necessary to direct the relief ventilation so as not to disturb the product or upset the performance of local exhaust hoods.

Types of Outlets for Local Relief

A few of the different types of outlets are shown in Fig. 3. In most cases, volume control is highly desirable. Directionalizing and damper control should be designed for easy adjustment from the floor by chain, sash cord, or pole. Where a constant total volume of supply make-up air must be maintained, an outlet similar to E will permit volume adjustment to the *work zone* without reducing the total air supply to the building area. A double deflection grille is available with gang-operated, horizontal face bars (similar to D) to accomplish the desired objective by directing the air down to the work zone or toward the ceiling. Such a grille could be installed on outlet F. Outlets A, B and C could be used without dampers for these applications. An inexpensive means of supplying summer relief air is shown in G. Easily-adjusted diffusers, which will provide a flat or down-blast air discharge pattern, are available.

Where overhead installations are not possible because of structural interferences or other difficulty, outlets near the floor may be used. These may be in the form of grilles located in pilasters, control panels, tables, equipment or in the floor itself. Such outlets have been quite successful in welding and foundry areas and at the work locations in kitchens.

CONTROL OF ENVIRONMENTAL GASES AND VAPORS, DUSTS AND FUMES

In general, the systems for the control of these atmospheric contaminants in industrial plants will be of three types:

1. *Local exhaust systems* will be indicated where the contamination originates at concentrated areas and is characterized by low or imperceptible air motion, or where the contaminant is a dust, mist or fume requiring a capture velocity exceeding 25 fpm. Design of this type system is discussed in Chapter 45, and will not be further treated in this chapter.
2. A system employing the *dilution* method will usually be indicated where the contamination originates at scattered points dispersed generally throughout the area.
3. Combination of local *exhaust* and *dilution* methods is often economical, since well designed exhaust hoods or openings, removing from the space that portion of the contamination load which is susceptible to such treatment, will often reduce greatly the air volumes required for dilution purposes. The choice of the type of system should be made on the basis of economic comparisons.

Design of Dilution Systems

The first step in the design of a system employing the dilution method is to determine as exactly as possible the nature and extent of the contaminating load. This will often be difficult, and may require construction of pilot production models. Often, however, the required data will be available from production records, showing the weight or volume rate of loss of the contaminating agent to the atmosphere, or it may be estimated from parallel operations in other plants, or by applying experienced engineering judgment. However obtained, the determination of the nature and magnitude of the contaminating load is an indispensable step in the proper design of the corrective system. Designs based on number of air changes per hour, or other rule-of-thumb methods, are hopelessly inadequate, and lead either to unsuccessful operation or to excessive and unnecessarily high cost of installation.

1. *Gases and Vapors.* Once having established the nature and magnitude of the contamination load, it is rarely necessary to completely remove contaminating agents from the atmosphere. For cases involving diffusible vapor or gas contaminants, maximum allowable concentrations (MAC) of commonly encountered gases and vapors have been established, and these data are tabulated in Chapter 8. From these data, and the previously established rate of addition of the contaminant to the space, the volume of air required to dilute the addition to a tolerable level can be calculated by the equation:

$$Q_a = \frac{Q_c \times 10^6}{(MAC) - (SAC)} \qquad (9)$$

where

Q_a = quantity of air circulated, cubic feet per minute.
Q_c = rate of generation of contaminant, cubic feet per minute.
(MAC) = maximum allowable concentration, ppm by volume.
(SAC) = concentration in supply air, ppm by volume.

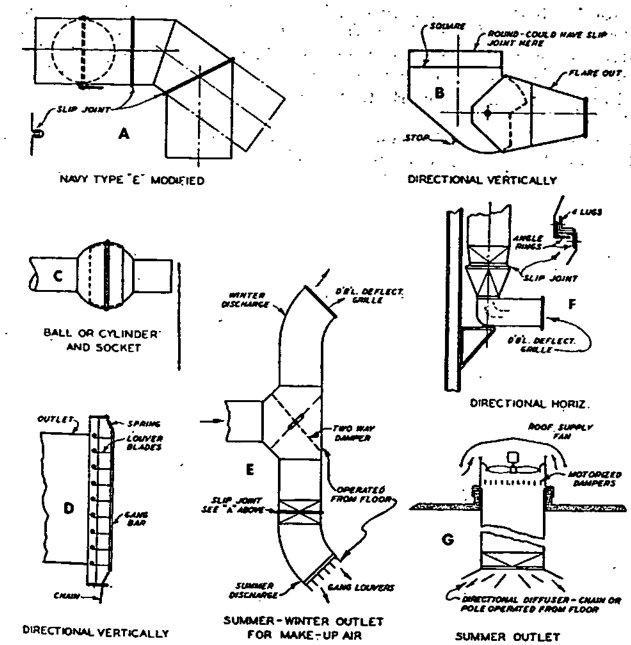

FIG. 3. DIRECTIONAL OUTLETS FOR SPOT COOLING

The rate of generation of the contaminating vapor will often be available as a *weight or volume* of liquid evaporated into the space per unit time. These may be converted to the units of Equation 9 by applying the principle that a pound-mol of a gas or vapor will occupy approximately 359 cu ft at standard pressure and temperature. Thus,

$$\text{cfm (vapor)} = \frac{W}{M_w} \times 359 \times \frac{t + 460}{492} \qquad (10)$$

where

W = rate of generation of contaminant, pounds of liquid solvent per minute.
M_w = molecular weight.
t = air temperature, Fahrenheit.