principle applies down to a velocity of 60 fpm; the following approximate equations for throw are to be substituted for equation (4)[2]:

For a spread of 15 deg on each horizontal side $$L = 0.55 \frac{Q_1}{\sqrt{A_1}} \quad (8)$$

For a spread of 30 deg on each horizontal side $$L = 0.37 \frac{Q_1}{\sqrt{A_1}} \quad (9)$$

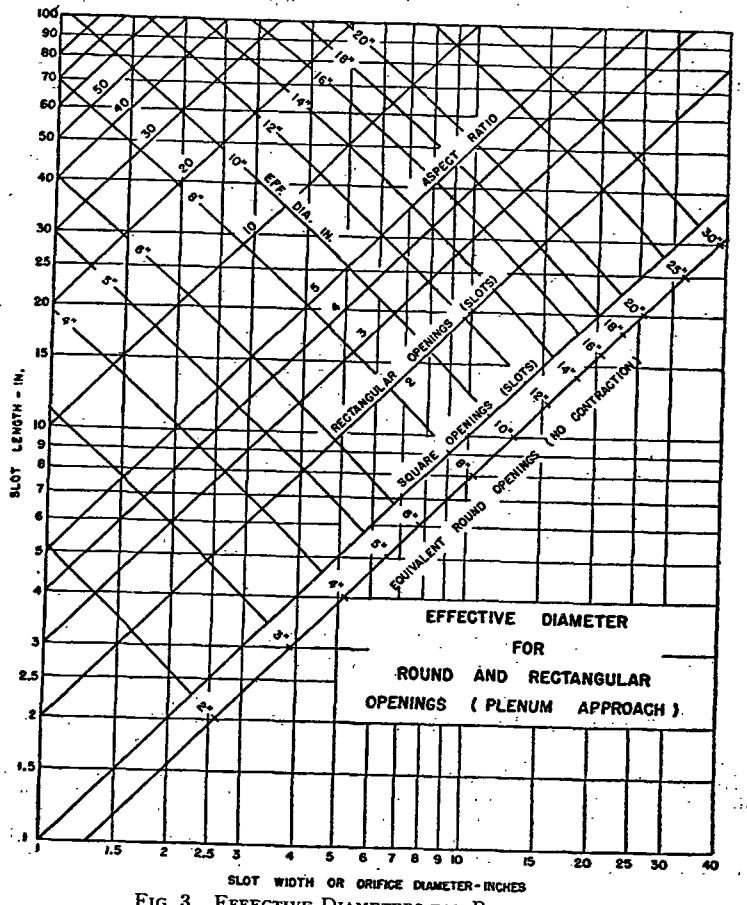


FIG. 3. EFFECTIVE DIAMETERS FOR ROUND AND RECTANGULAR OPENINGS (PLENUM APPROACH)

For a spread of 45 deg on each horizontal side $$L = 0.28 \frac{Q_1}{\sqrt{A_1}} \quad (10)$$

Guide Vanes

Vanes should have a depth of one to two times the spacing between the vanes. If the ratio of vane depth to spacing is less than one, effective control by means of the vanes cannot be obtained. Little improvement is obtained by increasing the ratio beyond two. The effect of various types of vanes is given in following paragraphs.

Straight Vanes. As mentioned previously, the included angle between both planes will be in the neighborhood of 14 deg, for a straight setting of the vanes as shown in Fig. 4.

Diverging Vanes. Such vanes set for an angular spread will have a marked effect on the direction and distance of travel of an air stream. An outlet having vertical vanes set straight forward in the center, with uniformly increasing angular deflection to a maximum at each end of 45 deg, will produce an air stream with a horizontal included angle of approximately 60 deg as shown in Fig. 4. The throw will be reduced one-half for such a vane setting. Increasing the divergence of the vanes reduces the air quantity handled by an outlet for a given duct static pressure. The primary function of the vanes is to spread the air horizontally. Spreading the air vertically entails the risk of hitting beams or other obstructions or of blowing primary air at excessive velocities into the occupied zone.

Converging Vanes. The blow of an outlet may be somewhat increased by converging the vanes of an outlet as illustrated in Fig. 4. Even with converging vanes, the resultant angle of spread of an air stream will not be less than 14 deg. The air converges for a few feet in front of the outlet, and then diverges more than if the vanes had been set straight.

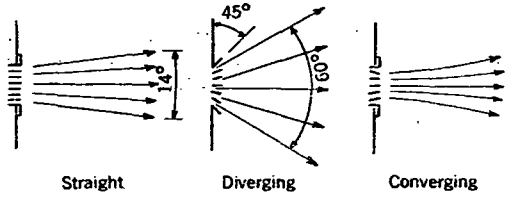


FIG. 4. SPREAD OF AIR STREAM WITH VARIOUS VANES

Both the horizontal and vertical vanes of an outlet are important. After an installation has been made, many conditions of draftiness or stuffiness can be alleviated by some vane adjustment, provided an independent means for regulation of static pressure behind the vanes is included.

Vertical Drop and Rise

The distance that the lower edge of the air stream drops below the bottom of the outlet is important, since the air stream should not reach the occupied zone until the velocity has fallen to about 50 fpm. The drop (H, ft) is influenced by two forces; the natural vertical spread of the stream and the gravitational force due to the difference in density between supply air and room air. For air emerging at room temperature, the drop will be a function of the spread only and will be equal to:

$$H_1 = L \times \tan\left(\frac{\text{Spread Angle}}{2}\right) \quad (11)$$

where

H_1 = drop due to spread (when emerging air and room temperature are the same), feet.
L = throw, feet.

When there is a temperature difference between the air stream and the room, there is an *additional* drop which is approximately[4]:

$$H_2 = \frac{n_1 (t_r - t_{as}) L^{n_2}}{V_1} \quad (12)$$