10. Design the air distribution system and the air outlets and inlets. (See Chapters 19 and 20.)
11. Calculate the total static pressure of the system.
12. Select the fan, motor, and drive. (See Chapter 17.)
13. Select the pump and motor.
14. Design the control system. (See Chapter 14.)

ZONING

The above general outline of procedure will prove satisfactory for the smaller and less complex installations. However, when dealing with air-conditioning systems for large buildings, after a proper analysis has been made of the conditions to be maintained and the heat loads encountered, it is generally considered best practice to divide the complete job into a

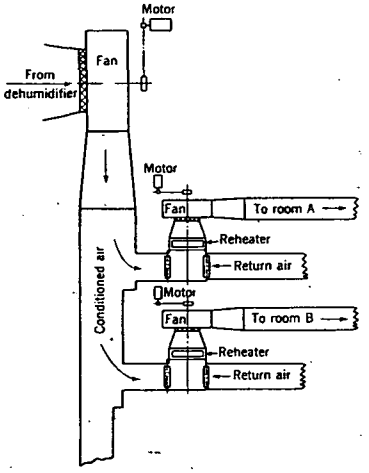

FIG. 3. CENTRAL DEHUMIDIFYING PLANT AND LOCAL RECIRCULATING FANS

number of suitably sized units. In some cases a unit per floor or group of floors may complete the design satisfactorily, whereas in others it may be advantageous to have separate units for each of the various outside exposures of the building. Where the floor area is large in relation to the outside wall exposure, it is obvious that provision must be made for the variable load to which the outside exposures are subjected. The heat loads on inside rooms are apt to be less variable since the fluctuations of the outside weather conditions are not directly involved. Such conditions often result in the natural zoning or segregation of rooms having similar exposures and internal heat loads.

LOCATION OF APPARATUS

Availability of space for apparatus and duct work is of primary importance when selecting the type of system for a given design. In general, for large installations, the refrigeration equipment, because of its size,

weight, and operating characteristics, is located in the basement along with the boilers, fire pumps, and other equipment. The air conditioning apparatus is generally located where clean outdoor air is readily available, the designer bearing in mind that supply and return air ducts, steam connections, water and drain connections, and electrical connections must be made to the equipment proper.

TEMPERATURE OF AIR LEAVING OUTLETS

In comfort conditioning applications, air has been distributed from properly designed outlets without producing drafts at temperatures varying from approximately five to thirty degrees below the required room temperature. Factors influencing the design and selection of air outlets are: ceiling height, type of ceiling, length of blow, and temperature and quantity of air to be distributed. Most summer conditioning installations are designed to supply the air to the conditioned space at from 8 to 15 deg below room temperature. Recently the use of specially designed nozzles has indicated the possibility of reducing the air quantity necessary to dissipate a given heat load by introducing the air into the room as much as thirty degrees below room temperature. Comfort conditioning systems employing differentials greater than fifteen degrees require special consideration and design experience because high pressure outlets or nozzles are usually used. Further, care must be taken to allow a sufficient air quantity under all load conditions to insure good distribution. If winter heating, as well as summer conditioning, is to be accomplished by the same distributing system, the design of the outlets will be influenced as discussed in Chapter 22. Industrial systems in which drafts are not objectionable usually employ a temperature differential equal to the dew-point depression.

AIR QUANTITY REQUIRED

For calculating the quantity of air required to absorb a given heat gain, the following approximate formulae may be used:

$$M = \frac{H_s}{60 \times 0.24 \times (t - t_y)} = dQ \qquad (1)$$

or, assuming a constant value of 0.075 lb for d,

$$Q = \frac{H_s \times 55.2}{60 \times (t - t_y)} \qquad (2)$$

where

Q = volume of air required, cubic feet per minute.
H_s = total sensible heat gain, Btu per hour.
t = room temperature, degrees Fahrenheit.
t_y = outlet temperature, degrees Fahrenheit.
M = weight of air required, pounds per minute.
d = density of air at the temperature and relative humidity of the room, pounds per cubic foot.

Example 1. The total sensible heat gain in a restaurant when held at 80 F is 199,736 Btu per hour. Assuming a 12 deg Fahr temperature differential between the entering air and the room temperatures, which is the same as assuming the dry-bulb temperature of the entering air to be 68 F, calculate the required air capacity of the system.