control of temperature or humidity usually is obtained by thermostat- or humidistat-operated valves (two-position or proportioning). The two-position valve will provide better dehumidification since a lower coil temperature will be maintained, but the temperature of the discharge air will fluctuate. With proportioning thermostats, better control of discharge air temperatures will be maintained. In both cases the sensible-latent heat ratio is basically a matter of coil design rather than a matter of automatic control. Proportioning three-way valves may be used as mixing or diverting valves for better pump performance, and may also be applied to an air washer used with a recirculating pump to control water temperature rather than volume.

Ice Bunkers. Where water is sprayed over the ice in bunkers and circulated to air washers or cooling coils, control is obtained by a thermostat in the water line from the bunker. The thermostat proportions a three-way valve to by-pass enough return water around the ice bunker to maintain a constant discharge temperature.

Compressors. Compressors may supply refrigerant to direct expansion cooling coils in air conditioning units, or to direct expansion coils in water-chilling units. In either case, the compressor motor may be started and stopped directly by a room or duct thermostat, or a pressure controller may be used to regulate the suction pressure of the compressor. In the latter case, a room or duct thermostat may be used to control a solenoid valve in the refrigerant supply line to the cooling coil. A high and low pressure cut-out is standard safety equipment on most compressor installations. Reduced capacity of the refrigerating unit may be obtained by means of temperature or pressure controlled unloading devices which vary the capacity of the compressor in some proportion to variations of cooling load. Program or step controllers, actuated by temperature or pressure, are commonly used in multiple compressor installations. It is desirable in such installations to return the program or step controller to the *off* position when the system is shut down to prevent the full electrical load of multiple compressors from being thrown across the line at the same time. Thermostatic control of water supply to water-cooled condensers may be achieved by means of self-contained controllers or valve and thermostat application.

Steam Jet Evacuators are controlled by a thermostat (in the chilled water) which adjusts a two-position steam supply valve. Multiple jets can be controlled by valves that open or close in sequence. This may be accomplished by using springs of different resistance to the operating force released by the thermostat. Automatic temperature control definitely is advisable.

Centrifugal Units. The control of centrifugal refrigeration units or other types of vacuum systems is customarily achieved by means of a thermostat in the chilled water to control the operating cycle of the equipment at full or reduced capacity. This is usually accomplished by the automatic regulation of vortex dampers at the inlet of the rotor.

Adsorption Units. Control of adsorption refrigeration may be obtained by a damper which, in response to humidity, varies the rate of air flow through or around the activated bed of adsorption material. Standard controls for cooling are used to reduce the dehumidified air to a desired dry-bulb temperature.

Absorption Units. Since at constant density, the absorption solution will extract water from the treated air in an amount proportional to the solution temperature, the moisture content of the air leaving an absorption unit is regulated by solution temperature. Solution density is held constant by a combination of float control and steam valve controlling the solution regenerator. Two basic methods of control are standard:

1. Constant solution temperature where the solution temperature is set so that, at the full load for which the unit is designed, the discharge air will have the desired moisture content. Proportioning control of the water and two-position control of the steam are recommended to maintain constant temperature.
2. Control by varying the solution temperature so that the moisture content of the discharge air remains constant regardless of load variation. Basically, this control is similar to the constant solution temperature control, with the addition of a hygrostat or wet-bulb controller controlling the water valve from space conditions. In order to gain a constant dry-bulb outlet temperature a heating coil is placed in the air stream and is served by a valve that responds to a proportioning thermostat in the discharge air stream.

CENTRAL FAN SYSTEMS

Automatic temperature control for central fan heating, cooling, ventilating, and air conditioning systems involves the proper application of various

types of controlling instruments and associated regulators such as valves, with operators, dampers with operators, relays and other auxiliary equipment which are described in earlier sections of this chapter. In central fan systems the conditions required dictate the type of built-up control system to be used. It is impossible to state in detail the control apparatus which will be required in even the most representative applications.

In general, in so far as automatic temperature and humidity control equipment is concerned, central fan systems may be divided into certain broad classifications, as follows: (1) heating, (2) humidifying, (3) ventilating and atmospheric cooling, (4) cooling and dehumidifying, (5) control of zone temperatures, (6) year 'round air conditioning with automatic change-over, (7) constant temperature and humidity.

The apparatus which enters into the automatic maintenance of temperatures and humidities for central fan systems which are designed to produce each of the effects listed in items 1 to 7, is indicated in the following paragraphs:

1. In *heating control*, there are three principal items to be considered: (1) control of temperature in the space; (2) prevention of objectionable drafts; (3) prevention of freezing within the space or in any part of the equipment. Usually in central fan systems, suitable thermostats operate valves in the steam or hot water supply to heating coils, or adjust face dampers across such coils and by-pass dampers around them. If the heating coils are sub-divided into two or more groups, such as preheaters and reheaters, a duct thermostat (following the preheaters, and located in the entrance to the chamber between the groups of coils) controls the preheaters; but it is essential that the preheater coils be of the steam distributing type. Similarly, a duct thermostat in the fan discharge, where any effect of stratification has been dissipated, operates the valves and dampers associated with the reheaters. In some cases, where there are more than one bank of preheaters, the practice is to place a freeze protection thermostat in the outdoor air intake to control the valve on the first bank of heaters, which is designed so that the heat-rise through it will not cause overheating. A room thermostat in the heated space may serve as the controlling instrument, with a thermostat in the fan discharge serving to prevent the delivery of air at a temperature which might cause drafts. If desired, similar action may be obtained from a thermostat in the return air connection. When there is only one heating coil, a limit thermostat in the fan discharge accomplishes the control, in conjunction with a thermostat in the heated space or in the return air.

2. *Humidity control* may be obtained by means of a hygrostat, usually located in the conditioned space or in the return air. Such controlling instruments may operate steam supply valves to humidifiers, mixing valves to control the temperature of the water to sprays, or a system of dampers to regulate the quantity of air passed through the humidifying chamber or by-passed around it. The control of humidity, according to dew-point temperature, is sometimes accomplished by means of a thermostat in the outlet of the humidifying chamber. However, the setting of the dew-point thermostat may have to be reset to compensate for varied space conditions.

3. The *control of ventilating* and *cooling* by the use of outdoor air consists of an arrangement of dampers, usually determining the relative quantities of outdoor air and return air which are to be delivered to the conditioned space. The damper positions are regulated by proper types of thermostats, located in the minimum outdoor air intake, the fan discharge, the conditioned space or the return air. Instruments are available which, with an adequate arrangement of dampers, will cause a maximum quantity of outdoor air to be handled until it becomes more economical to utilize return air.

4. *Cooling and dehumidifying* may be controlled by means of thermostats, and hygrostats or dew-point thermostats, which regulate dampers and mixing valves to maintain air of the proper temperature and humidity in the discharge from the central fan plant. Such controlling instruments normally are located in the fan discharge or in the return air, or both, and they may be associated with thermostats or hygrostats in the conditioned spaces.

5. Where a *separate duct serves each zone* of an area with which a central fan system is associated, a room thermostat in each zone may operate mixing dampers in the inlet to each zone duct, determining the quantity of warm air which is required from that portion of a plenum chamber into which heated air is delivered, and the quantity of cool air which should be taken from the other portion of the double