4.2.5 Metering devices

The functions of the metering devices are to regulate the flow of high-pressure liquid refrigerant from the liquid line into the evaporator and to maintain a pressure differential between the high and low pressure sides of the system in order to permit the refrigerant to vaporize under the desired low pressure in the evaporator and at the same time to be condensed at a high pressure in the condenser.
There are six basic types of refrigerant flow controls as shown below. Almost all recent room air conditioners and packaged air conditioners adopt the capillary tube or the thermostatic expansion valve. So these types are explained below.

- Hand expansion valve
- Automatic expansion valve
- Thermostatic expansion valve
- Capillary tube
- Low pressure float
- High pressure float

(1) Capillary tube

The simplest one of all metering devices is the capillary tube, which is shown in Fig.4-37. This is nothing more than a deliberate restriction in the liquid line. Because of its small tube size, it creates a considerable pressure drop. The diameter and length of the capillary tube are determined experimentally by capacity of the refrigeration unit, operation conditions and refrigerant charged volume.
This type of the metering device is generally used only in small equipment with fairly constant loads, such as room air conditioners and small sized packaged air conditioners.
The advantages and disadvantages of the capillary tube are as follows:

1. Low cost compared with expansion valve
2. Simple structure...difficult to be damaged
3. When the compressor stops, high and low pressure are equalized soon.

Disadvantages

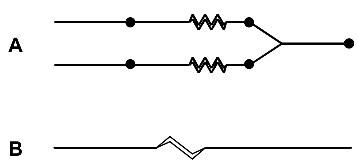
1. Difficult to determine the length and the diameter
2. Difficult to control the refrigerant volume depending on cooling load

*The amount of refrigerant in the system must be carefully calibrated, since all of the liquid refrigerant will move into the low-side during the off-cycle as the pressure is balanced.

Fig.4-37

The capillary tube is represented in the piping circuit diagram as shown in the figures on the right. Even though the symbol A or B is sometimes used, both of the symbols are the same, and the substance itself remains unchanged due to the choice of the symbols.

Fig.4-38



(2) Thermostatic expansion valves

Whereas the operation of the automatic expansion valve is based on maintaining a constant pressure in the evaporator, the operation of the thermostatic expansion valve is based on maintaining a constant degree of suction superheat at the evaporator outlet.
There are two kinds of thermostatic expansion valves, internal equalizing type and external equalizing type.

Thermostatic expansion valves

- Internal equalizing type
- External equalizing type

Fig.4-39

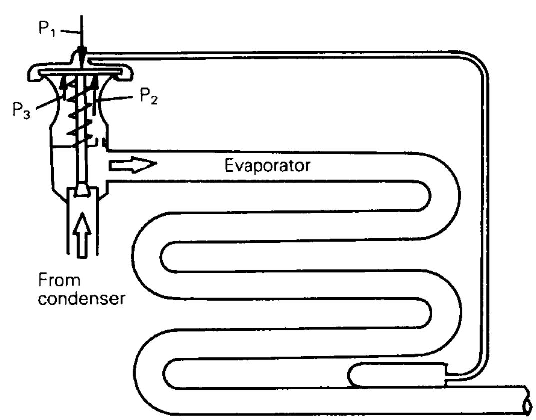
1) Internal equalizing thermostatic expansion valve

Fig.4-40 shows the structure of the internal equalizing thermostatic expansion valve.
Opening degree of the valve automatically changes according to the load fluctuations, adjusting the amount of refrigerant supplied so that neither wet compression nor superheated compression occur. Valve opening degree is determined by the state of equilibrium of the following three forces.

P_1: Force exerted upon the diaphragm by the gas pressure sealed in the sensor tube
P_2: Refrigerant evaporation pressure by the evaporator
P_3: Force of the superheat adjustment spring

When $P_1 = P_2 + P_3$, the valve controls the refrigerant flow under stable conditions. If load increases, the feeler bulb detects such increase, the temperature within the feeler bulb rises, and $P_1 > P_2 + P_3$ condition occurs. At this time, the diaphragm is pressed downward, and the valve begins to open.
Flow rate of the refrigerant increases in order to prevent super-heated compression (capacity insufficiency). On the contrary, if load decreases, the pressure in the feeler bulb reduces, and $P_1 < P_2 + P_3$ condition occurs. The valve then closes, the flow rate of refrigerant decreases, and a degree of superheating which prevents wet compression is constantly maintained.

Fig.4-40 Internal equalizing thermostatic expansion

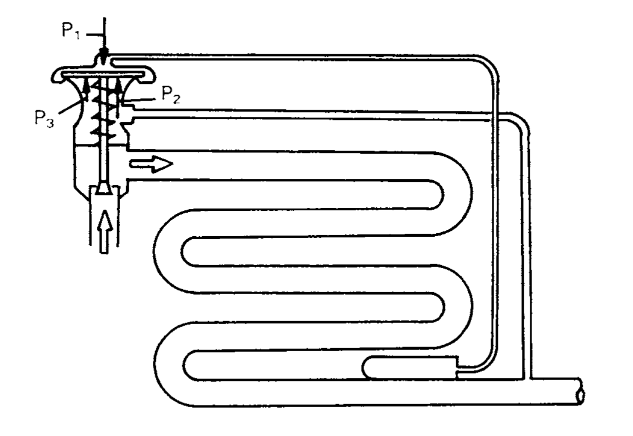


2) External equalizing thermostatic expansion valve

When the refrigerant passes through the evaporator, the pressure drops by a certain degree.

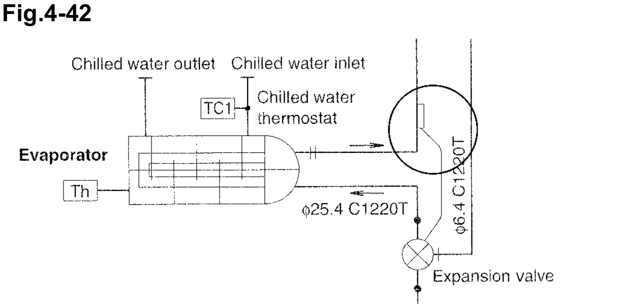
In case of an internal equalizing thermostatic expansion valve, if pressure drops greatly, degree of super-heat increases and super-heated compression occurs. To compensate for pressure drop in the evaporator, the external equalizing expansion valve (Fig.4-41) is used. In this valve, the internal equalizing port is eliminated and the pressure under the diaphragm is being taken from the end of the coil.

Fig.4-41 Internal equalizing thermostatic expansion valve



Thermostatic expansion valve has been substituted by electronic expansion valve in recent years, resulting in few models using it. In order to differentiate the valve in the piping circuit diagram, probing the presence of the feeler bulb as shown in the figure on the right locates the thermostatic expansion valve. (See Fig. 4-42)

Fig.4-42



4.2.6 Electronic expansion valve

With the progress of mechanization and electronic technology, frequency in use of electronic expansion valve becomes high. This is used for various system air conditioners and especially for the finer control.

The function of electronic expansion valve is the same as that of mechanical one. It can be electrically operated using a certain software. From now on, it must be used more and more.

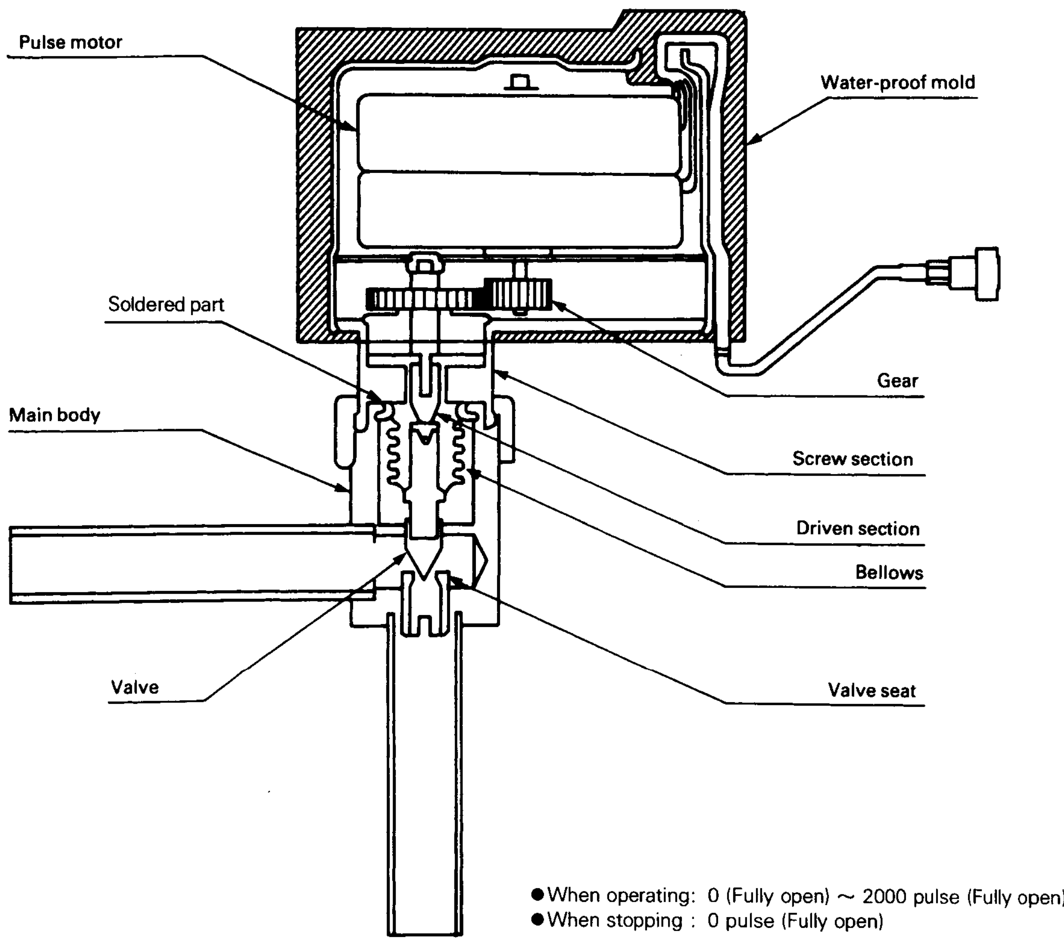
Both of them, EBM type linear control valves are used.

(1) Replacement of motor section

When the motor section is removed from the main body of the valve, the power source must be turned off, or the connector must be removed beforehand.

- When they are removed with the electricity is turned on, the screwdriver may jump out.

Fig.4-43



Structure of electronic expansion valve ··· its main body and motor section

(2) Disposition when electronic expansion valve will not open

In service working, when the screwdriver (portion to stop the valve)of the motor section jumps out, the repair procedure is as follows.

(3) Work Procedure

1) Turn off the power of indoor unit.
2) Pull the connector of electronic expansion valve out of the P-board.
3) Remove the motor section of electronic expansion valve from the valve-seat.
4) Replace (4) P (blue) with (2) P (yellow) connector pulled out.
5) Put the connector into the P-board.
6) Repeat several times on-off controls of the power of indoor unit — application of the theory of reversal. (At this time, confirm that the tip of screwdriver is sunk deeply than that of screw mechanism section.)
7) Turn off the power of indoor unit, and put the connectors (2) P and (4) P back in their places.
8) Attach the motor section of the electronic expansion valve to the valve section, securely.
9) Put the connector into the P-board, and repeat three times on-off controls of the power of indoor unit. (Detection of totally-enclosed state)
   With this, when the indoor unit becomes thermostat ON, the electronic expansion valve opens and returns to the normal operation.

Note: When the screwdriver is sunk too deeply with the operation (6), although the order of 2200 pulse "Close " is given from the P-board, it does not become totally-enclosed state. The operation (9) is necessary for once making the totally-enclosed state. Be sure to do this.