maintained in the heating element. Steam at 2 lb pressure and air entering at 60 F are used as the standard basis of rating[3]. The capacity of a heater increases as the steam pressure increases, and decreases as the entering air temperature increases. The heating capacity for any condition of steam pressure and entering air temperature other than standard may be calculated approximately from any given rating by the use of factors in Tables 1 and 2. Table 1 is used for the blow-through type and Table 2 for the draw-through type of unit. The formulae given under *unit ventilators* for calculating capacities also apply to unit heaters.

Temperature differences per foot of elevation when using unit heaters are generally less than corresponding variations for spaces heated with direct radiation[4]. The temperature to be maintained in the room, for recirculating heaters with intakes at the floor level, should be considered

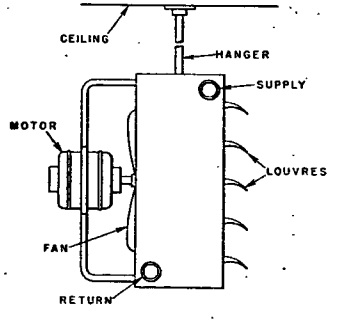

FIG. 3. SUSPENDED UNIT HEATER

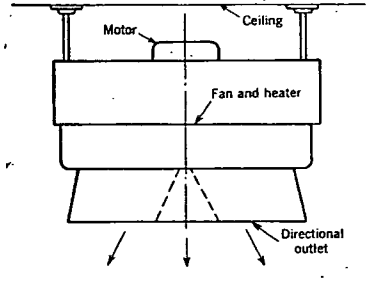

FIG. 4. VERTICAL BLOW UNIT HEATER

as the temperature of the air entering the heater. Where outside air is introduced, the temperature of the mixture must be calculated and used as the entering air temperature to the heater. Unit heaters taking in recirculated air at the floor level should maintain temperature differentials of less than 0.5 F per foot of elevation when the maximum capacity of the heaters is required.

The temperature variation from floor to ceiling with recirculating unit heaters taking air at some distance above the floor may reach as much as one degree per foot of elevation during the periods when the maximum capacity of heaters is required. Suitable allowance for this temperature variation should be made when calculating the capacity of unit heaters. Generally speaking, high velocity discharge units will maintain slightly lower temperature differences than low velocity discharge units. Correspondingly, units with lower air discharge temperatures will maintain slightly lower temperature differences than units with higher discharge temperatures. Suspended type of units, illustrated by Figs. 2, 3 and 4,

[3]A.S.H.V.E. Standard Code for Testing and Rating Steam Unit Heaters (A.S.H.V.E. TRANSACTIONS, Vol. 36, 1930, p. 165).

[4]A.S.H.V.E. RESEARCH REPORT No. 958—Temperature Gradient Observations in a Large Heated Space, by G. L. Larson, D. W. Nelson and O. C. Cromer (A.S.H.V.E. TRANSACTIONS, Vol. 39, 1933, p. 243). A.S.H.V.E. RESEARCH REPORT No. 1011—Tests of Three Heating Systems in an Industrial Type of Building, by G. L. Larson, D. W. Nelson and John James (A.S.H.V.E. TRANSACTIONS, Vol. 41, 1935, p. 185

being located in an elevated position above the floor will withdraw air from this higher level and discharge the heated air down into the working zone.

Unit heaters are customarily rated as free delivery type units. If outside air intakes, air filters, or ducts on the discharge side are used with the unit a reduction in air and heating capacity will result because of this added resistance. The percentage of this reduction in capacity will depend upon the characteristics of the heater and on the type, design and speed of the fans so that no specific percentage reduction can be assigned for all heaters at a given added resistance. In general, however, disc or propeller fan type units will experience a larger reduction in capacity than housed centrifugal fan units for a given added resistance and a given heater will have a larger reduction in capacity as the fan speed is lowered. The ratings to be expected under such conditions should be secured from the manufacturer.

Boiler Capacity

The capacity of the boiler should be based on the rated capacity of the unit heaters at the lowest entering air temperature and highest fan speed that will occur, plus an allowance for pipe line losses. It is unwise to install a single unit heater as the sole load on any boiler, particularly if the unit heater motor is started and stopped by thermostatic control. The wide and sudden fluctuations of load that occur under such conditions would require closer attention to the boiler than is usually possible in a small installation. Where oil or gas is used to fire the boiler, it is possible by means of a pressurestat to control the boiler, in response to this rapid fluctuation. In most cases, and particularly where the boiler is coal-fired, it is advisable to use two or more smaller unit heaters instead of one large unit.

Steam pressures below 5 lb can be used with safety for recirculating unit heaters when their heating surfaces are designed for those pressures, and when proper provision is made for returning the condensate. If units admit air that may be at a temperature below freezing, a steam pressure of not less than 5 lb should be maintained on the heating element, or a corresponding differential in pressure between the supply and returns should be maintained by means of a vacuum.

Piping Connections

Piping connections for unit heaters are similar to those for other types of fan blast heaters. The piping of unit heaters must strictly conform to the system requirements while at the same time permitting the heaters themselves to function as intended. The basic piping principles for steam systems are discussed in Chapter 15.

Rapid condensation of steam, especially during heating-up periods, is characteristic of this type of equipment. The return piping must be planned to keep the heating surfaces free of rapid condensation, while the steam piping must be ample to carry a full supply of steam to the surfaces to take the place of that condensed. An adequate size of pipe is therefore essential for all heating surfaces over which there is a flow of forced air. Especially is this true where the fan is operated under start-and-stop