cooling, dehumidifying, filtering, ventilation, air circulation, heating, and humidifying. Control of the air conditions is provided by manual switches, automatic devices or a combination of the two. The controls are usually mounted on the units.

The various elements required to produce the effects on the conditioned air are discussed herewith under separate headings.

Heating

Heating in the air conditioning unit is ordinarily accomplished by a heating coil of the non-ferrous finned tube type supplied with either steam or hot water. The steam or hot water is supplied from an external source.

In some cases the heating element may be an electric heater. Where electric power is low in cost, air conditioning units may provide heat from encased or open strip heaters (see Chapter 41). Radiant electric heaters are seldom used except as their radiant heat is absorbed by some receiving wall and then transmitted to the air in the form of convected heat.

Humidifying

Humidifying the air requires a source of heat which may be supplied by applying heat directly to the humidifier water, by applying heat to the air to be humidified, or by picking up heat directly from the air.

The oldest and best known method of humidifying air is by means of a spray. The simplest system is that in which the spray water is furnished from a constant water source, and the excess is permitted to run to waste. The spray effect may be accomplished either by a direct atomizing type which breaks the water down into fine particles by passing it through nozzles, or the water may be directed in a fine jet to a flat surface or target. In these methods some of the sensible heat of the air is transformed into latent heat. These methods are normally inefficient in the use of water. In some cases, the spray is impinged against a heated surface, thereby evaporating some of the water to increase the humidifying capacity. While this is practical in some instances, there is always the danger of scale formation where hard water is employed. A direct steam spray is used in industrial applications but is seldom used in air conditioning units for comfort work due to the resulting odors.

A popular method is to use a drip humidifier. In this type, the water flow is controlled by a solenoid valve and the water is poured into a pan. The pan contains a series of small holes through which the water passes and drips over a built-up section of galvanized screening. The air passes through the screens and picks up moisture.

Another method of humidifying is the evaporative pan type. This is used in comfort conditioning units and consists of a container offering as much water surface as possible and equipped with means of heating the water. The heat may be applied either electrically, by steam, hot water, or by circulation of the water from a heated space through the evaporating pan. Since the humidification is accomplished by surface evaporation only, if low pressure steam or hot water is used, it is essential that the air stream be directed across the surface and that the evaporating surface be large. The evaporative pan type of humidification limits the water wastage and is usually supplied with water through a float valve.

Due to the collection of salts in this evaporating pan such humidifying systems require occasional drainage and cleaning.

Other methods of humidification attempted in air conditioning units are through the use of wetted fabrics, porous earthenware plates, or other capillary surfaces. These methods rely upon the capillary absorption of the moisture up from the liquid level into the portion exposed to the air. They have a tendency to lose their effectiveness due to the resulting deposit of mineral salts at the evaporating surfaces thereby clogging the pores and reducing the contact of the air with the water. Also they frequently become foul and often support bacterial growth.

Cooling and Dehumidifying

The cooling and dehumidifying effects on air are produced either simultaneously as in the case of a direct expansion cooling coil, or separately as in the case of an adsorption process and separate cooling coil.

In conditioning units, the use of surface cooling is probably the most common method of producing reduction in dry-bulb temperature of the air and dehumidification simultaneously. The type of surface employed may be cast or fabricated from tubes. In present day practices finned tubes or plate fins through which tubes are passed form the most generally used cooling surface. The detailed fabrication of this surface and the arrangement of the tubes will depend largely upon the type of refrigerant for which it is intended.

The simplest construction is that in which chilled water or brine is used as the refrigerating medium. With direct expansion refrigerant it is usually necessary to provide a special arrangement of headers so that proper distribution of refrigerant through all the surface is obtained. In some cases, ordinary brine coils can be used when operated as a flooded refrigerant system. In some units a combination of a direct spray and a refrigerant surface is used, the spray being directed against the surface. Such systems claim the advantage of air washing together with the maintenance of a clean and effective cooling coil.

When suface coolers are used, adequate protection in the form of filters or at least lint screens are necessary to prevent fouling of the surface from the air borne dirt. Surfaces not so protected frequently becomes completely matted with lint, grease, and similar dirt.

The sources of refrigeration used with these surface type conditioning units are discussed in Chapter 24. However, they may be divided into the following groups:

1. Direct expansion refrigerant in which the liquid refrigerant is evaporated within the coils of the unit. The vapor from these coils may be recompressed in centrifugal, rotary, or reciprocating type compressors, and the refrigerant again returned to the evaporator coil.
2. Indirect refrigeration by means of:
   a. Cold well water.
   b. Cold city water.
   c. Artificial refrigerated water provided by direct expansion of refrigerant in a water cooler, direct steam jet refrigeration, or by the melting of ice.

Another direct means of cooling and dehumidification is through the use of ice. In such units the ice is brought into as intimate contact as