2. CONSTRUCTION OF MAIN COMPONENTS

2.1 INTAKE UNIT

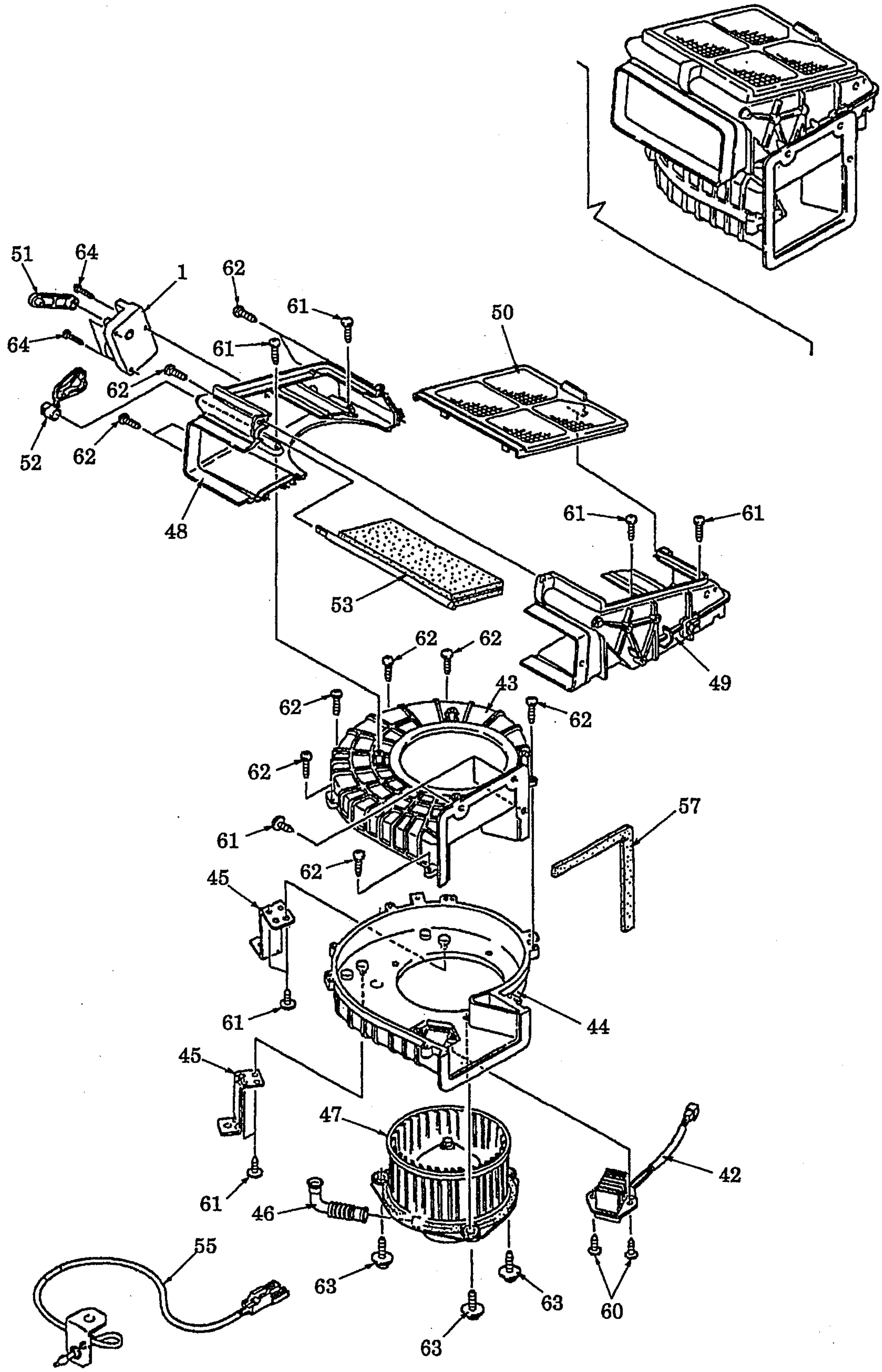

Fig. 3 Intake unit

2.2 AIR-CONDITIONER UNIT

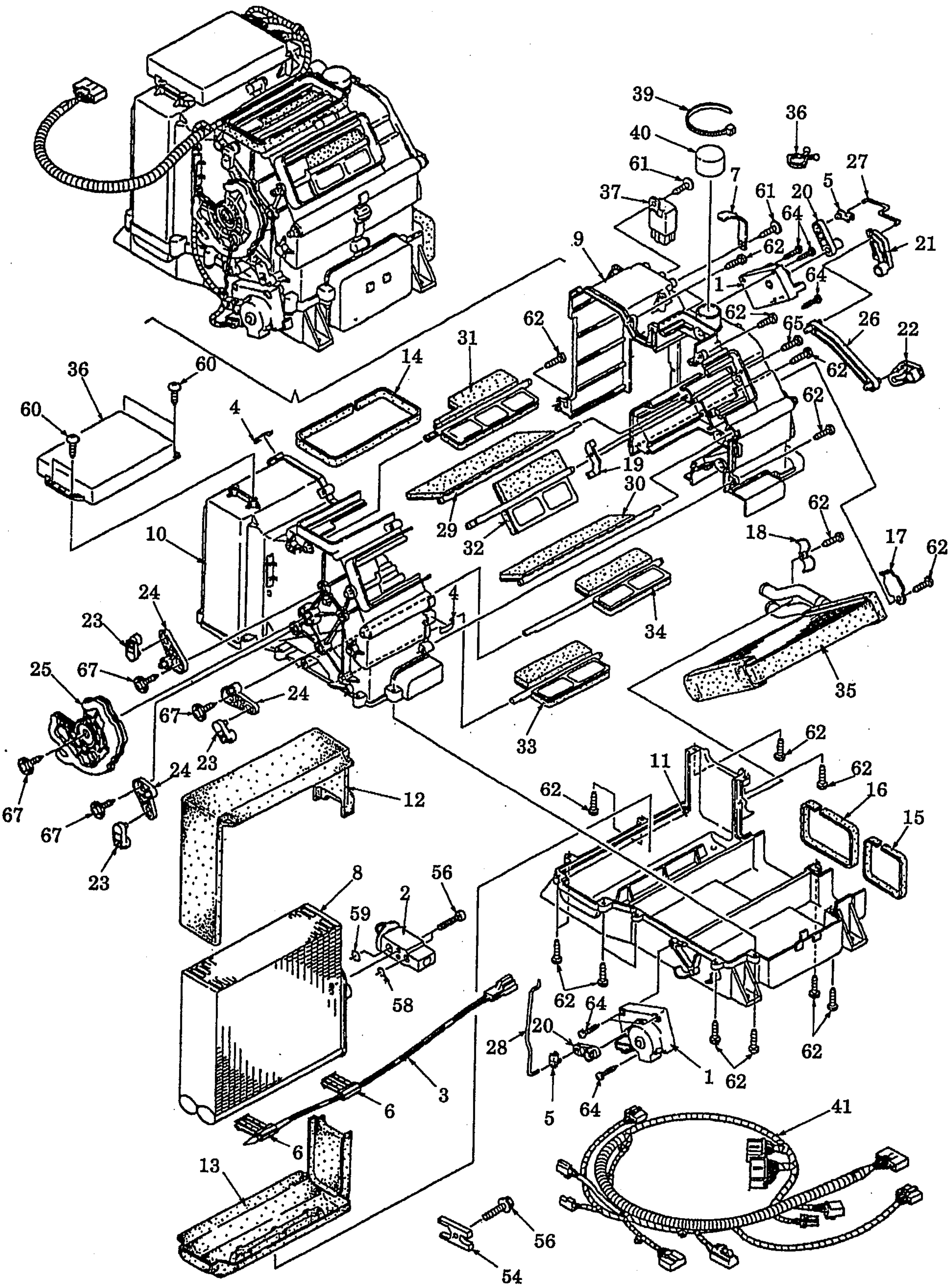

Fig. 4 Air-conditioner unit

No.	Part name	Q'ty	No.	Part name	Q'ty	No.	Part name	Q'ty
1	ACTUATOR	3	24	LEVER	3	47	BLOWER MOTOR	1
2	VALVE	1	25	CAM	1	48	CASING	1
3	THERMISTOR	1	26	ROD	1	49	CASING	1
4	CLAMP	2	27	ROD	1	50	FILTER	1
5	ROD HOLDER	2	28	ROD	1	51	LEVER	1
6	SENSOR HOLDER	2	29	DAMPER	1	52	LEVER	1
7	CLAMP	1	30	DAMPER	1	53	DAMPER	1
8	EVAPORATOR	1	31	DAMPER	1	54	FLANGE PLATE	1
9	CASING	1	32	DAMPER	1	55	SENSOR	1
10	CASING	1	33	DAMPER	1	56	SEMS BOLT	1
11	CASING	1	34	DAMPER	1	57	GASKET	1
12	THERMAL INSULATION MATERIAL	1	35	HEATER CORE	1	58	O-RING	1
13	THERMAL INSULATION MATERIAL	1	36	CONTROLLER	1	59	O-RING	1
14	PACKING	1	37	RELAY	1	60	TAPPING SCREW	6
15	PACKING	1	38	CLAMP	1	61	TAPPING SCREW	13
16	PACKING	1	39	BAND	1	62	SCREW	30
17	BRACKET	1	40	DUCT CAP	1	63	SEMS BOLT	3
18	CLAMP	1	41	HARNESS	1	64	TAPPING SCREW	9
19	PLATE	1	42	RESISTER	1	65	SCREW	1
20	LEVER	2	43	CASING	1	66	CAPSCREW	2
21	LEVER	1	44	CASING	1	67	TAPPING SCREW	4
22	LEVER	1	45	BRACKET	2			
23	LEVER	3	46	HOSE	1			

2.3 RECEIVER DRYER

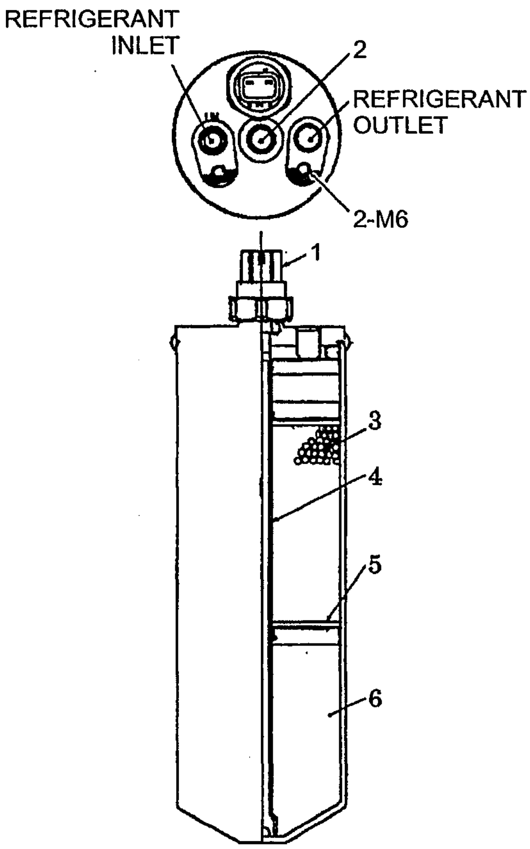

Fig. 5 Receiver dryer

No.	Part name	Q'ty
1	PRESSURE SWITCH	1
2	SIGHT GLASS	1
3	DESICCANT	1
4	SUCTION PIPE	1
5	FILTER	1
6	RECEIVER TANK	1

2.1 MECHANISM OF COOLING CIRCUIT

(1) Mechanism of Cooling

In the cooling process, the refrigerant that flows through the cooling circuit changes its phases from liquid to gas and vice versa during which process heat is transferred from the low temperature part (compartment) to the high temperature part (outside of the vehicle).

1) Kind of Refrigerant

Many kinds of refrigerants that change in that way are available, but the following requirements are needed for use in such applications:

- o Latent heat of vaporization (heat of vaporization) is large.
- o It is easy to liquefy (condense). (It dose not require very high pressure for condensation.)
- o It is easy to gasify (evaporate). (It evaporates sufficiently at not too low pressure, i.e. cools down an object.)
- o It has small specific heat. (Since the refrigerant itself is cooled by the expansion valve, the loss resulting from it must be held down to a minimum.)
- o It has a high critical temperature and a low solidification point
- o It is stable chemically and does not corrode and permeate into the circuit parts.
- o It is free from toxicity, objectionable odor, flammability and explosiveness and excels in thermal conductivity and electric insulation.
- o It has small specific volume.

Out of refrigerants meeting the above-mentioned requirements, ones having characteristics that suit the intended cooling unit are chosen and used. If a refrigerant other that those designated is used, sufficient refrigeration will not be performed or the equipment in which the refrigerant is used may be broken. Therefore, always use a designated refrigerant for the cooling unit.

Table 1 shows the principal characteristics of the R134a refrigerant that is used in this machine.

Table 1

Item	HFC-134a (R134a)
Chemical formula	CH_2FCF_3
Molecular weight	102.03
Boiling point	-26.19°C (-15.14°F)
Critical temperature	101.14°C (214.05°F)
Critical pressure	4.065 MPa (41.45 kgf/cm²)*1
Critical density	511 kg/m³ (31.9 lb/ft³)
Density of saturated liquid [25°C (77°F)]	1206 kg/m³ (75.3 lb/ft³)
Specific volume of saturated vapor [25°C (77°F)]	0.0310 m³/kg (0.496 ft³/lb)
Latent heat of vaporization [0°C (32°F)]	197.5 KJ/kg {47.19 kcal/kg}
Flammabillty	Nonflammable
Ozone destruction coefficient	0

*1 : 1 MPa (mega pascal) equals 10.1972 kgf/cm² (145 psi)

(2) Characteristics of Refrigerant (See Fig.6.)

In general, the fluid (general term of gas and liquid) has the following qualities:

1) As a gas under certain pressure is cooled down, it begins to condensate at a certain temperature to take a liquid state. The temperature at which condensation begins is unique to each substance (fluid) at a given pressure. The temperature determined by a given pressure is called saturation temperature.

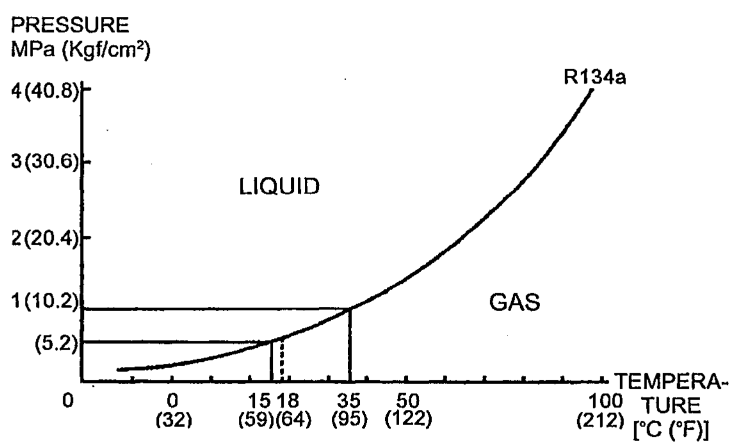

Fig.6 Pressure-temperature characteristics of R134a

2) Inversely to 1) above, the pressure at which a gas condenses for a temperature is determined. This pressure is called saturation pressure.
Fig.6 illustrates the relationships between the saturation temperature and the saturation pressure in the case of refrigerant R134a used in the air-conditioner. At the temperature and the pressure on the lower righthand side of the curve in Fig.6, the refrigerant take a gaseous state, while at the temperature and the pressure on the upper lefthand side of the curve, the refrigerant takes a liquid state.
Let us think of a case where an air-conditioner is operated in the midst of summer. As the refrigerant evaporates, it absorbs evaporation heat from the air of the compartment. In order to cool the inside of the compartment down to 25°C (77°F), the refrigerant must transform (evaporate) from a liquid to a gaseous state at a lower temperature. It can be seen from Fig.6 that R134a under a pressure above the atmospheric pressure is capable of cooling the inside of the compartment sufficiently. (If a refrigerant that requires a pressure below the atmospheric pressure to cool it to a required temperature is used, air is mixed into the circuits, thereby deteriorating the performance of the cooling unit.) In the process in which gaseous refrigerant is brought back to a liquid state, the refrigerant is cooled and condensed by the outer air exceeding 35°C (95°F). Accordingly the refrigerant is capable of condensing at a pressure exceeding 10.2 kgf/cm^2 (145 psi), as seen from Fig.6.

3.2 COOLING CIRCUIT

Fig.7 illustrates the cooling circuit of the car air-conditioner.

In this circuit diagram, the portion that cools the air of the compartment is the evaporator. The object air is cooled off by utilizing the fact the refrigerant takes heat off the surrounding area as evaporation heat as it evaporates in the cooling circuit. Since the part at which vaporization of the refrigerant takes place is the evaporator, cooled air is constantly delivered to the circumference of the evaporator by the blower fan. In the meantime, liquid refrigerant (slightly wet vaporized refrigerant) is fed into the evaporator, when "cooling" effect is attained. For instance, in order to cool the air to 15°C (59°F), the refrigerant can not absorb evaporation heat from the air unless it evaporates at a temperature lower that 15°C (59°F). For that purpose, it can be seen from Fig.6 that the pressure of the refrigerant in the evaporator must be less than 5.2 kfg/cm^2 (74 psi).

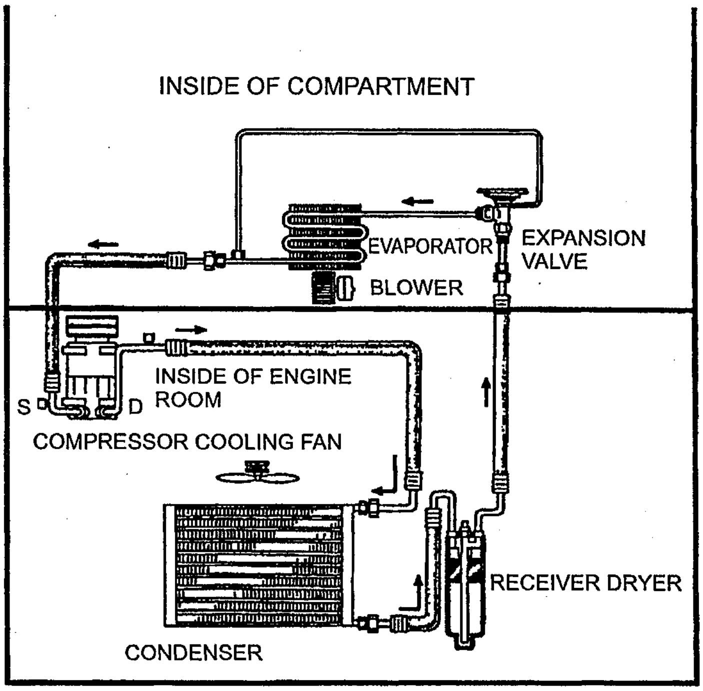

Fig. 7 Construction of cooling circuit

Consequently, the cooling circuit is so constructed that the evaporator can cool down an object (air in this case) sufficiently (i.e. so as to decrease the pressure in the evaporator) and that an adequate amount of refrigerant can be fed to the evaporator.
The feed rate of the refrigerant is controlled by the expansion valve, but the pressure in the evaporator is held low by the throttling action of the expansion valve and the suction action of the compressor. The compressor acts as a pump that allows the refrigerant to circulate. The compressive action of the compressor and the heat exchange (heat radiation) action of the condenser transform the refrigerant in a dry vapor state back to a liquid state.

3.3 COMPONENT PARTS

(1) Evaporator (See Fig.8.)
The evaporator is an important heat exchanger that absorbs the heat of the compartment air (object) by the utilization of the latent vaporization heat of the low-temperature, low-pressure liquid-state refrigerant. Therefore, it is necessary that satisfactory heat transfer between the object and the refrigerant take place in the evaporator.
To that end, the evaporator is equipped with fins on the air side in order to increase the heat transfer area of the air side and thereby perform excellent thermal transfer between the refrigerant and the air.
The humidity in the air condenses as the air cools down and adheres to the outside of the evaporator as water drops. The cooling effect deteriorates if the water drops freeze. Therefore, how to discharge water is an important point.
The amount of refrigerant supplied to the evaporator is controlled by the expansion valve which is described in the following. In order to attain proper control, it is necessary to reduce the pressure drop of the refrigerant of the evaporator. Accordingly, reducing the pressure drop is one element that makes the evaporator attain its full performances.

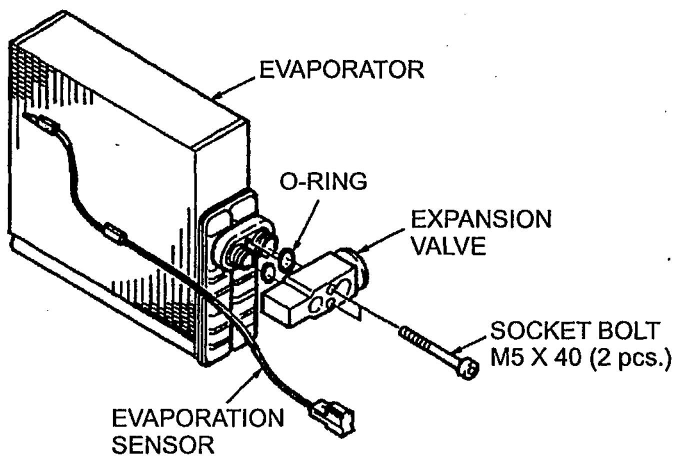

Fig. 8 Evaporator

(2) Expansion Valve
In order for the evaporator to fulfill its performances, a proper amount of low-pressure low-temperature liquid refrigerant must be fed to the evaporator.
If the feed rate is too low, the refrigerant completes vaporization early in the refrigerant completes vaporization early in the evaporator which results in deterioration of the cooling effect. If the feed rate is too high, unvaporized liquid refrigerant returns to the compressor (liquid back). This not only deteriorates the cooling effect, but also damages the compressor valves.

The expansion valve feeds the flowing high-pressure high-temperature liquid refrigerant to the evaporator as low-pressure low-temperature liquid refrigerant (damp vapor of low dryness). The expansion valve controls the feed rate of the refrigerant at the same time.
Fig.9 shows how the block type expansion valve is constructed. The temperature sensing part is provided in the shaft of the expansion valve to directly detect the refrigerant temperature at the outlet of the evaporator.
The diaphragm contains R134a in saturated state. The pressure in the diaphragm changes according to the temperature detected by the sensor. The change in the pressure causes the force acting upon the diaphragm to vary accordingly.
The high-pressure high-temperature liquid refigerant that is fed from the receiver side reduces the pressure abruptly as it passes through the valve (throttling action). On that occasion, part of the refrigerant evaporates by the heat of the refrigerant and cooled off. The result is that low-pressure low-temperature damp refrigerant vapor is fed to the evaporator.
The opening of the valve is determined by the equilibrium between the pressure (low) of the evaporator side, the action of the adjust spring and the pressing force of the diaphragm (the temperature of the refrigerant at the outlet of the evaporator to be sensed by the thermowell). The feed rate is controlled automatically so that under the pressure in the evaporator, the refrigerant is properly overheated (3~8°C) and goes out of the evaporator. This action is carried out by sensing the refrigerant temperature at the outlet of the evaporator as against the inlet pressure of the evaporator and consequently controlling the feed rate of the refrigerant.
This means that if the refrigerant pressure drop in the evaporator is excessive, it is difficult to control the overheating or the feed rate of the refrigerant. For this reason, the smaller the pressure drop of the evaporator, the better.
The expansion valve senses the pressure and the temperature at the outlet of the evaporator and controls the overheating of the refrigerant and the refrigerant supply to the evaporator more securely. The air-conditioner of this machine adopts a block type expansion valve.

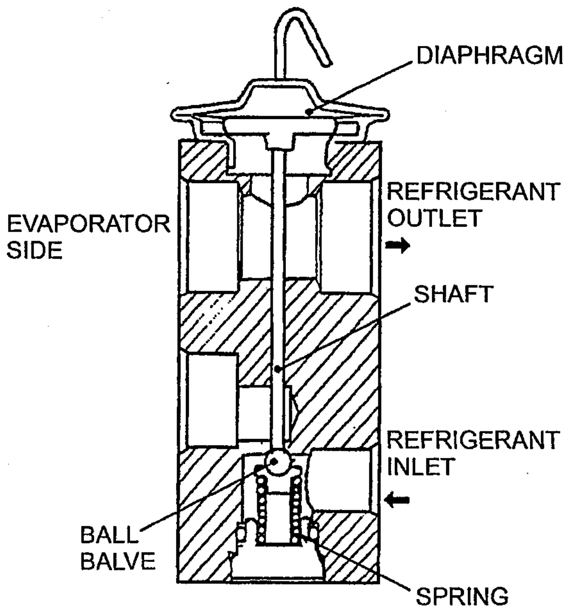

Fig. 9 Block type expansion valve

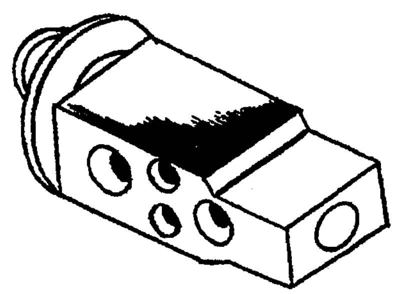

Fig. 10 Expansion valve outside view

(3) Compressor (See Fig.11)

The compressor performs the following three functions in the cooling circuit:

1) Suction action
2) Pumping action
3) Compressive action

1) The suction action, as combined with the throttling action, works to decrease the refrigerant pressure in the evaporator. This permits the refrigerant to vaporize at low temperature in order to perform cooling effect.
2) The pumping action serves to cause all the refrigerant to circulate in the cooling circuit. This enables continuous cooling.
3) The compressive action, as combined with the action of the condenser which is mentioned hereunder, transforms vaporized refrigerant back to a liquid state again.

The saturation temperature gets higher as the pressure increases. For instance, it becomes possible to cool down the refrigerant by the use of an outer air of 35°C (95°F) and liquefy it. The compressive action of the compressor works to turn low pressure vaporized refrigerant to high pressure vapor refrigerant. The condenser then serves to cool down the refrigerant. However, since the compressive action takes place only for a short period, the refrigerant hardly exchanges heat with outer air. That is to say, it takes a near form of thermally insulated compression, so that the refrigerant discharged by the compressor turns into high-temperature high-pressure vapor and is delivered to the condenser.

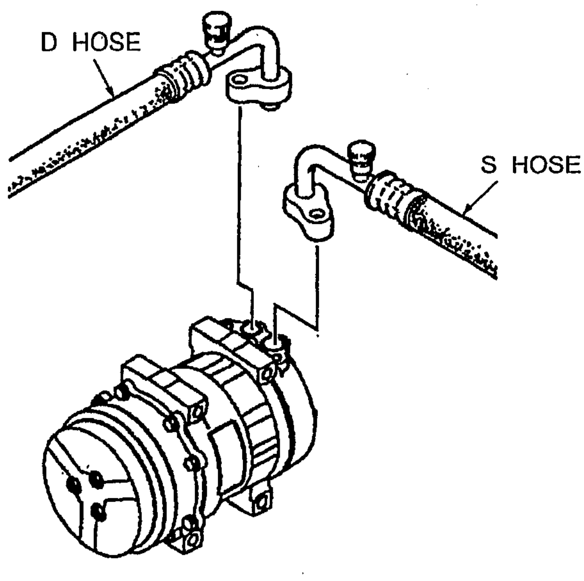

Fig. 11 Compressor

(4) Condenser (See Fig.12)

This is a heat exchanger that cools the vaporized refrigerant at high temperature and high pressure by the use of outer air and condenses the refrigerant. The direction in which heat moves is from the refrigerant to air, the opposite to the case of the evaporator. Fins are equipped on the outer air side to improve thermal transfer. If the refrigerant is not cooled well by the condenser, the air in the compartment can not be cooled sufficiently by the evaporator. For that purpose, it is necessary to secure ventilation required for cooling of the refrigerant.

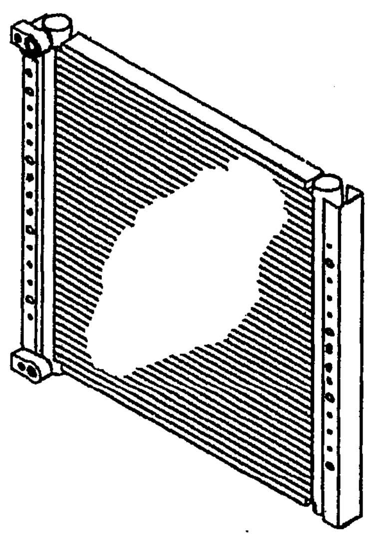

Fig. 12 Condenser

(5) Receiver Dryer (See Fig.13)

1) Receiver Tank

On the air-conditioner, the revolution of the compressor varies greatly which cause the proper flow of refrigerant in the cooling circuit to vary. It is the receiver tank that receives the variations. When the cooling circuit the variations. When the cooling circuit does not need much refrigerant, the receiver tank stores extra refrigerant temporarily and supplies it when the cooling circuit needs much refrigerant. The receiver tank also stores an extra amount of refrigerant to be used for filling balance and supplement small amounts of leakage of the refrigerant through penetration into rubber hoses.

2) Dryer

If water is mixed in the cooling circuit, it deteriorates the compressor valves and oil, corrodes the metallic parts of the circuit or clogs the circuit as the water freezes in the expansion valve. It is desirable that the amount of water mixed in the refrigerant should be held below a concentration of 30 ppm. The air-conditioner uses a molecular sieve as desiccant suited for the circuit, in order to absorb water content that intrudes into the circuit when the dryer is installed or when refrigerant is charged.

3) Sight Glass

This is a window with which the refrigerant level in the circuit is determined, the only means of confirming the inside of the circuit visually.

4) Filter

5) Pressure Switch

This machine employs pressure switches of high/low pressure type.

The pressure switch protects the circuit by cutting off the power supply to the compressor when high pressure increases abnormally high [more than 32 kgf/cm^2 (460 psi)].

The pressure switch also detects the leakage of refrigerant by cutting the power supply to the compressor when the pressure of the circuit falls below 2 kgf/cm^2 (28 psi).

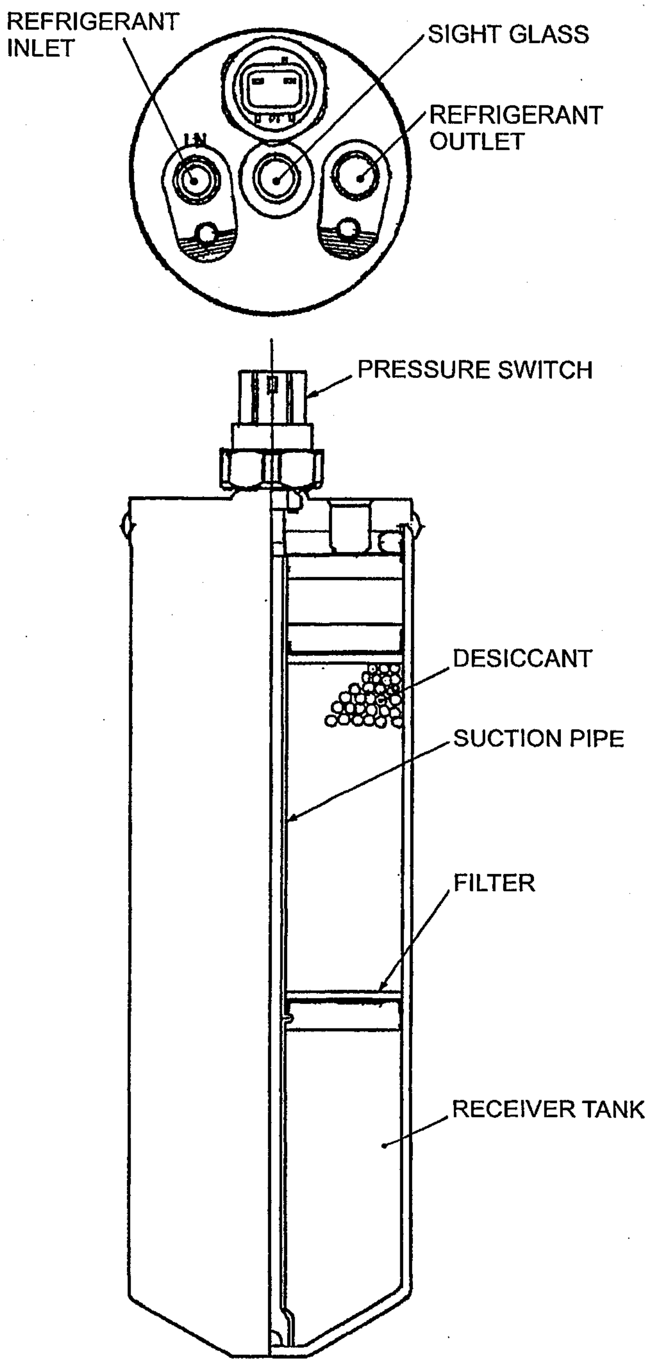

Fig. 13 Receiver dryer

4. DISASSEMBLY AND ASSEMBLY

4.1 PRECAUTIONS TO BE EXERCISED IN OPERATION

(1) Special Refrigerator Oil

This air-conditioner uses special refrigerator oil SP20 for use with new refrigerant R134a. Oils other than SP20 may not be used. Since SP20 tends to absorb moisture and may corrode paint and resin, the following points must be noted:

1) Keep open all pipe connections on a new compressor and the component parts of the installed refrigeration circuit.
(Remove valves and caps at the pipe openings of the compressor, just before connecting popes. If you have removed a pipe joint for repair, put a cap to both ports immediately).

2) Use care so SP20 does not adhere to the painted surface and resin parts. In case SP20 has adhered to such surfaces, wipe it off immediately.

(2) The receiver dryer is filled with desiccant to absorb moisture in the circuit. Therefore, remove the valve at the pipe port immediately before connecting pipes.

(3) Tightening Torque

1) Pipe Joints (See Table 2.)
When connecting pipe joints, coat the O ring with special oil (SP20) and fasten to the tightening torque indicated in the table, using a double spanner.

2) Screws and Bolts (See Table 3.)

(4) Amount of Oil for Compressor (See Table 4.)
The compressor SD7H (HD type) is filled with 135cc (8.2 cu-in) of oil. If the oil volume is small, seizure at high revolution and shortening of service life will occur. If the oil volume is large, the cooling ability will be deteriorated.
Once the air-conditioner is operated, part of the oil is dispersed in the refrigeration circuit. Therefore, when replacing the parts in Table 4, adjust the oil level to that of table.

(5) Before performing operation, stop the engine and turn off all power supplies to the equipment related to the air-conditioner.

(6) After the operation is over, confirm that all faults have been repaired completely, by operating the air-conditioner.

Table 2 Unit : kgf·cm (lbf·ft)

Pipe Fastening Part	Tightening Torque
D hose and compressor (M8 bolt)	200~250 (14~18)
D hose and condenser	200~250 (14~18)
L hose and condenser	120~150 (8.7~11)
L hose and receiver dryer (M6 bolt)	80~120 (5.8~8.7)
L hose and air-conditioner unit	120~150 (8.7~11)
S hose and air-conditioner unit	300~350 (22~25)
Inlet of expansion valve	120~150 (8.7~11)
Outlet of expansion valve	200~250 (14~18)
Pressure sensing part of expansion valve	70~90 (5.0~6.5)

Table 3 Unit : kgf·cm (lbf·ft)

Screw Size	Tightening Torque
N4, T4, machine screw, M4	8~12 (0.58~0.87)
N5, T5, machine screw, M5	20~25 (1.4~1.8)
M6 (mounting part of L hose joint)	80~120 (5.8~8.7)
M6 (except mounting part of L hose joint)	100~120 (7.2~8.7)
M8 (mounting parts of S,D hose joints)	200~120(14~18)
M8 (mounting part of A/C unit)	100~120 (7.8~8.7)
M8 (other than those mentioned above)	120~160 (8.7~12)
N10	400~550 (29~40)

Table 3

Part to be Replaced	Amount to be filled in
Evaporator	40 cc (2.4 cu·in)
Condenser	40 cc (2.4 cu·in)
Compressor	Drain out the volume of oil left in compressor to be replaced, from the new cpmpressor.