Moreover, the air is usually admitted, especially in summer, at temperatures lower than that of the room in order to effect the necessary cooling. Therefore, the air must be distributed uniformly, not with respect to floor space but with respect to the amount of heat to be absorbed in the various portions of the room. Thus it is necessary for the air conditioning engineer to have fairly exact information as to the distribution and sources of heat within the room, or else to have means of controlling the temperature or quantity of air supplied to the different sections independently. A great deal of attention has been given to various methods of air distribution. In industrial work there have been developed adjustable diffusers which will spread the air uniformly in a fan shaped manner. Such outlet may be provided also with dampers which will permit any desired reduction of velocity without changing the uniformity of distribution.

A second system of distribution utilizes a series of nozzles near the ceiling, discharging horizontally at high velocity from one side of the room toward the other. The size of the nozzles used and their spacing governs the distance to which the air may be carried. Such a system depends for its effect, primarily, upon the ejector action of a high velocity current of air. This induces a positive movement in a parallel direction of the surrounding air and this in turn produces a secondary current in the opposite direction over the entire floor area to be conditioned. The volume of the secondary air current when set into motion is usually several times that of the primary air discharged, the ratio depending upon the velocity of the air leaving the nozzles. This system is known as the ejector system of air distribution and is particularly effective in securing a thorough mixture of the air in the room and a corresponding uniformity of temperature and humidity. The ejector system has been applied largely and is used in the cooling and air conditioning of auditoriums, but can be applied to industrial problems, especially those involving the drying and processing of materials.

A third system of distribution aims at producing the required results with overhead outlets. This system is known as the pan system of air distribution. In this system the air is distributed entirely from overhead, symmetrical distribution, arranged to serve all areas being desirable. The air is discharged downward against a flat plate and is thus diffused radially in all directions, laying a blanket of cool air which mixes with the warmer air already in the room as it descends. The pan system of distribution has found favor in installations for auditorium cooling, as it is a most effective way to avoid drafts. It is also very useful in certain industrial applications where cooling is required and where it is desired not to have high velocities of air or sudden temperature changes.

A fourth method which was at one time largely used is the upward system. The air is delivered through mushroom hoods in the floor. In theater cooling and air conditioning, however, this upward delivery has objections unless very low velocities are used and unless all seats are occupied. Owing to complaint by occupants from drafts, and because of great variations in temperature between floors and upper levels its use is not general today.

HUMIDITY CONTROLLING DEVICES

Hygrostats are of two general types.

One type is a differential thermostat, in which one expansive element is affected by the wet-bulb temperature, which temperature is suitably maintained either by a wick or a spray of water, while another expansive element is normal to the room. These thermostatic elements are so interconnected that they will not be affected by changes of temperature alone, but will be affected only by changes in the relation between the wet and dry-bulb temperatures, which would result in changing the relative humidity. Such a correlation is made possible by the fact that there is practically a straight-line relationship between the relative temperature changes of wet and dry bulb for any definite relative humidity. As in the thermostat, these elements may be either of the solid expansion or of the vapor pressure type.

A second form of hygrostat depends upon the dimensional changes of hygroscopic materials due to changes in moisture content. In these instruments the humidity responsive element works directly upon pneumatic valves or electric contacts. The sensitive element expands or contracts in response to relative humidity changes and thereupon influences the actuating mechanism precisely as the thermostat responds to temperature changes.

It is found that suitable hygroscopic substances show no material change in physical size with changes of temperature, so long as the relative humidity is constant, although the actual moisture content of the hygroscopic material itself may undergo slight changes under these conditions. Certain types of these hygrostats have been made most sensitive and reliable.

Temperature and humidity controlling devices usually act upon the control valves or dampers in the air-conditioning apparatus through the medium of compressed air or electricity. For larger installations pneumatic control practically is universal in use on account of simplicity and reliability; and also on account of the fact that it permits delicate graduation of the movement of the dampers or valves in proportion to the temperature or humidity changes.

In smaller humidifying devices electric controls are very serviceable and reliable. Electricity has an advantage, because with it there are no auxiliaries, such as air compressors, air tanks, air filters, relief valves, etc., required. In the larger systems such accessories are warranted by the greater size of equipment and by the increased number of controls operated from the same compressed air source.

In the unit types of equipment, direct acting thermostats and hygrostats are sometimes used, in which the responsive element works directly upon the valves controlled, without the intermediary use of either compressed air or electric current.

UNIT AIR CONDITIONERS

For data on unit air conditioners, see Chapter 9, Unit Heaters and Air Conditioners.