4.3 Control devices

The four main components explained previously exhibit the sufficient effect in the refrigeration unit and air conditioner. In actual cases, however, the systems are operated under various conditions. In order to operate the system safely and effectively, the following control devices are mounted in the systems.

(1) Four-way valve

1 Outline

A four way valve is a representative one used in the heat pump type air conditioning system. This valve aims at the passage connection of the super heated refrigerant discharged from the compressor, to the indoor heat exchanger in case of heating operation, and to the outdoor heat exchanger in case of defrosting and cooling operation.

2 Structure and operating principle

This section discusses the structural drawing of the four way change-over valve. They are, a four way solenoid valve which operates as a pilot by electrical on-off signals, and the main body(slide valve)which operates by the pressure difference obtained with this pilot operation. The four way valve is made up of these two valves.

1) In case of cooling and constituting defrosting passage (solenoid valve: off-time)

The pilot (1) and (2) are connected, and high pressure gas is discharged from the compressor to enter Room (5). On the other hand, the pressure of Room (6) which passes through (3) and (4) already connected, is pulled into the compressor to become low pressure. At this time, pressure difference between high-pressure Room (5) and low-pressure Room (6) is produced. Owing to this pressure difference, the piston moves to the left and the slide valve connected together moves, too. That is the flow circuit of refrigerant mentioned as follows.

Compressor → Four way valve D → C → Outdoor heat exchanger → Indoor heat exchanger → Four way valve E → S → Compressor

Fig.4-47

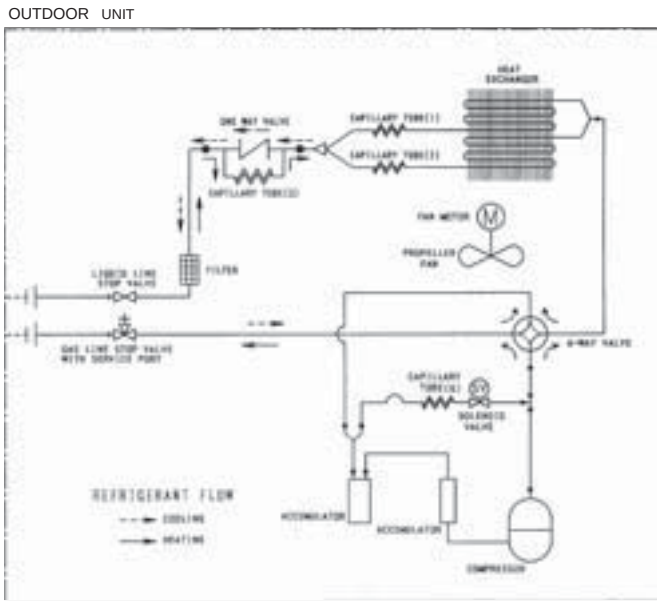
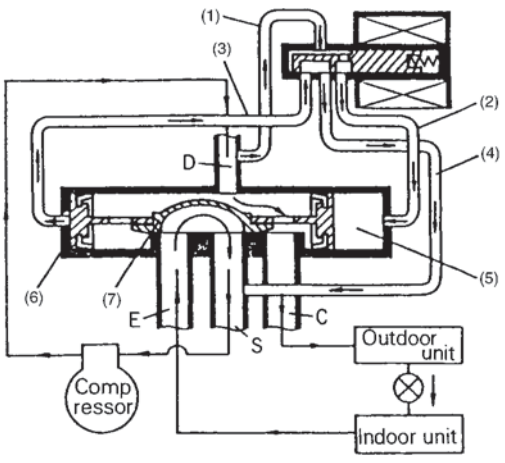


Fig.4-48



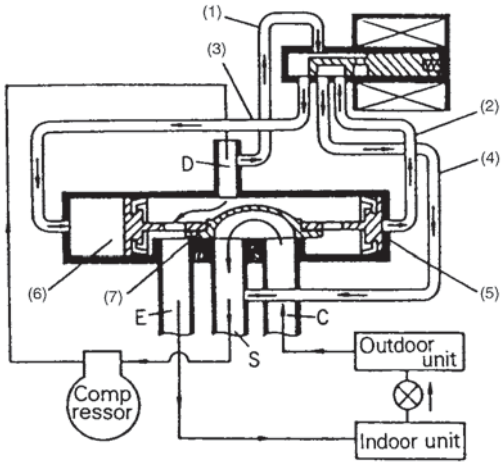
Off-time constituting of refrigerant passage

2) In case of constituting heating passage (Solenoid valve: on-time)

The pilot (1) and (3) are connected, and high pressure gas is discharged from the compressor to enter Room (6). On the other hand, the pressure of Room (5) which passes through (2) and (4) already connected, is pulled into the compressor to become low pressure, thus the slide valve functions in reverse of cooling time and the flow circuit of refrigerant in the heating is constituted.

(There is constitution of refrigerant passage at off-time heating or on-time cooling, too.)

Fig.4-49

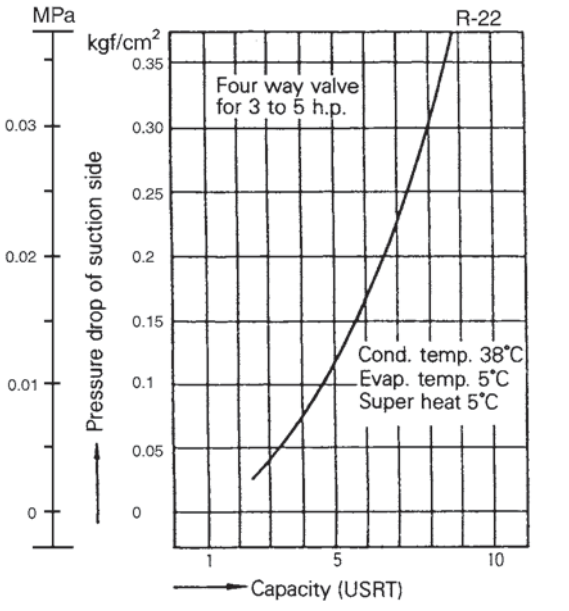


On-time constituting of refrigerant passage

3 Function and specification

1) This is a circuit changing valve which functions by electric signal, and there is no middle position, therefore the direction changing by fully open is possible.
2) This is generally used in the range of +10% to -15% of the constant passage voltage AC 100V or 200V.
3) Function pressure difference means the pressure difference between the high pressure of the suction side of the compressor. The function pressure difference is expressed by the maximum and the minimum.
4) Distinction of the size:It is necessary to choose the size which conforms to the to the system capacity to ensure the normal function by (1) to (3) in the standard value. Generally, a manufacturer's indicated conditions (pressure drop of the low pressure circuit, the capacity at the condensation temperature or at the evaporation temperature) are mentioned on the catalog. Therefore, more than the minimum requirement must be secured.
5) Test pressure: Generally, the maximum pressure which can be used is 3.0 MPa (30kg/cm^2) abs and airtight test pressure is 3.6 MPa (36kgf/cm^2) abs or so.
6) Fluid temperature: This limit is -20˚C to +120˚C or so, so that the fluid sufficiently withstand the winter evaporation temperature or the summer discharging gas temperature.

Fig.4-50



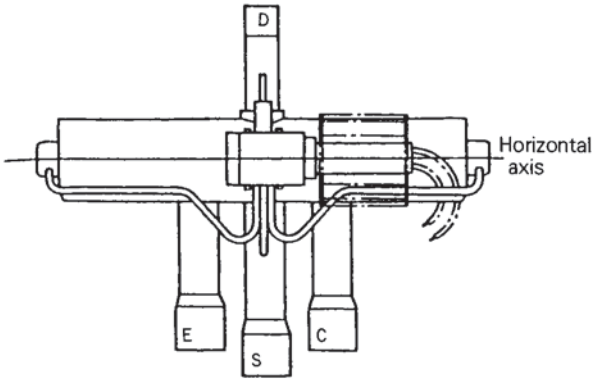
Tendency of capacity & pressure drop

4 Caution on handing

1) Installation position

In the piping, refrigerating machine oil or the other flows besides the refrigerant. For this reason, it is necessary to be careful so that these substances should not exert bad influences upon the pilot solenoid valve or the main body. More, there is a case where the installation position is structurally limited. Be careful, please.
The axis of the main body should be installed horizontally, and the axis of the solenoid valve section should be set above the axis of the main body.

Fig.4-51



Installation position

2) Heat-resistance temperature at the time of brazing

It is necessary to follow the heat-resistance temperature indicated by the manufacturer to prevent the carbonization of the oil in the main body and the heat influence. As a means, the main body must be covered by moist cloth and the temperature must be secured not exceeding +120˚C.

(2) Liquid receiver

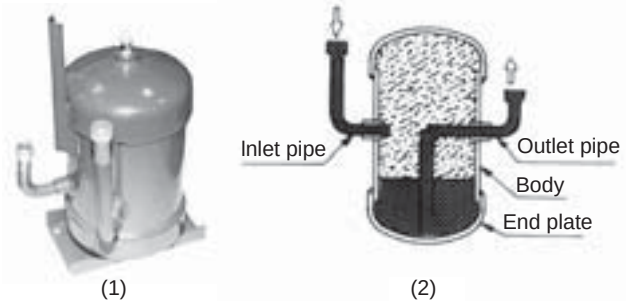
The liquid receiver is installed between the condenser and the metering device and temporarily holds the refrigerant which has been liquefied by the condenser before being sent to the expansion valve. As a result, only the refrigerant completely liquefied can be supplied to the metering device. The liquid receiver is also used as a container in which surplus refrigerant is stored since amount of the refrigerant circulated differs with the following conditions.

- Length of the connection piping between the condensing (outdoor unit) and the fan coil (indoor) unit.
- Changes in operating conditions

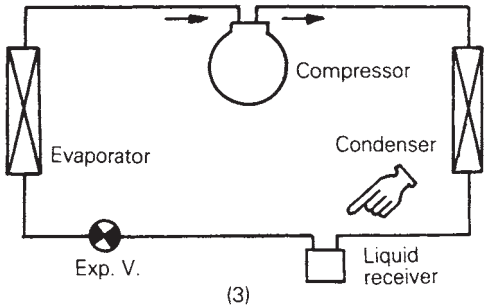
Note:
The receiver must not be used in the capillary tube system, because during off-cycle, liquid flows to the evaporator through the capillary tube and when the compressor starts again, there is a fear of liquid compression.

The configuration as shown in the figure on the right, which frequently appears in the piping circuit diagram, is a circuit used for liquid sealing prevention, which bypasses high-pressure gas through the direct receipt of resistance with the capillary from the liquid receiver. This circuit unites the function of fusible plug with pressure equalization at the time of stopping the operation.

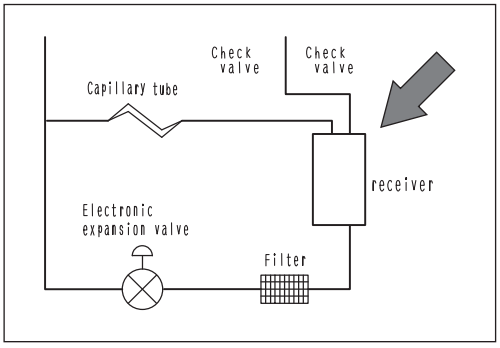
Fig.4-52



(1) (2)



(3)



(3) Dryer filter (Filter)

The dryer filter removes moisture and minuite particles of foreign objects from the refrigerant during operation. It is a copper cylinder containing desiccating agent and is installed between the condenser and the metering device.
Moistre contained in the refrigerant causes the following troubles.

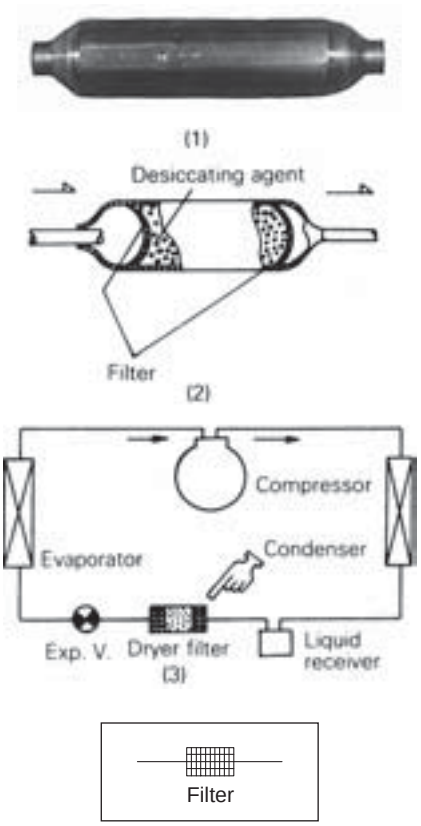
1. The expansion valve or capillary tube is stopped up with ice.
2. Hydrochloric acid is created, which corrodes metals.
3. Copper plating takes place.

As desiccating agent, Molecularseeve is used, because its absorption capacity does not decrease by high temperature or low partial pressure.
Molecularseeve is reclaimable by heating it from 150˚C to 300˚C.

Filter

Even though dryer filter stuffed with drying agent was previously used, since recently broken mesh of filter causes the drying agent to move through the circuit, thus resulting in clogging of narrow parts such as expansion valve. Therefore, the filters are only used in many cases.

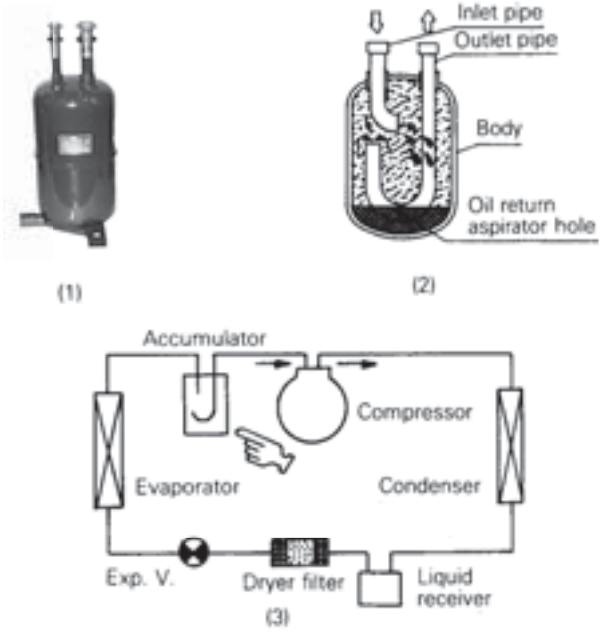
Fig.4-53



(4) Accumulator

The accumulator is installed between the evaporator and the compressor and functions to prevent the liquid refrigerant from entering the compressor.
The accumulator contains the liquid refrigerant and returns only the gaseous refrigerant to the compressor.
The oil admixed in the liquid refrigerant is separated from the refrigerant at the bottom of the accumulator, and returns to the compressor together with the suction gas, through a small hole in the suction pipe.

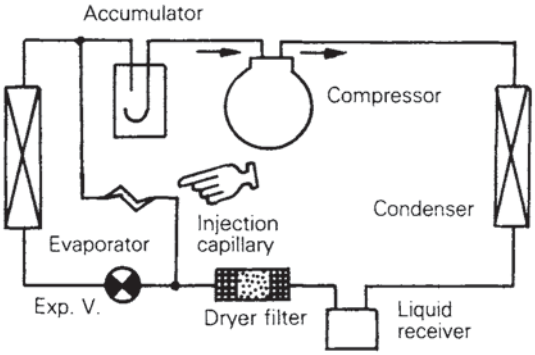
Fig.4-54



(5) Injection capillary

When cooling load increases and the discharge pressure rises, the discharge gas temperature rises and the compressor motor is over-heated.
The injection capillary is used for preventing the compressor motor from over-heating.
The structure of the injection capillary is the same with that of the capillary tube, and it is connected to the compressor or the suction pipe.
A certain constant volume of the liquid refrigerant passes through the injection capillary, where the refrigerant is changed to the low temperature liquid refrigerant, and cools the compressor motor.

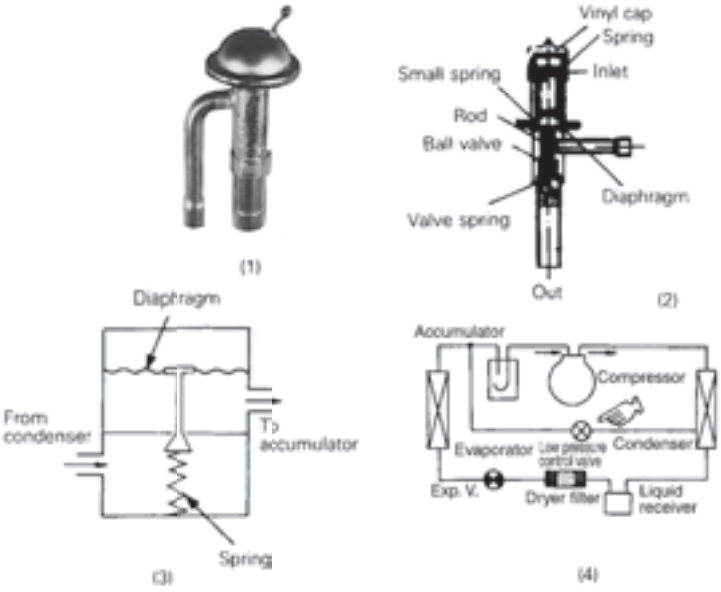
Fig.4-55



(6) Low pressure control valve

The low pressure control valve controls cooling operation.
The low pressure control valve senses the low pressure which is about 4kgf/cm^{2}G or less (the pressure of the fan coil unit) and bypasses the discharge gas from the compressor to the accumulator.

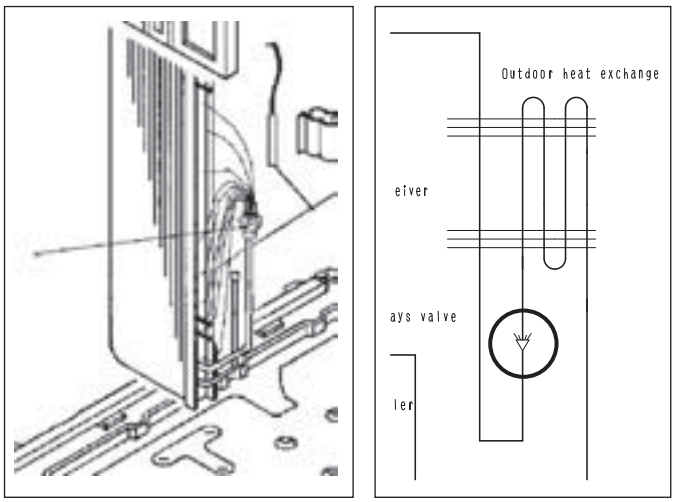
Fig.4-56



(7) Distributor

Heat exchanger with a cross fin coil is not designed so that a single coil passes all through the heat exchanger and consists of two or more circuits. Therefore, a distributor is used to distribute the refrigerant.

Fig.4-57



(8) Gas/liquid heat exchanger

The gas/liquid heat exchanger is used in the multi system. During operation, the high temperature liquid refrigerant (before it is sent to the expansion valve) and the low temperature gaseous refrigerant (before it is sent to the compressor) are exchanged in heat in this heat exchanger. The function of this heat exchanger is shown with broken line on the Mollier chart. [See Fig.4-58 (3)]

- Amount of subcooling becomes high so that liquid refrigerant (before it is sent to the expansion valve) does not become the flash gas easily.
- The cooling capacity increases.
- The low temperature gas is heated to a suitable superheated degree so as to prevent wet compression.

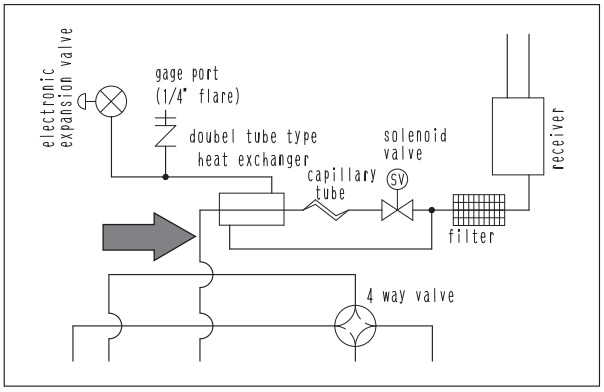
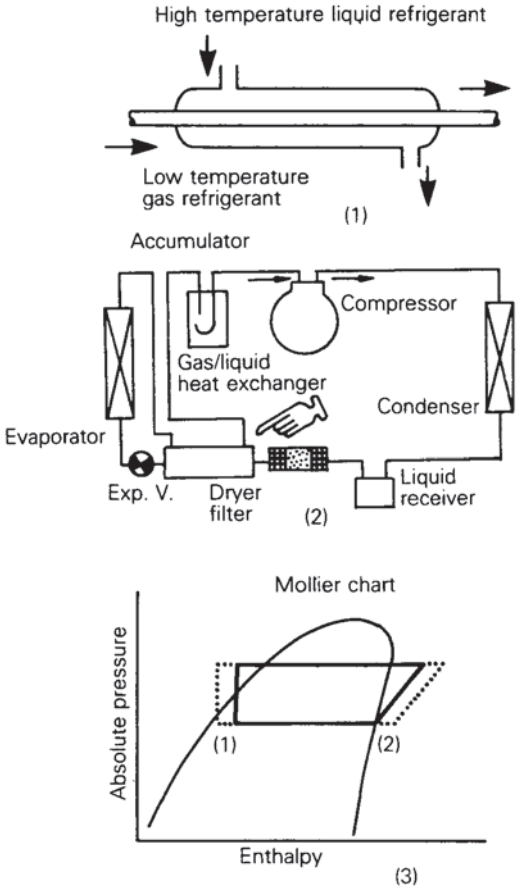


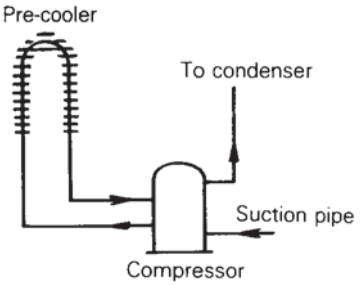
Fig.4-58



(9) Pre-cooler

There are two types of pre-cooler, one constructed as a U-shaped copper pipe with aluminium fins, and the other using part of the cooling piping of the condenser. Either type functions to cool the compressor discharge gas and to return it to the compressor. This protects against overheating of the compressor motor and reduces power consumption.

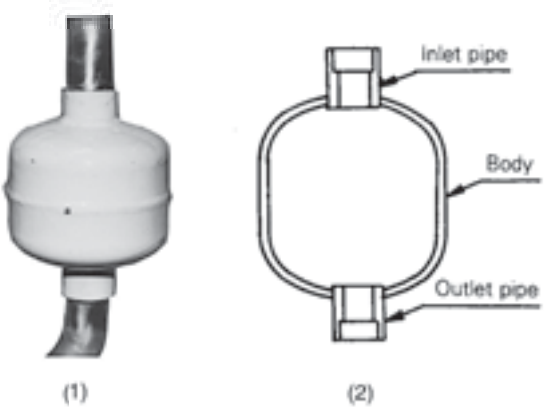
Fig.4-59



(10)Muffler

Some air conditioner provides a muffler to break up the pressure pulses which create noise. The muffler is usually located between the compressor discharge and the condenser and installed vertically to provide efficient oil movement.

Fig.4-60

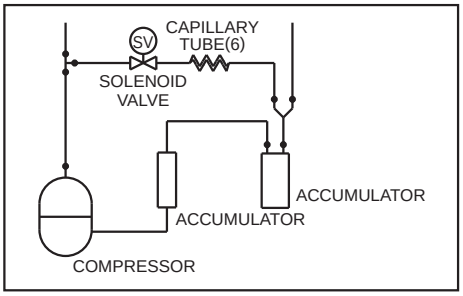


(11)Solenoid valve

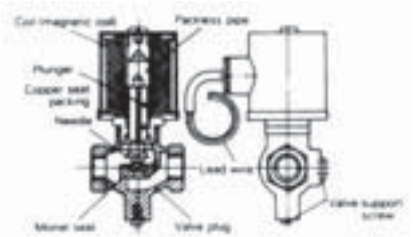
In case of the multi system, the refrigerant flow for the fan coil units stopped during cooling operation should be blocked. The solenoid valve is used to open or close the refrigerant circuit by energizing it on and off.

The solenoid valve resembles the electronic expansion valve in the piping circuit diagram. Therefore, do not confuse with it. The illustrated piping circuit is used for pressure equalization of high and low pressures while the unit stops running in order to reduce the torque for restarting the compressor.

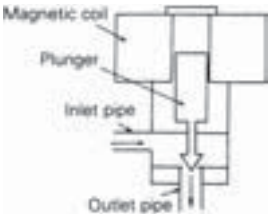
Fig.4-61



(1)



(2)

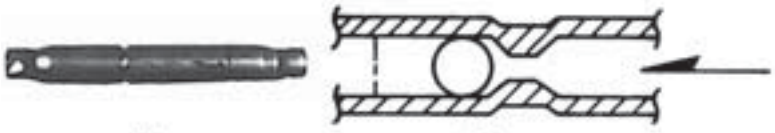


(3)

(12)Check valve

This valve allows the refrigerant to flow in one direction only. As shown in figure on the right, the structure is quite simple, but care must be taken to install it in the correct direction. In this reason, an arrow on its surface indicates the direction of refrigerant flow.

Fig.4-62



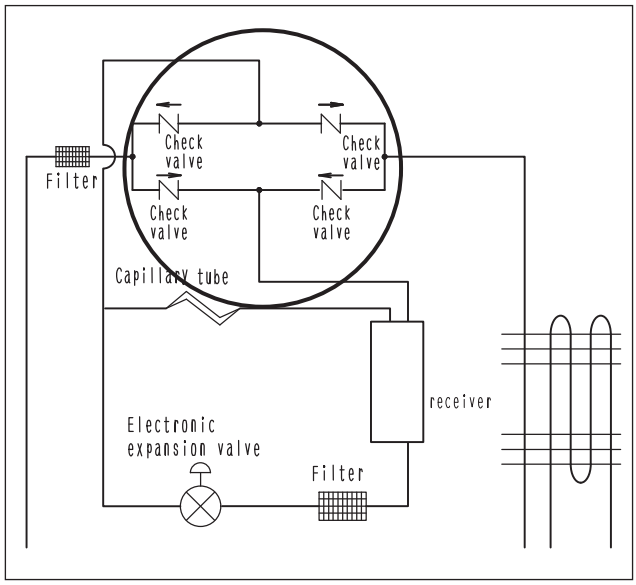
(1) (2)

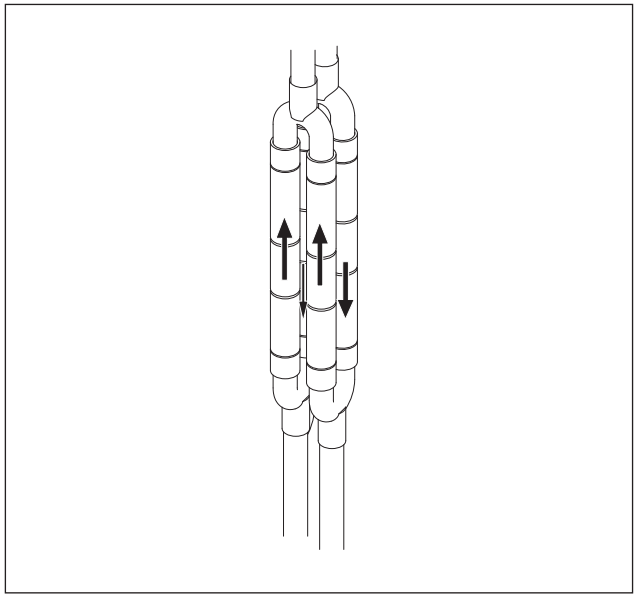
(13)Bridge circuit

The bridge circuit is made in combination of four check valves in order to use the components downstream from this circuit in common even though the refrigerant flows in the opposite direction in cooling and heating, which is frequently introduced the recent SkyAir Series.

As shown in the figure on the right, capillary tube for liquid sealing prevention use as well as liquid receiver, filer, and electronic expansion valve can be used as common parts.

Fig.4-63





4.4 Safety devices

(1) High pressure switch (HPS)

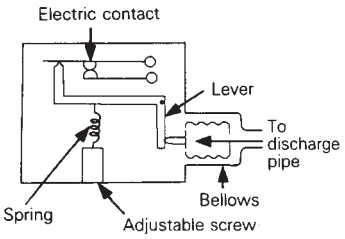
If the refrigerant pressure of the high pressure side becomes abnormally high, the high pressure switch stops the operation of the unit automatically, preventing it from breaking down. It is installed on the discharge pipe.

The bellows of the switch accepts the discharge pressure and translates the force to the lever.

When the discharge pressure is higher than the pressure setting, the bellows of the switch pushes the lever, the electric contact opens and the compressor stops.

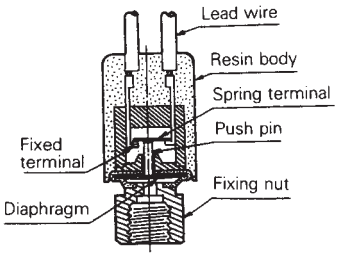
Fig.4-64

(1)

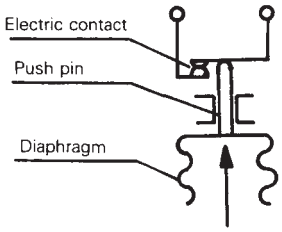


(2)

(3)



(4)



(5)

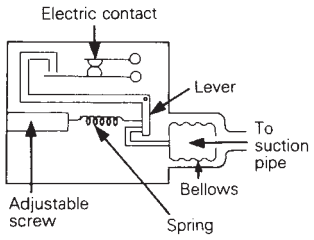
(2) Low pressure switch (LPS)

If the refrigerant pressure of the low pressure side becomes abnormally low, the low pressure switch stops the operation of the unit automatically, preventing it from breaking down. It is installed on the suction pipe. The bellows of the switch accepts the suction pressure and translates the force to the lever.

When the suction pressure is lower than the pressure setting, the bellows pulls the lever, the electric contact is open and the compressor stops.

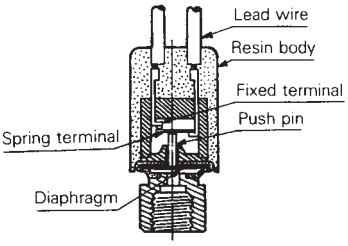
Fig.4-65

(1)

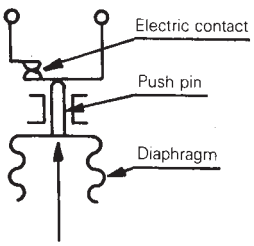


(2)

(3)



(4)



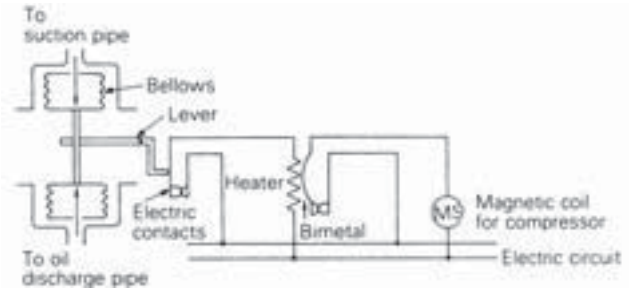
(5)

(3) Oil pressure switch (OPS)

The oil pressure switch is used in the large size unit having the semi-hermetic compressor to prevent the compressor metal from burning. It is installed on the discharge pipe. When the oil pressure does not rise to the required level within the predesigned period (approx.45 seconds after starting the compressor), this switch will automatically come into operation to stop the compressor and protect it from burning out.

Fig.4-66

(1)

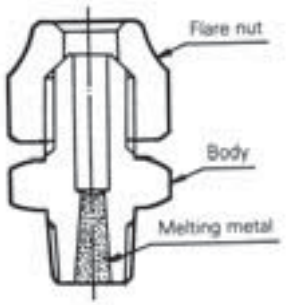


(2)

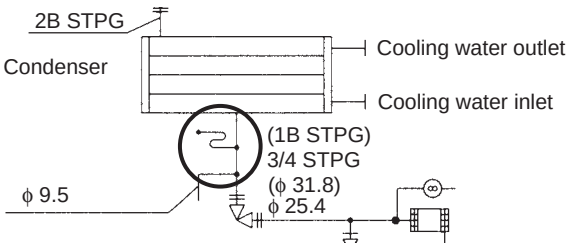
(4) Fusible plug

In case fire takes place or the high pressure switch does not work properly, the fusible plug or the safety valve (which is stated next) prevents the unit from accident. The fusible plug is used in the small unit and is installed in the condenser or the liquid pipe between the condenser and the metering device.
When the condensing temperature becomes higher than the temperature setting (approx.70~75˚C), the fusible metal melts and the refrigerant is blown out.

Fig.4-67



(1) (2)

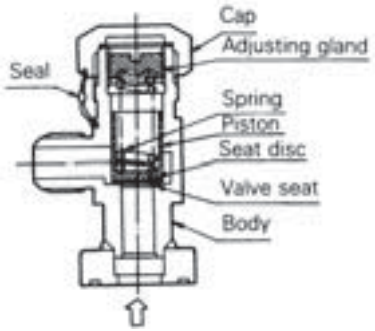


(3)

(5) Safety valve (relief valve)

The function of the safety valve is the same with that of the fusible plug.
The safety valve is used in the large units and is installed in the condenser.
When the condensing pressure becomes higher than the pressure setting, such pressure pushes open the sheet valve and the refrigerant is blown out.

Fig.4-68



(1) (2)

(6) Pressure regulating value

This valve opens at a certain pressure difference for prevention of pressure increase, thus resulting in no damage of functional parts due to the increase of pressure in transportation or storage.

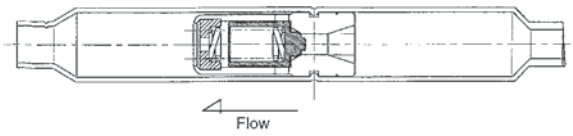
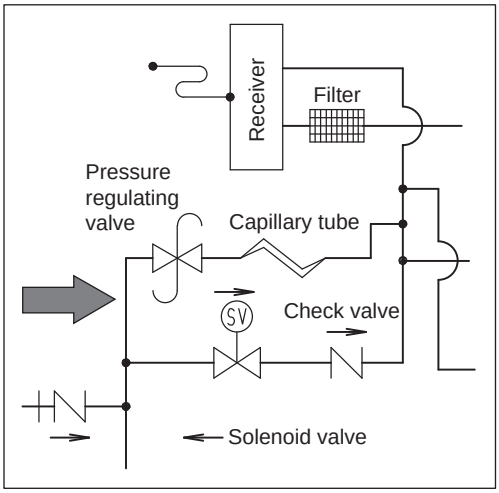


Fig.4-69



(7) Stop valve

This valve is used for closing or opening the refrigerant circuit and normally located on an outdoor unit. It does normally located on an outdoor unit. It does not regulate the flow rate of refrigerant, because full-close or full-open style is normal. Typical two types of stop valve are shown on the right.

Fig.4-70