some extent for office applications where appearance is not a major factor.

Unit heaters may be adapted to a number of industrial processes, such as drying and curing, with which the use of heated air in rapid circulation with uniform distribution is of particular advantage. They may be used for moisture absorption, such as fog removal in dye houses, or for the prevention of condensation on ceilings or other cold surfaces of buildings in which process moisture is given off. When such conditions are severe, it is necessary that the heaters draw air from outside in enough volume to provide a rapid air change and that they operate in conjunction with ventilators or fans for exhausting the moisture-laden air. (See discussion of Condensation in Chapter 4.)

There are three major factors to consider in the application of unit heaters, as follows:

1. Location of Unit.
2. Air Distribution.
3. Heating Medium.

Heaters may be distributed through the central portions of a room discharging toward exposed surfaces, or may be spaced around the walls, discharging along the walls and inward as well, especially when there are considerable roof losses.

Suspended type units are located in an elevated position withdrawing air from this higher level and discharging the heated air down into the working zone. This type of installation is illustrated in Figs. 2 and 3. Suspended type units provide excellent temperature distribution.

In closely occupied spaces where direct air drafts into the working zone are not permitted, the floor mounted unit will give more uniform temperature distribution. These units draw the cold air from the floor and discharge the heated air above the working zone.

In general, it is better to direct the discharge from the unit heaters in such fashion that rotational circulation of the entire room content is set up by the system rather than to have the heaters discharge at random and in counter-directions.

Various types and makes of unit heaters are illustrated in the *Catalog Data Section* of this edition. Usually hot blasts of air in working zones are objectionable, so heaters mounted on the floor should have their discharge outlets above the head line and suspended heaters should be placed in such manner and turned in such direction that the heated air stream will not be objectionable in the working zone. In the interest of economy, however, the elevation of the heater outlet and the direction of discharge should be so arranged that the heated air shall be brought as close to the head line as possible, yet not into the working zone. In general, the higher the elevation of the unit, the greater the volume and velocity required to bring the warm air down to the working zone, and consequently, the lower the required temperature of the air leaving the unit.

Low or high pressure steam as well as hot water are generally used in unit heaters. Direct-fired units are also available. Superheated steam can be satisfactorily used in unit heaters provided the capacity is based on saturated steam temperature and not on the total temperature. If

unusually high superheat is used, trouble may be experienced from the excessive expansion and contraction of the heating elements.

Electric, Direct-Fired, and Turbine-Driven Units

The foregoing discussion relates generally to units in which steam or hot water is used as the heating medium. Electric unit heaters are applied where electric power is abundant and cheap and where other forms of fuel are scarce and expensive. The low first cost, easy control, and inexpensive installation of this type of heating have also accounted for many other installations in which electricity has conveniently provided heat for short periods of time. (See Chapter 44.)

A recent development in gas burning equipment is the direct-fired industrial unit heater. These heaters are of the warm-air type and are equipped with fans which cause the air to pass over the heating surfaces at a fairly high velocity and then direct the warm air into the space to be heated. As is the case with the steam-fed unit heaters, the gas-fired appliances may be used for heating stores, shops, and warehouses. They usually are suspended in the space to be heated and in most instances leave the entire floor and wall area free for commercial use. Partial or complete automatic control also may be secured on appliances of this type. This type of heater is often used for temporary heat during building construction or where the installation of a steam or hot water plant is for some reason not justified. For permanent installations, it is usually advisable to provide an exhaust duct from the gas-fired unit heaters to remove products of combustion from the occupied space. While this is not necessary in large open industrial plants, in smaller closed rooms, it becomes essential.

Where high pressure steam is available it is sometimes used to drive a steam turbine direct-connected to the unit heater. The exhaust from this turbine, reduced in pressure, is then passed into the heating coil where it is condensed and returned to the boiler.

UNIT VENTILATORS[5]

Unit ventilators are similar in principle to unit heaters since ventilators incorporate an encased heating surface through which outside air is forced by means of a blower or fan and may or may not have provision for recirculation of air. While unit heaters are largely used for commercial and industrial applications, unit ventilators are intended primarily for schools, offices, and semi-commercial establishments. A typical unit ventilator is illustrated in Fig. 8.

Specifications

Unit ventilators usually consist of a semi-decorative cabinet containing the following necessary or optional parts:

1. Outside air inlet.
2. Inlet damper for closing the opening to the outside air inlet when the unit is not in use.

[5]A roof ventilator is sometimes termed a *unit ventilator*. For information on roof ventilators, see Chapter 42.