the temperature, humidity, and motion of the air within the conditioned space. Air conditioning with unit equipment has gained in popularity during the last few years and some equipment offered does not fulfill the basic requirements of a true air conditioning unit. It is to be noted that air conditioning equipment must have the ability not alone to alter the temperature or humidity within the conditioned space, but it must *control* these conditions. Thus, some equipment that attempts to provide cooling or humidification does not have the capacity or means of actually controlling these conditions.

In selecting and specifying the unit types, the results desired should be carefully determined. If the simultaneous control of temperature, humidity, air motion, and distribution within the enclosure is not required then the simpler and less expensive unit heaters and unit coolers may be considered. Complete air conditioning should simultaneously *control* the following features:

1. Air temperature.
2. Air humidity (moisture content).
3. Air motion and distribution.
4. Air purity.

Three general classifications of unit air conditioners are recognized:

1. All-year conditioning involving the control of these conditions both in summer and winter and thus requiring both heating and cooling as well as humidifying and dehumidifying.
2. Winter conditioning in which heating and humidifying alone are controlled together with air motion and air purity.
3. Summer conditioning involving cooling and dehumidifying with air distribution and cleaning.

The means of accomplishing these functions are outlined herewith:

Heating

The normal air conditioning unit derives its heating function from a heating coil, usually of the non-ferrous finned tube type supplied with either steam or hot water. Steam may be supplied directly from a self-contained and built-in oil or gas fired unit, from a separate domestic steam boiler, or even from an outside source of a central heating plant. Hot water is supplied either from a separate hot water boiler or in rare instances from a domestic water heater.

In domestic or household conditioning units, adapted from a warm-air heater to which humidification is added, or possibly all-year-round conditioning, a direct-fired air interchanger is frequently used. The source of heat in this case may be from the combustion of coal, oil, or gas. A wide variety of designs and structures are used. In such direct-fired systems, the bulk and volume of the heat transfer surface is necessarily large in proportion to the rest of the equipment.

Where electric power is low in cost, electric heat has been furnished in unit air conditioners either in the form of encased heaters, or open wire heaters. (See Chapter 39.) Radiant electric heaters are seldom used except as their radiant heat is absorbed by some receiving wall and there transmitted to the air in the form of convected heat.

Another method of applying electric heat is by means of the reversed refrigeration cycle, whereby electric energy is used to compress a refrigerant and to deliver the heat of compression, withdrawn from a lower temperature source, to the conditioned space by locating the condensing coils in the air circulation circuit of the unit conditioner. While this method of heating has gained wide interest, it is practical only in a limited number of applications. Its economic practicability depends largely upon the availability of a source of heat during the winter season at as high a temperature as is possible. Thus, while it is frequently applicable in mild climates, it is not of great value in the northern climates where sub-freezing temperatures are common. It has the other unfortunate property that when the outdoor temperature is the lowest and the heat requirement the greatest, the heating capacity of the system is a minimum. This means that in many installations, an auxiliary and separate source of heat must be supplied to carry through these peak winter conditions. Such factors as these have limited a more general application of this principle. (See Chapter 2 on Refrigeration.)

Humidifying

A very wide variety of humidifying means have been used to furnish humidification in winter to air conditioning units. The oldest and best known is by means of a direct spray which is used in many different ways. The simplest system is where the spray water is furnished from a constant water source, such as city water, and is permitted to run to waste. Under such conditions, the spray may be either of the direct atomizing type where, by means of the nozzles, the water is broken into fine particles or of the so-called target spray type, where a fine stream of water under pressure is caused to impinge upon a flat surface or target. Such methods are normally rather inefficient in the use of water.

Any spray system where water is run to waste must of necessity atomize as completely as possible to provide for evaporation of the maximum amount of water. This normally calls for moderately high pressures and for very fine orifices or passages in order to produce fine atomization. This in turn involves the danger of occasional clogging of the nozzles with resulting service problems. Recently a number of self-cleaning nozzles have come on to the market which give promise of reducing this hazard. Such methods even at best are wasteful of water inasmuch as only a comparatively small proportion of the water used is actually evaporated, the remainder running to waste. In spite of the water wastage this method is normally more economical in the case of small conditioning units than the installation of a pump to recirculate and reuse the waste water.

In the larger conditioning units where much larger quantities of water are used and the amount of water wastage becomes an appreciable item, it frequently is profitable to install a recirculating pump. Comparatively few units employ this recirculating system. It is important to note that when spray water is recirculated in such equipment in industrial areas and in large cities, it becomes necessary that water treatment be supplied, in order to reduce the corrosive action resulting from the absorption of acids and impurities from the air.