

FIG. 8. OUTLET CELLS FOR PAN OUTLETS OR GRILLES

a constant rate.[11] Due to partial reflection at the boundaries of the enclosure, the intensity of sound at any point in the space builds up to some maximum value. In a large room at a point remote from the source of sound (the supply opening) the intensity can be shown to be substantially proportional to the rate at which sound energy is generated, and inversely proportional to the number of sound absorption units (sabins) in the room. It would thus appear that doubling the sound absorption of the room would halve the intensity and result in a noise level decrease of 3 db.

Grille noise is similar in character to fan vortex noise. Knowing the noise level at the face of a grille for a given grille blade setting, the noise will vary as given in Equation 8 where V is the velocity of the air through the grille.

$$db\ (\text{change}) = 50 \log_{10}\left(\frac{V_2}{V}\right) \tag{8}$$

For a change in blade setting Equation 9 applies, and in this case the total pressure is measured directly behind the face of the grille. For a typical air conditioning grille the noise level at the grille face may be approximately 48 db with a total pressure behind the grille of 0.1 in.

$$db\ (\text{change}) = 25 \log_{10}\left[\frac{(\text{Total Pressure})_2}{(\text{Total Pressure})_1}\right] \tag{9}$$

The resultant room noise level can be approximated by Equation 10.

$$\text{Room Level} = \left[\begin{matrix}\text{Noise Level at}\\ \text{Face of Grille}\end{matrix}\right] - 10 \log_{10} \frac{\text{Total Room Absorption in Sabins}}{\text{Total Grille Area}} \tag{10}$$

Grille Selection

In practice the allowable total sound and the required air flow are usually known, and it is desired to determine the maximum allowable velocity. In comparing sound ratings of various grilles several factors must be known if the information is to be properly applied:

1. The threshold intensity on which the decibel ratings are based.
2. The distance from the grille at which data were taken.
3. If stated as sound level versus velocity for a given grille, the *core area* (not nominal area) must be known.
4. The sound absorbing characteristics of the test room.
5. Whether or not corrected for test room sound level; if not, the room level (without grille noise) must be known.
6. Methods used for recording data. (Characteristics of sound meter).

Since total sound and air flow are both functions of velocity and area, the solution of the problem implies a trial and error method. It has been

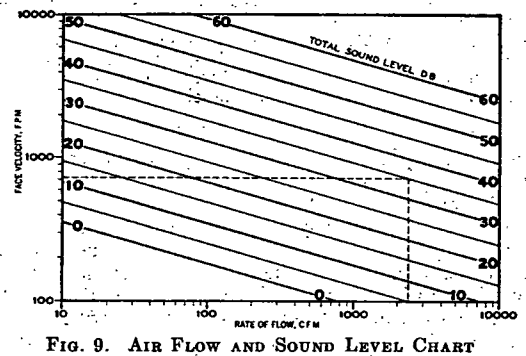


FIG. 9. AIR FLOW AND SOUND LEVEL CHART

found possible to present these data with sufficient practical accuracy as a family of uniform curves, as illustrated in Fig. 9, which are based on these assumptions:

1. Threshold intensity = 10^{-16} watts per square centimeter.[1]
2. Microphone location 5 ft from lower edge of supply opening on a line downward at 45 deg, and in a plane bisecting the supply opening perpendicularly.
3. Where data are given as sound level versus velocity, the rating is per square foot of core area.
4. The room is assumed to have 100 sabins absorption.
5. Plotted data are sound levels of *supply openings only*, correction having been made for test room level.
6. Data taken with a direct reading sound-level meter with frequency weighing network intended to approximate the response of the human ear.

If the published ratings are in terms of decibels per square foot, correction must be made for area to secure the total sound level of supply openings of more or less than one square foot area from Equation 11.

$$\text{Decibel Addition} = 10 \log_{10} A \tag{11}$$

where

A = core area, square feet.

With Fig. 9 it is possible to find directly the velocity in feet per minute which will give a predetermined total sound at a predetermined rate of flow expressed in cubic feet per minute. The values used are arbitrarily chosen for the purpose of discussion, and do not necessarily represent data referring to any particular design of air supply opening. A correction chart is shown in Fig. 10 for a room having a sound absorption other than 100 sabins.

Example 3. Determine the core area (see Chapter 30) of an air supply grille which will maintain a noise level of not more than 40 db in a room having 100 sabins of sound absorption, if an air volume of 2400 cfm is required to maintain the proper air conditioning.

Solution. Assuming a grille noise rating of at least 5 db below the noise level of the room, Fig. 9 shows that the limiting grille velocity for a total sound level of 35 db is about 725 fpm, and the core area becomes fixed at 2400 ÷ 725 or 3.31 sq ft.

If the room absorption had been greater, the previously selected velocity of 725 fpm would be safe, since the sound level reduces. If the room absorption had been 200 sabins, a correction of plus 1.3 should be made by reference to Fig. 10, and the per-