



## Chapter 3 Classification of air conditioners

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## Chapter 3 Classification of air conditioners

### 3.1 Air conditioning

Air conditioning is defined as "the process of treating air so as to control simultaneously its temperature, humidity, cleanness and distribution to meet the requirements of the conditioned space". As indicated in the definition, the important actions involved in the operation of an air conditioning system are;

(1) Temperature control

Room temperature is controlled to the predesigned dry bulb temperature by cooling or heating room air.

(2) Humidity control

Room air is controlled to the predesigned relative humidity by humidifying or dehumidifying room air.

(3) Air filtering, cleaning and purification

Room air is cleaned by removing dust and dirt from the air.

(4) Air movement and circulation

Air which is controlled in temperature and humidity and cleaned is distributed throughout a room. As a result, room air can be maintained evenly in temperature and humidity conditions.

Fig.3-1

1. Room air is cooled or heated

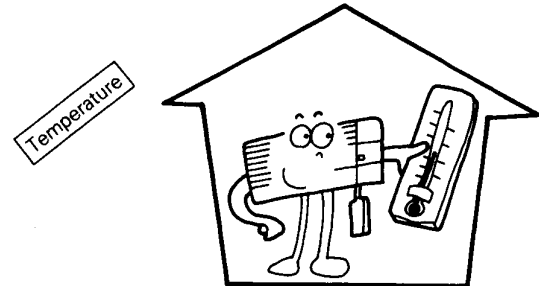


Fig.3-2

2. Room air is humidified or dehumidified

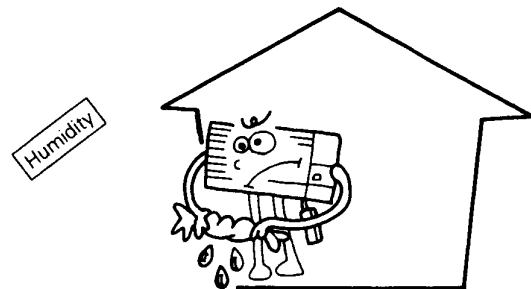


Fig.3-3

3. Room air is cleaned by removing dust and dirt from it.

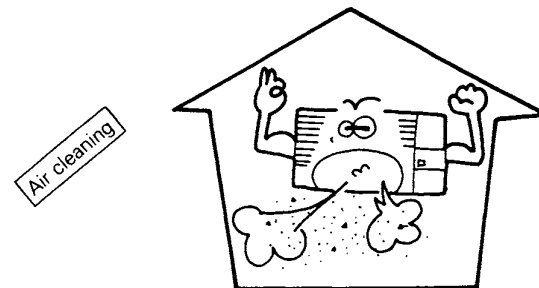
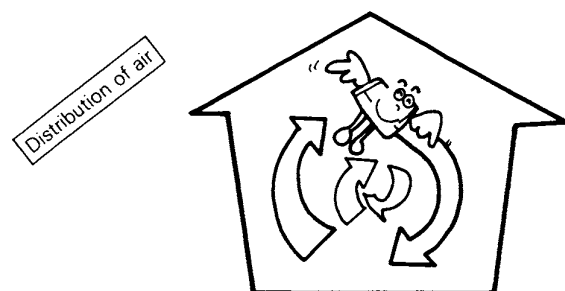


Fig.3-4

4. Controlled air is distributed throughout a room





Temperature, humidity, cleanness and distribution of air are called "Four elements of air conditioning". By controlling these four elements, room air can be comfortably maintained regardless of outdoor temperature. Should these four elements be replaced with the works of the air conditioner, the room air is drawn in the air conditioner, where dust and dirt are removed from the air by the air filter(cleanness of air)and is sent to the evaporator, where temperature of the air is reduced by evaporation of the refrigerant(temperature), and at the same time, humidity in the air is removed as condensation(humidity). As a result, the air distributed from the air conditioner is cool and crisp and can be distributed throughout the room by the evaporator fan(distribution of air stream). Such works are repeated so as to perform air conditioning.

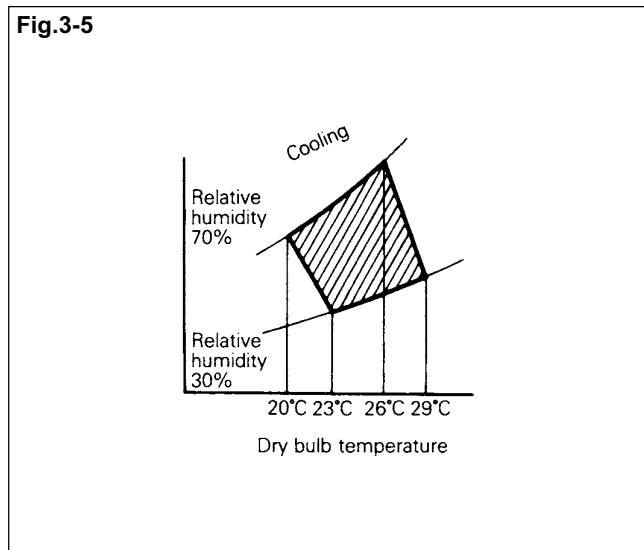
### 3.2 What is comfortable air?

The heat and coldness that the man feels depend not only on air temperature(dry bulb temperature), but also on humidity and distribution of air.

In addition, the general comfortable zone is within the range shown with oblique lines in Fig.3-5, although comfort differs with the distinction of sex, age and work.

In case of cooling, however, although room air conditions are within the comfortable zone, the room air is not always optimum. For example, if temperature difference between indoor and outdoor is nearly 10°C because room air is controlled so as to be within this zone, one feels coolness and heat strongly when he enters in and out of a room, which makes him feel uncomfortable.

Such discomfort is called "cold shock". Consequently, it is important to control room air temperature so as not to feel "cold shock" during cooling by adjusting the thermostat. The optimum temperature difference between indoor and outdoor is from 3 to 6°C in consideration with health and economy.



### 3.3 Classification of air conditioners

The main stream of air conditioners is packaged(Unitary) air conditioners, but they are gradually diversified in shapes and kinds owing to building utilities.

There are many kinds of classifications of air conditioners, but the representative classifications will be explained below.

#### 3.3.1 Classification by expansion methods

Expansion methods are largely classified in two types; i.e. direct expansion and indirect expansion. The direct expansion method is that heat is directly exchanged between air to be conditioned and the refrigerant, and the air conditioners adopt this method. The indirect expansion method is that heat is exchanged indirectly between air to be conditioned and the refrigerant by means of water or brine. The systems combining the chillers or centrifugal water chillers with fan coil units adopt this method.

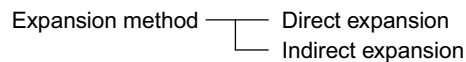


Fig.3-6 Direct expansion

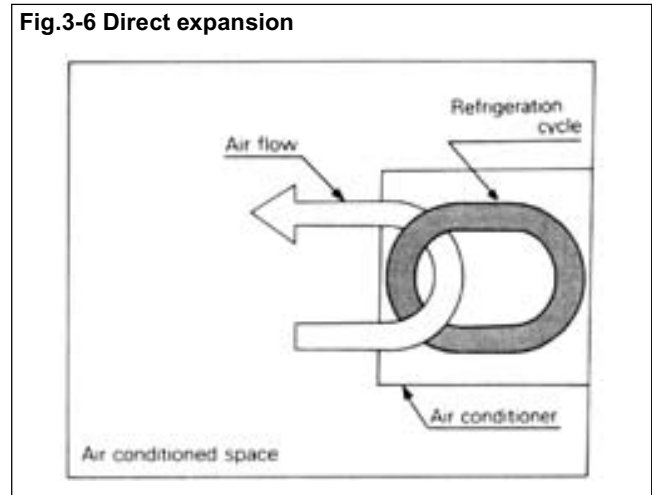
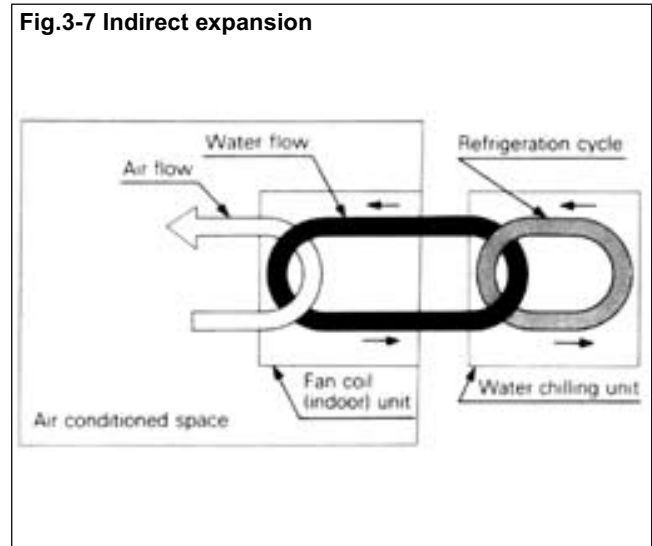


Fig.3-7 Indirect expansion

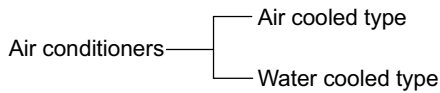




### 3.3.2 Classification by heat rejection methods

Heat rejection methods are largely classified in two types; i.e. water cooled type by means of water, and air cooled type by means of air.

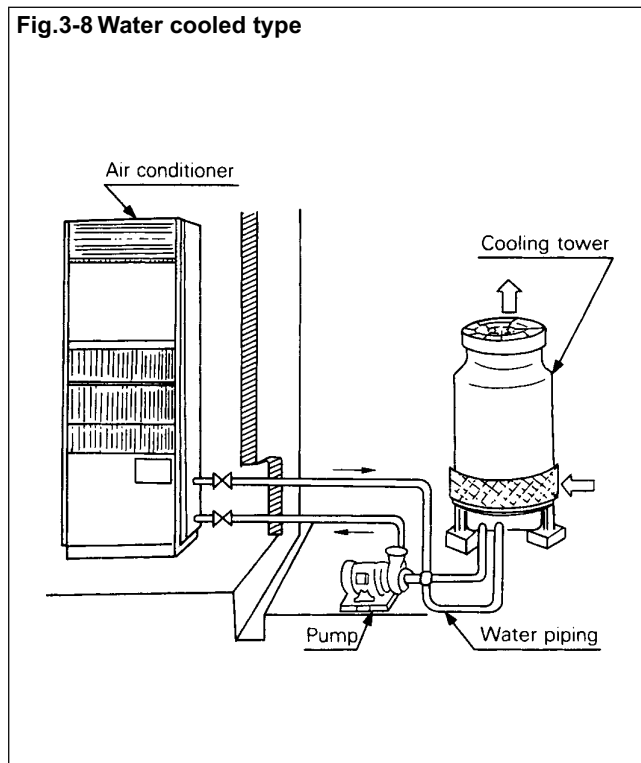
(As the recent tendency, the air cooled type air conditioners which are free from maintenance work increase.)



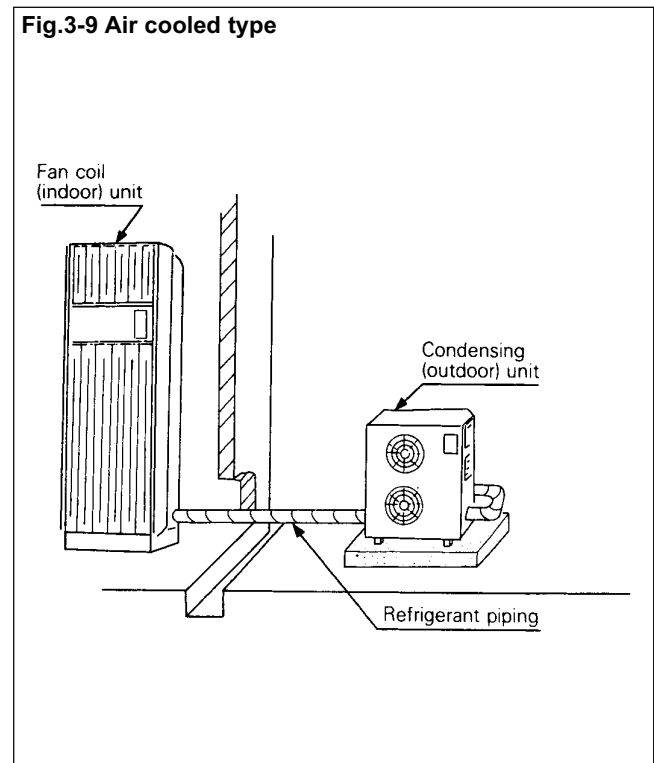
**Table 3-1 Features of air cooled and water cooled types**

| Items                         | Air cooled type  | Water cooled type   |
|-------------------------------|--|---|
| ① Condensing medium           | <ul style="list-style-type: none"> <li>Outdoor air</li> </ul>  | <ul style="list-style-type: none"> <li>Well water, city water</li> <li>Cooling tower water</li> </ul>   |
| ② Incidental works            | <ul style="list-style-type: none"> <li>Power supply</li> <li>Refrigerant piping (Split type only)</li> </ul>   | <ul style="list-style-type: none"> <li>Power supply, cooling water piping</li> <li>Pump for well water or water circulating pump for cooling tower</li> </ul> |
| ③ Cooling capacity per 0.75kw | Approx. 8,790~10,465 kJ/h (2100~2500kcal/h)  | Approx. 12,558kJ/h (3000kcal/h)   |
| Noise                         | Comparatively high (Outdoor unit)  | Low   |
| Check points                  | <ul style="list-style-type: none"> <li>Conditions of outdoor air intake (chemicals, dust and dirt)</li> <li>Short-circuit of distributed air</li> <li>Outdoor air temp.</li> </ul> | <ul style="list-style-type: none"> <li>Quantity and quality of cooling water</li> <li>Position of a cooling tower</li> </ul>                                  |

**Fig.3-8 Water cooled type**

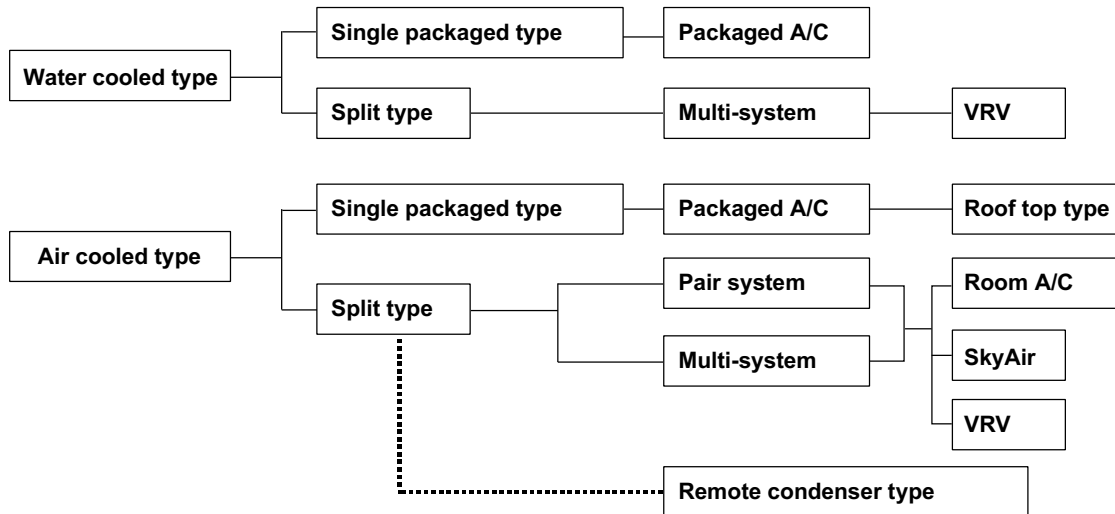


**Fig.3-9 Air cooled type**





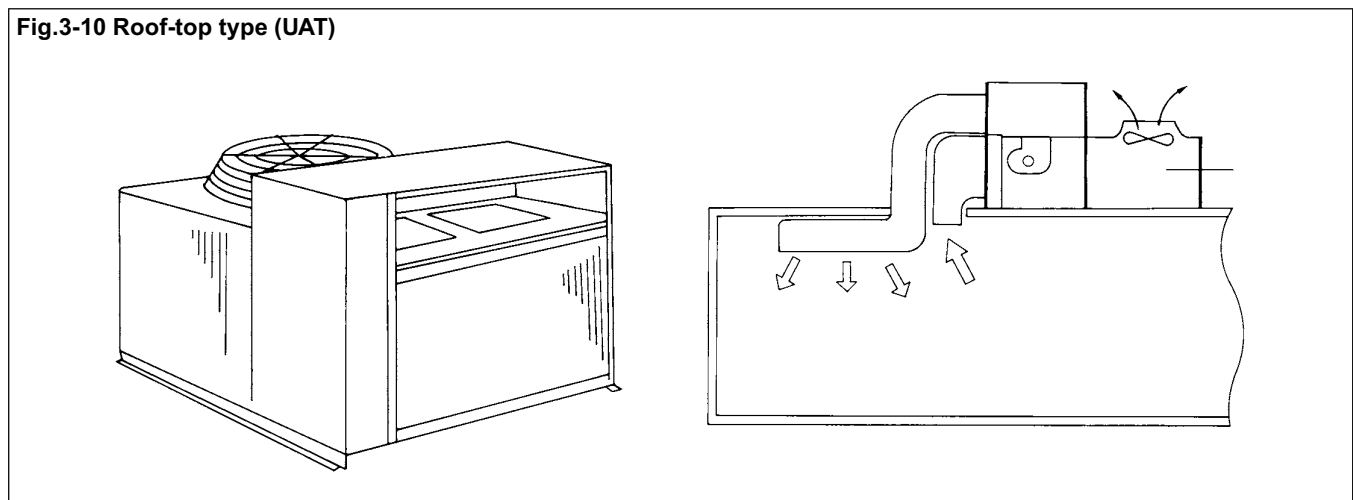
### 3.3.3 Classification by structure



**Table 3-2 Features of Single packaged type and Split type**

| Items                    | Single packaged type   | Split type   |
|--------------------------|--|--|
| Structure                | One package type with all necessary components incorporated  | Indoor units and outdoor units are manufactured independently.   |
| Installation work        | <ul style="list-style-type: none"> <li>Incorporation of all necessary components results in heavy weight per unit.</li> <li>No piping work requires no skillful piping worker, while the Roof top type requires duct work.</li> </ul>  | <ul style="list-style-type: none"> <li>Piping work is required.</li> <li>Through holes must be made in the wall.</li> </ul>  |
| Location of installation | <ul style="list-style-type: none"> <li>In the case of indoor installation, a large dead space is required due to the floor installation.</li> </ul>  | <ul style="list-style-type: none"> <li>The indoor unit is light in weight and requires a minimal floor space.</li> <li>The outdoor unit has a large flexibility of the installation site.</li> </ul>   |
| Noise Problem            | <ul style="list-style-type: none"> <li>The indoor installation requirement results in operation at a high noise level including the compressor.</li> <li>By the central system, airflow sound is only heard in the room. Therefore, superb duct design enables low-noise operation.</li> </ul> | <ul style="list-style-type: none"> <li>Except for remote condenser type, no compressor noises remain in the room.</li> <li>On all types incorporating the expansion valve (or capillary tube) in indoor unit, refrigerant passing sound is heard.</li> </ul> |

**Fig.3-10 Roof-top type (UAT)**

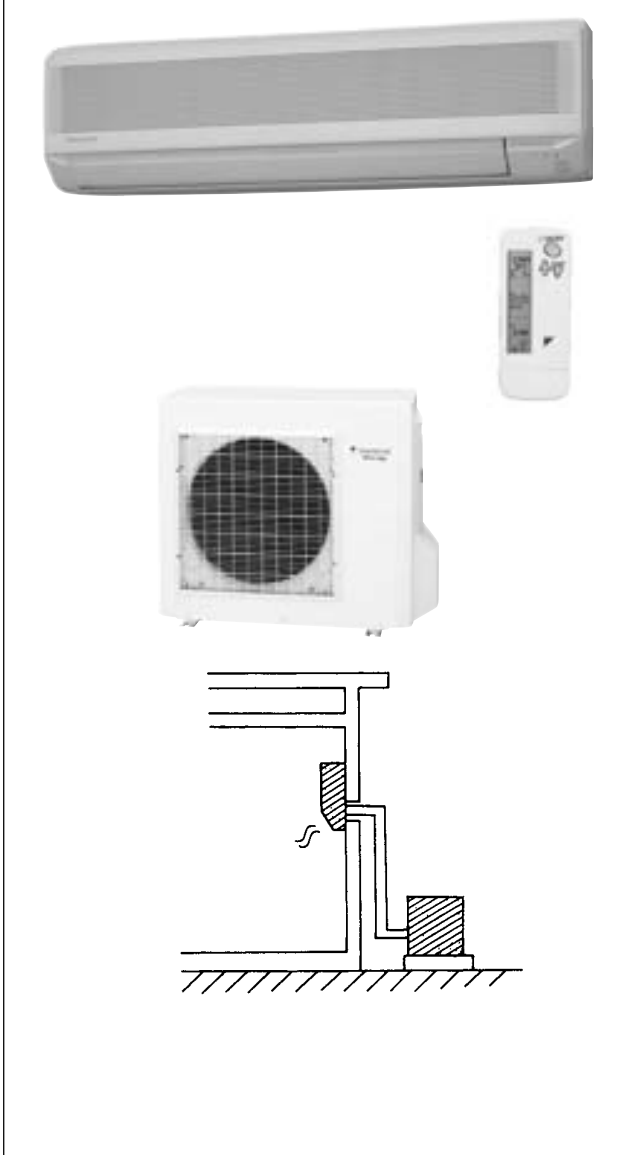




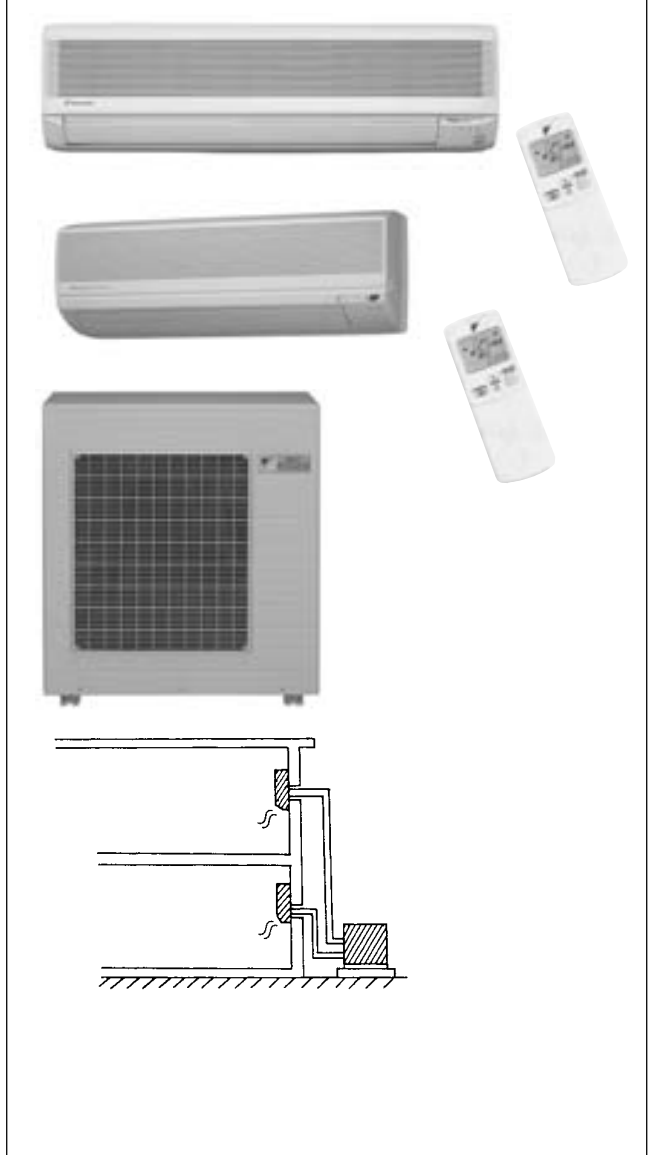
**Table 3-3 Features of Split-pair and Multi-system**

| Items                    | Pair System  | Multi-system  |
|--------------------------|--|---|
| Installation Work        | <ul style="list-style-type: none"> <li>Increasing the number of applicable rooms increases the number of outdoor units. As a result, the number of through holes in the distribution pipes increases.</li> <li>The work itself is easier than that for Multi-system, thus required no skills of a high level.</li> </ul> | <ul style="list-style-type: none"> <li>Even though there are a number of applicable rooms, one outdoor unit can cover. Therefore, the number of through holes in the pipes can be minimized.</li> <li>The work itself becomes more complicated than that for Pair System due to additional work such as brazing.</li> </ul> |
| Location of Installation | <ul style="list-style-type: none"> <li>In the case of a system of multiple outdoor units, larger space is required.</li> </ul>   | <ul style="list-style-type: none"> <li>Less number of outdoor units achieves less floor space required.</li> </ul>  |
| Control                  | <ul style="list-style-type: none"> <li>It is hard to perform the centralized control of a multiple of pair systems.</li> </ul>   | <ul style="list-style-type: none"> <li>There are a number of models, which enable the centralized control of a large number of indoor units</li> </ul>  |
| Noise problem            | <ul style="list-style-type: none"> <li>The more outdoor units are provided, the noise source is dissipated.</li> </ul>   | <ul style="list-style-type: none"> <li>Since the noise source is concentrated on one place, it is convenient to take countermeasures such as the installation of noise insulation wall.</li> </ul>  |

**Fig.3-11 Split type (Pair system)**



**Fig.3-12 Split type (Multi-system)**





### 3.3.4 Classification by locations of compressor (in case of the split type air conditioners)

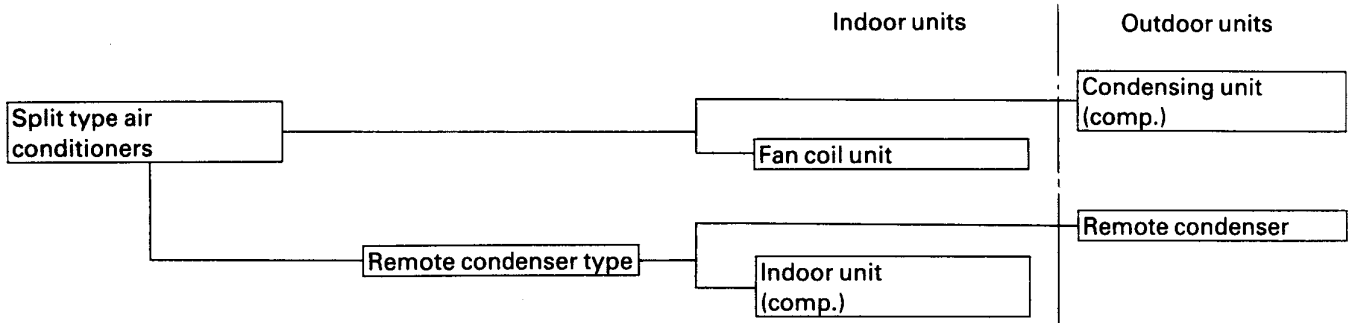


Fig.3-13 Split type

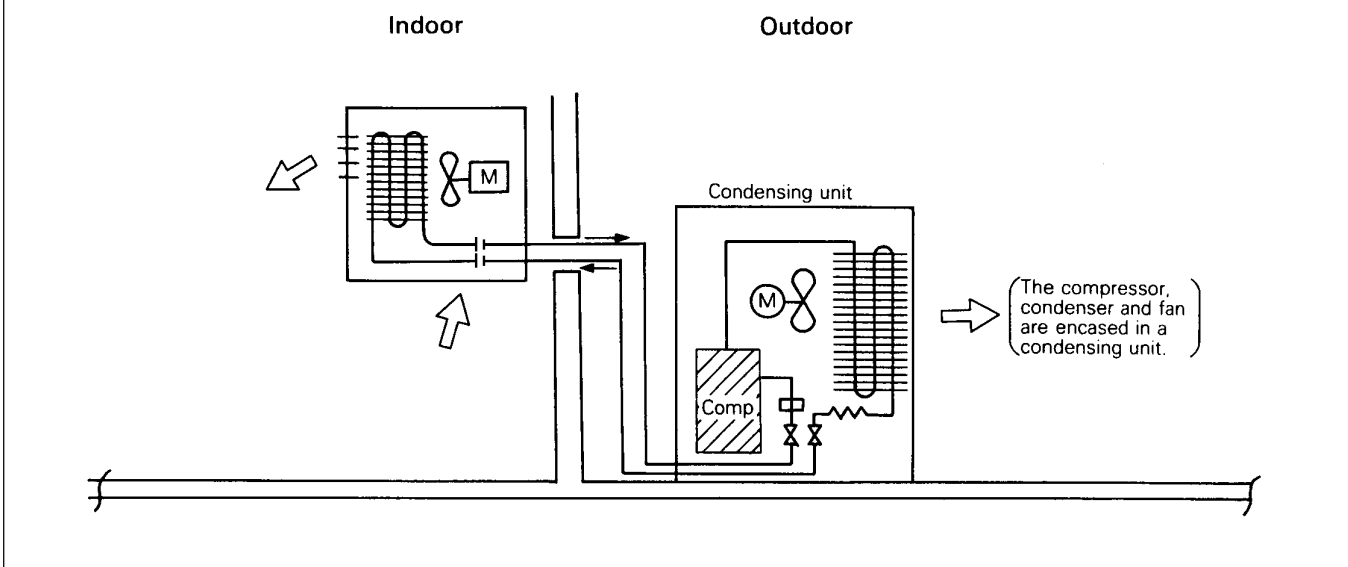
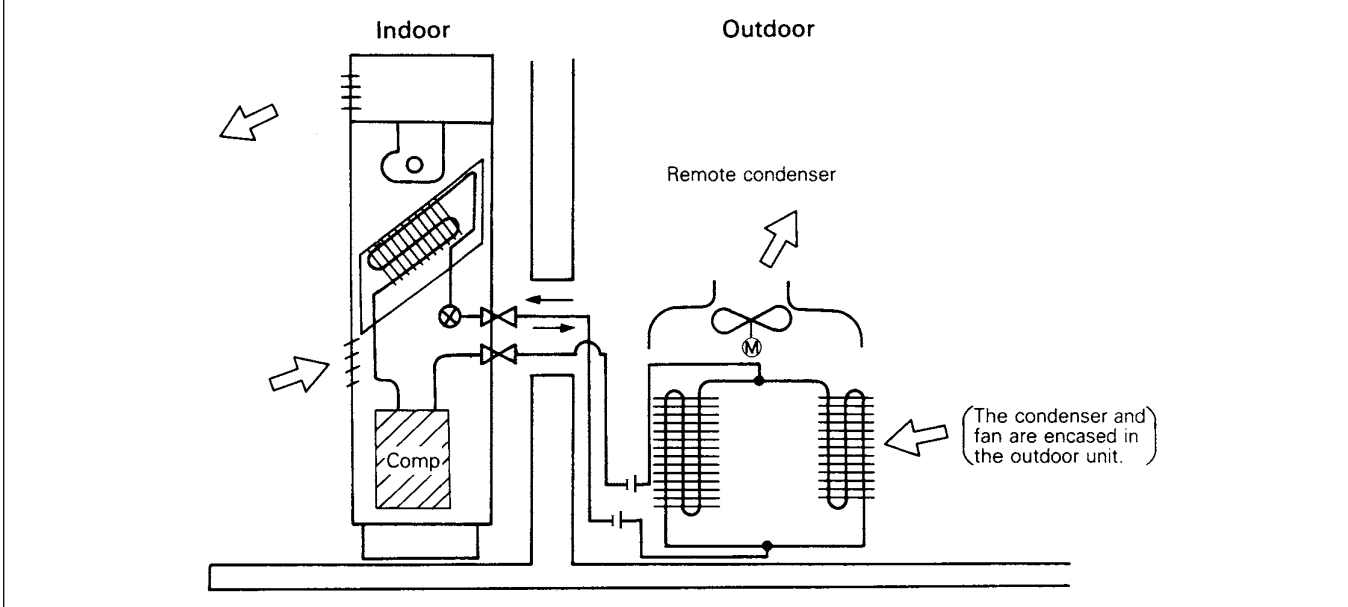


Fig.3-14 Remote condenser type

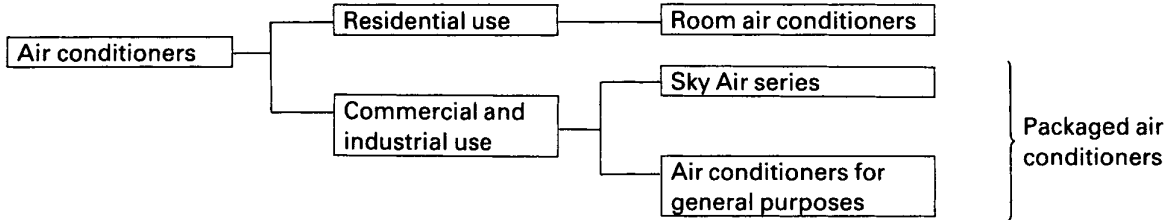




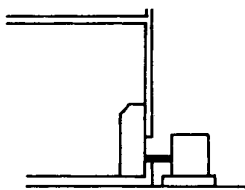
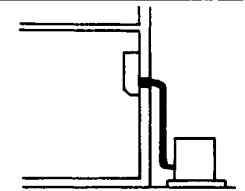
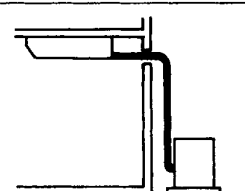
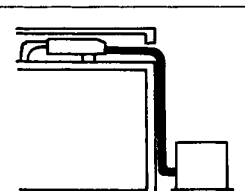
### 3.3.5 Classification by using positions

Air conditioners are largely classified in the residential use, commercial use and the industrial use.

In general, residential air conditioners are referred to as room air conditioners and commercial and industrial air conditioners as packaged air conditioners.



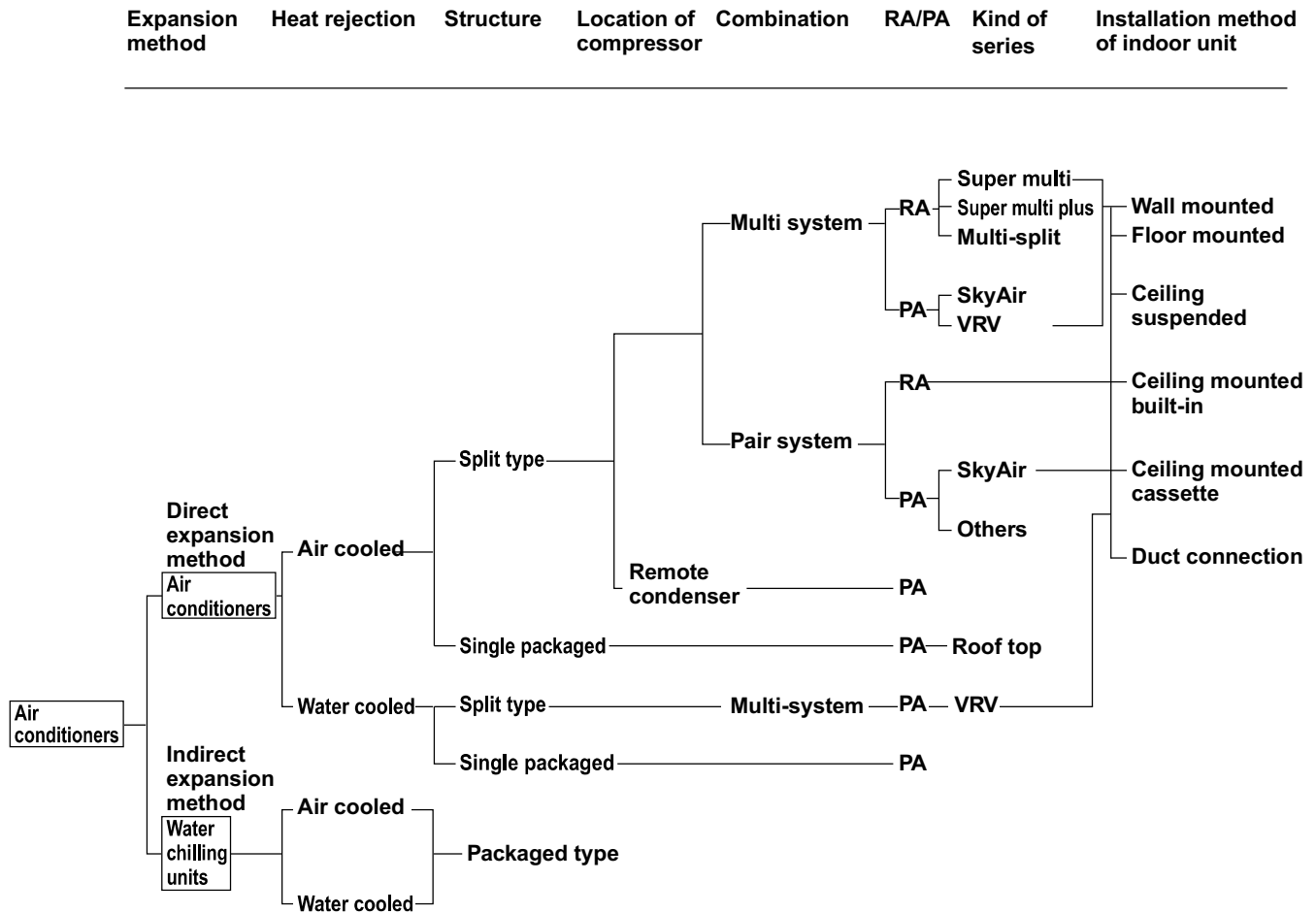
### 3.3.6 Classification by installation methods of fan coil (indoor) units

|                            | Kinds                         | Rough sketch  |
|----------------------------|-------------------------------|---|
| Fan coil<br>(indoor units) | Floor mounted type            |  <p>The unit is installed on the floor and is capable of distributing the conditioned air widely.</p>  |
|                            | Wall mounted type             |  <p>The unit is installed at the middle of the wall. Since the unit is of the thin type, the room space can be used effectively.</p>  |
|                            | Ceiling suspended type        |  <p>The unit is suspended from the ceiling and distributes the conditioned air horizontally. Namely, not only the floor area, but also the wall face can be used effectively.</p> |
|                            | Ceiling mounted cassette type |  <p>The unit is installed in the ceiling, so room space can be fully used and is good from the interior designing point of view.</p>  |





### 3.3.7 Table of classification of air conditioners



### 3.3.8 Classification of central air conditioning systems

There are several classification methods available for the air conditioning systems. This section describes the classification by decentralization degree and thermal transfer medium of air conditioners.

#### (1) Classification by decentralization degree of air conditioners

The decentralization degree methods are classified into centralized type (or central type) and individual type, and also into the in-between types such as each floor type and decentralized type.

1. **Centralized type:** The central type is that air conditioning is performed over several floors through large-sized air conditioners and others, and used for air conditioning aimed at large area such as buildings.
2. **Each floor type:** The each floor type is that air conditioning is performed by floor and used when each floor has different intended use and time zone to be air-conditioned.
3. **Decentralized type:** The centralized type is that air conditioning is performed by partitioning a room into several air-conditioning zones and installing air conditioners in each zone in decentralized manner. This system is used to segment the indoor space.
4. **Individual type:** The individual type is that air conditioning is performed by installing individual air conditioner for each room and used for small-sized air conditioning system such as that for houses and stores.

\* Lately, in terms of operation control, inspection/ maintenance, energy saving, and others, the each floor

type and the decentralized type have been increasingly introduced, compared to the centralized type.

#### (2) Classification by thermal transfer medium

##### 1. Total air method

The total air method is that conditioned air from the air conditioner is fed to each room through duct. Since heat is all transferred by means of air, this method is referred to as total air method.

The total air method enables the intake of outdoor air, thus making it favorable in order to upgrade the indoor air cleanliness factor. However, air has a low heat capacity and requires larger ducts in size according to the airflow rate, thus resulting in increased number of restrictions in installation.

##### 2. Total water method

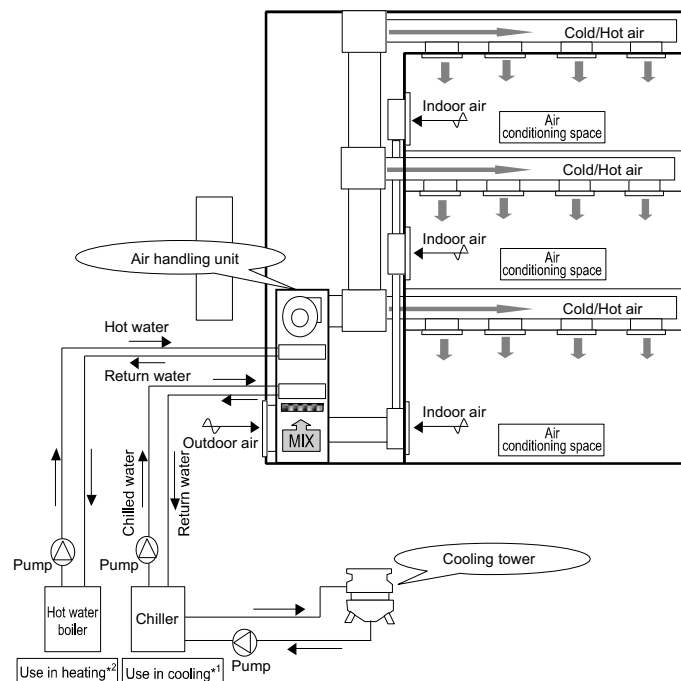
The total water method is that heat transport up to the inside of room is all performed by means of water. The fan coil unit type represents this method. It is a convenient method to perform air conditioning, while being behind other methods in terms of keeping the air cleanliness factor constant because indoor air is to be circulated for air conditioning.

##### 3. Water-air method

The water-air method is that indoor air-conditioning is performed in combination of conditioned air from the air conditioner and chilled water from chiller or else. This method performs air conditioning by means of both air and water, thus being referred to as water-air method. The typical example is that the fan coil unit type supports the perimeter area of room (perimeter zone) while the single duct type supports the central area of the room (interior zone).

#### Total air method · Total water method · Water-air method

Fig.3-15 Total air method (Example of typical installation)

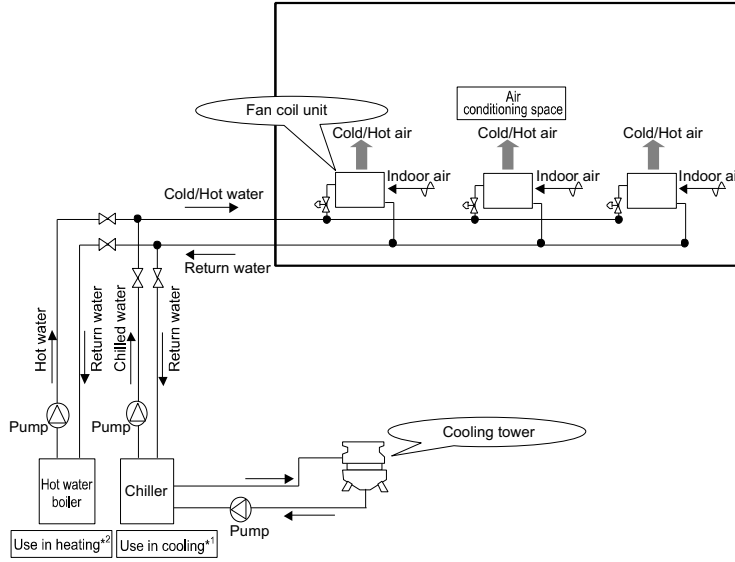


\*1: If air cooled type chiller is used, no cooling towers are required.

\*2: If heat pump type chiller is used, no hot water boilers are required.

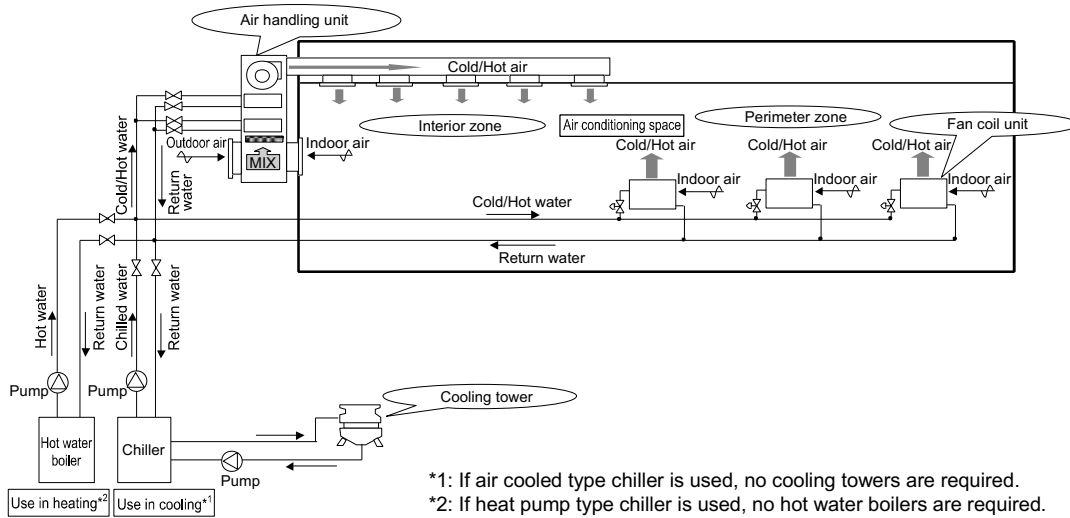


**Fig.3-16 Total water method (Example of typical installation)**



\*1: If air cooled type chiller is used, no cooling towers are required.  
 \*2: If heat pump type chiller is used, no hot water boilers are required.

**Fig.3-17 Water-air method (Example of typical installation)**



\*1: If air cooled type chiller is used, no cooling towers are required.  
 \*2: If heat pump type chiller is used, no hot water boilers are required.



**4. Refrigerant method**

The refrigerant method is that indoor air-conditioning is performed through making use of evaporation and condensation effect of fluorocarbon gas (Flon gas). According to the innovation of air conditioning technology in recent years, this method is widely used regardless of the sizes of buildings.

Compared to methods making use of water or air, this method will has advantages in equipment costs, energy consumption, installation space, maintenance costs, and others. The following figures show the examples of respective installations.

● **Room air conditioner**

The room air conditioner is an air conditioning system installed at home and the pair type of room air conditioners, which indoor unit and outdoor unit are installed in a pair, is

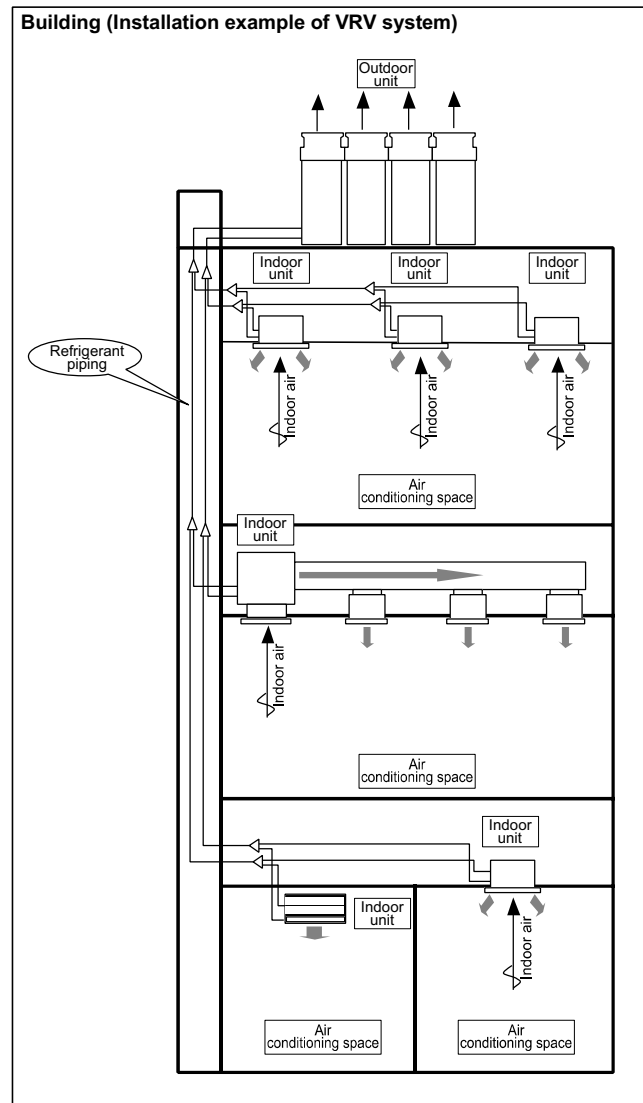
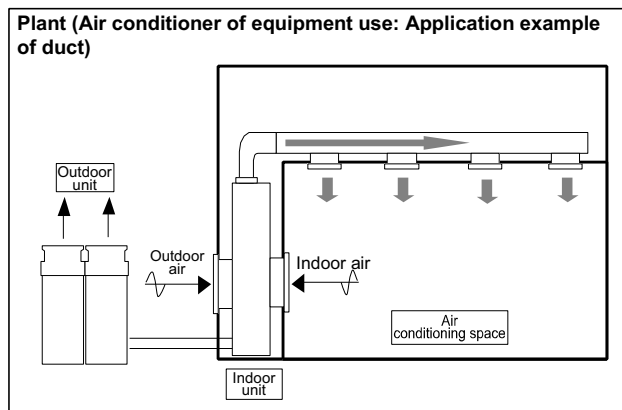
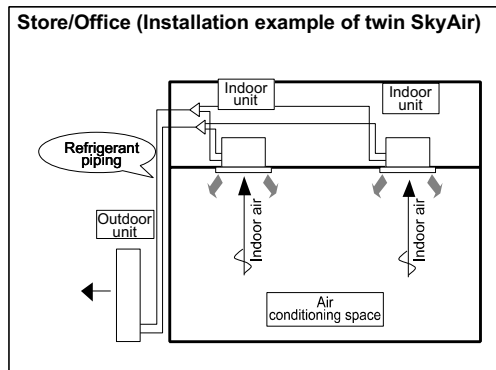
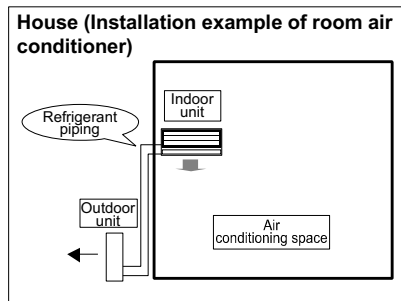
**Refrigerant method (House, store, office, plant, building)**

currently the mainstream. Besides the pair type, the multi-type, which enables the installation of 2 to 3 indoor units in a system, is available.

● **Package air conditioner for business use**

Generally, as the air conditioning system used at any other place than home, the package air conditioners are used in a variety of ways for diversified applications such as stores, offices, plants, and buildings. Besides those for plant use, there is a wide choice of variations available for indoor units. Currently, the ceiling mounted cassette types come into common use, and the support of optional accessories enables the incorporation with air cleaning and humidifying functions.

Fig.3-18





### 3.3.9 Configuration of Air Conditioning System

Numbers of air conditioning systems, including the total air method, total water method, and water-air method, consist of the following equipment.

#### 1. Heat source unit

The heat source unit is used to produce chilled water, hot water or vapor required for air conditioners.

This unit consists of heat source units such as chiller (e.g. turbo chiller and water chilling unit), absorption type chiller/ water heater, and boiler together with various equipment required to operate the heat source units such as pump, cooling tower, and oil tank.

#### 2. Air conditioner

The air conditioner consists of cooling coil, heating coil, humidifier, air filter, and others, which treats indoor heat loads to keep air clean.

The air conditioner sometimes takes in outdoor air (referred to as fresh air as well) and mixes it in return air from rooms. This outdoor air replaces indoor air contaminated due to breathing, odor, or smoking of people in the rooms.

#### 3. Fan and duct

The fan serves as a power to transport air through transport path that is the duct.

Air treated with the air conditioner is transported through the duct and fed into the room from the air outlet. Air, which has treated the indoor heat loads, is returned from the air inlet back to the air conditioner through the duct.

#### 4. Pump and piping

The pump serves as a power to transport the heating medium such as water through transport path that is the piping.

Chilled water, hot water, or vapor, which is produced with the heat source unit, is transported to the air conditioner through the piping, where the heat loads are treated. After that, it is returned to the heat source unit. In order to discharge heat removed through chiller or absorption type chiller to the outside, the pump transports cooling water up to cooling tower through the piping.

#### 5. Automatic control unit

On air conditioners, the chilled and hot water flow rates are adjusted and the discharge temperature and relative humidity are controlled.

Furthermore, the airflow rate of the discharge air may be controlled. The intake amount of outdoor air is controlled as well.

On heat source units, the chilled and hot water temperatures are kept constant and, at the same time, the number of operating units and their capacities are controlled according to the load capacities. On pumps, the number of units and the capacities are controlled.

Thus, the automatic control unit is a unit to operate the entire air conditioning system so that it can keep the indoor temperature and relative humidity under the most favorable conditions and economical running conditions.