

water vapor in the saturated mixture, provided sufficient water and time are furnished for saturation.

Table 5, Chapter 1, shows the amount of moisture required to saturate a space at various temperatures. When the proper amount of moisture is determined, it is only necessary to set the air washer (dew-point) thermostat for the corresponding temperature of saturation; then if the air entering the washer has more humidity than desired, the excess will be condensed; and if it has less, the deficiency will be absorbed from the sprays.

For example, the dew-point temperature at 70 F and 40 per cent relative humidity is 45 F. Therefore, if the air temperature is maintained at 45 F as it leaves an air washer (assuming it is fully saturated) and then is heated to 70 F, it will have a relative humidity of 40 per cent. If it is desired to maintain these conditions in a given space, the air temperature can be raised to any necessary point, say 120 F (at which the relative humidity will be only 9 per cent). When the heat in the air has been dissipated, the space temperature being maintained at 70 F, the relative humidity will be 40 per cent.

2. Within ordinary operating ranges, saturated air will have a relative humidity of approximately 50 per cent when its temperature is raised 20 deg. For example, saturated air at 40 F raised to 60 F has a relative humidity of 48 per cent; 60 F saturated air raised to 80 F has a relative humidity of 50 per cent. (See Table 4, Chapter 1.) Thus a differential thermostat can be used to maintain a nearly constant relative humidity of 50 per cent by holding the dew-point temperature 20 deg below the dry-bulb temperature.

3. The total heat of the air and the water vapor mixed with it varies directly with the wet-bulb temperature. For example, the occupants of an auditorium give off sensible heat which tends to raise both the dry-bulb and the wet-bulb temperatures of the space; but the occupants also give off moisture which increases the absolute humidity and tends to further raise the wet-bulb temperature by an amount which is a direct indication of the heat expended by each occupant in evaporating this water. This relationship is useful in regulating the total heat, as wet-bulb temperatures can be controlled directly by means of a thermostat having a sensitive element covered with water-fed wicking, similar to a wet-bulb thermometer.

For example, the total heat of air at 80 F and 60 per cent relative humidity is the same as for air saturated at 70 F, i.e., 33.96 Btu per pound, both having a wet-bulb temperature of 70 F. Air at 80 F and 60 per cent relative humidity (70 F wet-bulb = 33.96 Btu per pound) reduced to 70 F and 50 per cent relative humidity (58½ F wet-bulb = 25.37 Btu per pound, total heat) must give up 8.59 Btu per pound. If the sensible heat and moisture pick-up in an auditorium is 8.59 Btu per pound of air handled in the conditioning system, the wet-bulb temperature of the air entering the space must be maintained at 58½ F to secure a final condition of 80 F and 60 per cent relative humidity.

Control of Relative Humidity

The following are the most commonly used methods of controlling relative humidity:

1. A thermostat is located in or at the outlet of a spray-type air conditioner which maintains a constant saturation temperature of the air leaving the conditioner by varying the temperature of water entering the suction of the pump supplying the spray nozzles, or by varying the temperature of the air entering the conditioner, or both. The temperature of the air entering the conditioner may be varied by use of tempering heaters, or by the proper proportioning of supply and return air entering the conditioner. This thermostat is known as a dew-point thermostat, as it determines the dew-point temperature of the air introduced into the conditioned spaces. A second thermostat in the room, or in the path of the air leaving the room, maintains a constant dry-bulb temperature by varying the amount of sensible heat added to the air leaving the conditioner, or by varying the volume of air introduced into the conditioned spaces. These two thermostats, in combination, control the dry-bulb and dew-point temperatures, which accordingly fix the relative humidity.

2. A wet-bulb thermostat is located in the room, or in the path of the air leaving the room, to maintain a constant wet-bulb temperature by varying the saturation temperature at the air conditioner outlet. A dry-bulb thermostat is located in the room to maintain a constant dry-bulb temperature, which in combination with a constant wet-bulb temperature fixes the relative humidity.

3. A differential thermostat may be used to control relative humidity. This instrument consists of two thermostatic elements, one of which is in the path of the air leaving

the conditioner, and the other under the influence of the dry-bulb temperature in the room. Instruments of this kind maintain a constant relative humidity by maintaining a constant difference between the dew-point temperature and the dry-bulb temperature in the room. (See Item 2 under Air Conditioning Systems.) One thermostatic element may be equipped with a moistening device to permit it to operate on wet-bulb temperatures. Such an instrument can be used to control the wet-bulb depression and thus the relative humidity.

4. A humidistat which responds directly to changes in humidity may be used to maintain a predetermined relative humidity with constant or with varying temperature. It may do this by varying the dew-point temperature of air leaving a conditioner; by varying, with dampers, the proportion of moist and dry air; by varying the amount of moisture otherwise added to the air; or by varying the dry-bulb temperature.

CENTRAL FAN AIR CONDITIONING SYSTEMS

In central fan air conditioning systems as described in Chapters 9 and 22, varying amounts of outside and recirculated air are used, except where contamination prevents re-use, and in general for obtaining humidity

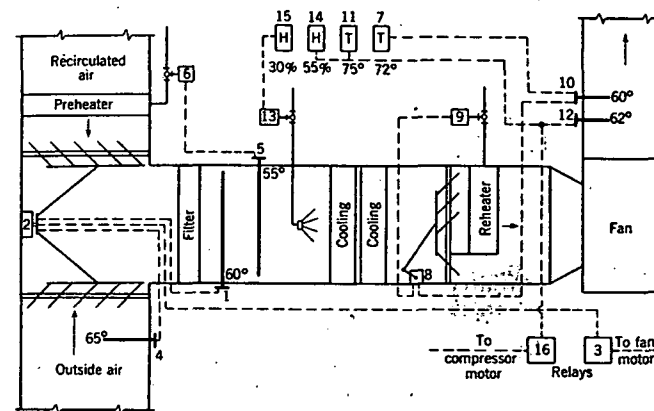


FIG. 11. ALL-SEASONS AIR CONDITIONING SYSTEM WITH COMPLETE AUTOMATIC CONTROLS

control under winter conditions heat is supplied to the air after it has passed the cooling coils. There are many control variations in use, and it is impractical to attempt a description of all the more usual ones in the limited space available. The following described system is, however, representative of many which are now in use.

Fig. 11 is a diagrammatic view of a completely automatic control system for heating and cooling, humidifying and dehumidifying. No manual switching is required between summer and winter operations. The control is fully automatic even in the spring and fall and under conditions where cooling and dehumidification is required in relatively cold weather.

Description of Control Units

Thermostat 1 controls damper 2 so that as the temperature at the thermostat rises above its setting, more outside air and less recirculating air is used. Relay 3 in the fan motor circuit is so arranged that when the