the recovery and recycling machine to **LO** pressure side charging valve (3) on the compressor (1). Connect high pressure side hose (red) to **HI** pressure side charging valve (2) on the compressor (1).
2) Follow the manufacturers instructions and discharge the system.

IMPORTANT

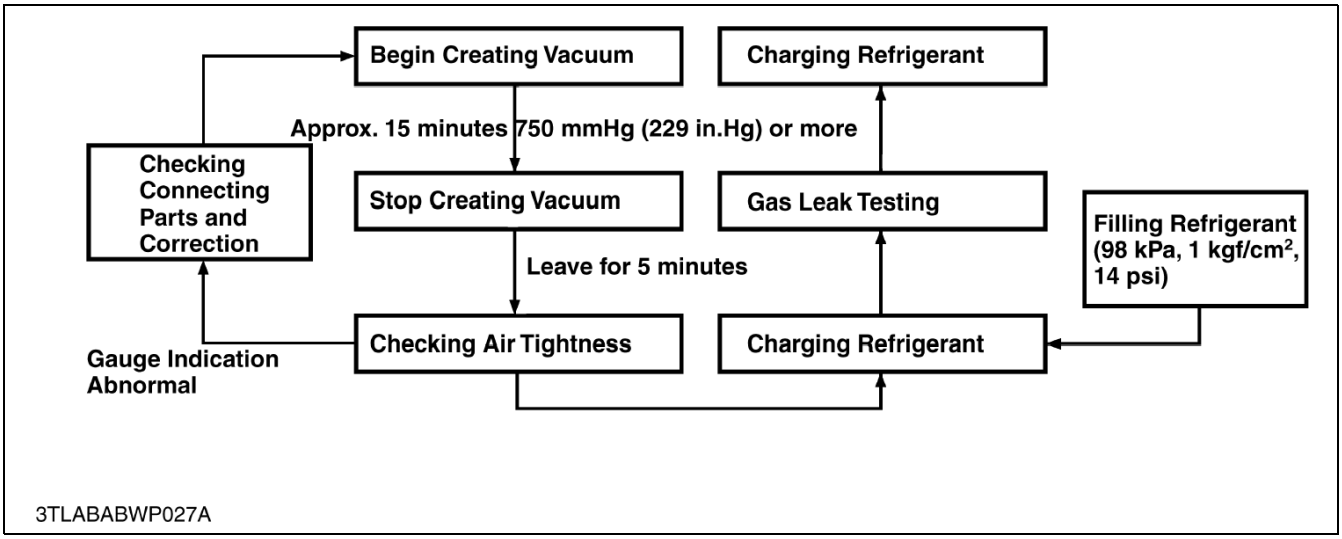
Use only R134a refrigerant recovery and recycling machine. Eliminate mixing R134a equipment, refrigerant, and refrigerant oils with R12 systems to prevent compressor damage.

CAUTION

Protect fingers with cloth against frostbite by refrigerant when disconnecting the hose to the charging valve.

Vaccum and charging unit in the Hirakata Factory Assembly Line.

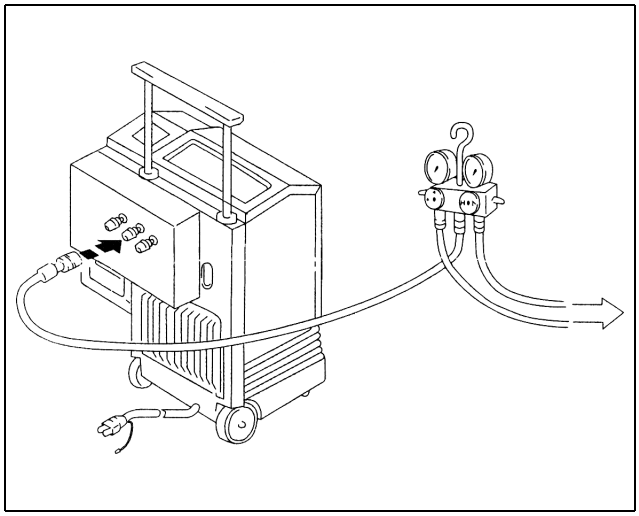
(2) Evacuating the System

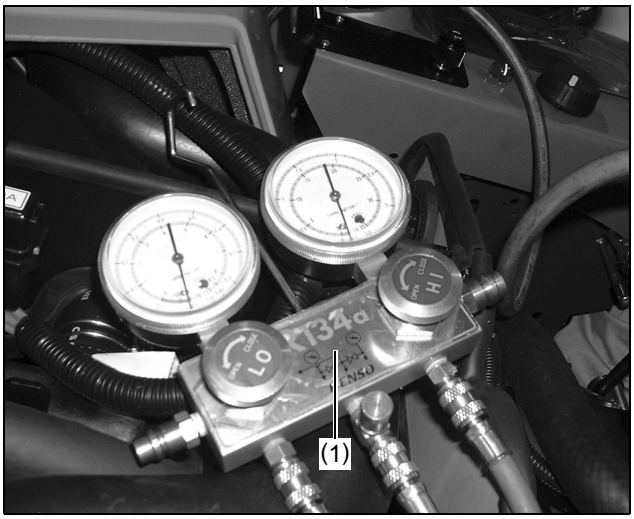


Evacuating the System

1) Discharge refrigerant from the system by R134a refrigerant recovery and recycling machine. (Refer to **"Discharging the system"**.)
2) Connect the charging hose (7) (red) to the **HI** pressure side charging valve and connect the charging hose (9) (blue) to the **LO** pressure side charging valve.
3) Connect the center charging hose (8) (green) to a vacuum pump inlet.
4) Open both valves (6), (10) of manifold gauge fully. Then run the vacuum pump (1) to evacuate the refrigerant cycle. (For approx.**15 minutes**.)
5) When **LO** pressure gauge (10) reading is more than **750 mmHg (299 in.Hg)**, stop the vacuum pump (8) and close both valves (6), (10) of manifold gauge fully.
6) Wait for over 5 minutes with the **HI** and **LO** pressure side valves (6), (10) of gauge manifold closed, and then check that gauge indicator does not return to 0.
7) If the gauge indicator is going to approach to 0, check whether there is a leaking point and repair if it is, and then evacuate it again.

(1) Vacuum Pump (Running)
(2) Vacuum Pump Adaptor
(3) LO Pressure Gauge
(4) HI Pressure Gauge
(5) Compressor
(6) HI Pressure Side Valve (Open)
(7) Red Hose
(8) Green Hose
(9) Blue Hose
(10) LO Pressure Side Valve (Close)





(1) Manifold gauge

(3) Charging the System

Charging an Empty System (Liquid)

This procedure is for charging an empty system through the HI pressure side with the refrigerant in the liquid state.

CAUTION

- **Never run the engine when charging the system through the HI pressure side.**
- **Do not open the LO pressure valve when refrigerant R134a is being charged in the liquid state (refrigerant container is placed upside-down).**

IMPORTANT

After charging the refrigerant in the liquid state with approx. 850±50 g (1.1 lbs) through the HI pressure side, be sure to recharge the refrigerant in the vapor state to specified amount through the LO pressure side.

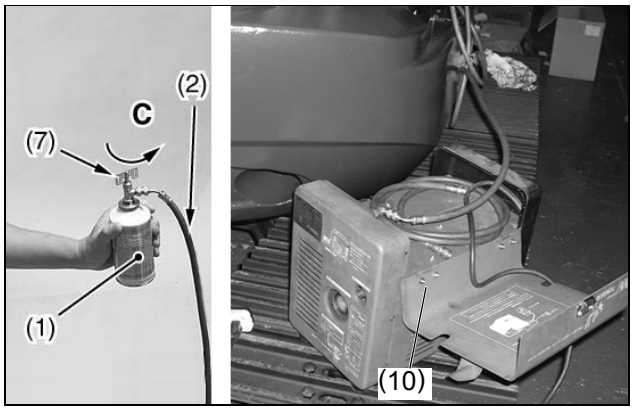
1) Close the HI and LO pressure side valves (5), (6) of manifold gauge after the system is evacuated completely.
2) Connect the center charging hose (2) to the can tap valve (7) fitting, and then loosen the center charging hose at the center fitting of manifold gauge until hiss can be heard.
   Allow the air to escape for few seconds and tighten the nut.
3) Open the HI pressure side valve (5) fully, and keep the container upside-down to charge the refrigerant in the liquid state from the HI pressure side.
4) Charge the refrigerant in the liquid state with approx. 850±50 g (1.1 lbs) from the HI pressure side.

Note : If LO pressure gauge does not show a reading, the system is clogged and must be repaired.

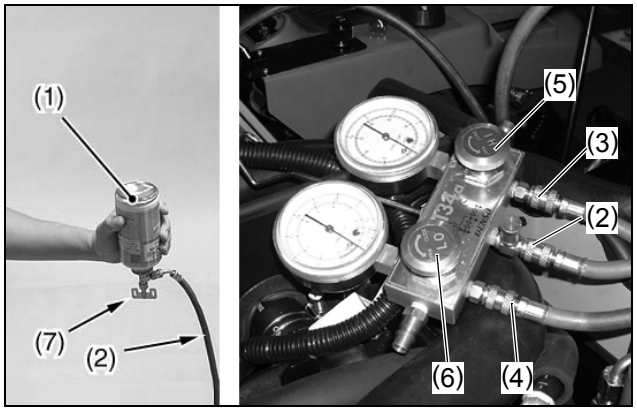
5) Close the HI pressure side valve (5) of manifold gauge and can tap valve of refrigerant container.

(1) Refrigerant Container (R134a)
(2) Green Hose
(3) Red Hose
(4) Blue Hose
(5) HI Pressure Side Valve (Open)
(6) LO Pressure Side Valve (Close)
(7) Can Tap Valve (Open)
(8) Compressor

A : Air Purge
B : Loosen the Nut
C : Open the Can Tap Valve

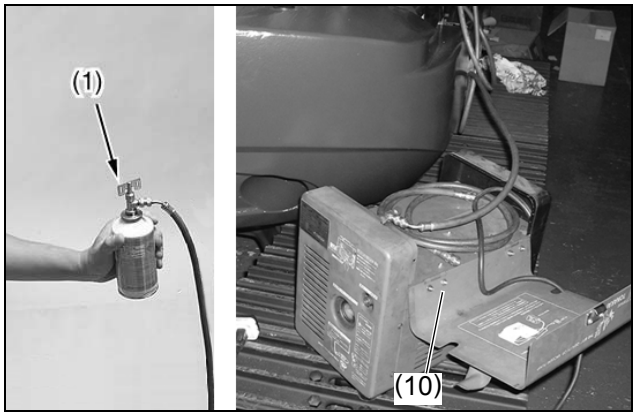


(10) Gas charger



Charging an Empty or Partially Charged System (Vapor)

This procedure is to charge the system through the **LO** pressure side with refrigerant in the vapor state. When the refrigerant container is placed right side up, refrigerant will enter the system as a vapor.



(10) Gas charger

CAUTION

Never open the HI pressure valve of manifold gauge while the engine is running.

Note :

- **Do not turn the refrigerant container upside-down when charging the system by running the engine.**
- **Put refrigerant container into a pan of warm water (maximum temperature 40 °C (104°F)) to keep the vapor pressure in the container slightly higher than vapor pressure in the system.**

1) Check that the HI pressure valve (5) is closed.
2) Start the engine and set an approx. **1500 min^{-1}(rpm)**.
3) Turn on the A/C switch.
   Set the temperature control lever to maximum cooling position and the blower switch to **HI** position.
4) Open the **LO** pressure valve (6) of manifold gauge and the can tap valve (1) on refrigerant container and charge the refrigerant until air bubbles in the sight glass of the receiver vanish.
5) After charging the specified amount of refrigerant into the system, close the **LO** pressure valve (6) of manifold gauge and can tap valve (1), then stop the engine.
6) Check for gas leak with an electric gas leak tester.

Reference

- Specified amount of refrigerant (total) :
  800 ±50g (1.76 to 1.98 lbs) [Refrigerant R134a]
- Manifold gauge indication at fully charged system (at ambient temperature : 30°C (86°F)) HI pressure side : 1.27 to 1.66 MPa
  13 to 17 kgf/cm^2
  185 to 242 psi
  LO pressure side : 0.15 to 0.20 MPa
  1.5 to 2.0 kgf/cm^2
  21 to 28 psi

(1) Can Tap Valve
(2) LO Pressure Gauge
(3) HI Pressure Gauge
(4) Compressor (Running)
(5) HI Pressure Valve (Close)
(6) LO Pressure Valve (Open)

(4) Checking Charge Refrigerant Amount

After charging the refrigerant, check for amount of charging refrigerant as follows.

Note : The pressure on the following checking are the gauge indications at ambient temperature 30°C (86°F), so it should be noted that the pressure will differ some what with the ambient temperature.

1) Disconnect the **2P** connector (4) of magnetic clutch.
2) Start the engine and set a approx. **1500 min^{-1}(rpm)**.
3) Connect the **2P** connector (4) of magnetic clutch to battery directly, and then set the blower switch to **HI** position.
4) Leave the system for approx. **5 minutes** until the refrigerant cycle becomes stable, keeping pressure on the **HI** pressure side from 1.27 to 1.66 MPa (13 to 17 kgf/cm^2, 185 to 242 psi).
5) When the refrigerant cycle is stabilizer, turn off the blower switch and let the compressor alone to run. Then pressure on the **LO** pressure side gradually drops. At this time, if pressure on the HI pressure side is maintained from 1.27 to 1.66 MPa (13 to 17 kgf/ cm^2, 185 to 242 psi), air bubbles which pass through the sight glass becomes as stated below depending on refrigerant charged amount.

A : Insufficient refrigerant charge

Air bubbles pass continuously the sight glass when pressure on the **LO** pressure side is over 99.0 kPa (1.01 kgf/cm^2, 14.4 psi). In this case, charge the refrigerant from the **LO** pressure side.

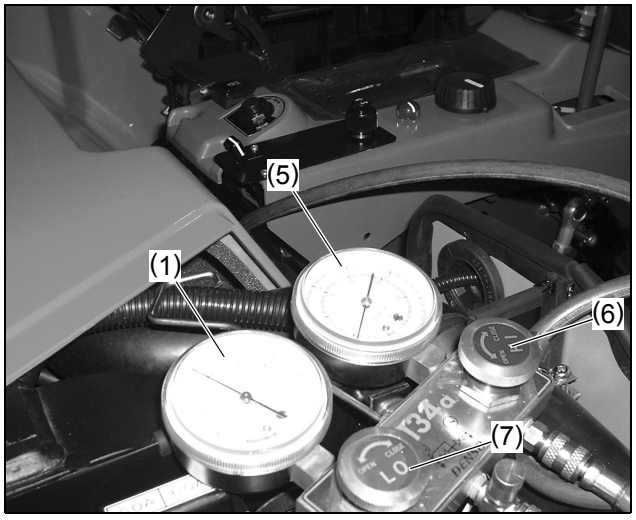
B : Properly refrigerant charge

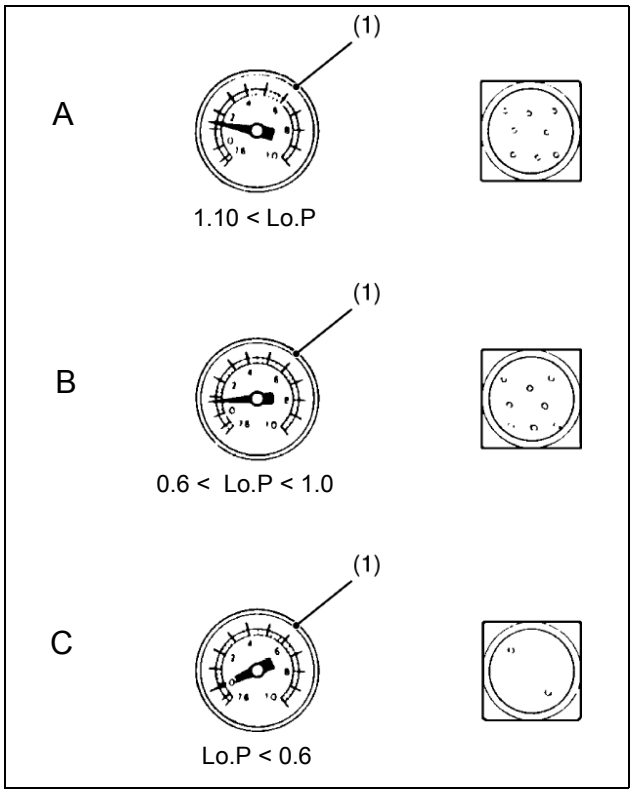
Air bubbles pass through the sight glass continuously when pressure on the **LO** pressure side is within 59 to 98 kPa (0.6 to 1.0 kgf/cm^2, 9 to 14 psi).
If the charge refrigerant amount is proper, no air bubble is observed on the sight glass at pressure on the **LO** pressure side over 99.0 kPa (1.01 kgf/cm^2, 14.4 psi) when the blower switch is turned on. When the blower switch is turned off, bubbles pass through the sight glass in case pressure on the **LO** pressure side is within 59 to 98 kPa (0.6 to 1.0 kgf/ cm2, 9 to 14 psi).

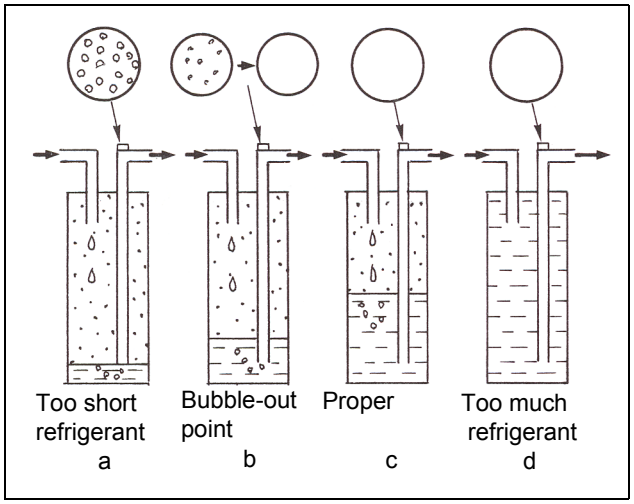
C : Excessive refrigerant charge

Air bubbles pass through the sight glass time to time or no air bubble is observed when pressure on the **LO** pressure side is under 59 kPa (0.6 kgf/cm^2, 9 psi).
In this case, discharge excessive refrigerant gradually from the **LO** pressure side.

(1) **LO** Pressure Gauge
(2) To Battery
(3) Compressor (Running)
(4) **2P** Connector
(5) **HI** Pressure Gauge
(6) **HI** Pressure Valve (Close)
(7) **LO** Pressure Valve (Close)







(5) Charging procedure of refrigerant (Summary)

arging preparations

1) Connect the gauge manifold.
2) Hoses to be connected
   Red hose: High-pressure side (H)
   Blue hose: Low-pressure side (L)
   Green hose: Vacuum pump, service canister gas
3) Be careful not to confuse the high- and low-pressure sides.

Vacuum buildup

1) For about 10 minutes.
2) Gauge pressure at -750 mm^2/Hg.
3) Close the valve and turn off the pump.

Checking air-tightness

1) After the vacuum buildup, leave the system as it is for about 5 minutes.
2) Make sure the gauge pointer does not swing back.
3) If the pointer swings back, check the pipe connections for looseness and correct as required.
4) Start from the vacuum buildup again.

Charging through high-pressure side

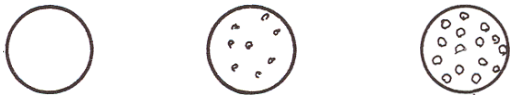
1) Reconnect the charging hose to the gas canister. Using a valve, let air out of the hose.
2) Feed the refrigerant through the high-pressure side until the low-pressure gauge reads 1 kgf/cm^2.
   (1) Keep the engine off.
   (2) Feed all the gas from a service canister.
   (3) Do not place the service canister upside down.
3) Using a gas detector, carefully check for gas leak.

Charging through low-pressure side

1) Be sure to close the high-pressure valve.
2) Engine at idling speed (up to 1500 rpm), air-conditioner with Hi switch on.
3) When replacing the service canister, carry out air-bleeding from the hose (using a valve).
4) Never open the high-pressure valve.

Checking the charging amount

1) Refrigerant amount : 850 ±50g (1.76 ±0.11 lbs)
2) Gauge pressure
   High pressure : 1/2 of ambient pressure (kgf/cm^2)
   Low pressure: 1/10 of high pressure (kgf/cm^2)
3) Check through the sight glass.



Too much　　Proper　　Too short

Checking for gas leak

1) Do this job in a well-ventilated place.
2) An electric gas leak tester may respond to gasoline, light oil, exhaust gas and the like, misleading you.
3) For each check spot, check it not in one direction, but all around it.

G. Main Components Servicing

a. Compressor

(1) Checking

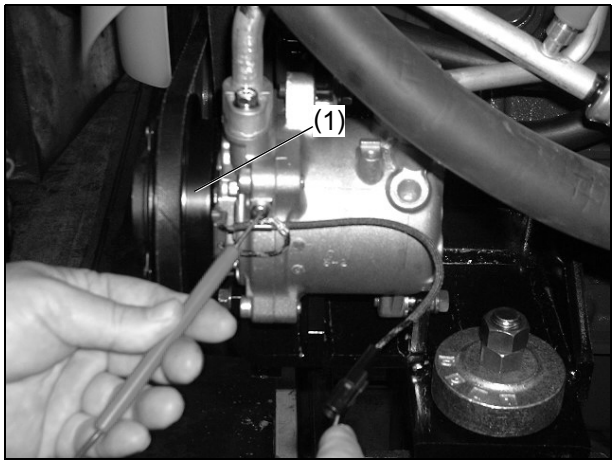
Operation of Magnetic Clutch

1) Start the engine.
2) Check whether abrasion or abnormal noise is heard when only the magnetic clutch pulley is running while the A/C switch is pushed **OFF.**
3) Check that the magnetic clutch (1) does not slip when the A/C switch and blower switch are turned **ON** (when the air conditioner is in operation).
4) If anything abnormal is found, repair or replace.

Stator Coil

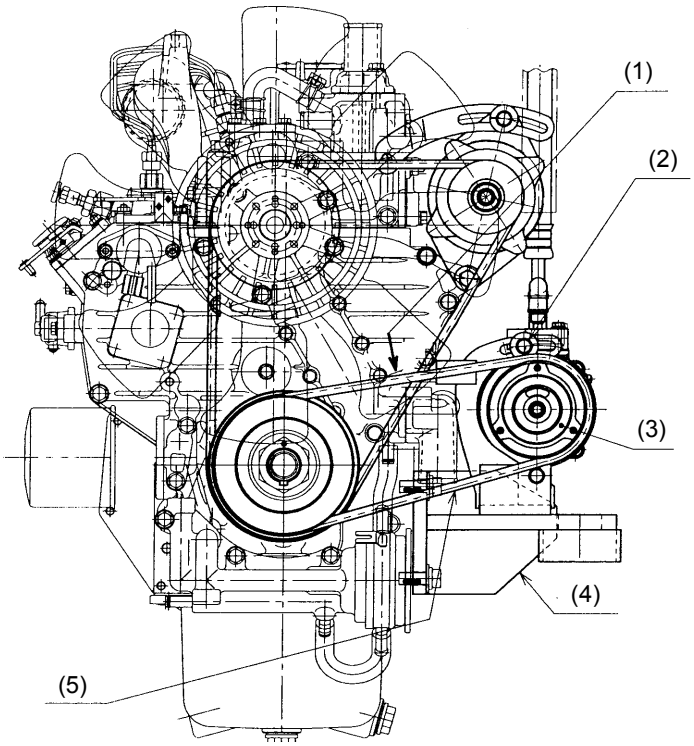
1) Measure the resistance of the stator coil with an ohmmeter across the **2P** connector.
2) If the measurement is not within the factory specifications, replace the stator coil.

Stator coil resistance	Factory spec.	3.5 to 4.0Ω

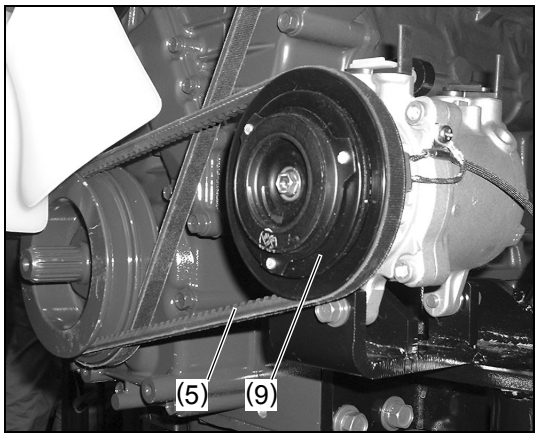


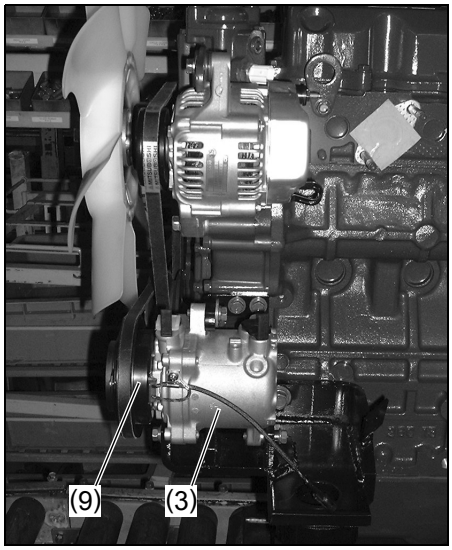
(1) Magnetic Clutch

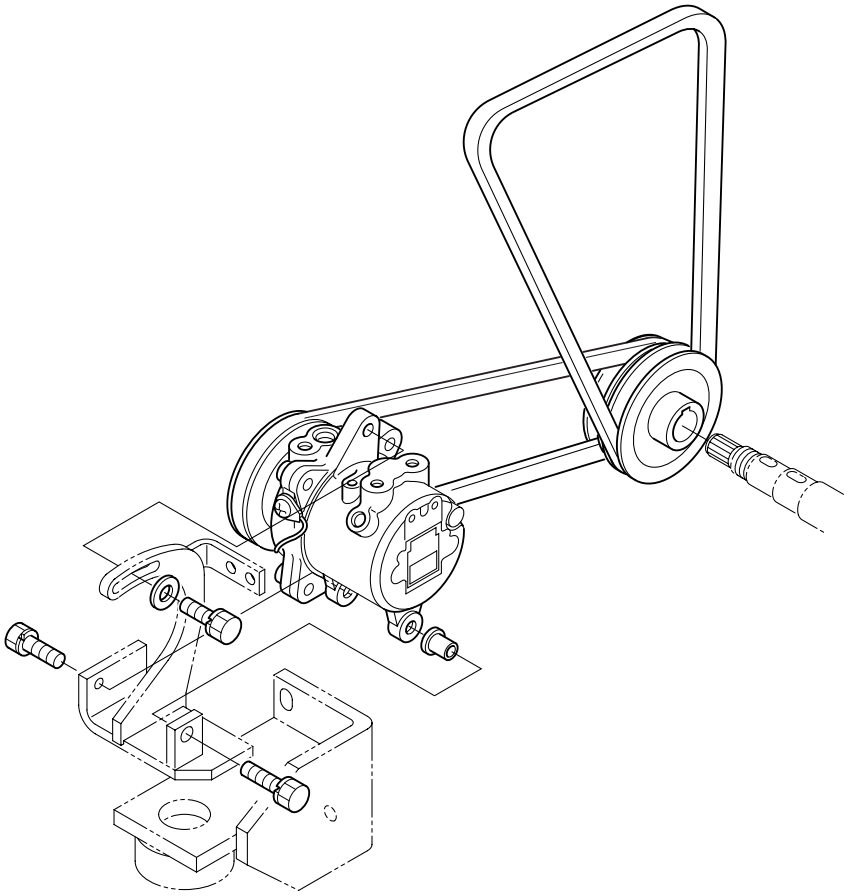
(2) Disassembling and reassembling

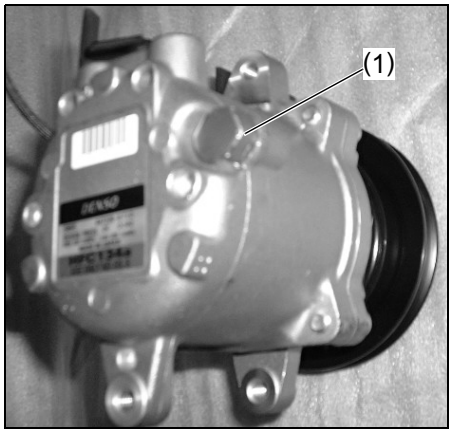


(1) Belt tension check position
(2) Bolt : 01123-60830
Plain washer : 04015-60080
(3) Compressor : T2055-7255 △
(4) Engine bracket 1, A/C : RD118-4757 △
(5) V-belt (33.5) : RD118-4912 △
(6) Bolt : 01123-60820
(7) Pulley
(8) Bush
(9) Magnet clutch

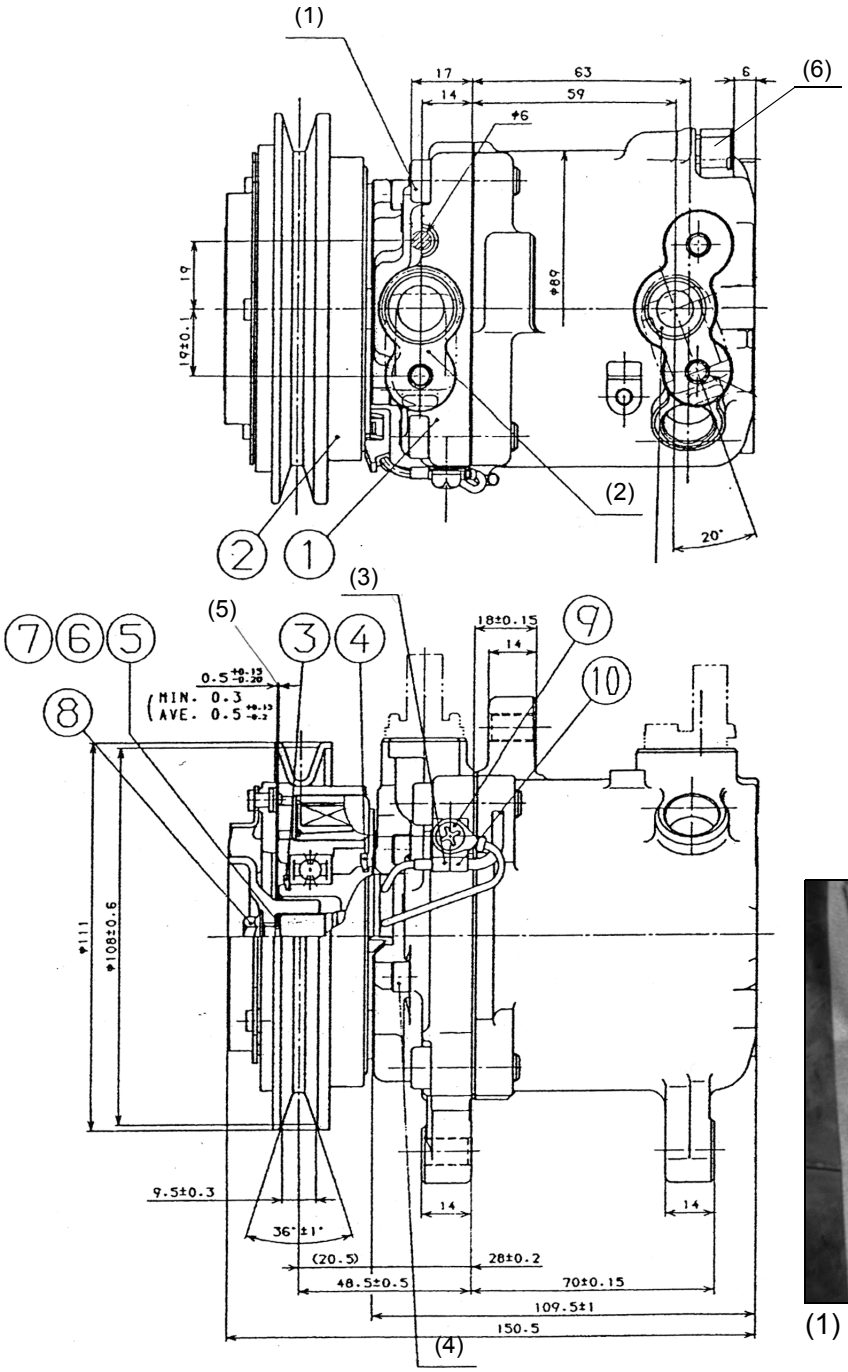




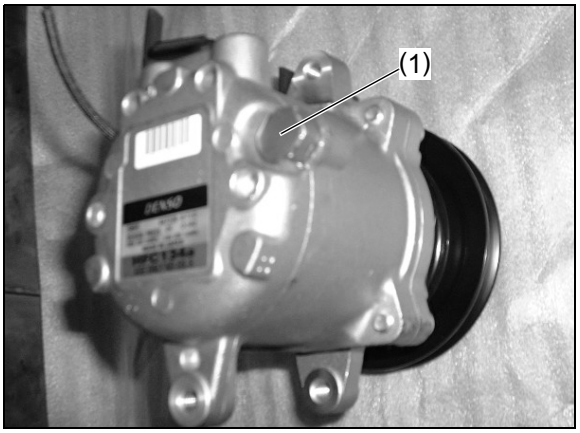




(1) Relief valve



① Compressor assy
② Magnet clutch assy
③ Snap ring
④ Snap ring
⑤ Plate washer, t = 0.1
⑥ Plate washer, t = 0.3
⑦ Plate washer, t = 0.5
⑧ Head bolt
⑨ Screw
⑩ Lead wire clamp



(1) Relief valve

Note : **1.** When handling the compressor, be careful not to let out the charged gas.
2. The turning direction must be clockwise when viewed from the clutch side.
3. The compressor's internal pressure must be 0-0.03 MPa (gauge) for part delivery.

(1) M8 bolt, 4 pcs
(2) Rubber cap
(3) Clamp
(4) M5 bolt, 4pcs
(5) Clearance
Average : $0.5^{+0.15}_{-0.20}$ mm ($0.02^{+0.006}_{-0.008}$ inch) Min : 0.3mm (0.012 inch)

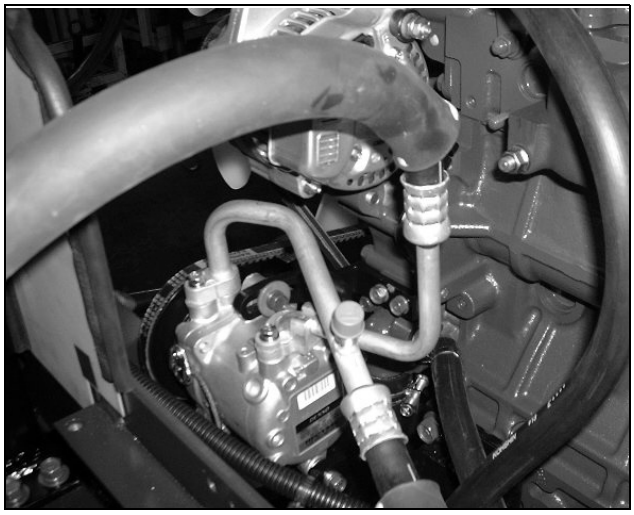
(6) Relief valve pressure setting ;

Opening pressure (Gauge)	3.43 - 4.14 MPa	(35 - 42.2 kgf/cm^2)	(498 - 597 psi)
Closing pressure (Gauge)	2.75 Mpa	(28.1 kgf/cm^2)	(399 psi)
Tightening torque	13.2 ±1.49 N•m	(135 ±15 kgf•cm)	9.76 ±1.08 ft-lbs

(3) Compressor dismounting

1) Discharge the refrigerant from the system. (Refer to **"Discharging the System"** : See page VI-S-24.)
2) Disconnect the low pressure pipe (suction) and high pressure pipe (discharge) from the compressor, then cap the open fittings immediately to keep moisture out of the system.
3) Disconnect the 2P connector of magnetic clutch.
4) Remove the air conditioner belt and remove the compressor.

(1) Compressor (2) Alternator
(3) V-pulley

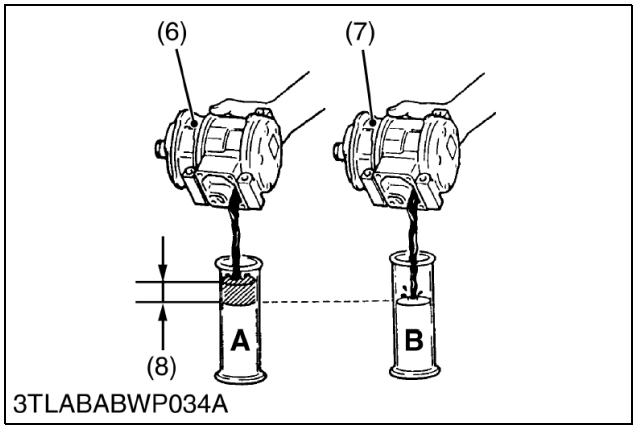


When reassembling

- After reassembling the compressor, be sure to adjust the air conditioner belt tension (see page G-28) and recharge the refrigerant to the system. (Refer to **"Charging the System"** : See page 10-S19.)
- Apply compressor oil (**NIPPONDENSO ND-OIL8** or equivalent) to the O-rings and take care not to damage them.

When replacing compressor

- When replacing the compressor with a new one, meet the oil amount with old one.



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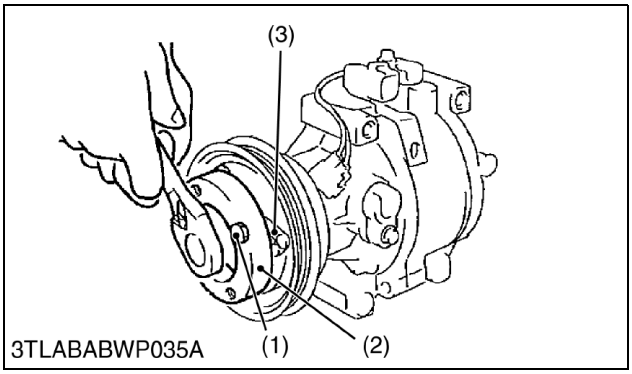
Tightening torque	High pressure pipe and low pressure pipe mounting screw	7.9 to 11.8 N•m 0.81 to 1.20 kgf•m 5.8 to 8.7 ft-lbs
	Compressor mounting screws M8 bolt	16.7 to 19.6 N•m 1.7 to 2.0 kgf•m 12.3 to 14.5 ft-lbs

(1) High Pressure Pipe (5) Compressor
(2) Low Pressure Pipe (6) New Compressor
(3) 2P Connector (7) Old Compressor
(4) Air-conditioner Belt (8) Remove the Excess Oil (**A-B**)



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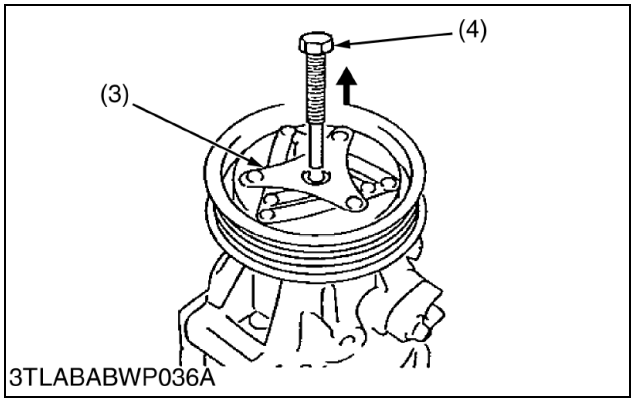
(4) Hub Plate

1) Three stopper bolts (1) are set in stopper magnet clutch (2) at the position corresponding to the shape of compressor.
2) The stopper magnet clutch (2) is hung on hub plate (3) and it is fixed that the compressor rotates.
3) Remove the magnet clutch mounting screw or nut.
4) Remove the hub plate (3).
   Compressor is used remover magnet clutch (4).
5) Remove the shims.



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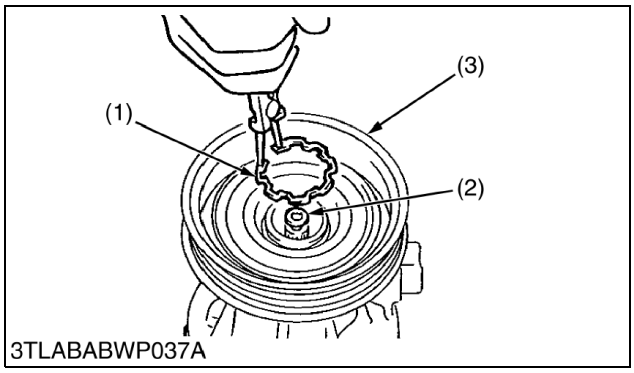
When reassembling

- Do not apply grease or oil on the hub plate facing.
- Do not use the screw or nut again.
- It is confirmed to turn rotor by hand after assembling and not contact with stator.
- Check and adjust the air gap before tight the magnet clutch mounting screw or nut to the specified torque.

Tightening torque	Clutch mounting screws	10.8 to 16.2 N•m 1.10 to 1.65 kgf•m 8.0 to 11.9 ft-lbs

(1) Stopper Bolt
(2) Stopper Magnet Clutch
(3) Hub Plate
(4) Remover Magnet Clutch



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(5) Rotor

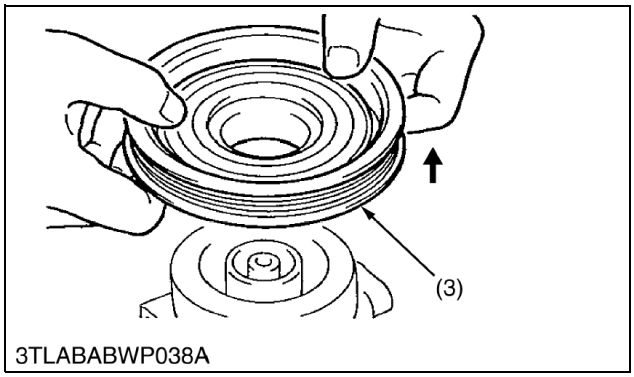
1) Remove the cir-clip (1).
2) Remove the rotor (3).

When reassembling

- Do not use the cir-clip again.
- Assemble the cir-clip for the tapered side to become outside of rotor.
- The width of expanding of cir-clip is set in boss of shaft as a minimum.

Type of compressor	Code No. for circlip
Slide vane type	

(1) Cir-Clip
(2) Shim
(3) Rotor



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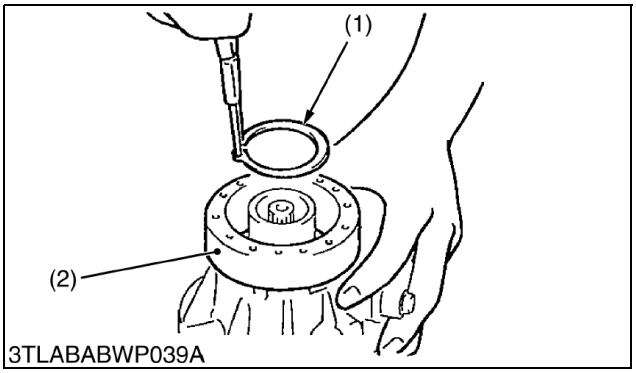
(6) Stator

1) Remove the lead wire from compressor body.
2) Remove the external circlip (1).
3) Remove the stator (2).

When reassembling

- Do not use the cir-clip again.
- Assemble the cir-clip for the tapered side to become outside of front housing.
- The width of expanding of cir-clip is set is boss of shaft as a minimum.
- Match and assemble the concave part (3) of the front housing (5) and the pin (4) of stator.

(1) External Circlip
(2) Stator
(3) Concave Part
(4) Pin
(5) Front Housing



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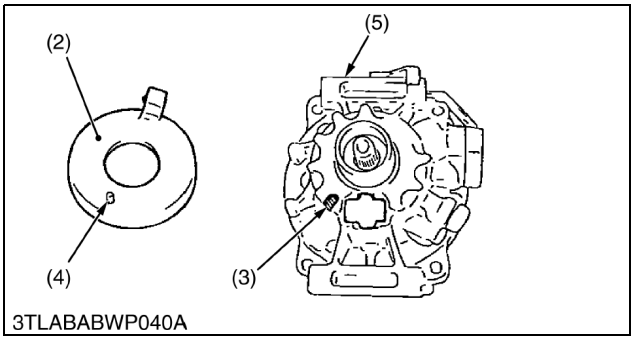

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(7) Adjustment of Air-gap

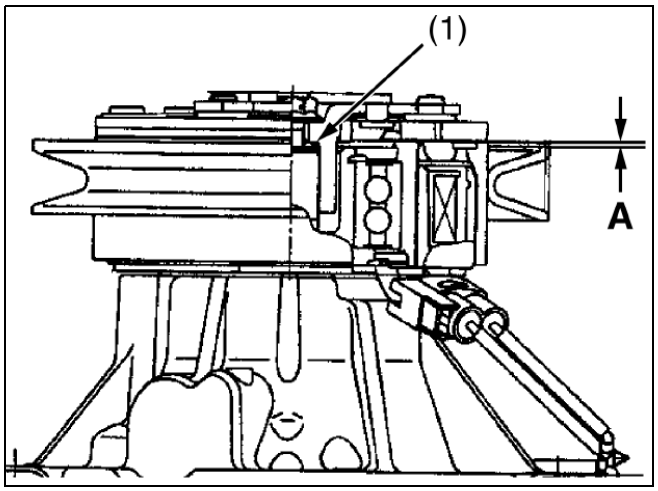
1) Measure the air-gap with a feeler gauge.
2) When the measurement value comes off from factory specification, adjustment shim is added or deleted.

Air-gap	Factory spec.	0.30 to 0.65 mm 0.012 to 0.024 in.

Reference

	Adjustment shim
0.10 mm (0.0039 in.)	
0.30 mm (0.0118 in.)	
0.50 mm (0.0197 in.)	

(1) Shim A : Air-Gap



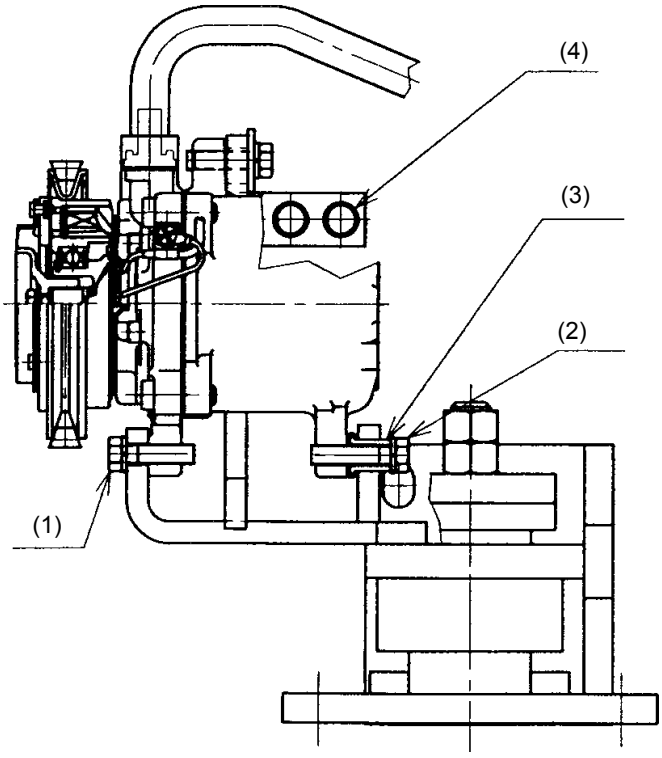
(8) Compressor installation

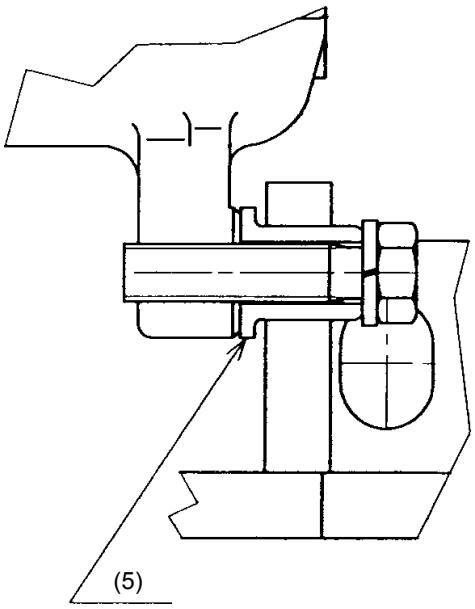
1) Insert (3) bush (compressor) as shown in the left.

Note : Surely check the direction of bush insertion.

2) Temporarily tighten the three M8 bolts and adjust the belt tension. Tighten up the two bolts at the pulley first and then the bolt at the bush.
3) Tightening torque :
   M8 bolt ; 16.7 - 19.6 N•m
   (1.7 - 2.0 kgf•m)
   12.3 - 14.5 ft•lbs

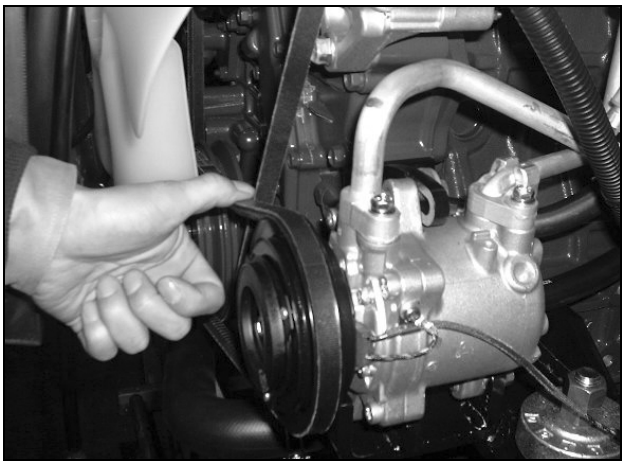
(1) Bolt : 01123-60830
(2) Bolt : 01123-60835
(3) Bush (Compressor) : T0270-7232 r
(4) Bolt : 01123-60820
(5) Flange part of bush





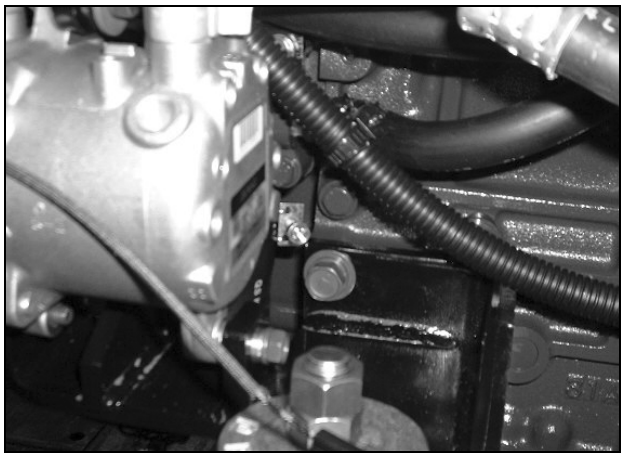
(9) V-belt tension

V-belt : BANDO RPF 2335 9.5 x 850 La
l = 33.5, RD118-4912B, cog belt
Belt deflection amount
12-15 mm (0.47 - 0.59 in.)
at pressing force
58.8 - 68.6 N (6 - 7 kgf)
13.2 - 15.4 lbw



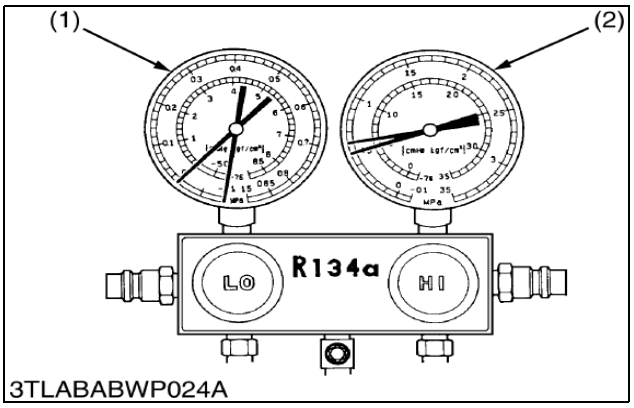
(10) Engine bracket 1, A/C

1) Tightening torque
M12 ; 77.5 - 90.2 N•m
(7.9 - 9.2 kgf•m)
57.1 - 66.5 ft•lbs
M8 ; 16.7 - 19.6 N•m
(1.7 - 2.0 kgf•m)
12.3 - 14.5 ft•lbs



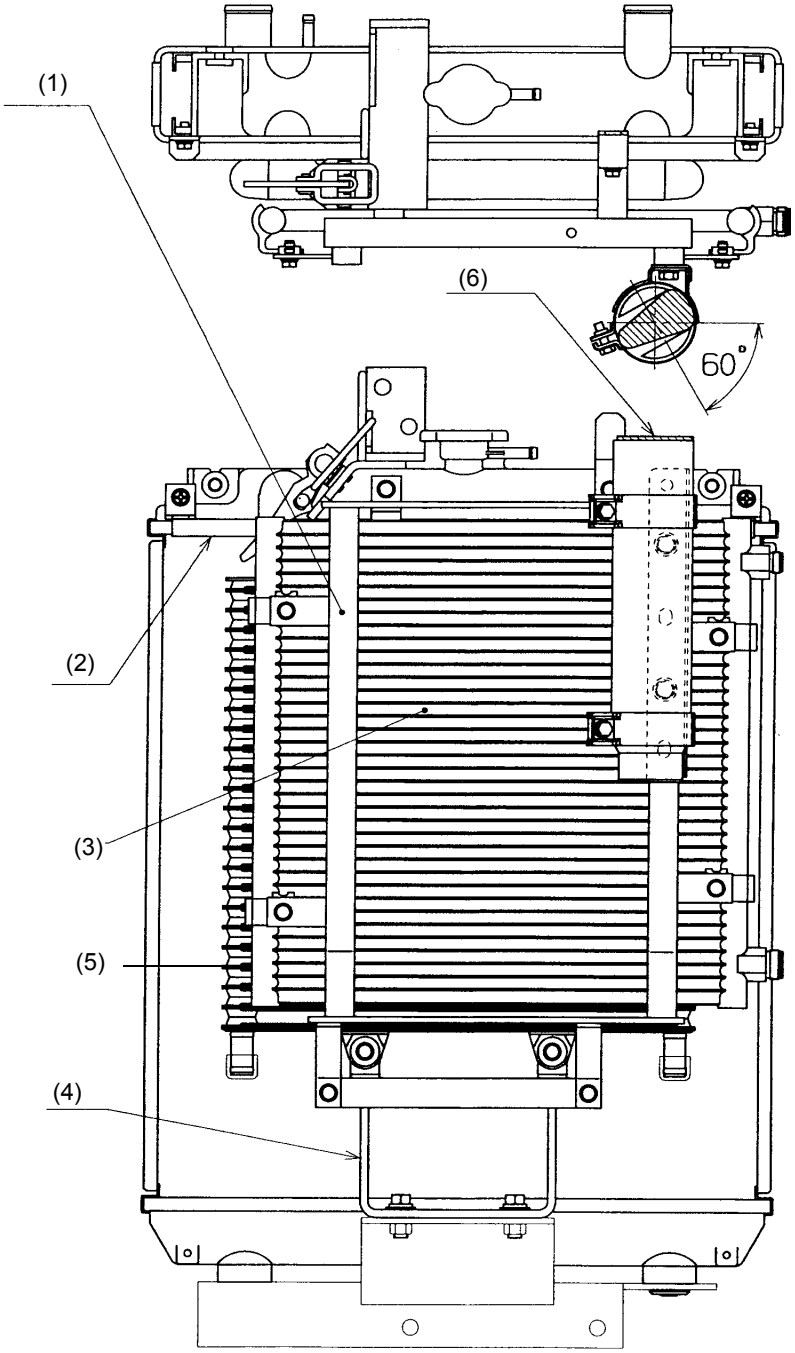
(11) Relief valve

1. Relief opening pressure :
3.4 - 4.14 MPa (35 - 42.4 kgf/cm^2) 498 - 603 psi
2. Valve closing pressure :
2.76 Mpa (28.1 kgf/cm^2) 400 psi



b. Condenser and Receiver

(1) Parts location



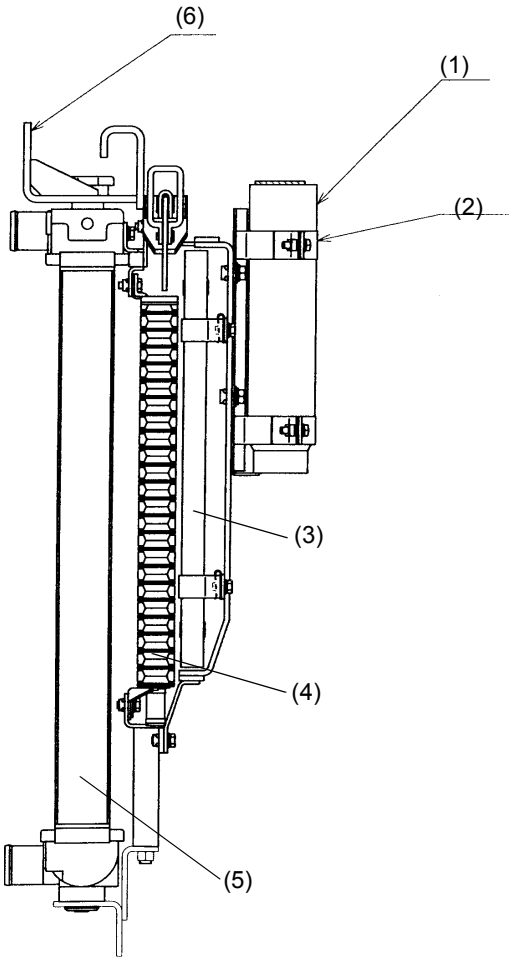
(1) Condenser support : RD411-4766 △
mounting bolt : 01025-60616, 4pcs
(2) Radiator bracket 2 : Rd411-4762 △
(3) Condenser : T1065-7222 △
Mounting bolt : 01025-60616, 4pcs
Nut : T1065-7229 △
(4) Radiator support 1 : RD0411-4768 △
(5) Oil cooler
(6) Receiver

Note : Receiver contains desciccant inside.
Do not remove the rubber cap until when connecting the hoses.

Condenser specifications

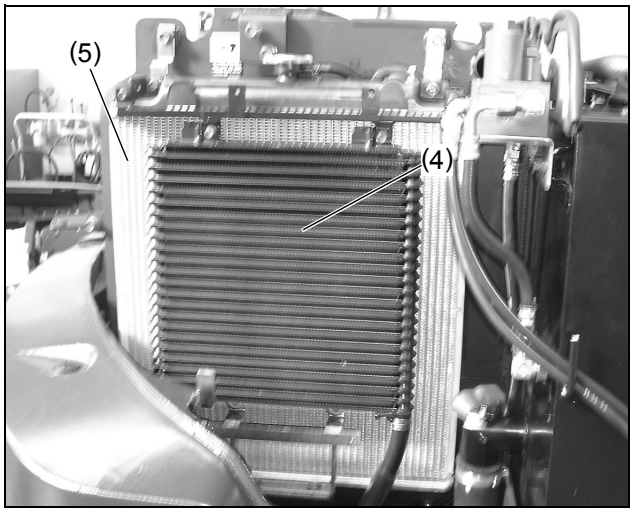
Core dimension mm (inch)	H	364.2 (44.3)
	W	325.0 (12.8)
	T	16.1 (0.63)
	Fin pitch	3.8 (0.15)
Radiation area (m^2)		0.1199
Max allowable pressure MPa (kgf/cm^2) psi		3.53 (36) 512

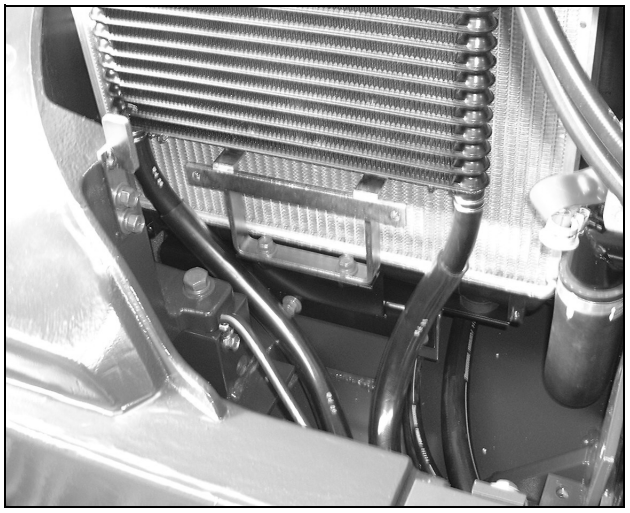
(1) Receiver : T0070-7927 △
(2) Receiver holder : T0070-7928 △
Mounting bolt : 01125-60816, 2pcs
(3) Condenser
(4) Oil color
(5) Radiator
(6) Cooler bracket : RD411-4765 △

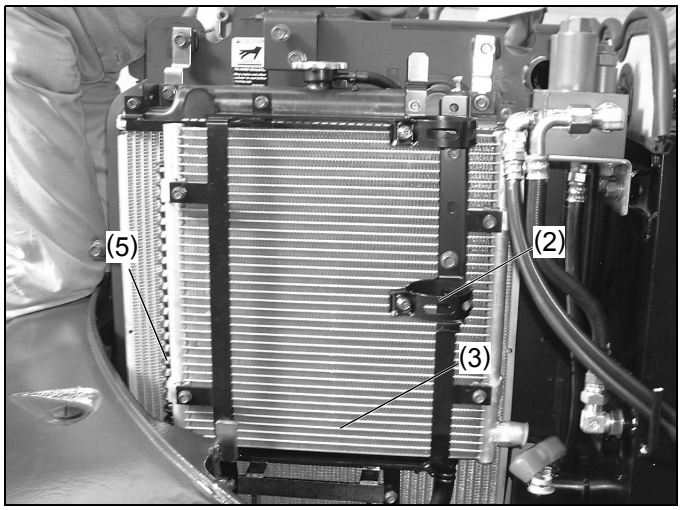


(2) Installation of condenser and receiver

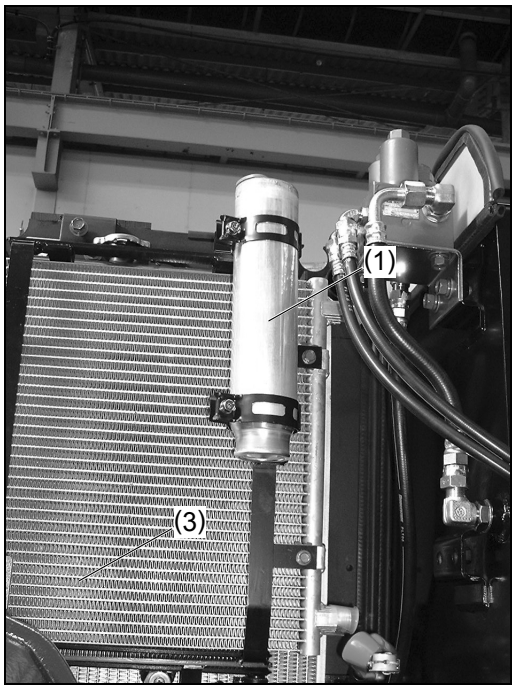
1) Install radiator bracket 2 onto the radiator.
2) Install radiator support 1 at the bottom of the radiator.
3) Install the oil cooler.
4) Install the condenser onto the condenser support.
5) Mount the condenser support onto the radiator bracket.
6) Install the receiver holder.
7) Install the receiver.

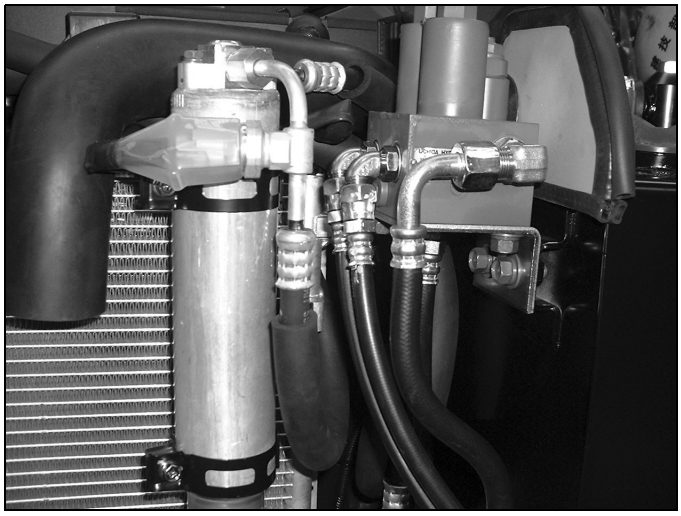


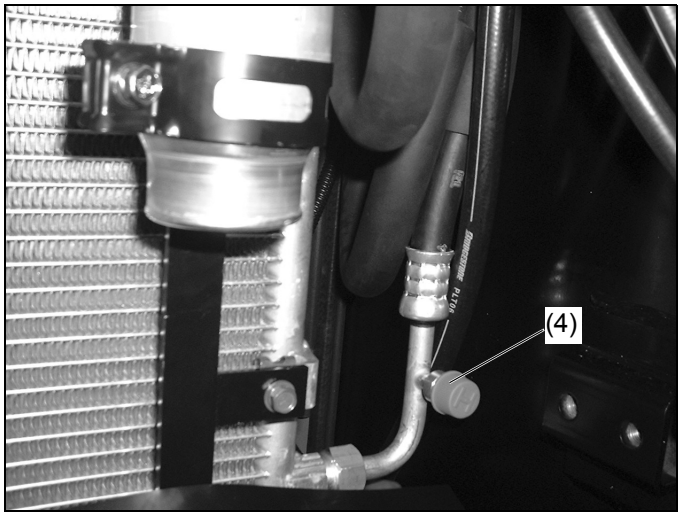




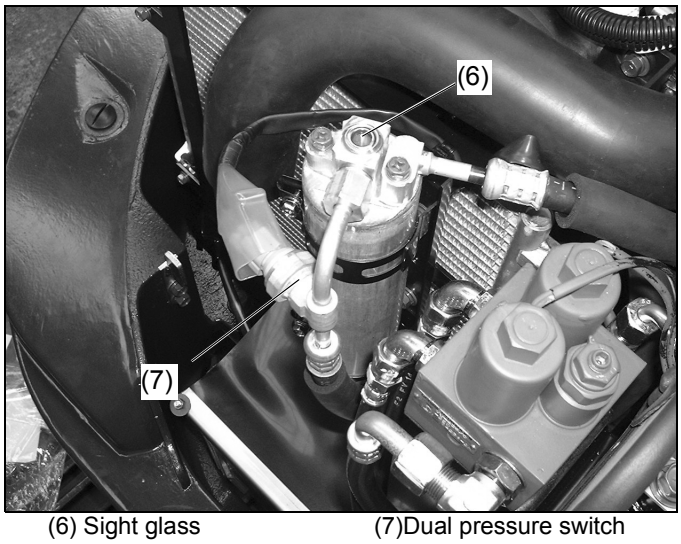
(2) Receiver holder
(3) Condensor
(5) Radiator







(4) High pressure port

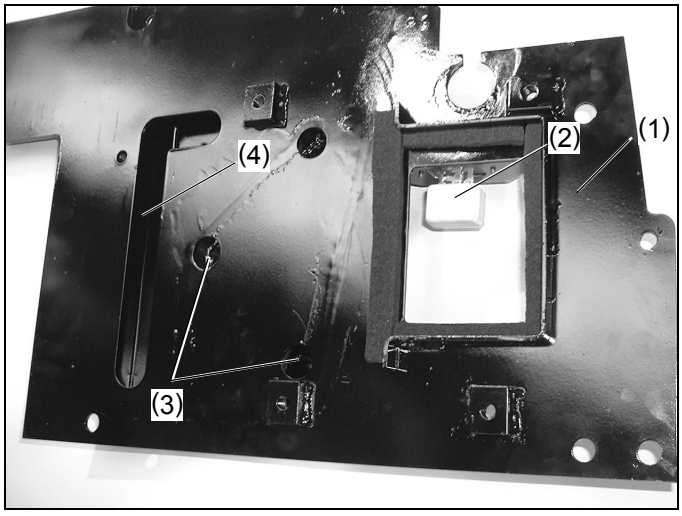


(6) Sight glass (7)Dual pressure switch

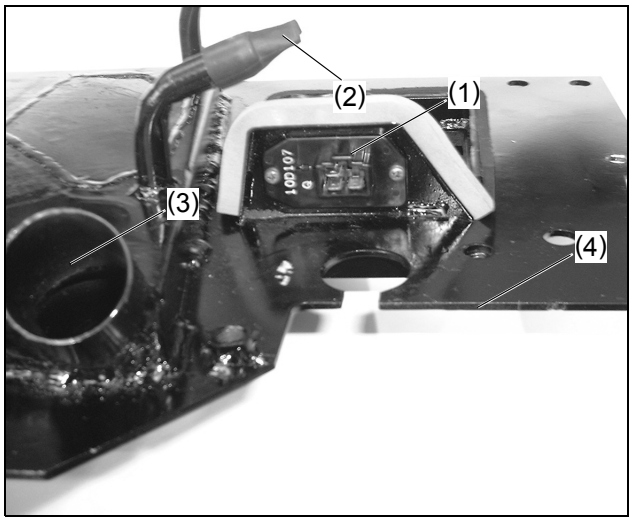
c. Air conditioner unit

1. Mounting proceduse

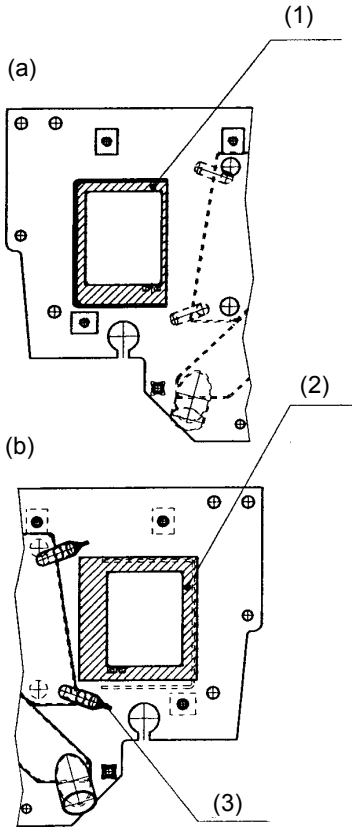
1) Put the sealing parts on the step 3.
2) Install drain boot.
3) Install the resister.
4) Install the duct assy with step 3. Connect the wire harness.
5) Place the step 3 on the swivel frames.
6) Install A/C unit on step 3.
7) Parts location



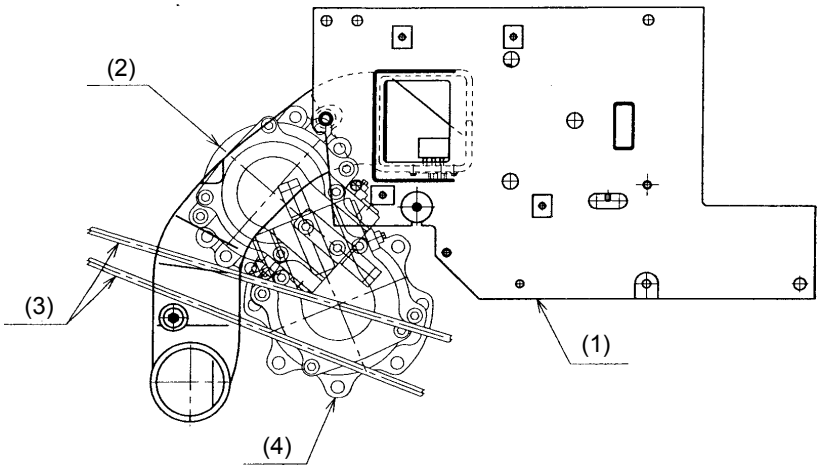
(1) A/C step (3) : RD118-4783 △
(2) Resister
(3) Water drain
(4) Air suction inlet



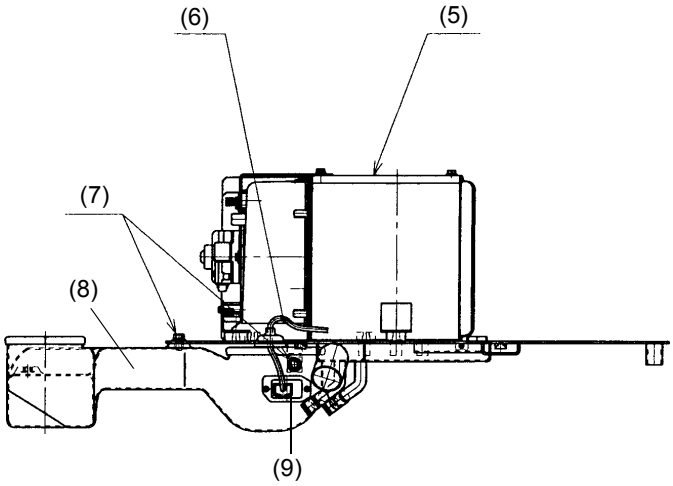
(1) Resister
(2) Water drain boot
(3) Air inlet from outside
(4) A/C step (3), bottom side



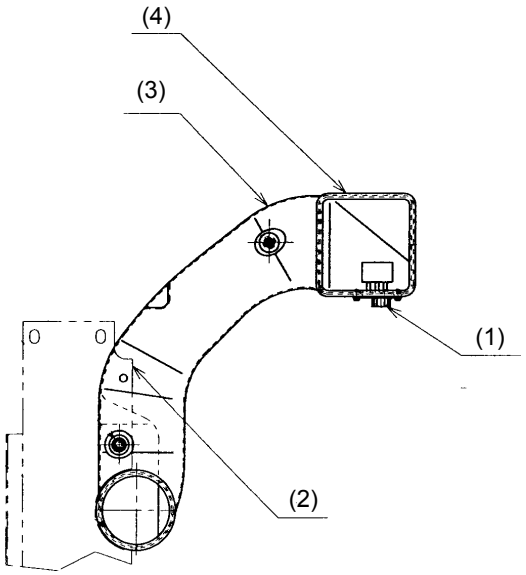
(a) Upper surface of A/C step (3)
(b) Bottom surface of A/C step (3)
(1) Seal 2 : RD118-4792 △
(2) Seal 1 : RD118-4791 △
(3) Drain boot : 6A671-71690 △



(1) A/C step (3)
(2) Swivel motor, KX121-3
(3) Travel control rod
(4) Swivel motor, KX161-3
(5) A/C unit : RD118-5370 △
(6) Blower wire harness : RD118-5348 △
(7) Bolt : 01125-60816, 2 pcs
(8) Duct assy
(9) Resister

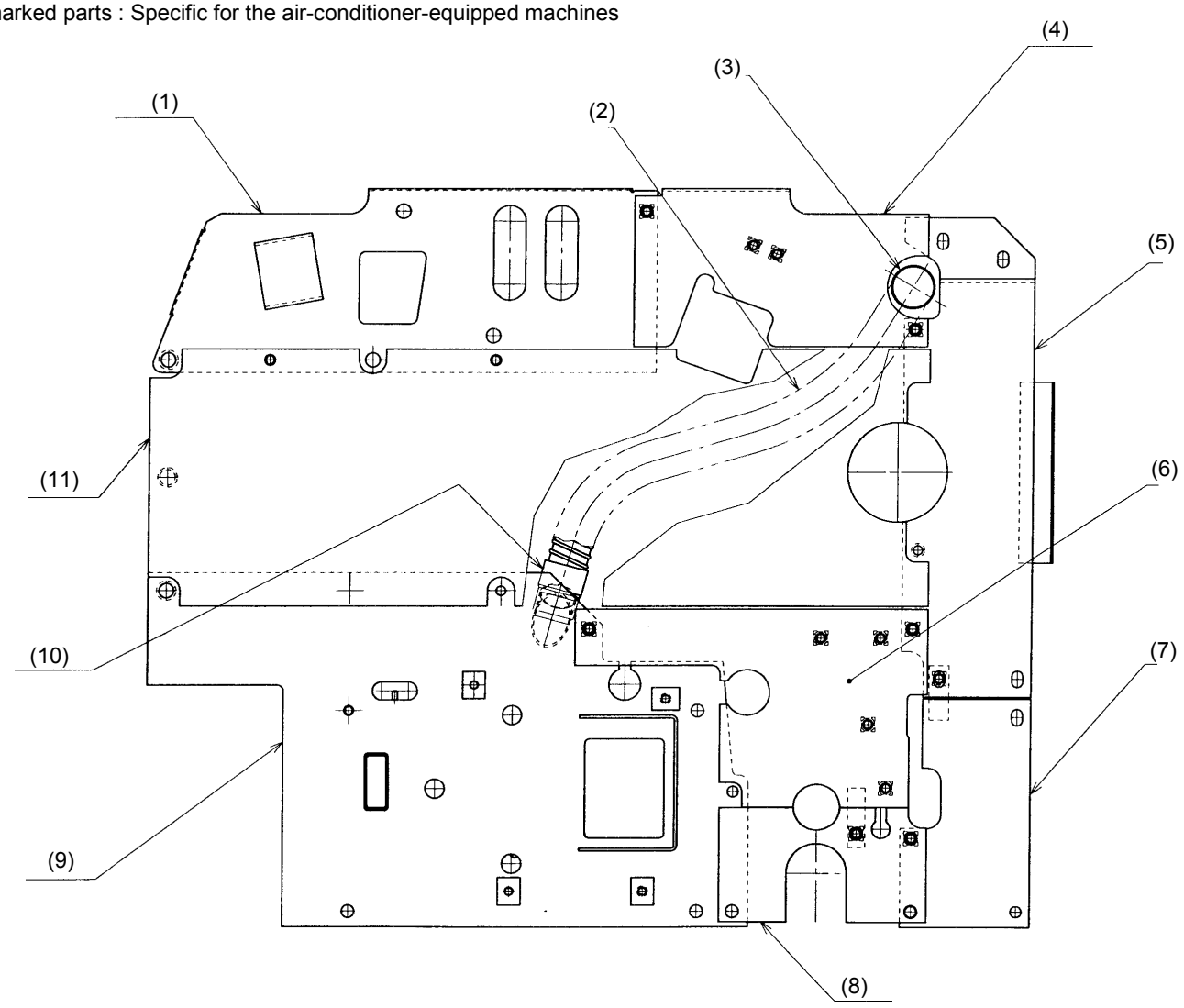


(1) Resister : T1065-7218 △
Mounting screw : 03024-60412, 2 pcs
(2) Step support
(3) Trim (3) : Rp821-4237 △
(4) Duct assy : RD118-4740 △



2 Location of steps

*-marked parts : Specific for the air-conditioner-equipped machines



(1) Step 1, L : RD118-4411 △
(2) Defroster hose, 700 : RB419-4928△
(3) Insert to filter cover, A/C.
(4) Step assy (1, R, A/C) : RD118-4777 △
Step (1, R, A/C) : RD-118-4778 △
(5) Step support, A/C : RD118-4167 △
(6) Step (4,A/C) : RD118-4782 △
(7) Step support 2 : RD118-4119 △
(8) Step assy (5) : RD118-4403 △
Step (5) : RD118-4421 △
(9) Step 3, A/C : RD118-4783 △
(10) Insert to pipe of step 3, A/C.
(11) Step 2, A/C : RD118-4779 △

3 Dismounting steps

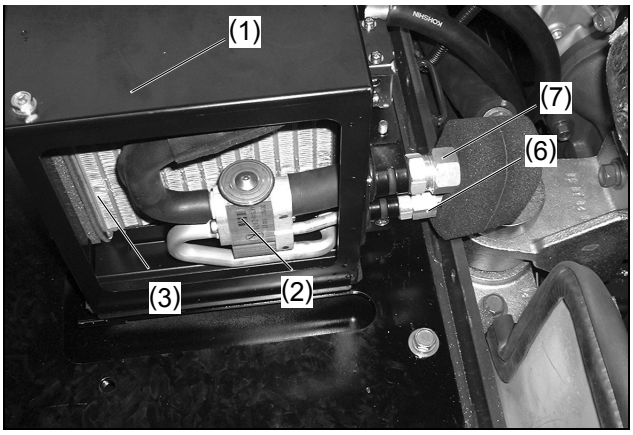
1) Remove the cab and seat.
2) Disconnect the heater hoses (5).
3) Disconnect the cooler pipe (liquid) (6) and cooler pipe (suction side) (7).
4) Remove the screws and take off the unit.
5) Remove the duct hoses.

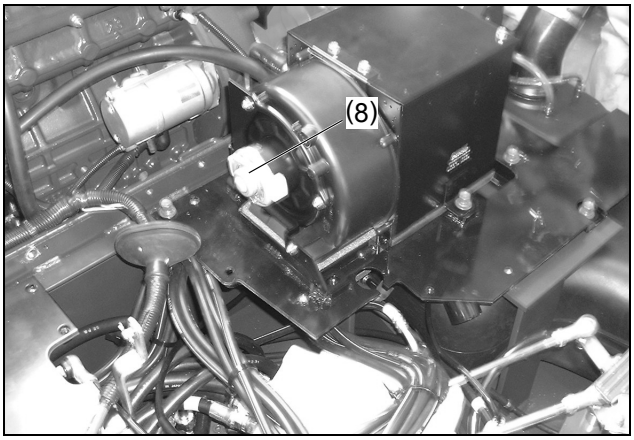
When reassembling

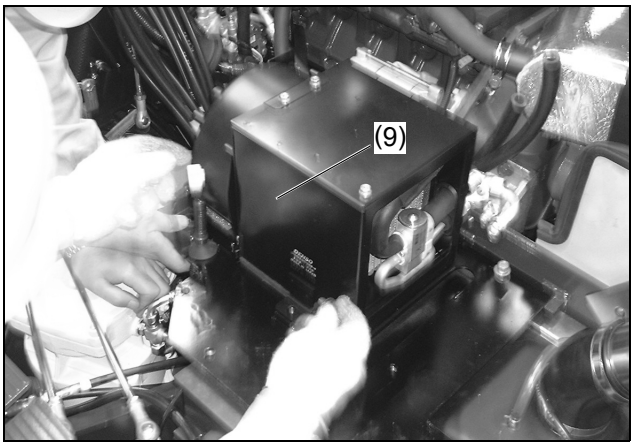
- When reconnecting the cooler pipes with the unit, apply compressor oil (NIPPONDENSO OIL8 or equivalent) to O-rings.
- When remounting the unit, tighten five screws by hand and finally retighten them after aligning the inner roof duct with the unit duct.
- When connecting the heater hose with A/C unit, hose should be put into the A/C unit pipe more than 30 mm (1.2 in.)

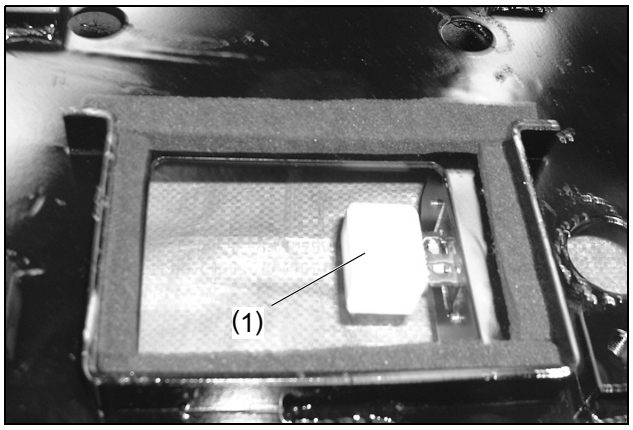
Tightening torque	A/C unit mounting screw(M6)	3.92 to 6.86 N•m 0.40 to 0.70 kgf•m 2.89 to 5.06 ft-lbs
	A/C unit mounting screw(M8)	9.8 to 11.68 N•m 1.00 to 1.19 kgf•m 7.23 to 8.6 ft-lbs
	Low pressure pipe (Cooler pipe (suction)) retaining nut	29.4 to 34.3 N•m 3.0 to 3.5 kgf•m 21.7 to 25.3 ft-lbs
	High pressure pipe (Cooler pipe (liquid)) retaining nut	11.8 to 14.7 N•m 1.2 to 1.5 kgf•m 8.7 to 10.8 ft-lbs

(1) Unit Cover
(2) Expansion Valve
(3) Evaporator
(4) Heater Core
(5) Heater Hoses
(6) High Pressure Pipe (Cooler Pipe (Liquid))
(7) Low Pressure Pipe (Cooler Pipe (Suction Side))
(8) A/C blower
(9) A/C unit

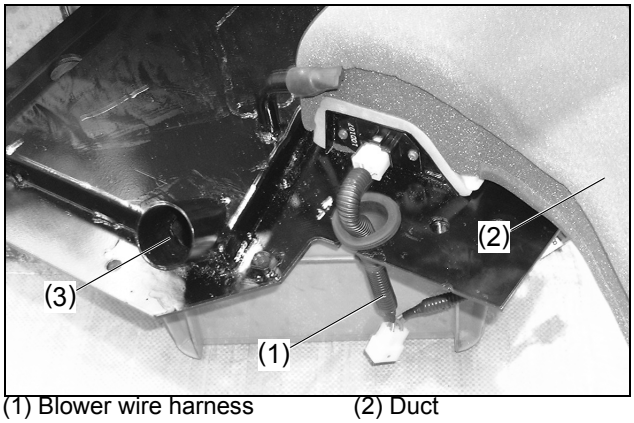




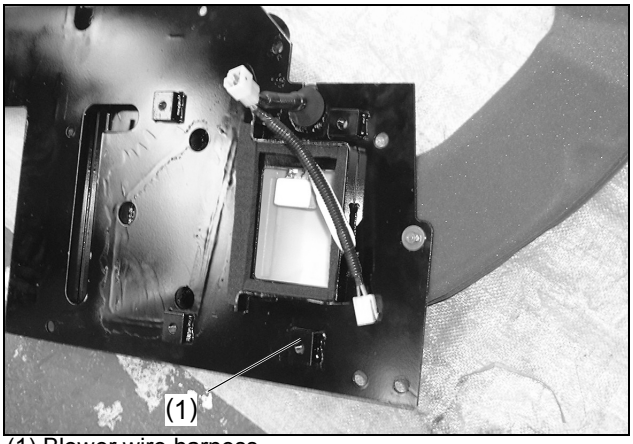




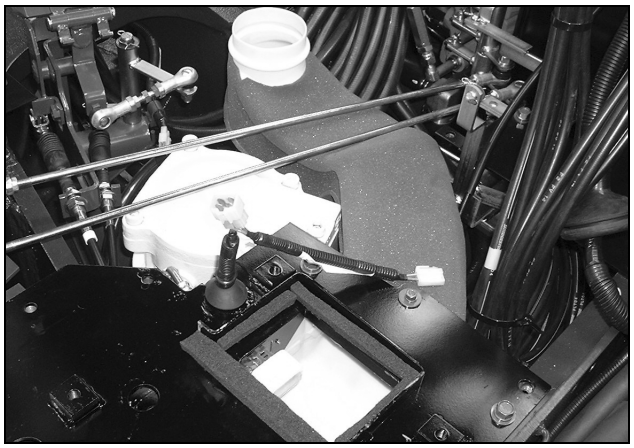
(1) Resister



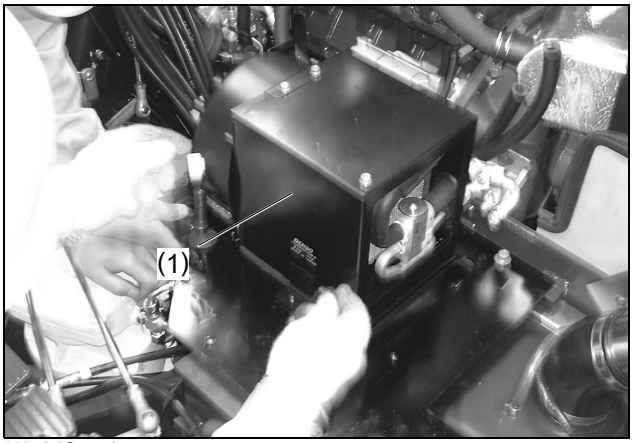
(1) Blower wire harness (2) Duct
(3) Air inlet from outside



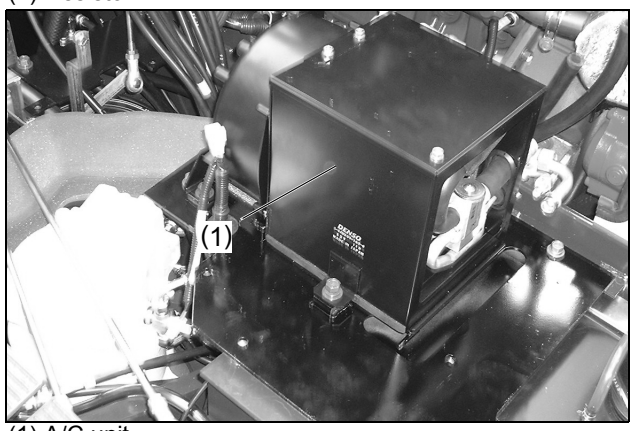
(1) Blower wire harness



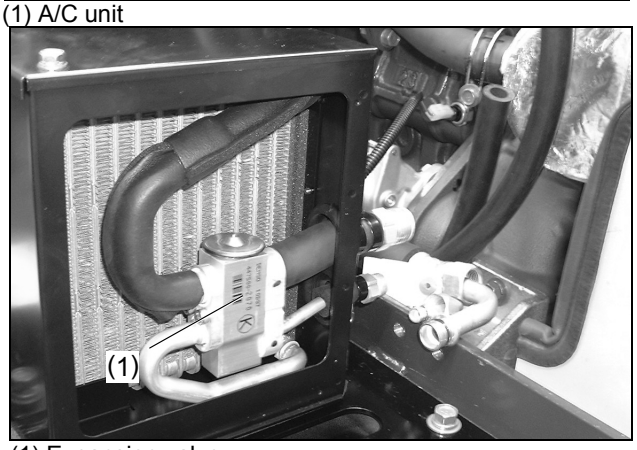
(1) Resistor



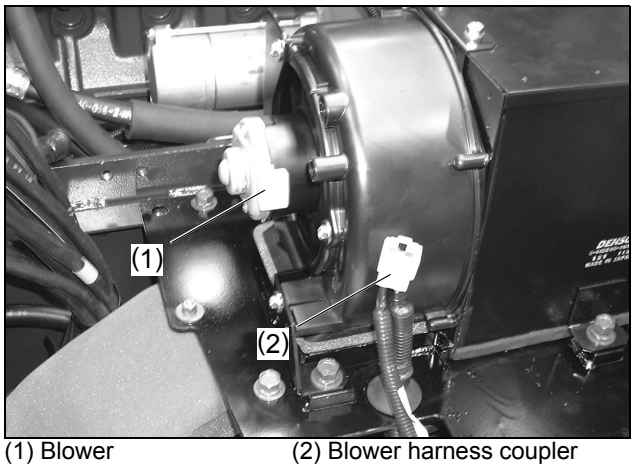
(1) A/C unit



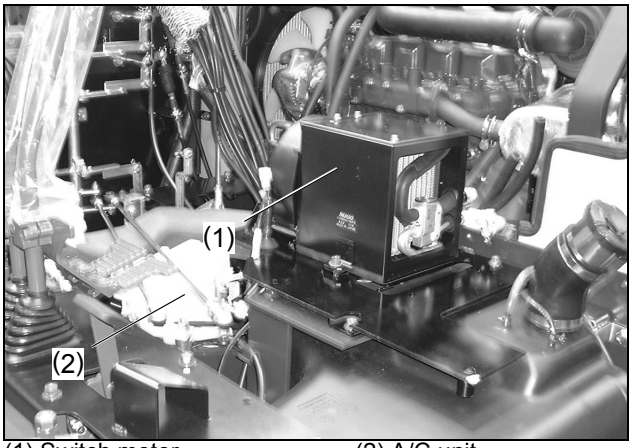
(1) A/C unit



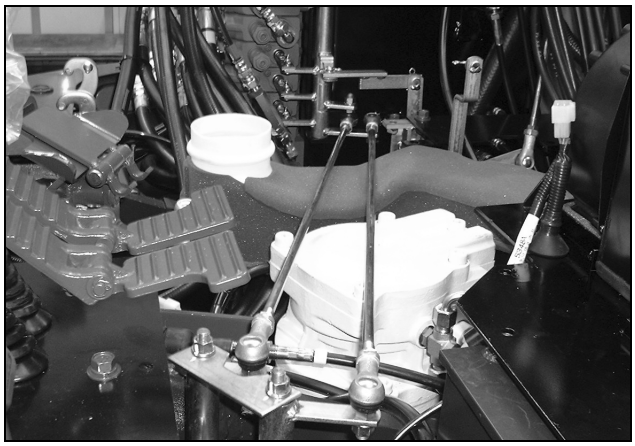
(1) Expansion valve

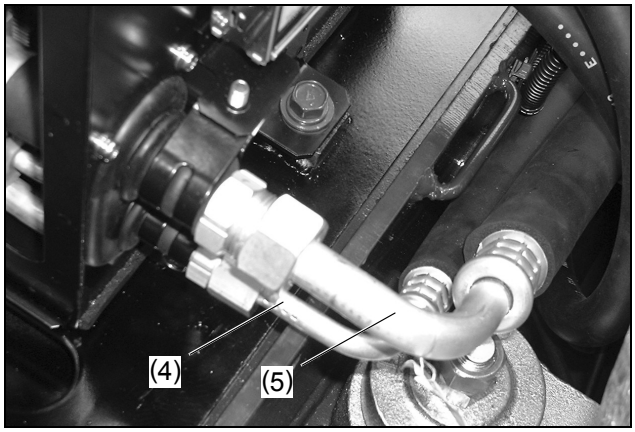


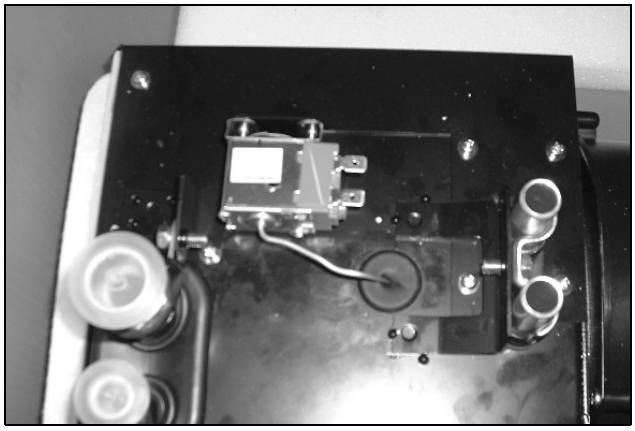
(1) Blower (2) Blower harness coupler

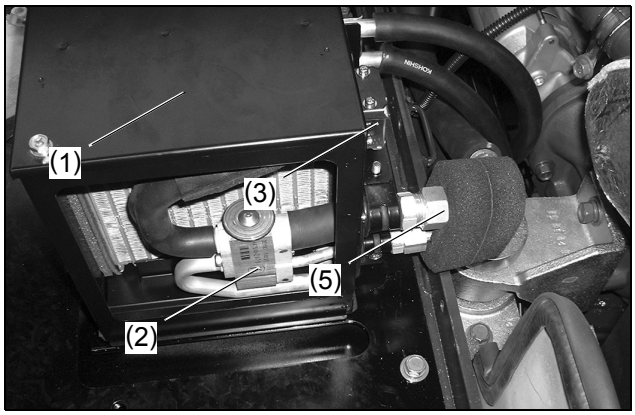


(1) Switch motor (2) A/C unit









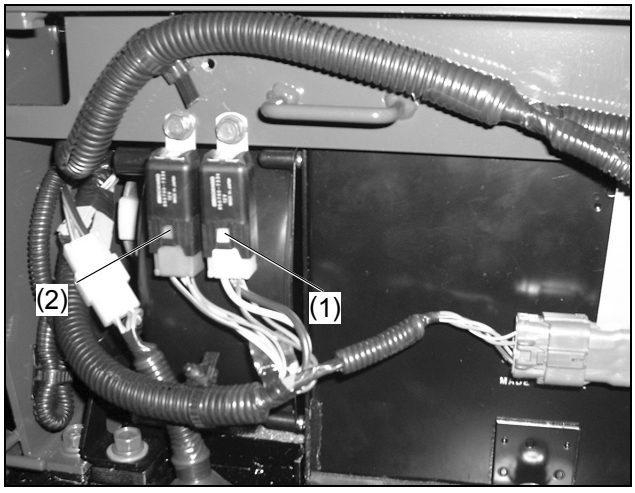
(1) A/C unit (2) Expansion valve
(3) Thermostat (4) High (5) Low

d. Electrical System Components

(1) A/C Blower Relay and Compressor Relay

1) Remove the front cover, and disconnect the relay connectors.
2) Perform the following checkings **1)** and **2)**.

(1) A/C Blower Relay
(2) Compressor magnet clutch Relay, (Blue coupler)



1 Connector Voltage

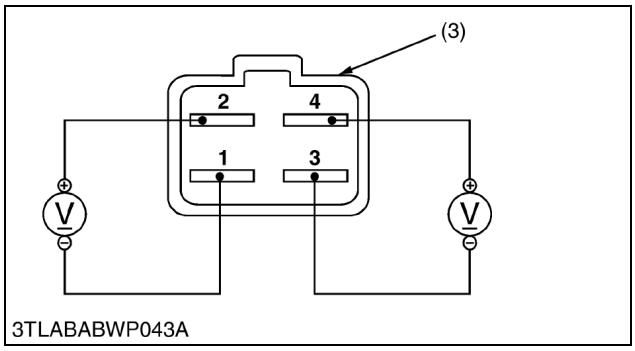
a) A/C Blower Relay

1) The voltage across the **4** terminal and chassis should be approx. battery voltage.
2) When turning the main switch **ON** and A/C blower switch to **LO** position, the voltage across the **2** terminal and chassis should be approx. battery voltage.

b) Compressor Relay

1) The voltage across the **4** terminal and chassis should be approx. battery voltage.
2) When turning the main switch **ON**, A/C blower switch to **LO** and A/C switch **ON**, the voltage across the terminal **2** and chassis should be approx. battery voltage.

(1) A/C Blower Relay
(2) Compressor Relay(Magnet clutch relay)
(3) Connector Side

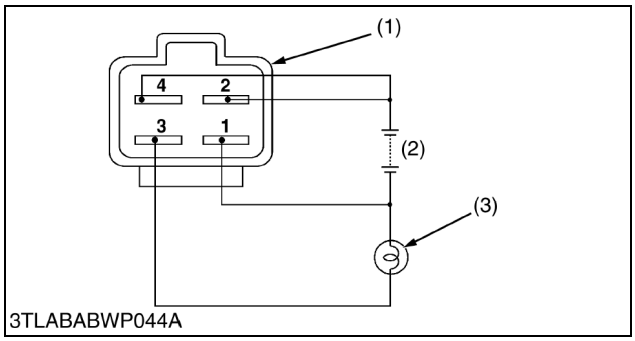


3TLABABWP043A

2 Relay Test

1) Remove the relay (1).
2) Connect the battery (2) and bulb (3) with the relay (1) as shown in the left figure.
3) In this condition, the bulb should light on if the relay is proper.
4) If the bulb light off when disconnecting the jumper lead from the relay **4** terminal, the relay is proper.

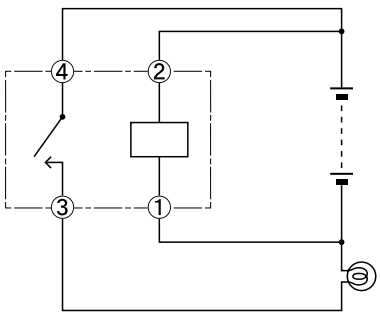
(1) Relay (2) Battery (3) Bulb

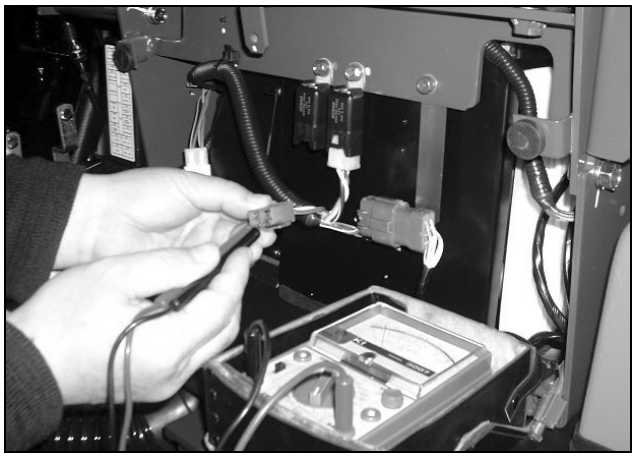


3TLABABWP044A

(2) Relay specs (at 20°C)

Rated voltage	: 12 V DC
Rated coil current	: 0.12 ±0.2 A
Max. current	: 20 A
Voltage drop	: 0.2 V or less
Min. operating voltage	: 8 V or less
Operating voltage range	: 10 - 16 V

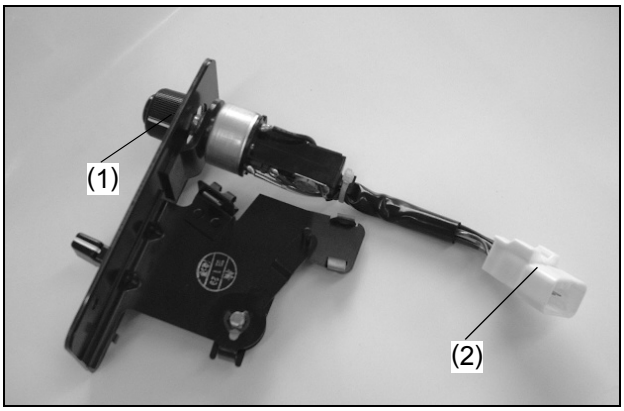




(3) A/C Blower Switch

1) Remove the A/C switch assy and disconnect the A/C blower switch connector (1).
2) Perform the following checkings **1)** and **2)**.

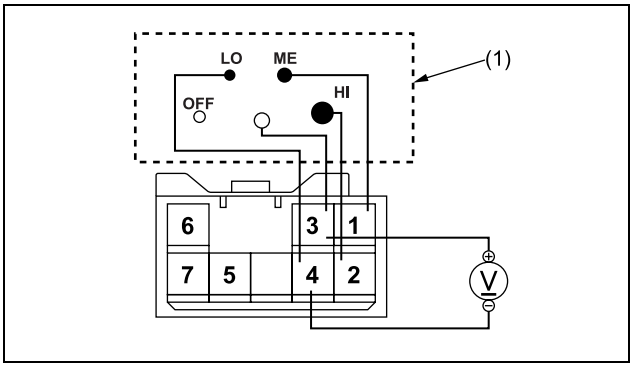
(1) A/C blower switch (2) A/C Blower Switch Connector



1 Connector Voltage

1) Turn the main switch **ON**.
2) Measure the voltage with a voltmeter across the connector **4** terminal and **3** terminal.
3) If the voltage differs from the battery voltage, the wiring harness, A/C relay, fuse or main switch is faulty.

Voltage	4 terminal - 3 terminal	Approx. battery voltage

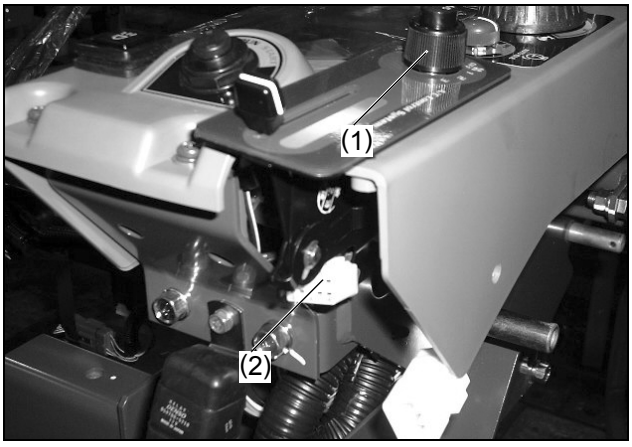


2 A/C Blower Switch

1) Check the continuity through the switch with an ohmmeter.
2) If the continuity specified below are not indicated, the switch is faulty.

Position \ Terminal		3	4	1	2
A/C Blower Switch	OFF	●			
	●(Low)	●	●		
	●(Medium)	●	●	●	
	●(High)	●	●		●

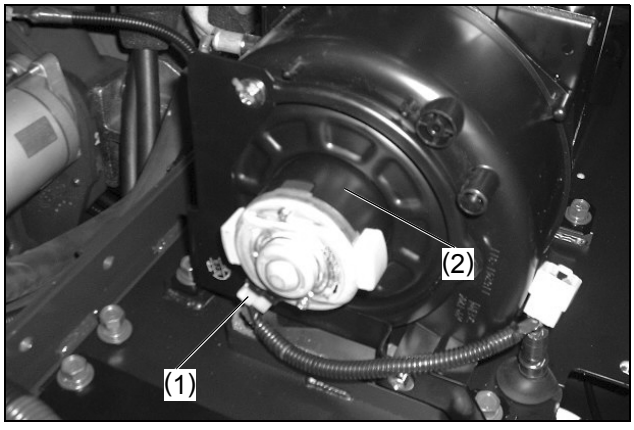
(1) A/C switch coupler (2) A/C Blower Switch Connector



(4) A/C Blower Motor Test

1) Remove the wire harness coupler.
2) Turn the blower motor (2) by hand and check whether it turns smoothly.
3) Disconnect the connector (1) of blower motor (2).
4) Connect a jumper lead from battery positive terminal to connector **B** terminal.
5) Connect a jumper lead from battery negative terminal to connector **E** terminal momentarily.
6) If the blower motor does not run, check the motor.

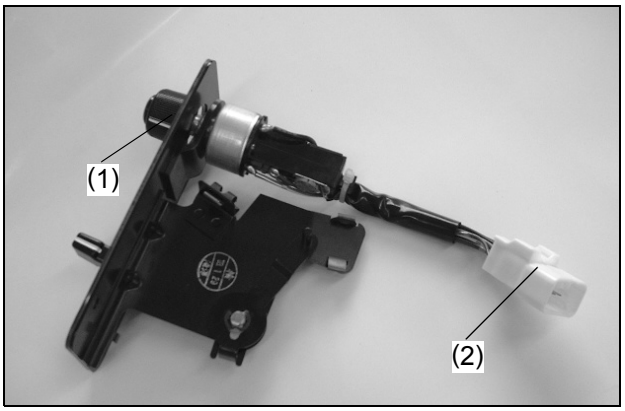
(1) Blower Motor Connector (2) Blower Motor



(5) A/C cooler switch

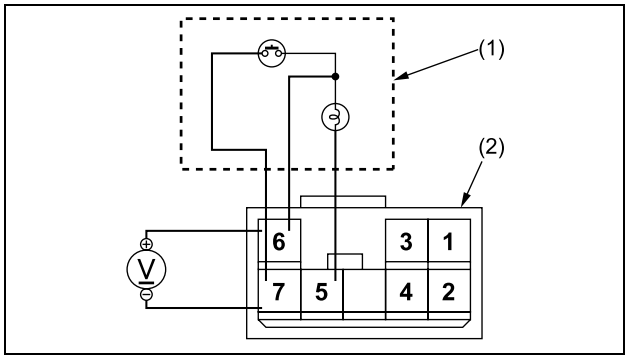
1) Remove, and disconnect the A/C switch connector (2).
2) Perform the following checkings **1)** and **2)**.

(1) A/C Switch (2) A/C Switch Connector



1 Connector Voltage

1) Turn the main switch ON.
2) Measure the voltage with a voltmeter across the connector 7 terminal and 6 terminal.
3) If the voltage differs from the battery voltage, the wiring harness, A/C relay or fuse is faulty.



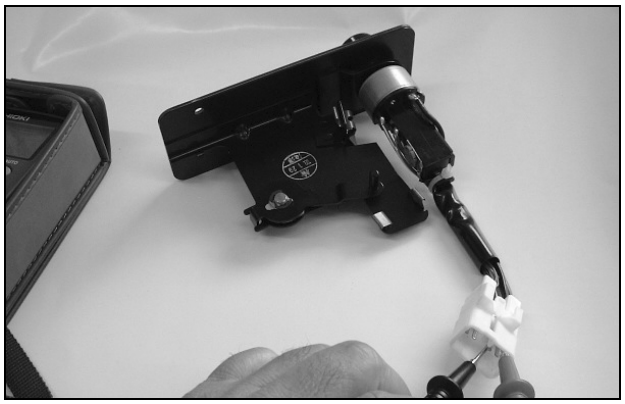
2 A/C cooler switch

1) Check the continuity through the switch with an ohmmeter.
2) If the continuity specified below is not indicated, the switch is faulty.

Position	Terminal	7	6	5
A/C Cooler Switch	OFF*2	●		
	ON*1	●	●	

*1 :Push the A/C cooler switch button to ON position.Approx. resistanse : 0.1 Ω
*2 :Push again the A/C cooler switch button to OFF position.lamp resistance : 12 - 13.5 Ω
When lamp is damaged ; ∞ Ω

(1) A/C Switch (2) A/C Switch Connector

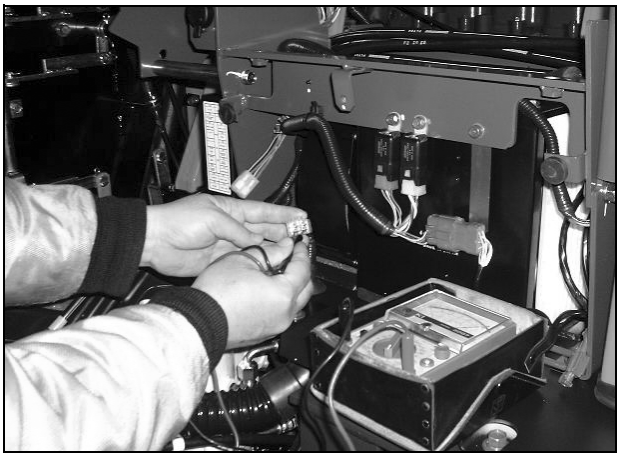


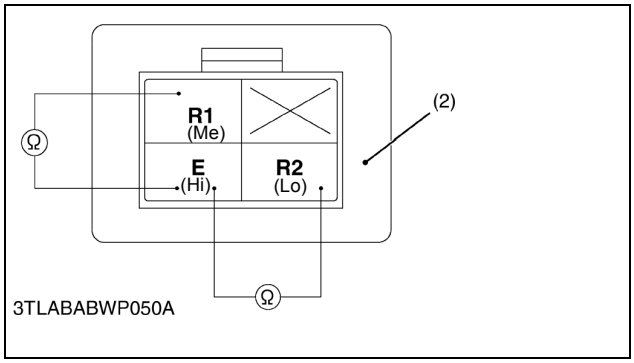
(6) A/C Blower Resistor

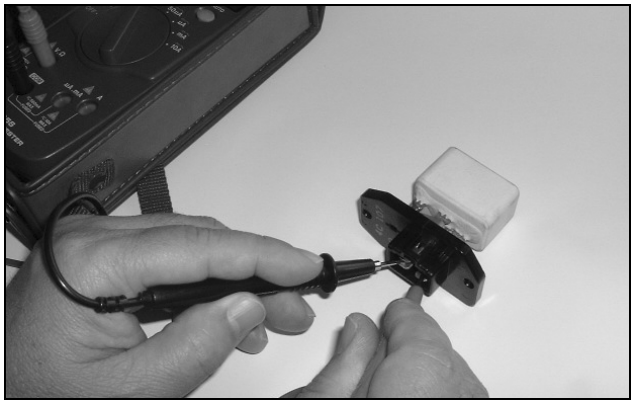
1) Remove the A/C unit and duct.
2) Disconnect the 4P connector (1) for A/C blower resistor (2).
3) Measure the resistance with an ohmmeter across the R1 terminal and E terminal, and across the R2 terminal and E terminal.
4) If the factory specifications are not indicated, A/C blower resistor is faulty.

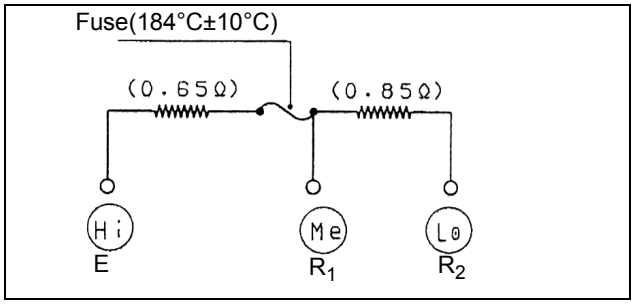
Voltage	R1 terminal - E terminal	Approx. 0.65Ω
	R2 terminal - E terminal	Approx. 1.5Ω

(1) A/C Blower Resistor Connector (2) A/C Blower Resistor





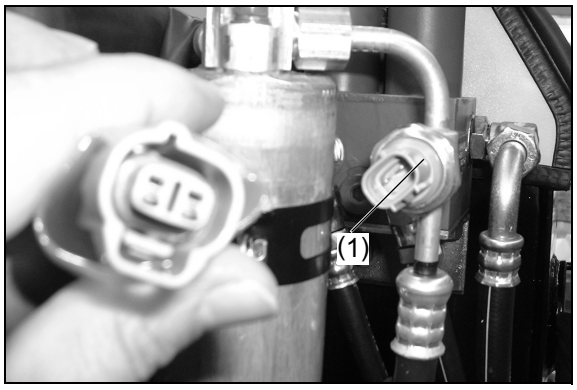




(7) Dual pressure switch

1. Location

(1) Dual pressure switch



2. Continuity test

Before charging the refrigerant : No continuity
After charging the refrigerant : Continuity
(When A/C switch off or even Engine key switch is off.)
(Approx. 0.1Ω)

Troubleshooting : No continuity indicates no charging of refrigerant or gas leakage out of the system. So check and recharge.

3 Operating pressure

Low pressure side :

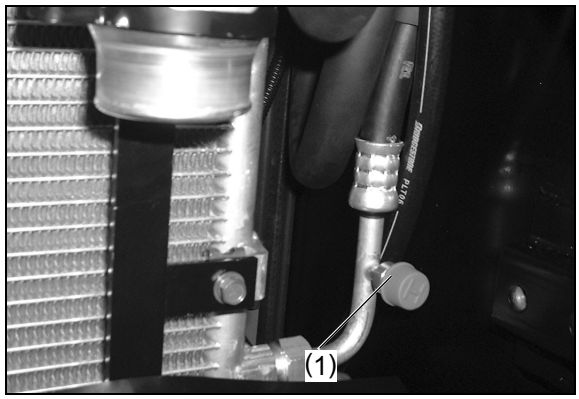
a:OFF pressure valve : 0.196±0.02 MPa
(2.0±0.2 kgf/cm^2)
28.4±3.0psi

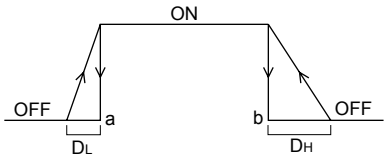
D_L:Differential : 0.02MPa or lower
(0.2 kgf/cm^2)
2.8 psi

High pressure side :

b:OFF pressure valve : 3.14±0.2 MPa
(32.0±2.0kgf/cm^2)
455.4±28.4psi

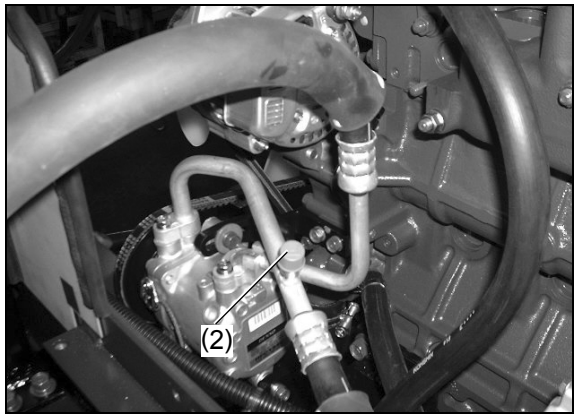
D_H:Differential : 0.59±0.2MPa
(6.0±3.0kgf/cm^2)
85.64±42.7psi





Sealing pressure : 3.53MPa
(36.0kgf/cm^2)
512.0psi

Durable pressure : 5.30MPa
(54.0 kgf/cm^2)
768.7 psi



(1) High pressure gauge port
(2) Low pressure gauge port

4 HI Pressure Side

1) Connect the manifold gauge (6) to compressor as following procedure.
   Close the **HI** and **LO** pressure valves (5), (7) of manifold gauge tightly, and connect the charging hoses (red and blue) (1), (4) to the respective compressor service valves. (Refer to **HANDLING OF SERVICE TOOLS** : See page VI-S-15.)

Note : Be sure to drive out the air in the charging hoses at the manifold gauge connection end by utilizing the refrigerant pressure in the refrigerant cycle.

2) Start the engine and set at approx. 1500 min-1(rpm). Turn on the A/C switch, then set the blower switch to **HI** position.
3) Raise pressure on the **HI** pressure side of the refrigerant cycle by covering the condenser front with a corrugated carboard, and the pressure switch (9) is activated and the compressor magnetic clutch is turned off. At this time, read the **HI** pressure gauge of the manifold gauge. If this pressure reading differs largely with the setting pressure, replace the pressure switch with a new one.

Setting pressure	Factory spec.	Pressure switch **OFF**	More than approx. 3.14 MPa 32 kgf/cm^2 455 psi

5 LO Pressure Side testing

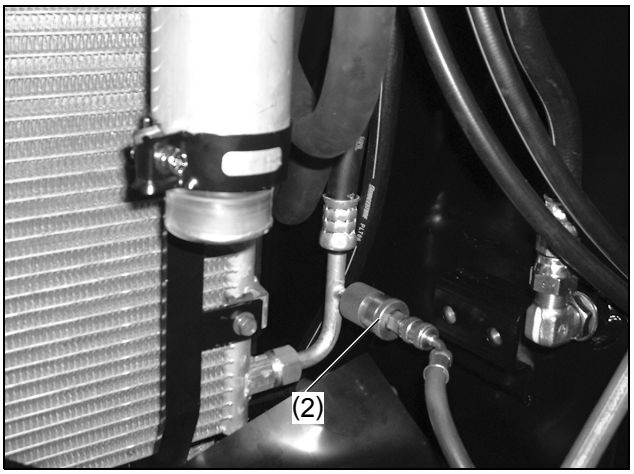
1) Disconnect **2P** connector of pressure switch.
2) Measure the resistance with an ohmmeter across the connector terminals.
3) If 0 ohm is not indicated at normal condition, there is no refrigerant in the refrigerating cycle because gas leaks or pressure switch is defective.

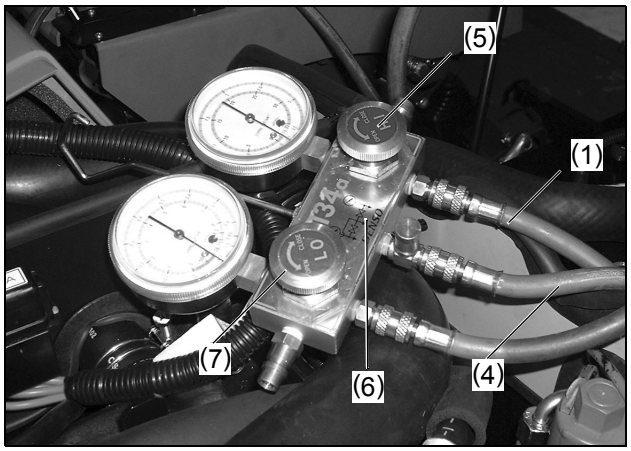
Reference

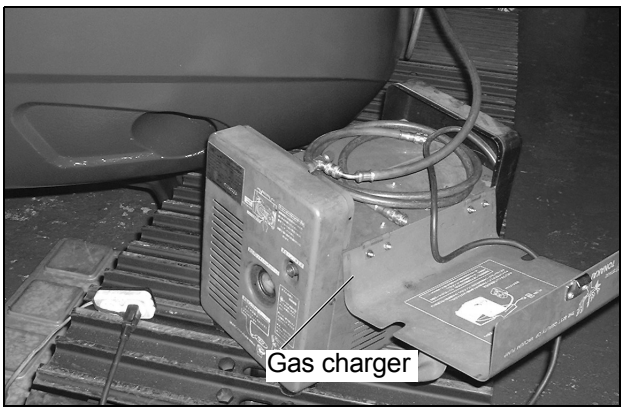
Setting pressure	Factory spec.	Pressure switch **OFF**	More than approx. 0.196 MPa 2.0 kgf/cm^2 28.4 psi

- The resistance of pressure switch is 0~0.1 ohm in normal running, but is becomes infinity if the pressure is abnormal (out of factory spec.). Because the pressure switch starts to work.

(1) Charging Hose (Red)
(2) HI (High Pressure Side) Charging
(3) LO (Low Pressure Side)
(4) Charging Hose (Blue)
(5) HI Pressure Valve
(6) Manifold Gauge Valve
(7) LO Pressure Valve Charging
(8) Gas charger

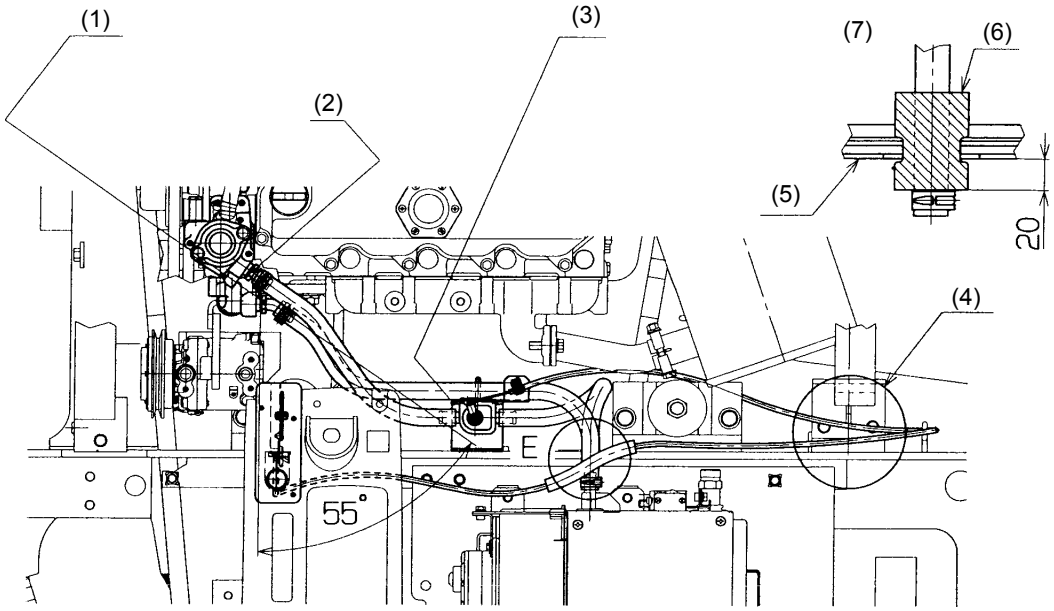




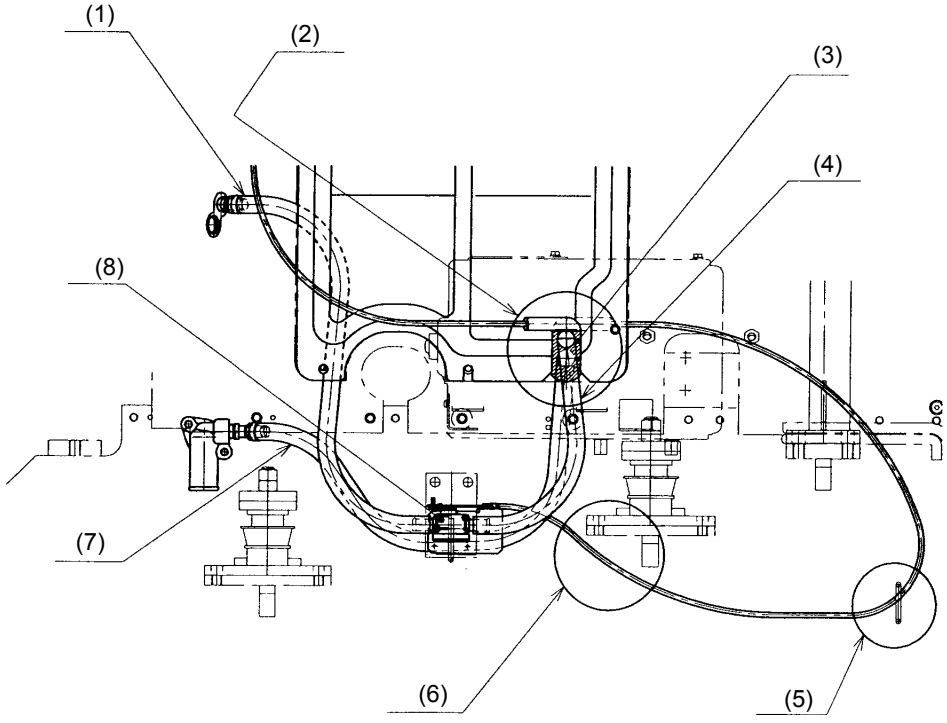


e. Heater hose and control cable

(1) Parts location



(1) Water pipe joint, out : T1065-7282 △
This joint should be installed horizontally.
(2) Water pipe joint : T1065-7281 △
(3) Hot water valve bracket : RD118-4744 △
Bolt : 01135-61020, 2 pcs
(4) Go through the front side of arch.
(5) Bonnet cover 1
(6) Cushion 1
(7) E-detail



(1) Heater hose 1 : RD118-4741 △
L = 690 mm
Hose clamp:09318-88185,6 pcs
(2)When placing the cover assembly (bonnet, A/C), make sure the sealant of cable (valve, A/C) runs on the cushion (1).
(3) Cushion (1)
(4) Heater hose 2 : RD118-4742 △
L = 405 mm
(5) Go through the rod ring of swivel frame.
(6) Go under engine bracket.
(7) Heater hose 3 : RD118-4743 △
L = 795 mm
(8) Hot water valve : T0270-6750 △
Screw : 03024-50408, 2pcs

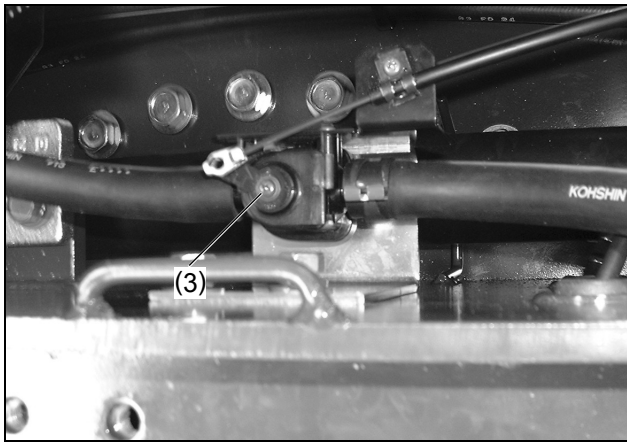
(2) Water Valve Control Cable (White Tape)

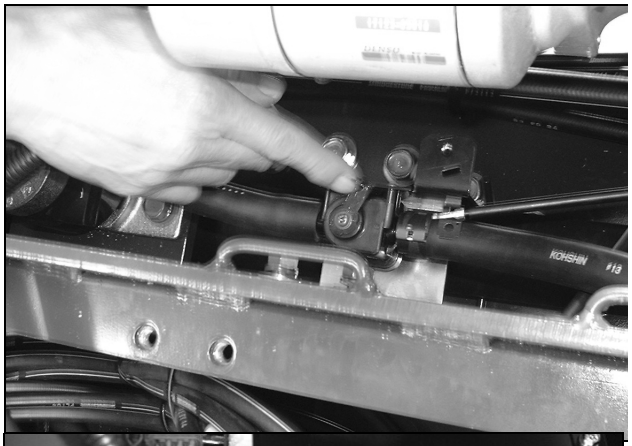
1. When disconnecting the water valve cable (1), follow the next reassembly procedure.

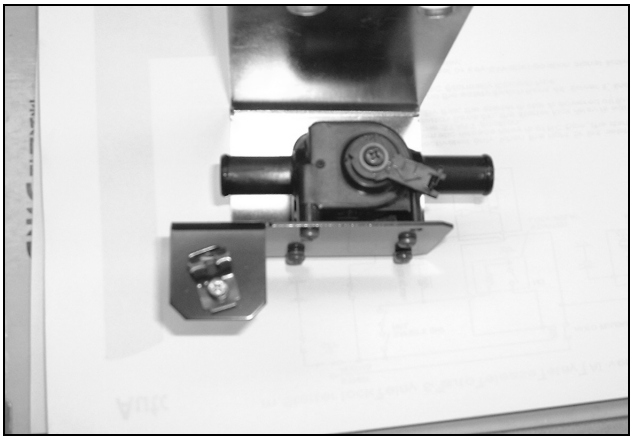
When reassembling

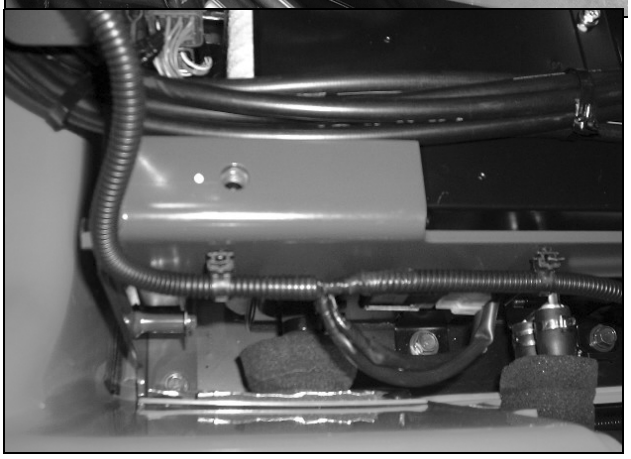
- Fully close the water valve (3) and reconnect the cable (1).
- Set the control at MAX COOL position. Fit the inner cable in position, and press and fix the outer cable by the cable clip (2) in the direction of arrow (A) as shown at left.
- Move the temperature control lever several times to make sure the water valve is fully closed at MAX COOL position.
- Do no allow the water valve cable to bend just away from the control, nor to get caught by the covers or the like.

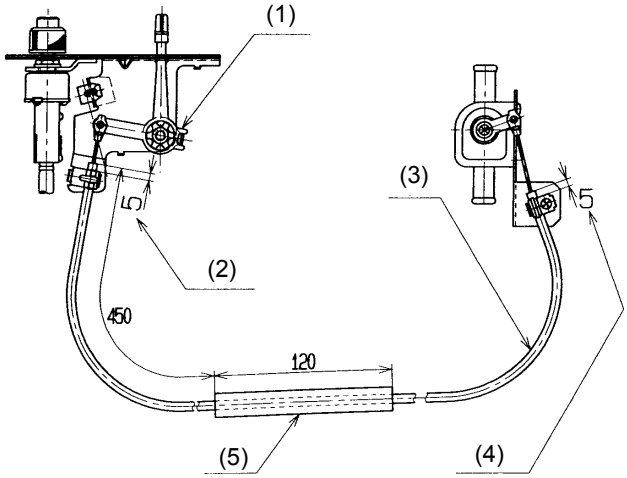
(1) Water Valve Control Cable a : 5 to 10 mm (0.20 to 0.40 in.)
(2) Cable Clip
(3) Water Valve A : Direction of Pulling Outer Cable





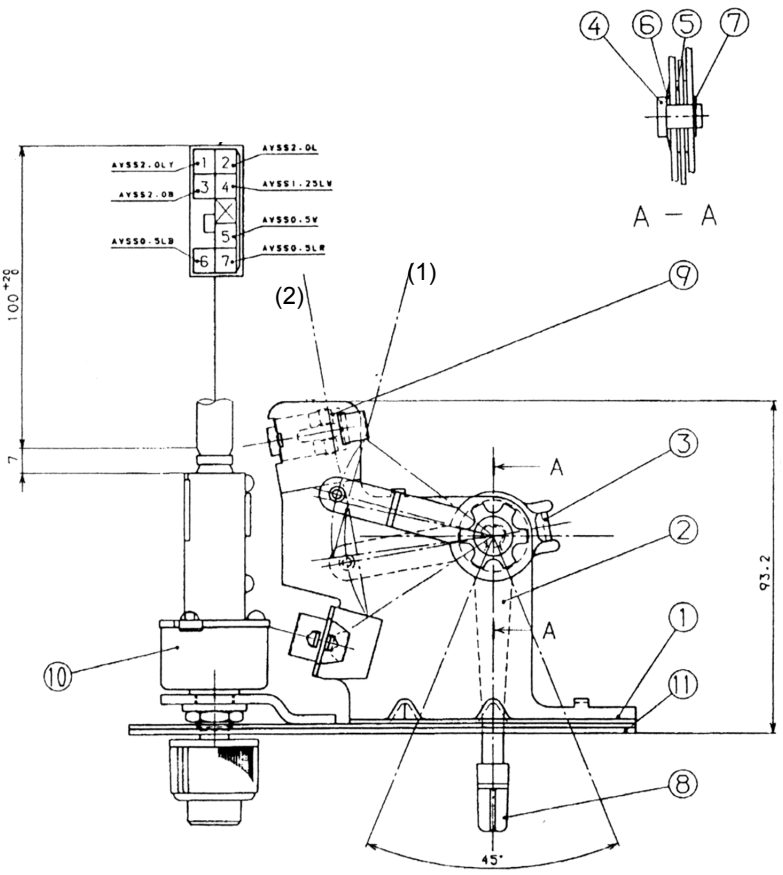






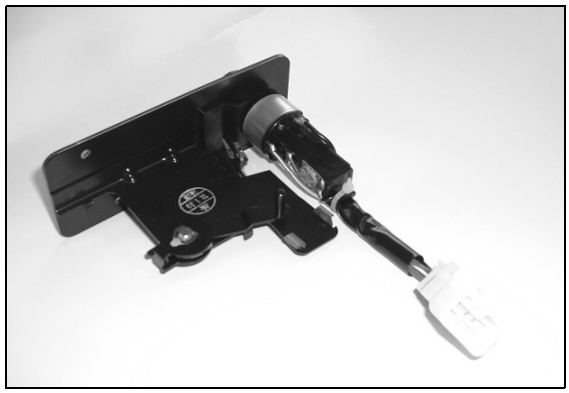
(1) A/C switch assy : RD118-5361 △
Screw : 3F760-5333 △ , M4 - 10
(2) Let the outer cable 5 mm (0.2") come long from clamp end.
(3) A/C valve cable : RD118-4745 △
(4) Let the outer cable 5 mm (0.2") come long from clamp end.
(5) Sealing material
(6) Hoses and cables should not rink itself.

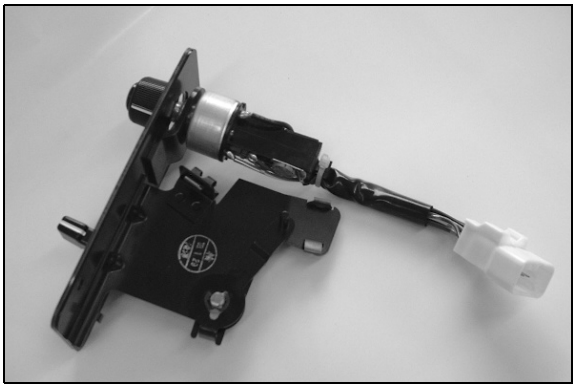
(3) A/C switch

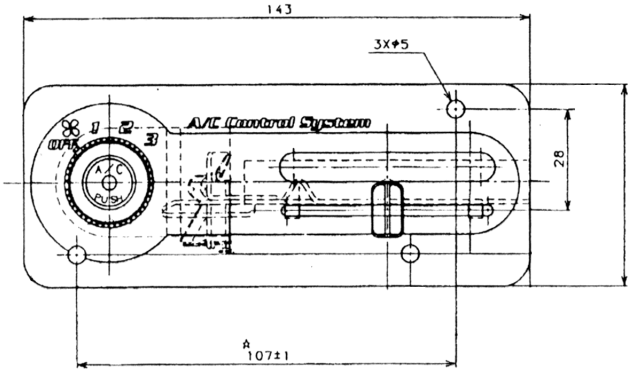


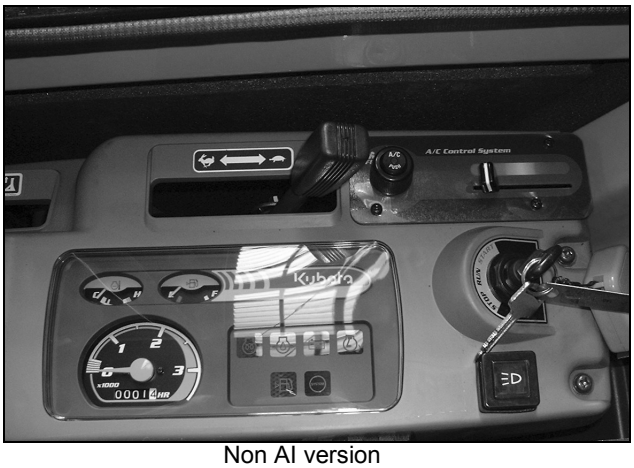
(1) W/V cable, stroke 35 mm
(2) A/M door cable, stroke 32 mm

1 Control base sub assy
2 Control lever sub assy
3 Control lever sub assy
4 Pin
5 Washer
6 Wave washer
7 E-ring
8 Control knob
9 Lock clamp
10 Cooler switch assy
11 Ornament sub assyA/C switch









Non AI version

AI version

f. Cooler hoses installation

(1) Handling the air-conditioner parts

Do not remove the cooler hose caps until connecting the hose. Do not keep the receiver's cap, in particular, open longer than 3 minutes (because of the desiccant inside).

Water or dust entry into circuit
↓
Circuit clogged

(2) Cooler hose

Cooler hose tightening torque

M24×1.5 Nut Suction hose Ⓓ	29.4~34.3N·m(3.0~3.5kgf·m)
M22×1.5 Nut Discharge hose Ⓐ	19.6~24.5N·m(2.0~2.5kgf·m)
M16×1.5 Nut Liquid hose Ⓒ	11.8~14.7N·m(1.2~1.5kgf·m)
Compressor M6 bolt Ⓓ	7.9~11.8N·m(0.8~1.2kgf·m)
Receiver M6 bolt Ⓒ	3.9~6.9N·m(0.4~0.7kgf·m)

Low torque
↓
Gas leak
High torque
↓
Thread damage

Pipe connection

Apply compressor oil (ND-OIL8) to the O rings.
Install up to the step at the pipe end. Then tighten up the nut.

O-ring damage
↓
Gas leak
Poor fitting
↓
Thread damage, gas leak

.**Tightening the hoses**

Note that their mating parts are easy to get damaged
Apply another wrench to the mating part to keep it from turning.

Pipe distortion and damage
↓
Gas leak

(3) Gas charging

With a gas charger

Keep the engine off. Be sure to feed the gas through the high-pressure side (H).

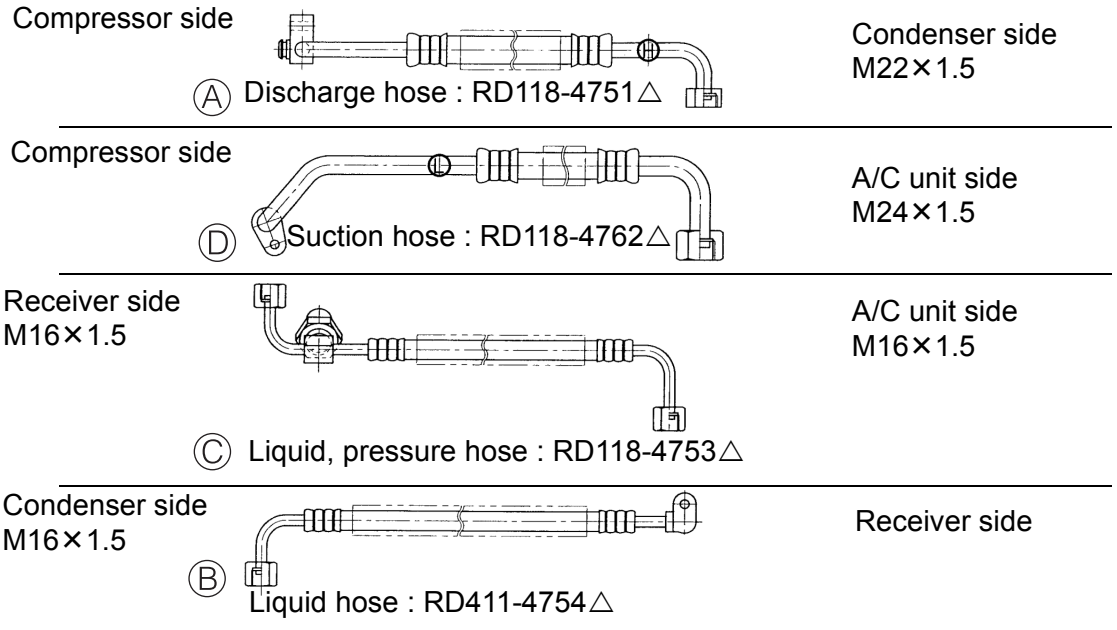
Without a gas charger

1) Keep the engine off. Feed the gas through the high-pressure side (H).
2) Then run the engine at below 1500 rpm and feed the gas through the low-pressure side (L).

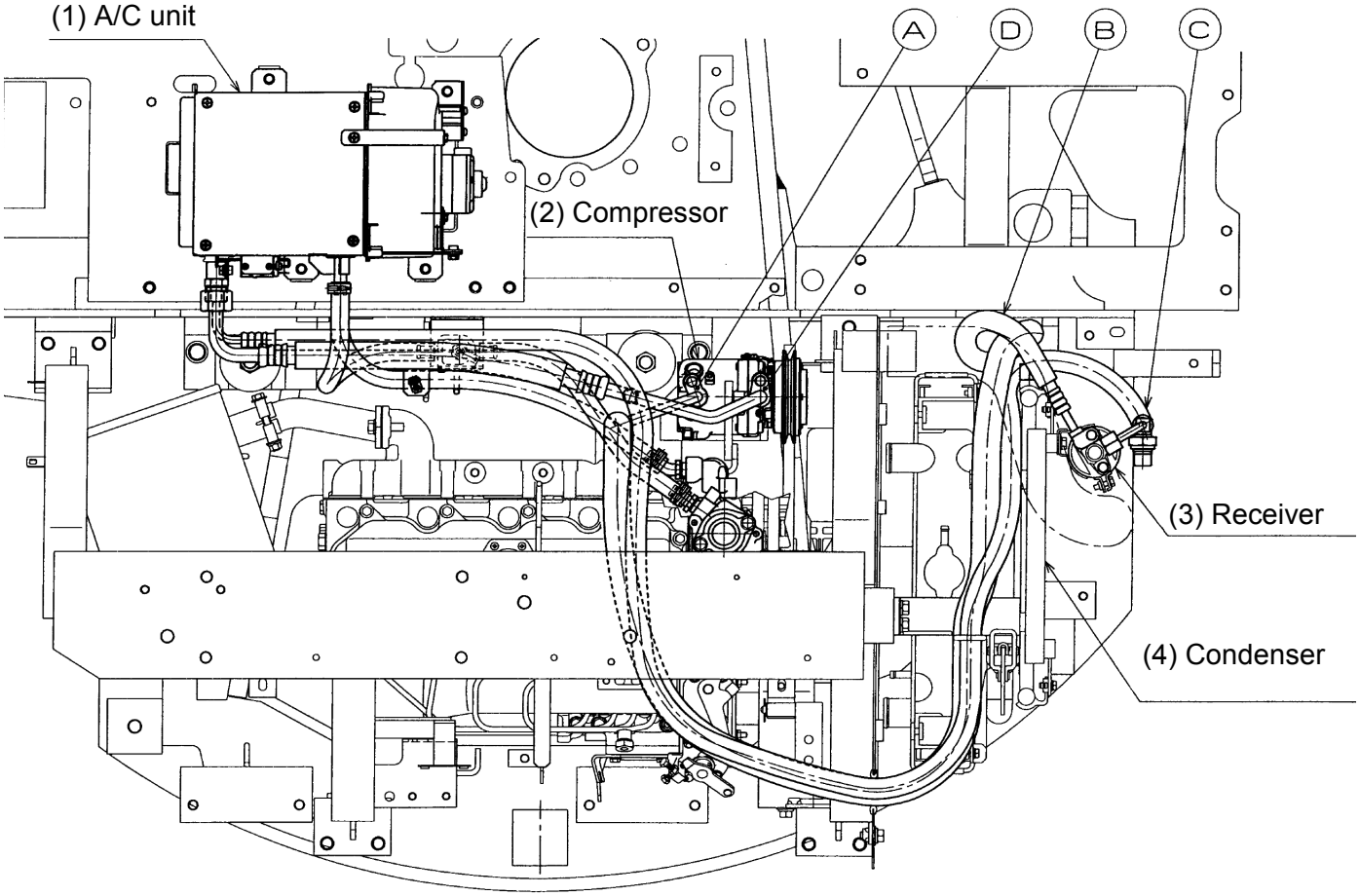
Wrong gas charging
↓
Liquid compression
↓
Compressor failure

Charging amount(Refrigerant : HFC134a)
800±50g(1.76 ±0.11 lbs)

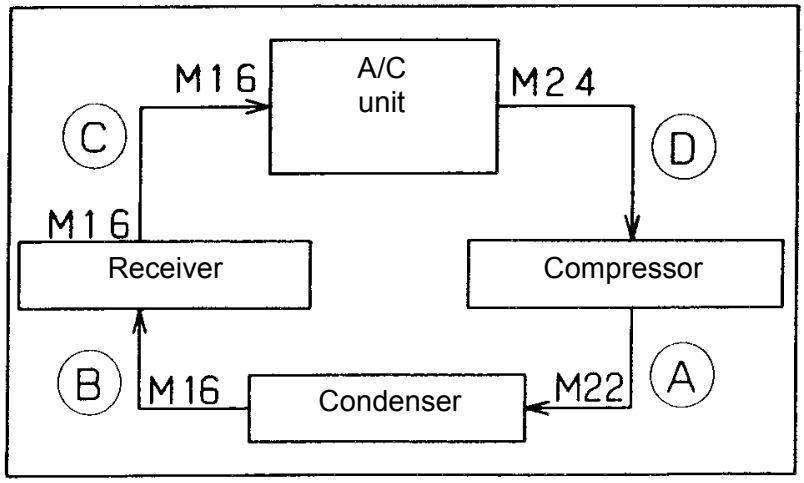
Too much or short gas
↓
Poor cooling



(4)Cooler hoses layout 1



Connection of cooler hoses



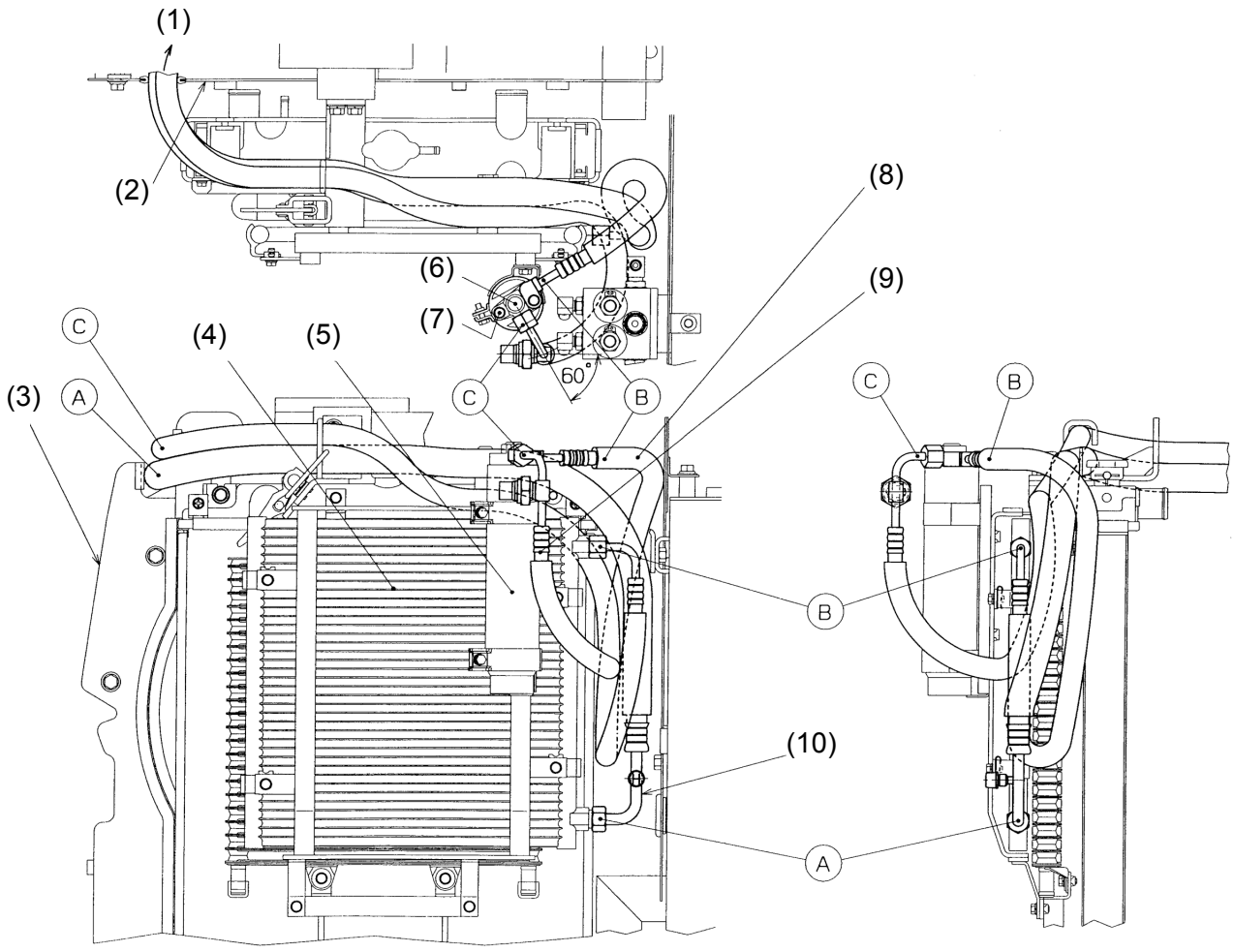
Ⓐ Discharge hose : RD118-4751△

Ⓑ Liquid hose : RD411-4754△

Ⓒ Liquid pressure hose : RD118-4753△

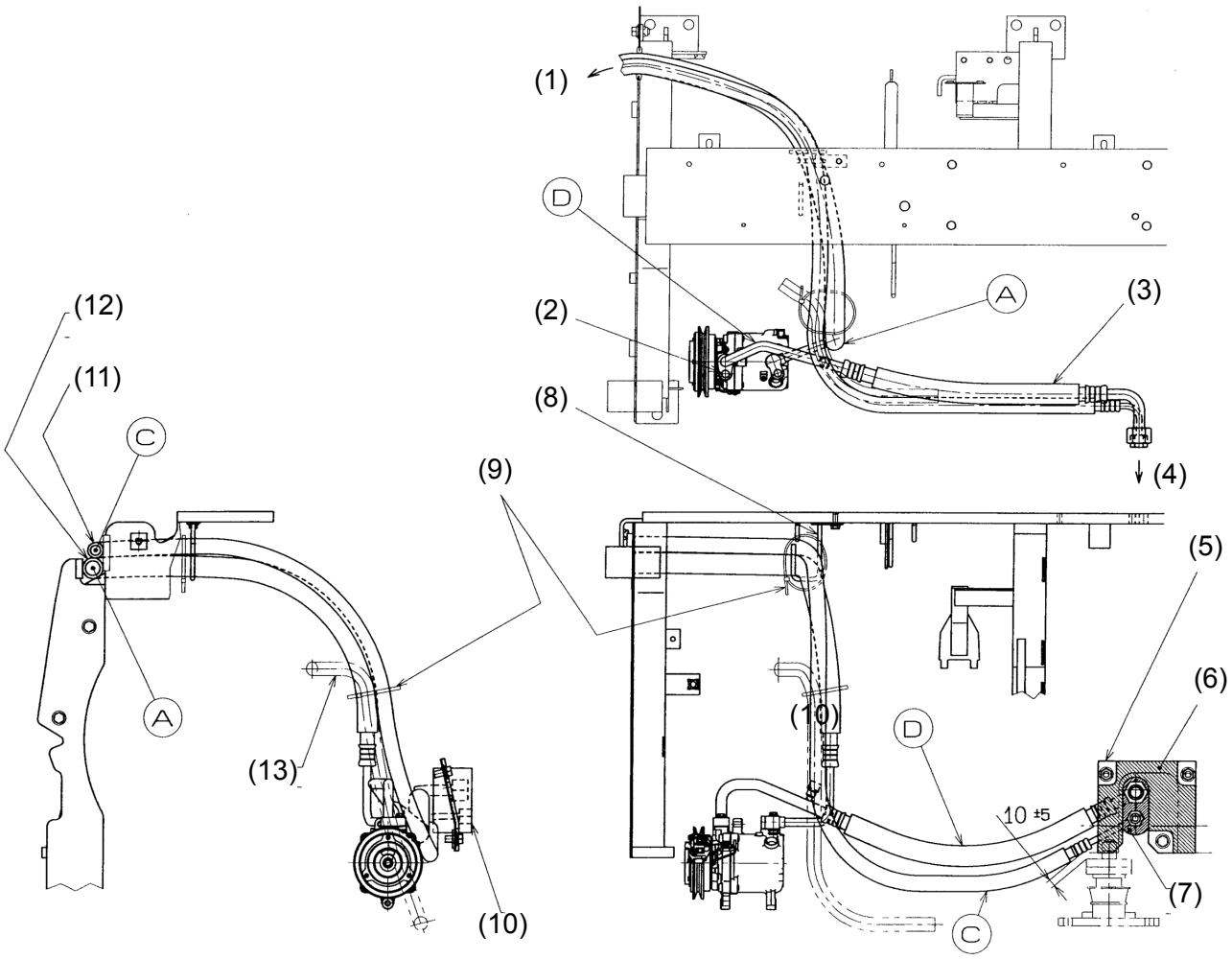
Ⓓ Suction hose : RD118-4762△

(5) Cooler hoses layout 2



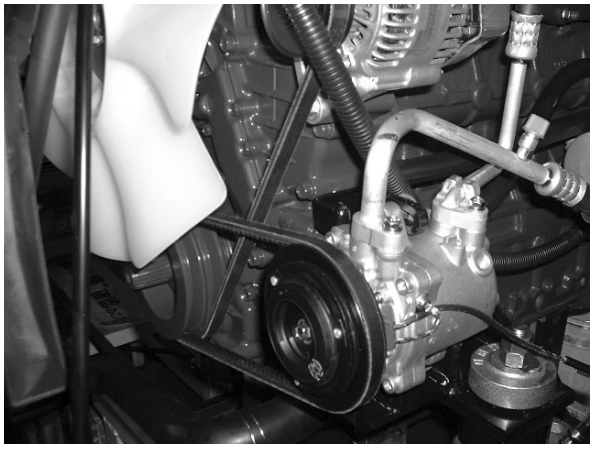
(1) To A/C unit, compressor△
(2) Arch from aasy : Rd118-4760△
(3) Arch plate assy : Rd118-4770△
(4) Condenser
(5) Receiver
(6) Receiver joint : T0270-8717△
(7) Bolt : 01025-50625
(8) Liquid hose : RD411-4754△
(9) Liquid pressure hose : RD118-4753△
(10) Discharge hose : RD118-4751△

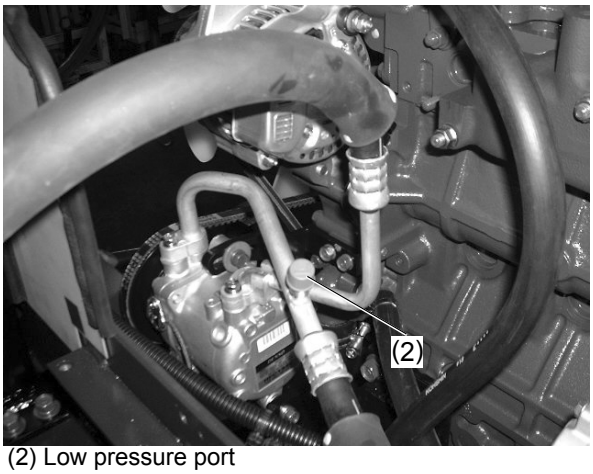
(6) Cooler hoses layout 3



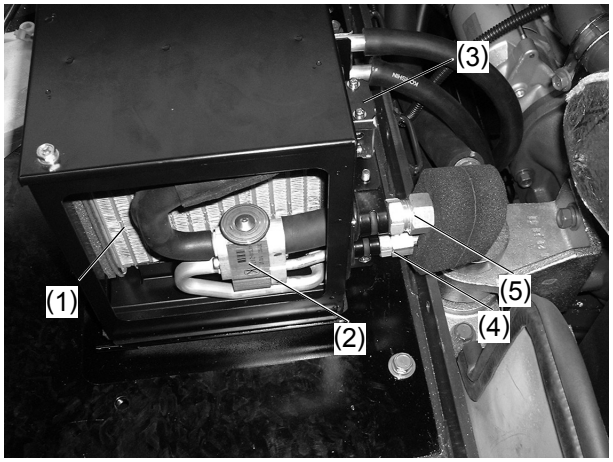
(1) To condenser, receiver
(2) Flange bolt : 01754-50625, 2 pcs
(3) Suction hose : RD118-47620
(4) To A/C unit
(5) Bonnet cover 2 : RD118-4789△
(6) Heat insulator : RD118-4789△
(7) Cushion (2) : RD118-4715△
(8) Hose guide : RD411-47580△
Flange bolt : 01754-50816
(9) Cord band : 55311-4126△
(10) With the hose in place, install the cushion (2) up to this position to seal the hose.
(11) Liquid pressure hose : RD118-4753△
(12) Discharge hose : RD118-47510△
(13) Heater hose 1 : RD118-4741△

7. Hoses Layout photos

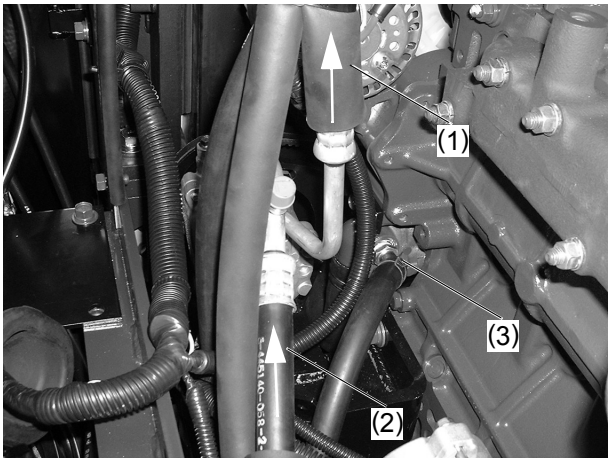




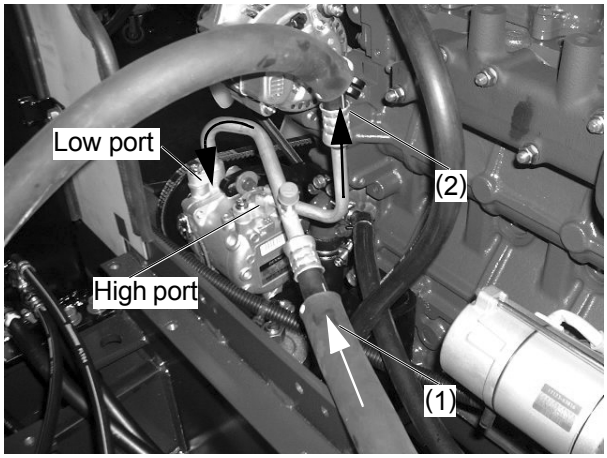
(2) Low pressure port



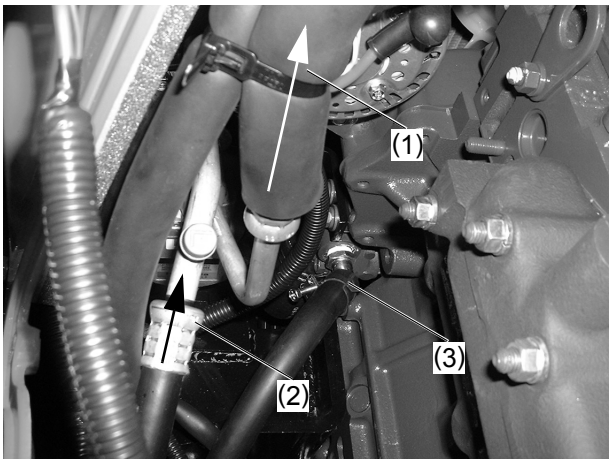
(1) Evaporator
(2) Expansion valve
(3) Thermostat
(4) High pressure hose
(5) Low pressure hose



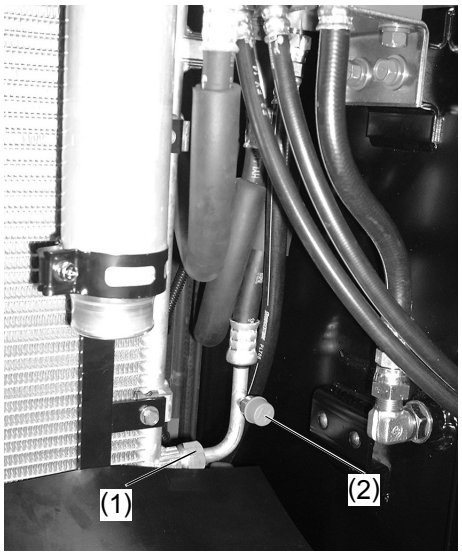
(1) Compressor H port to condenser lower port (H)
(2) Compressor L port from A/C unit upper port
(3) Engine lower port



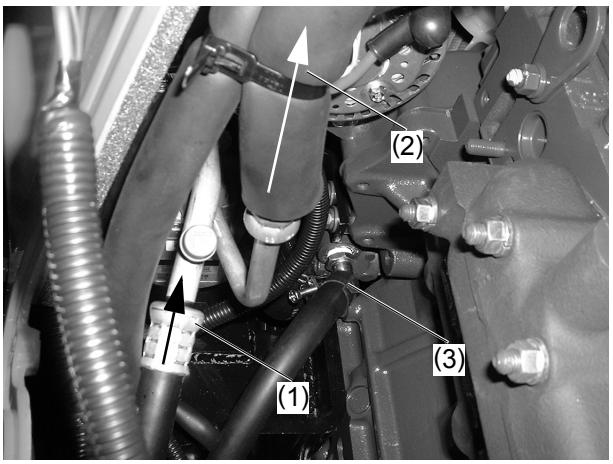
(1) A/C unit outlet port to compressor L port
(2) Compressor H port to condenser lower port (H)



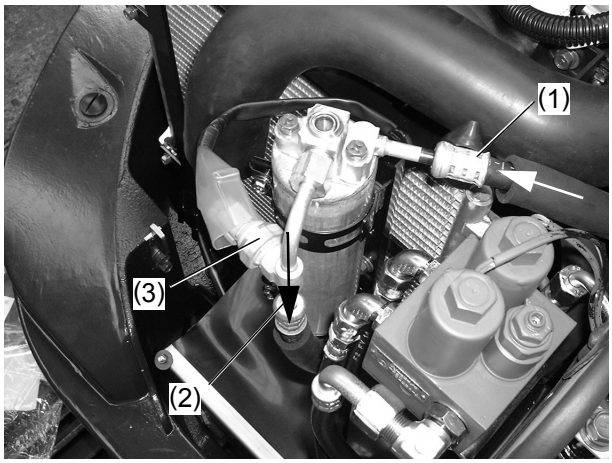
(1) To condenser
(2) From A/C unit
(3) Engine heater hose



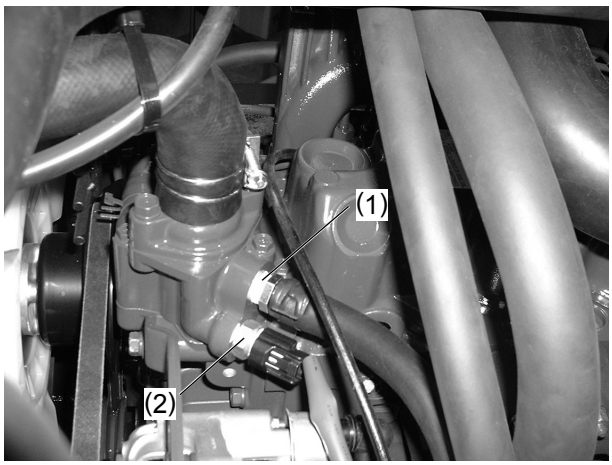
(1) From compressor H port
(2) High pressure port



(1) From A/C unit to compressor L port
(2) From compressor H port to condenser lower port (High pressure)

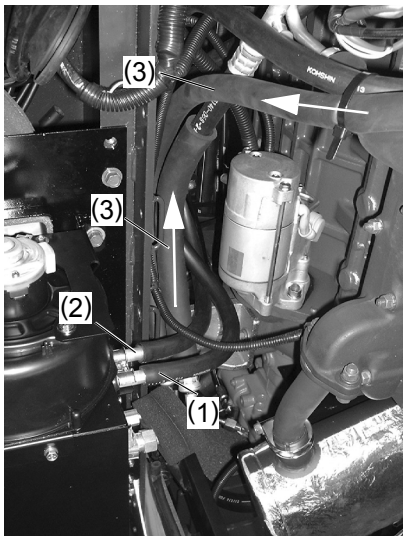


(1) From Condenser
(2) To A/C unit
(3) Dual pressure switch



(1) Engine upper port
(2) Temp. sensor

(1) To A/C unit
(2) From compressor to condenser lower port

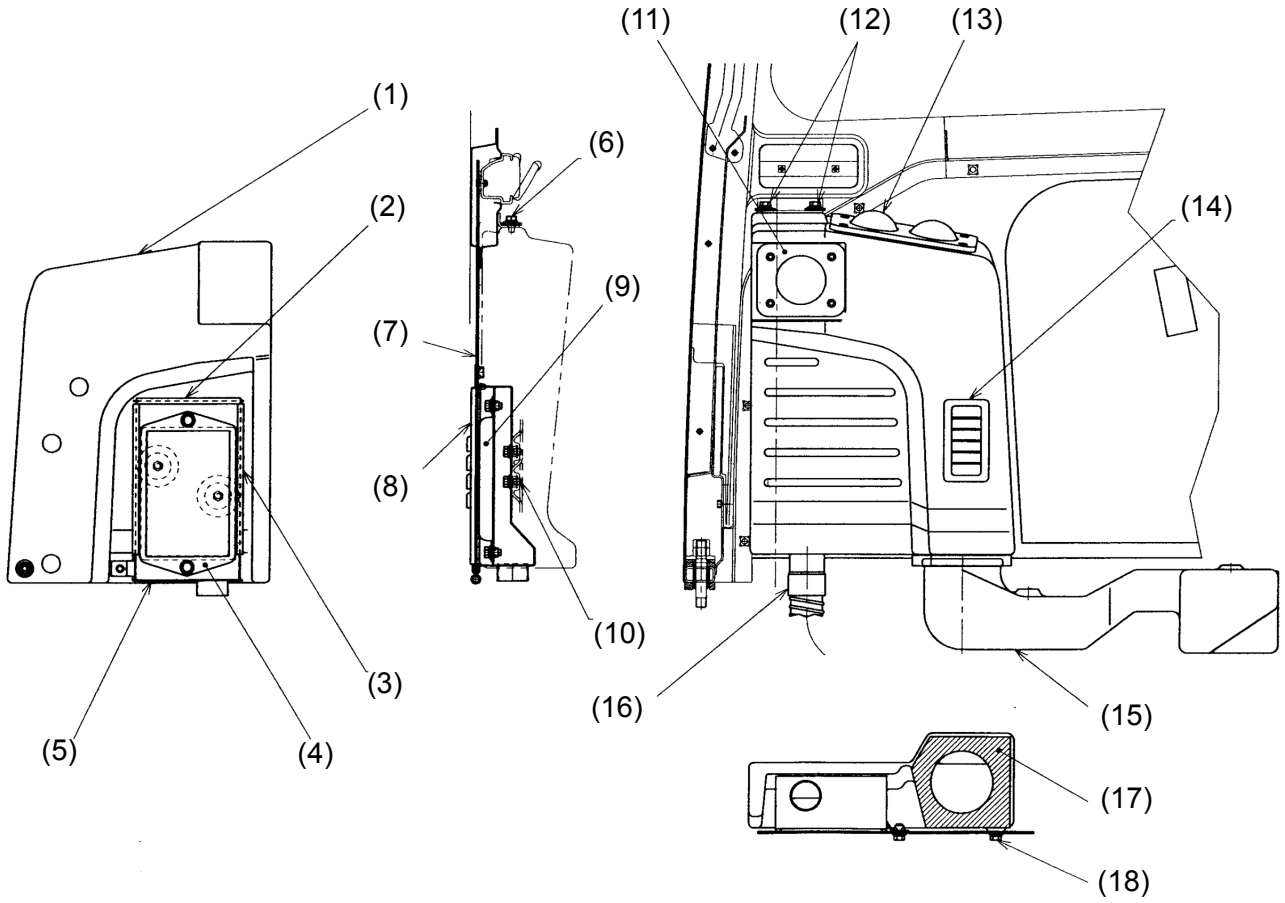


(1) Heater upper inlet from engine upperport
(2) Heater lower inlet from engine lower port
(3) A/C unit to compressor suction port (L)
(4) Receiver to A/C unit

g. Duct cover installation

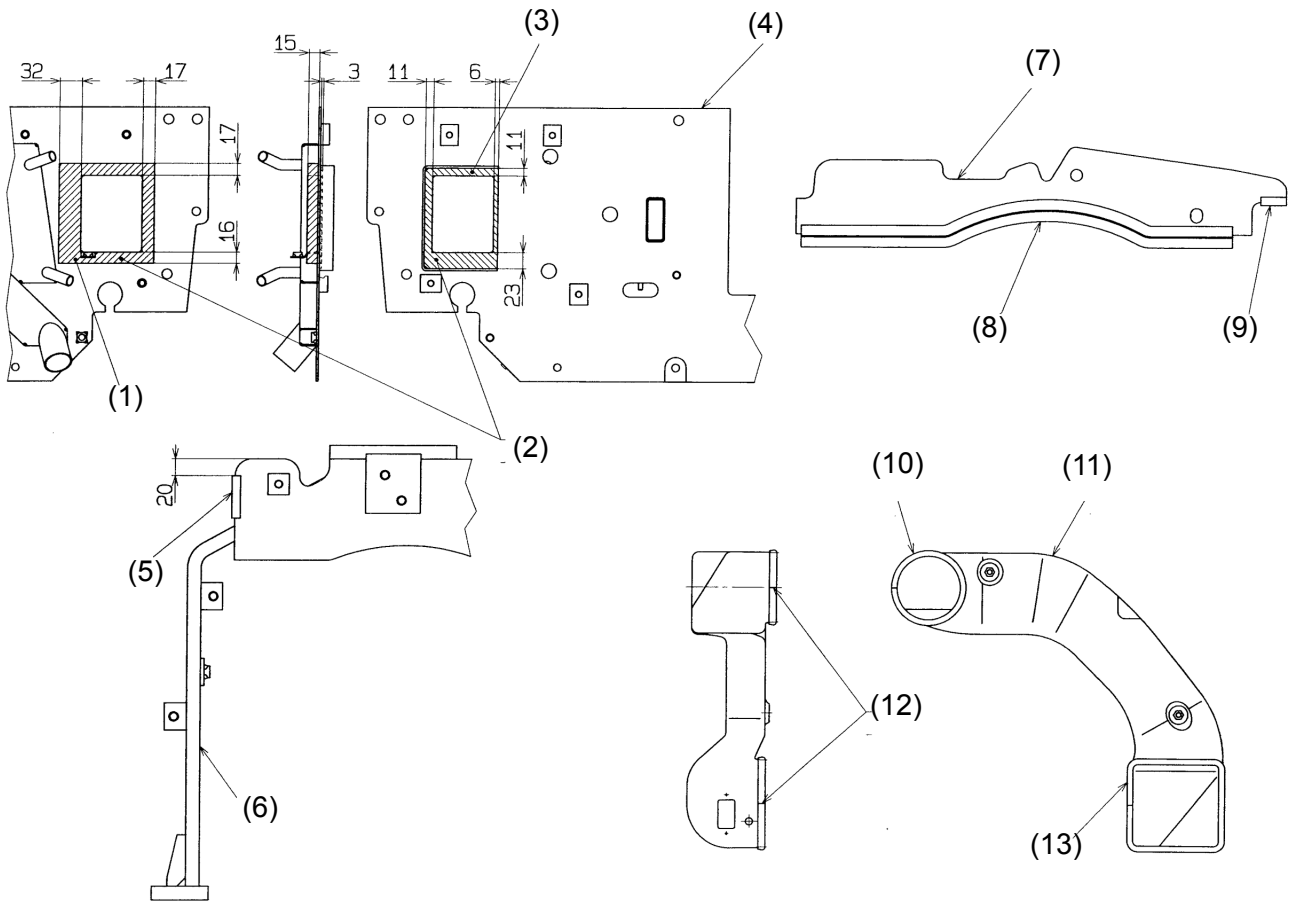
Installing the duct cover

1) Attach the filter cover on the duct cover.
2) Attach the inner filter on the above parts.
3) Connect the defroster hose (700) and temporarily fix the duct cover at the cap A.
4) Attach the outer cover (1) to the cover assembly (R).
5) Attach the duct cover onto the above parts.
   Finally fit all the parts and tighten up the bolts from point A.

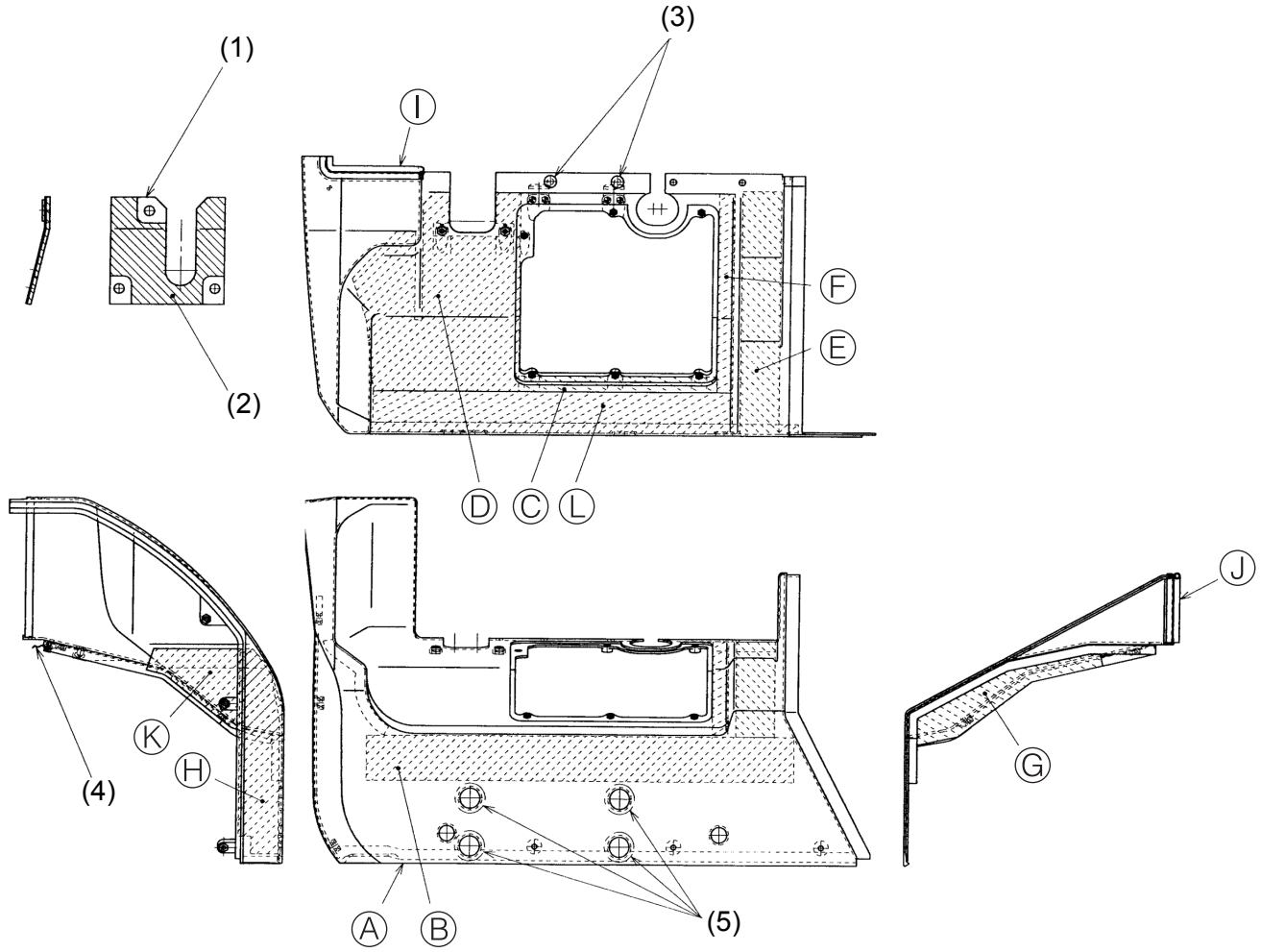


(1) Duct cover : RD118-4721△
(2) Trim : 68311-4238△
(3) Trim, 2 pcs : RC101-5336△
(4) Filter plate, A/C : RD118-4704△
    Bolt : 01125-60816, 2pcs
(5) Filter cover, A/C : RD118-4707△
(6) Bolt : 01125-60816, 2 pcs
(7) Cover assy, R , A/C : RD118-4705
    Bolt : 01125-60816, 8 pcs
(8) Cover 1 : RD118-4731△
    Bolt : 01125-60816, 6 pcs
(10) Bolt : 01125-60816, 2pcs
(11) Grill 2 : RD118-4723△
    Rivet, 4 pcs : RD118-4754△
(12) A-part
(13) Front grill : 3G710-5029 △
    Rivet, 4 pcs : RD118-4754△
(14) Grill assy, A/C : 3F760-5605△
(15) Duct assy, A/C : RD118-4740△
(16) Defroster hose, 700 : RB419-4928△
(17) Seal : RD118-4725△
(18) Bolt, 2 pcs : 01125-60816

h Noise absorber and trims



(1) Seal 1 : RD118-4791△
(2) Align the holes of the sealants with those of the steps.
Be careful not to confuse the applying direction.
(3) Seal 2 : RD118-4792△
(4) Step 3, A/C : RD118-4783△
(5) Grommet (50) : 68191-4236△
(6) Arch plate : RD118-4121△
(7) Arch plate assy, A/C : RD118-4770△
(8) Trim (515) : RD411-4132△
(9) Grommet (30) : RP301-4234△
(10) Trim 2-310 : RD118-4794△
(11) Duct, A/C : RP118-4749△
(12) Bond together the ends of the trims securely.
(13) Trim (3) : Rp821-4237△

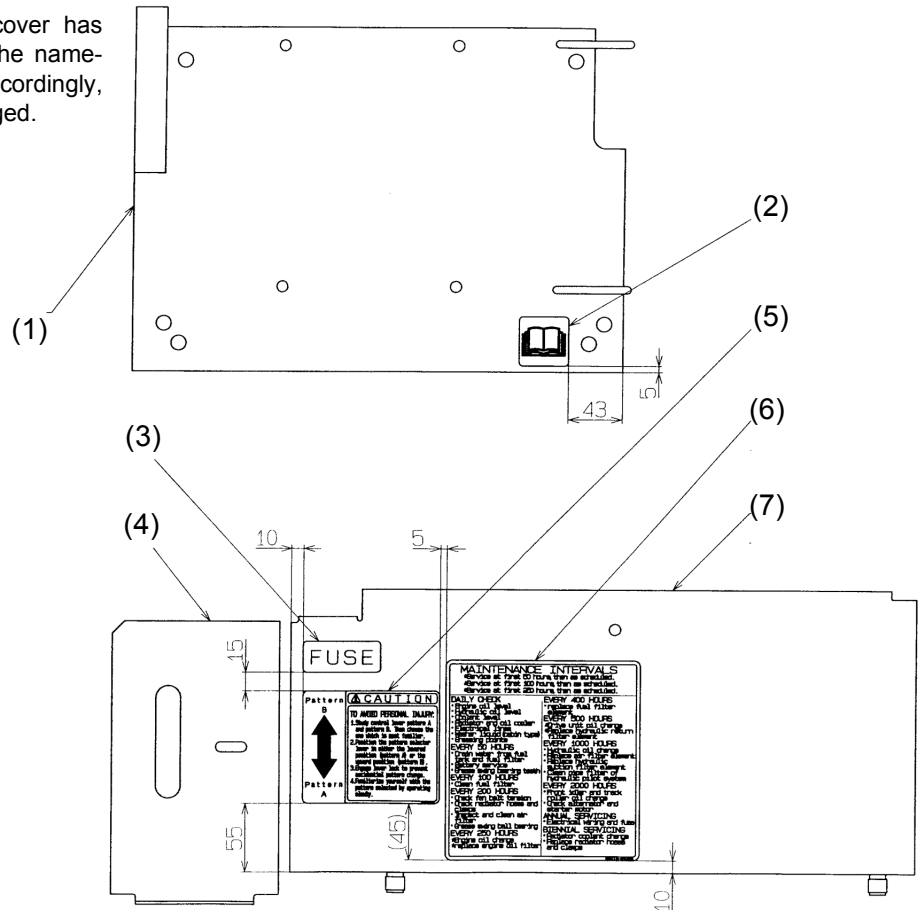


(1) Bonnet cover 2, A/C : RD118-4789△
(2) Heat insulator cover, A/C : RD118-4797△
(3) Label, canopy, 2 pcs : R2401-4525△
(4) Plate spring, A/C, 2 pcs : RD118-4376△
Bolt, 4 pcs : 01125-60816
(5) Label, 4 pcs : RD118-4519△

Ⓐ Bonnet 1, L
Ⓑ Noise absorber 1, Bonnet L
Ⓒ Noise absorber 2, Bonnet L
Ⓓ Noise absorber 3, Bonnet L
Ⓔ Noise absorber 4, Bonnet L
Ⓕ Noise absorber 5, Bonnet L
Ⓖ Noise absorber 6, Bonnet L
Ⓗ Noise absorber 7, Bonnet L
Ⓘ Trim (5)
Ⓙ Trim (6)
Ⓚ Noise absorber 8, Bonnet L
Ⓛ Noise absorber 9, Bonnet L

i. Labels

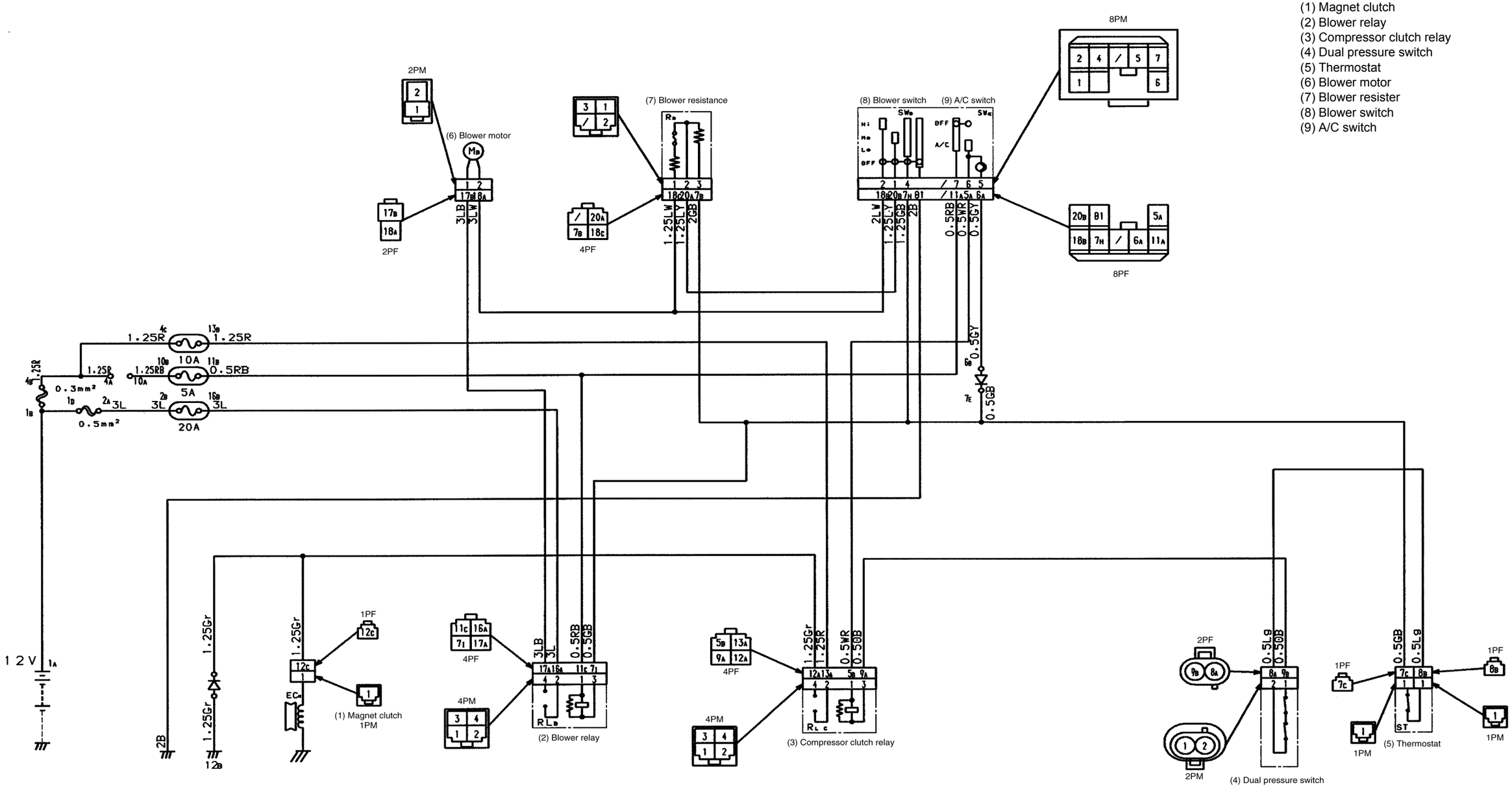
The seat support cover has been redesigned. The name-plate position, accordingly, has also been changed.



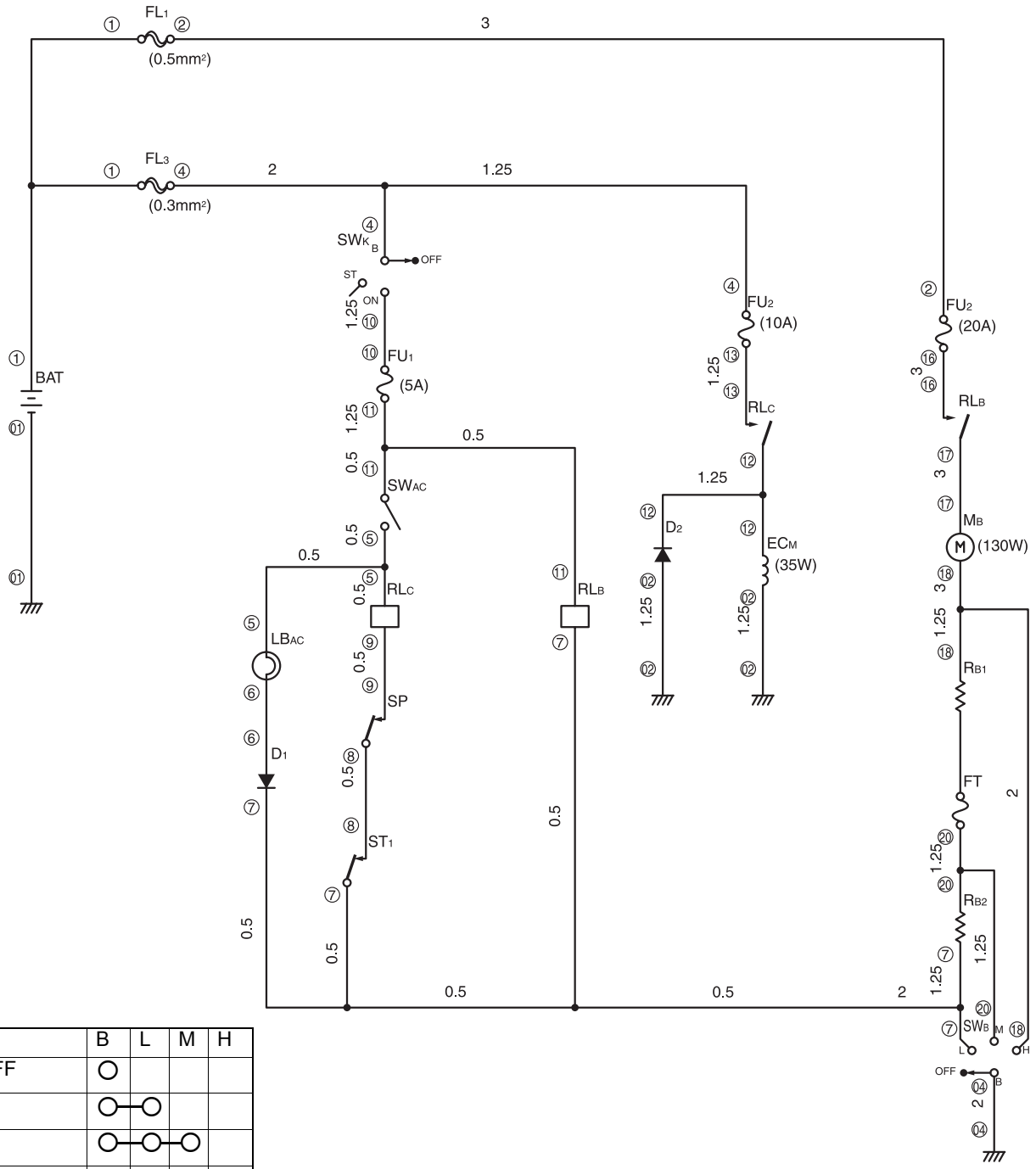
(1)Seat bracket, A/C : RD118-4786△
(2)Label, book : RC418-5783△
(3)Label, fuse ; RC418-5781△
(4)TPSS lever bracket : RD118-4796△
(5)Label, caution, control pattern : RC418-5732△
(6)Label, maintenance : RC418-5746△
(7)Seat support cover : RD118-4788△

j. Wire harness route

(1) Magnet clutch
(2) Blower relay
(3) Compressor clutch relay
(4) Dual pressure switch
(5) Thermostat
(6) Blower motor
(7) Blower resister
(8) Blower switch
(9) A/C switch



A/C electric circuit diagram(DENSO A/C)



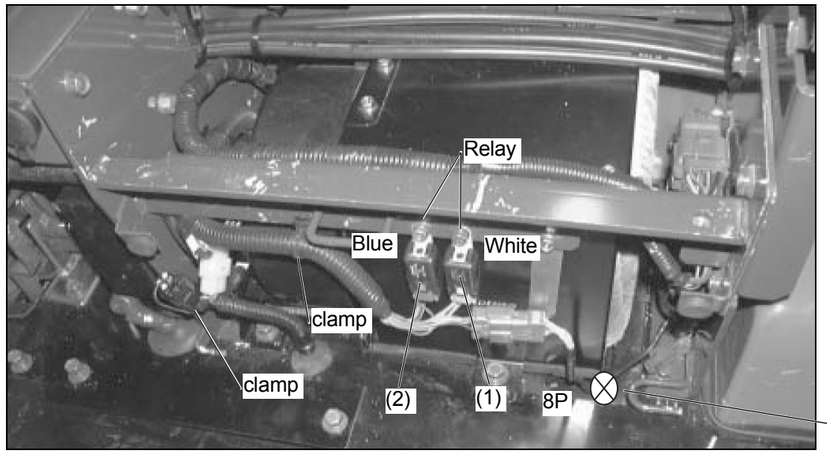
SWB

	B	L	M	H
OFF	○			
1	○—○			
2	○—○—○			
3	○—○—○—○			

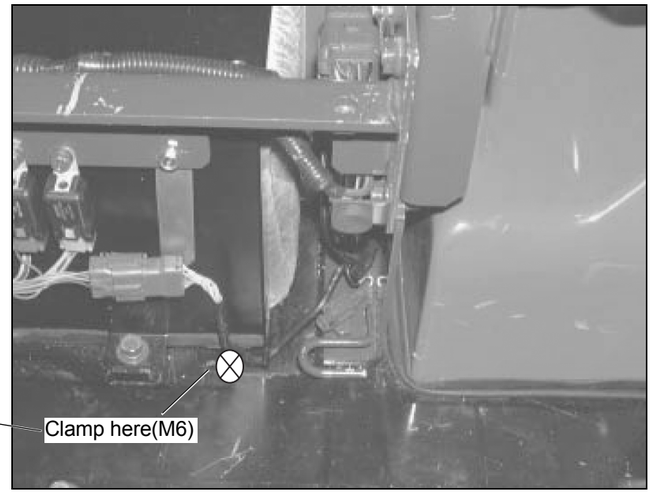
⑫	1.25	⑨	0.5
⑬	1.25	⑩	1.25
⑭	2	⑪	0.5, 1.25
②	3	⑫	1.245
④	2, 1.25	⑬	1.25
⑤	0.5	⑯	3
⑥	0.5	⑰	3
⑦	0.5, 2, 1.25	⑱	2, 1.25
⑧	0.5	⑳	1.25

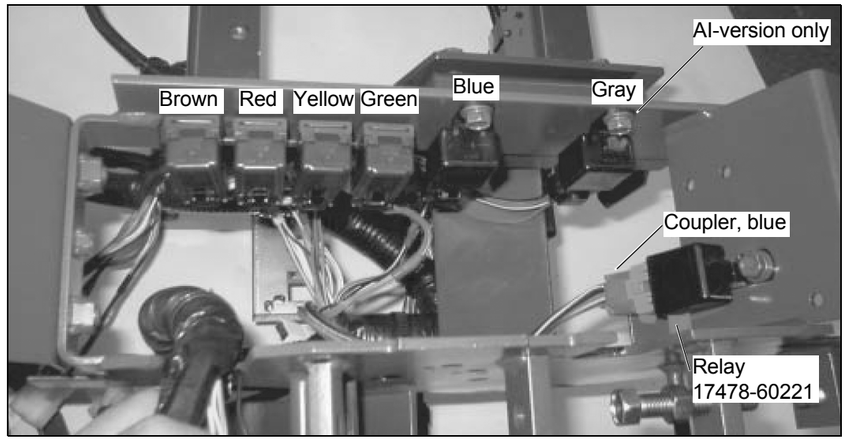
BAT: Battery
D_1 : Diode 1
D_2 : Diode 2
EC_M : Magnet clutch
FL_1 : Fusible link 1
FL_2 : Fusible link 2
FT : Resister, thermo fuse
FV_1 : Control Fuse
FV_2 : Control Fuse
FV_4 : Blower Fuse
LB_{AC} : A/C unit lamp
MB : Blower motor
R_{B1} : Blower resister 1
R_{B2} : Blower resister 2
RL_B : Blower relay
RL_C : Compressor clutch relay
SP : Dual pressure switch
ST_1 : Thermostat
SW_{AC} : A/C switch
SW_B : Blower switch
SW_K : Main key switch

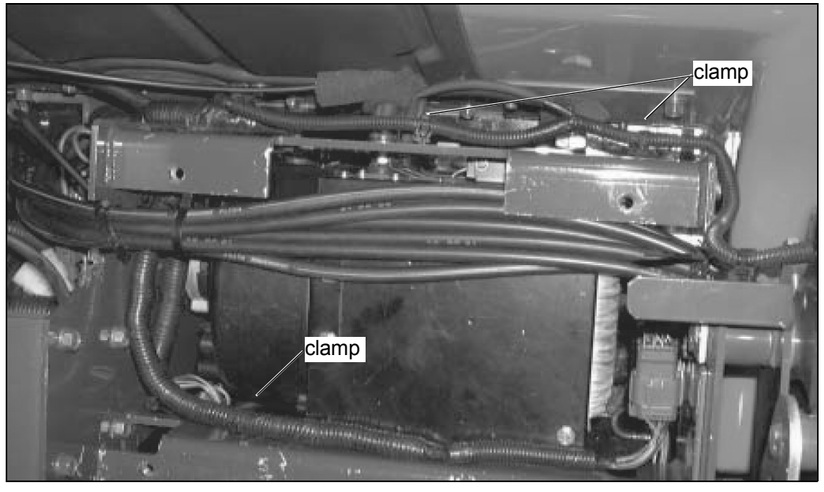
k. Wireharness clamps for A/C version

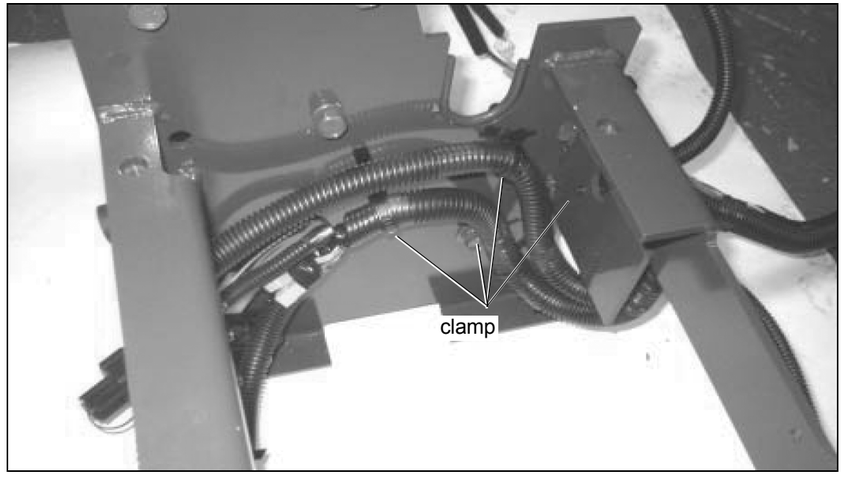


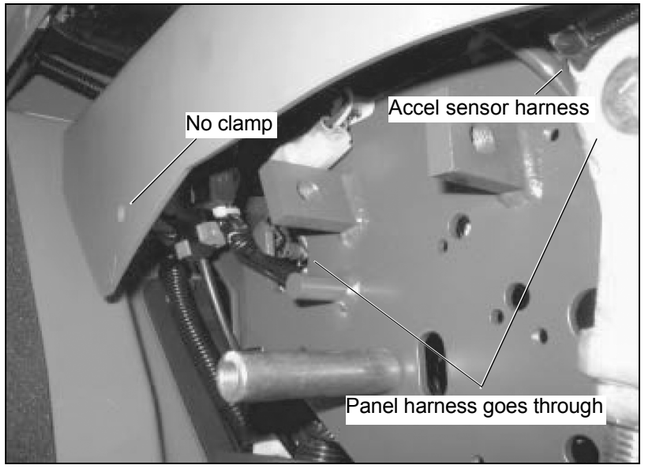
(1) A/C blower relay
(2) Compressor magnet clutch relay (Blue coupler)

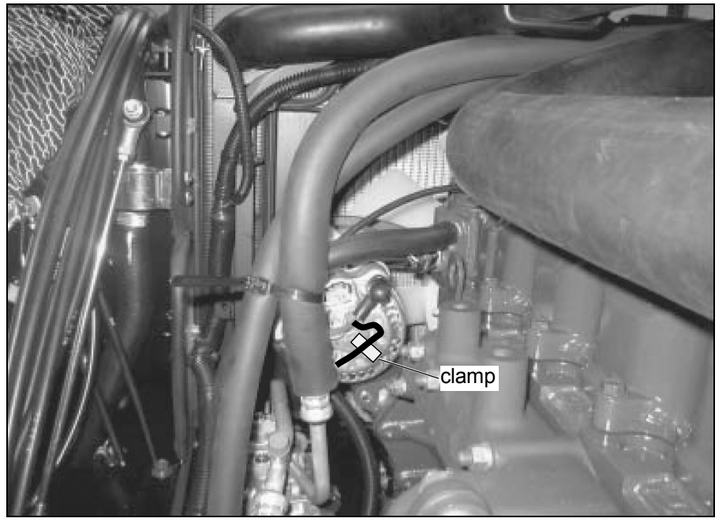


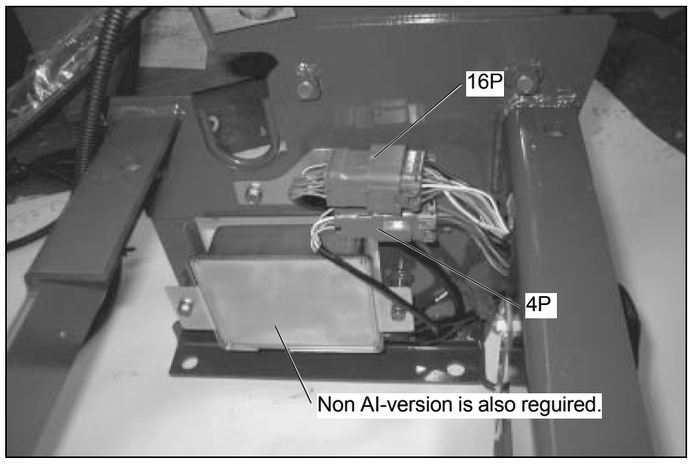


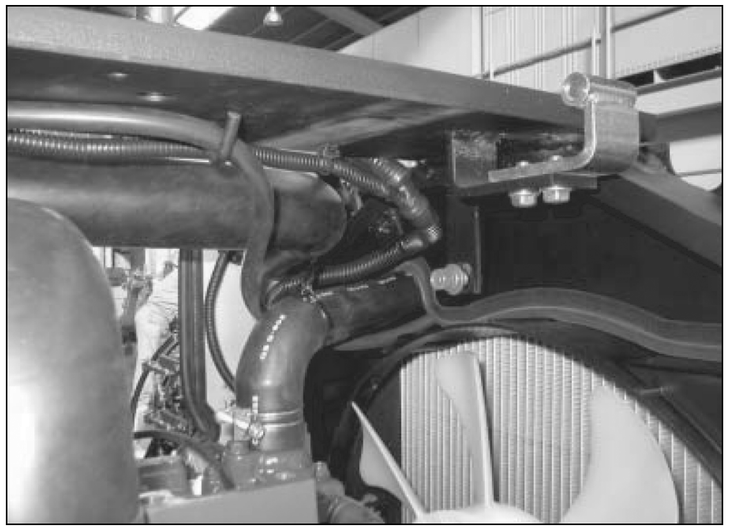


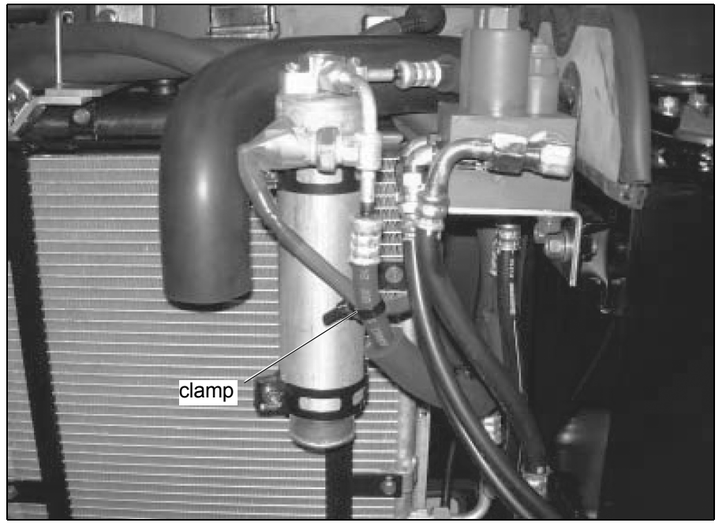



No clamp
Accel sensor harness
Panel harness goes through


clamp


16P
4P
Non AI-version is also reguired.




clamp

I. Parts identification of Air conditioner version

(1) Changes in the engine

Mounting the air-conditioner-specified engine(different types of drive pulley, alternator, etc.)
Engine bracket (1) changed
Heart hose outlet section redesigned

(2) Changes in the radiator and oil cooler

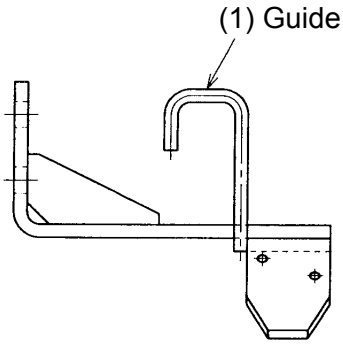
Bracket and support to be replaced . . . . . Condenser impossible to set up

(3) Changes in the frame (arch)

Lock bracket to be replaced . . . . . Condenser impossible to set up

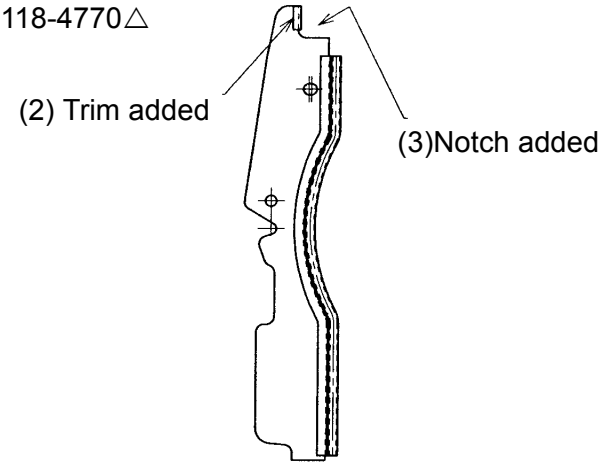
3-1 Lock bracket : RD411-4765△

*The parts shown below will be attached in the same positions as before.



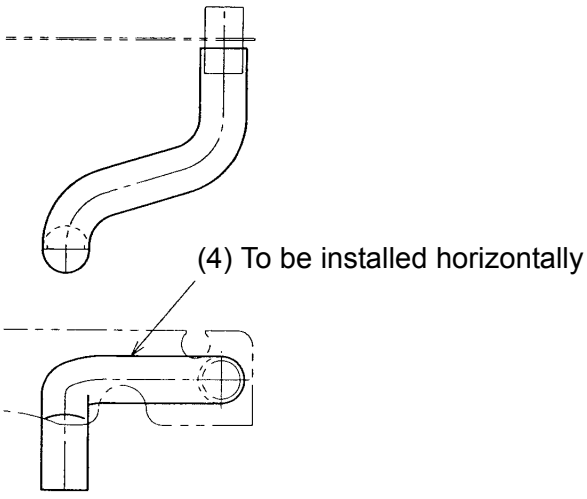
Arch plate assembly to be replaced . . . . . Cooler pipes impossible to connect

3-2 Arch plate assy : RD118-4770△



Inlet hose to be replaced . . . . . Condenser, receiver, etc. impossible to set up

3-3 Inlet hose 3 : RD411-4761△



(4) Changes in the steps

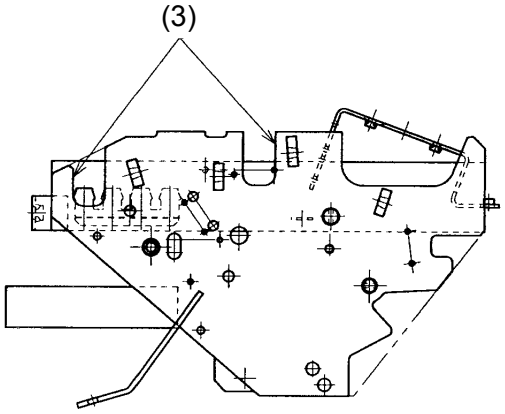
Floor parts, except the left step (1)and step support (2), to be replaced

A/C unit, duct, duct cover, etc. impossible to set up

(5) Changes in the right-side control

Right control bracket (1) to be replaced. Harness impossible to clamp

Ⓐ Control bracket 1, R : RD518-4456△

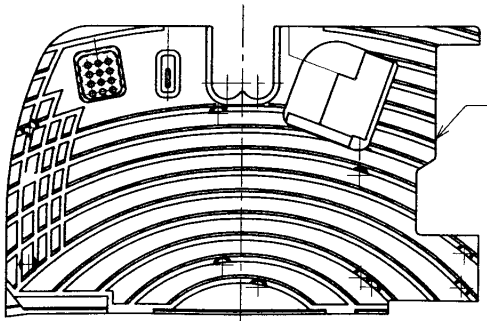


(6) Replacing the rubber mat

To be replaced by the air-conditioner-specific one

. . . . . Duct cover impossible to set up

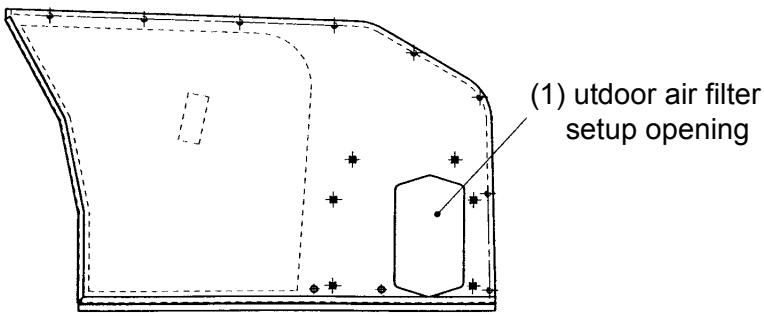
Ⓑ Rubber mat 1 : RD118-4973△



(7) Changes in the cabin

Cover assembly (R) to be replaced . . . . Duct cover impossible to fix

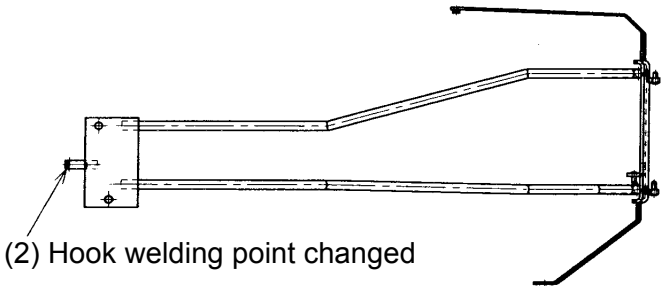
Ⓒ Cover assy, R : RD118-4705△



(8) Replacing the bonnet frame (R)

To be replaced by the air-conditioner-specific one. . . .Right bonnet impossible to lock

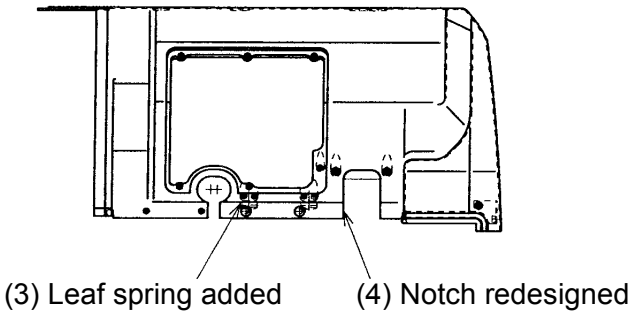
Ⓓ Bonnet frame, R : RD118-4764△



(9) Replacing the left bonnet (1)

To be replaced by the air-conditioner-specific one. . . .Cooler pipes impossible to connect

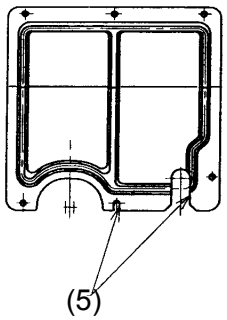
Ⓔ Bonnet assy 1, L : RD118-4780△



(9) Replacing the bonnet cover assembly (1)

To be replaced by the air-conditioner-specific one. . . .Heater hose impossible to connect

Ⓕ Bonnet cover assy 1 : RD118-4771△



(11) Replacing the seat support cover

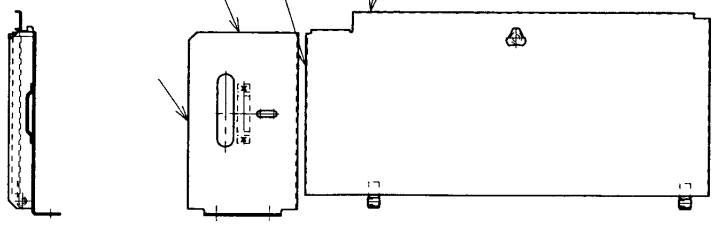
To be replaced by the air-conditioner-specific one. . . .Cover impossible to open and close

Ⓖ

(6)TPSS lever bracket : RD118-4796△

(7)

(8)Seat support cover
: RD118-4788 △



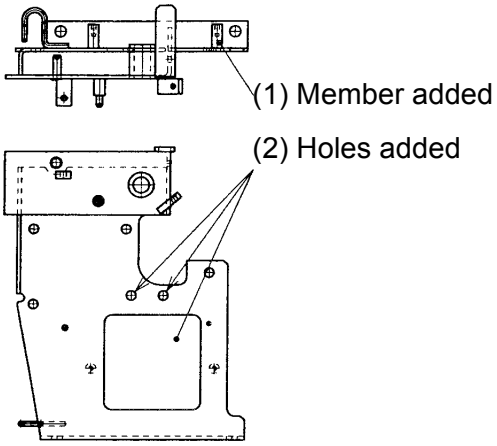
(12)Replacing the seat mount parts

Seat support (L), seat support (R) and seat bracket to be replaced

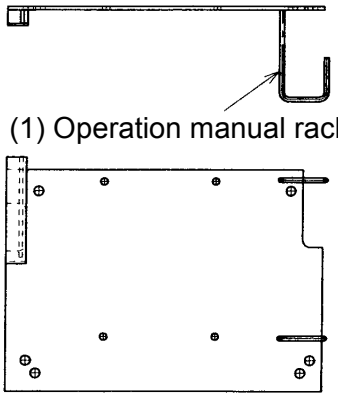
. . . . . A/C unit impossible to set up

Operation manual impossible to put in

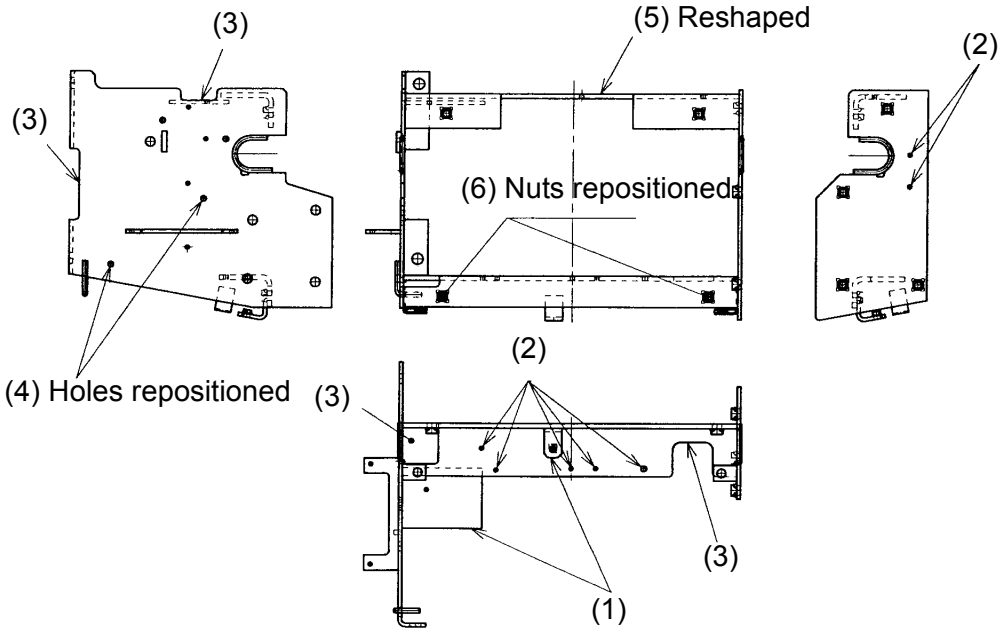
Ⓗ Seat support, L : RD118-4784△



Ⓗ Seat bracket : RD118-4786△



Ⓗ Seat support, R : RD118-4785△



(13)Replacing the wire harness

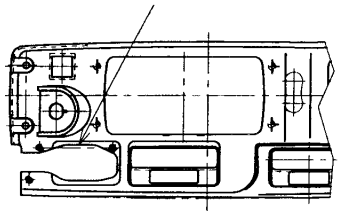
Main wire harness (engine) to be replaced . A/C and related components impossible to start

(14)Replacing the upper cover (R)

Upper cover (R) to be replaced . . . . . A/C-related switches impossible to set up

Ⓘ Upper cover, R : RD118-4761△

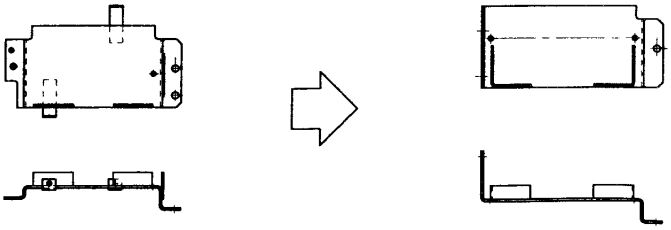
(7) Notch, hole, etc. added



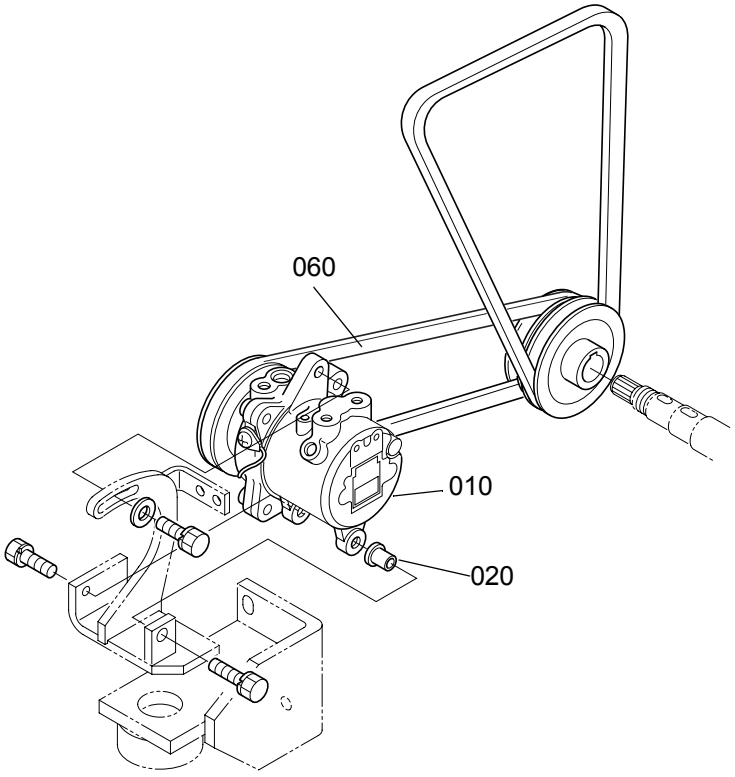
(15)Replacing the battery-related parts (Only for the KX121-3US without AI(Type: 95D31R --> 80D26R))

Battery bracket to be replaced. . . . . Battery impossible to set up

Ⓙ Battery bracket : Rd118-5329△ : RD411-5329△

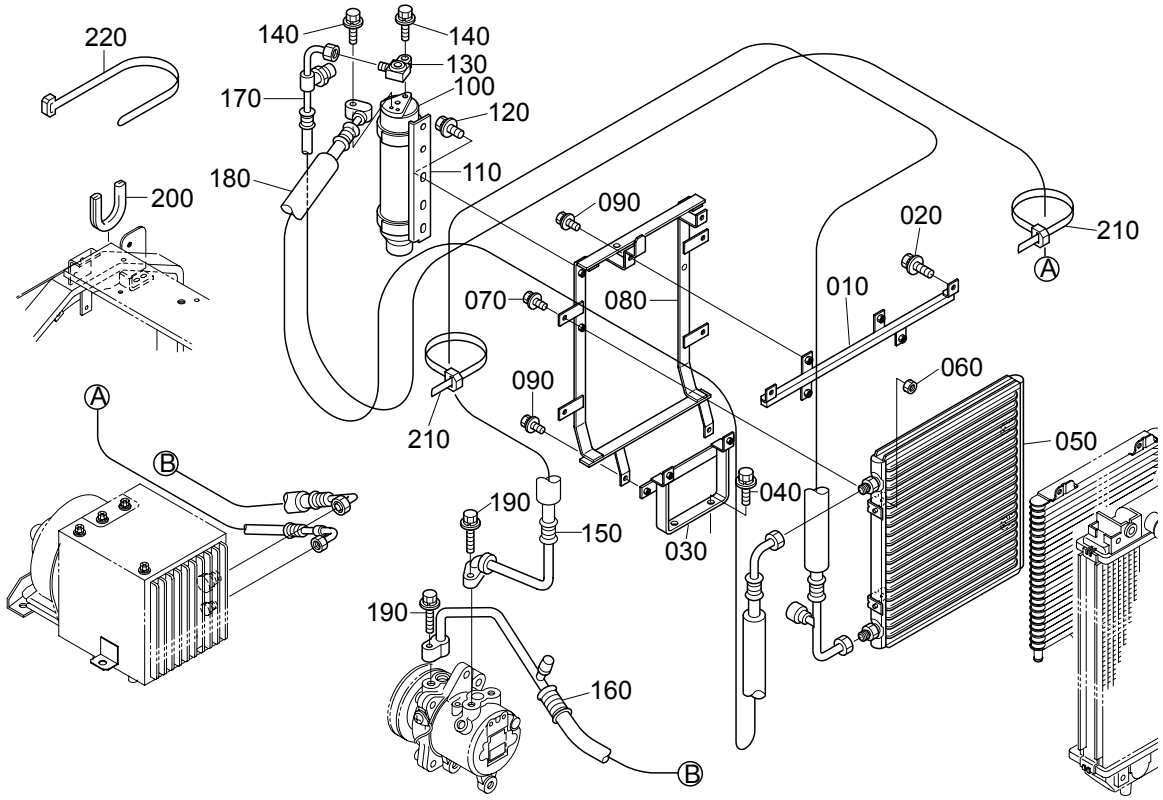


(16) Compressor



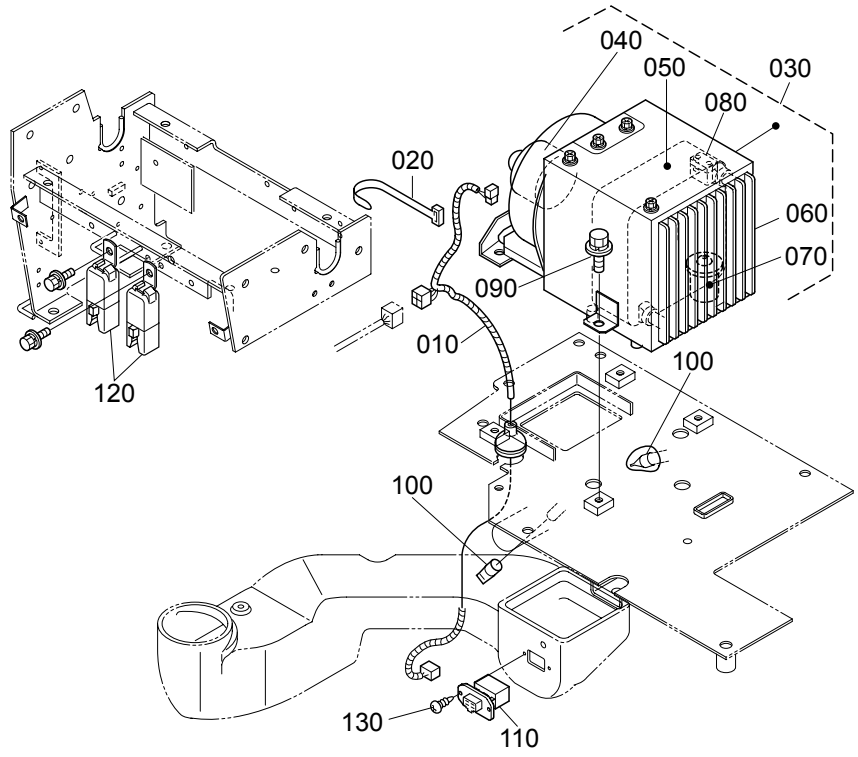
010 : Compressor 020 : Bush 060 : V-belt

(17) Receiver and condenser



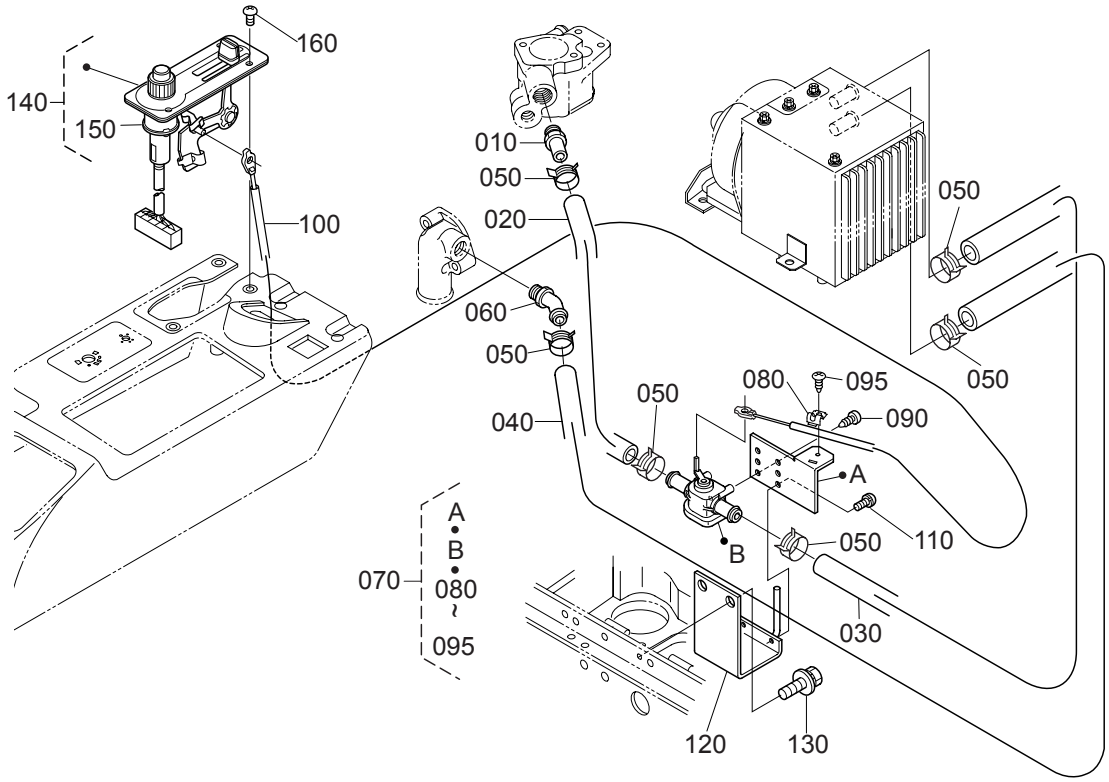
050 : Condenser
100 : Receiver
130 : Sight glass

(18) Air conditioner unit



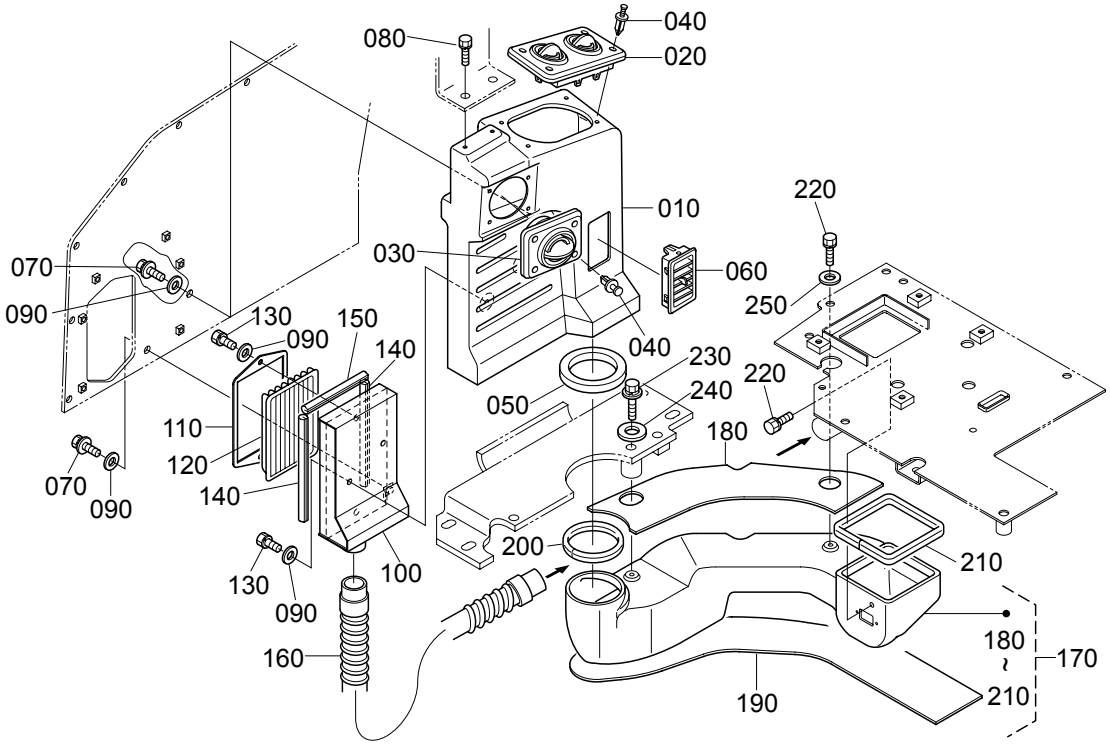
010 : Wire harness
030 : A/C unit assy
040 : Blower
070 : Expansion valve
080 Thermostat
110 : Blower resistor
120 : Relay

(19) A/C switch and heater valve

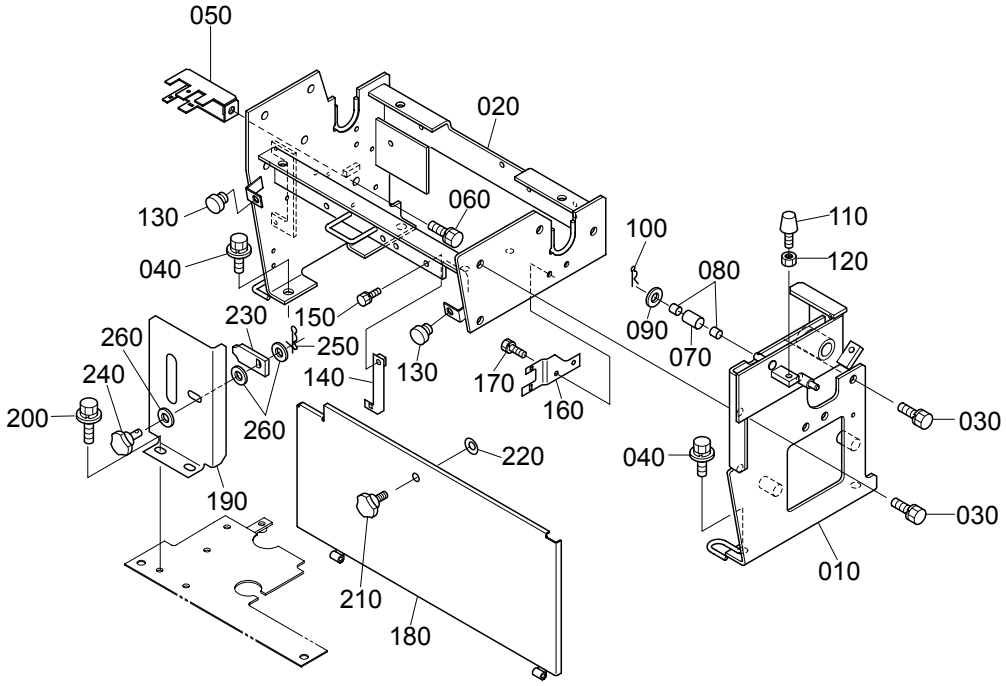


100 : Cable
140 : A/C switch assy
B : Hot water valve

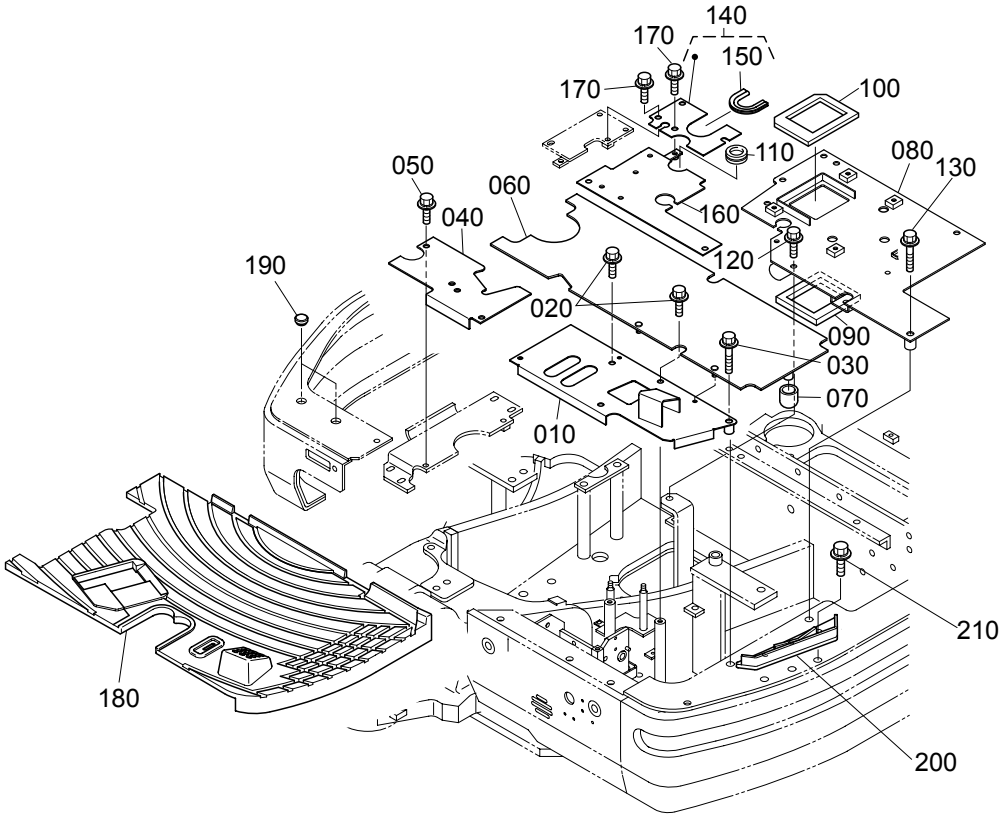
(20) Duct



(21) Seat support



(22) Step plate



(23) Bonnet, left