Since 55 effective diameters are equal to 30 ft as required, 1 effective diameter = 30/55 = 0.545 ft or 6.56 in.

On Fig. 3 vertically below intersection of 6.56 in. effective diameter line, and equivalent round opening line, read 8.5 in. in lower margin.

Example 4: A jet of air issues from a pipe or from air orifice having a well-rounded

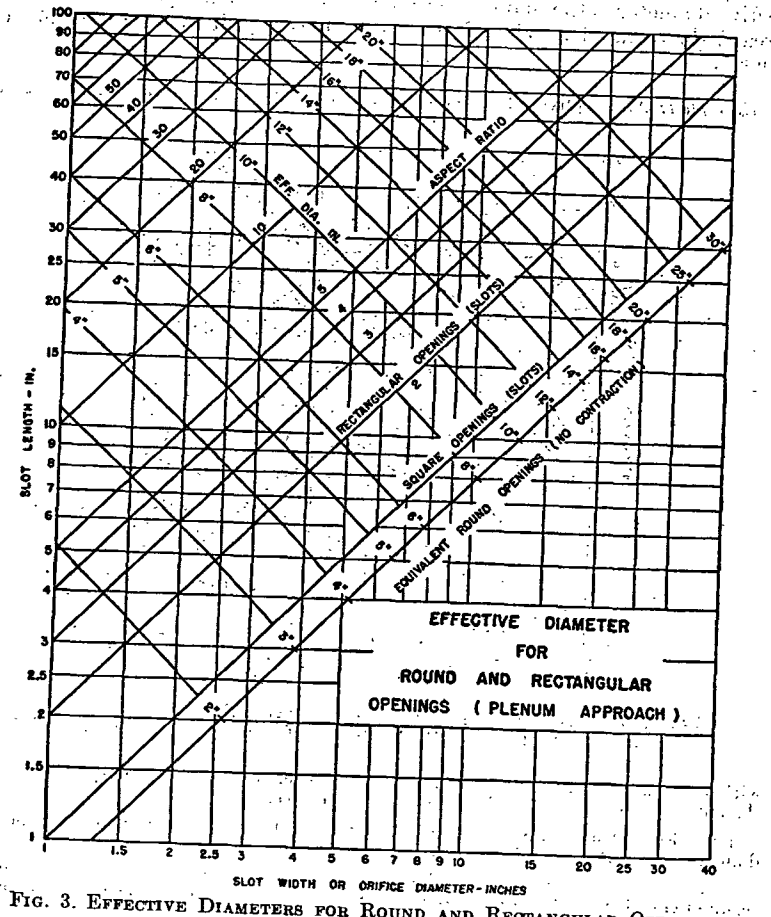

FIG. 3. EFFECTIVE DIAMETERS FOR ROUND AND RECTANGULAR OPENINGS (PLENUM APPROACH)

entrance (coefficient of discharge = 1.0) and delivers air with the same velocities and with the same throw as in *Example 3*. What is the required diameter?

In this case since the coefficient of discharge is unity, the effective diameter of the jet is the actual diameter of the pipe or orifice, or 6.56 in., as obtained in *Example 3*.

Spread

The induction effect results in the spreading of the air stream. The total angle included by the air stream from straight flow outlets has been meas-

ured and found to be between 14 and 25 deg. The angle will depend on the type of approach, type of outlet and velocity.

The effect of vertical bars placed in the face of the outlet to increase the spread, may also be deduced from the momentum theory. Assuming that there are no horizontal deflecting bars, and that the air spreads vertically through a total angle of 14 deg; that a uniform velocity exists at any section of the air stream; and that the conservation of momentum principle applies down to a velocity of 60 fpm; the following approximate equations for throw are to be substituted for Equation 4:[2]

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

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

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

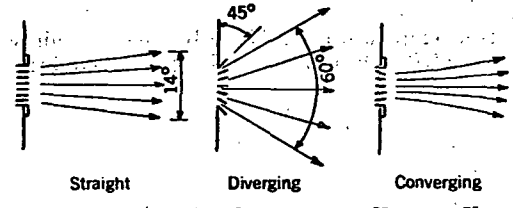

FIG. 4. SPREAD OF AIR STREAM WITH VARIOUS VANES

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.

Both the horizontal and vertical vanes of an outlet are important. After an installation has been made, many conditions of draftiness or stuffiness