$$PWL_s = PWL - 10 \log_{10}[q \cdot p^2] \text{ dbe} \quad (18)$$

where

q = quantity of air discharged, cfm.
p = pressure, inches of water.
PWL = sound power level actually measured.

Since static pressure p_s is more frequently measured for fans than total pressure p_t, p_s may be used under most normal operations conditions (when the difference between p_s and p_t is less than 20 percent) and the error will then be less than 1 db. Near free discharge, p_s becomes zero and p_t must be used. In other words, PWL_s is the sound power level that a similar (although hypothetical) fan would produce when operating at 1

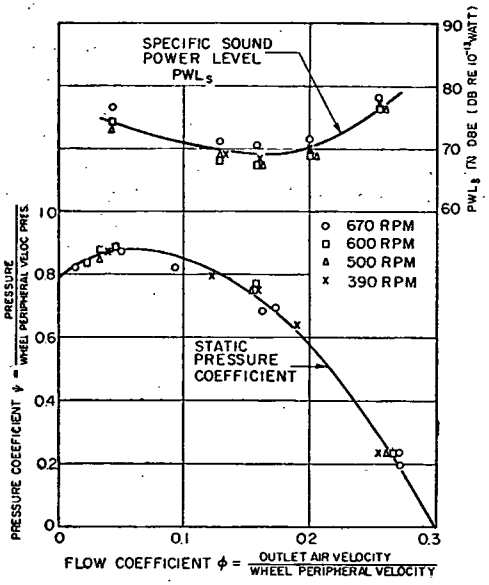

FIG. 5. SPECIFIC FAN CHARACTERISTIC CURVES, INCLUDING SPECIFIC SOUND POWER LEVEL

These data are for a particular fan. The quantities ψ_s, ϕ and PWL_s are discussed in the text. Such curves apply to all fans in a similar series.

cfm and a total pressure of 1 in. of water. As an example, the specific power level for one fan tested is shown on Fig. 5.

Although few data are available to confirm the conclusion, it is indicated that such a plot also holds throughout a series of fans for all eight of the frequency bands provided rotor or blade passage frequencies are not predominant.

Approximate Overall Sound Power Level

In practice, data of the type shown in Fig. 5 are usually not available. Hence, in design an estimate has to be made of the overall sound power level and of the shape of the noise spectrum. Tests on centrifugal fans

ranging in size from 0.01 hp to 100 hp show that the sound power level in a duct *either* upstream or downstream from the fan can be found within ±4 db from the simple relation:

$$PWL = 100 + 10 \log_{10} W_E + 10 \log_{10} p \text{ dbe} \quad (19)$$

where

W_E = nameplate electrical horsepower of the motor driving fan (assuming that the motor is operating near rated hp).
p = pressure head, inches of water.
dbe = number of decibels *re* 10^{-13} watt.

(See discussion following Equation 18).

The assumption is made that the fan is being operated near the "knee" on its operating characteristics, *i.e.*, near maximum efficiency or near the minimum in the curve of specific sound power (upper curve on Fig. 5).

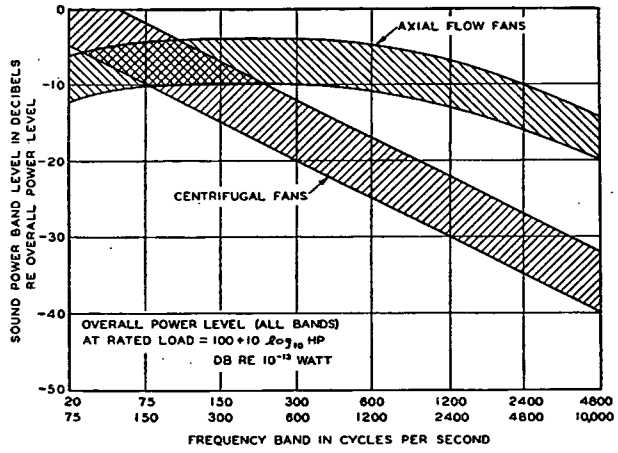

FIG. 6. CHART FOR DETERMINING THE SOUND POWER BAND LEVELS FOR VENTILATING FANS OF TWO TYPES

The over-all power level is first determined from Equation 19 or 20 and is added algebraically to the ordinate in Fig. 6. *Acoustics* BY L. L. Beranek (McGraw-Hill, 1954 Second Printing). Used by permission.

By assuming a fan mechanical efficiency of 50 percent, Equation 19 can be put in the form of Equation 18 with PWL_s = 65 dbe, *i.e.*,

$$PWL = 65 + 10 \log_{10} q + 20 \log_{10} p \text{ dbe} \quad (20)$$

where

q = air quantity, cfm.
p = pressure head, inches of water.

(See discussion after Equation 18.)

It should be emphasized that Equations 19 and 20 are intended to be used only when actual noise data are not available. All fans of the same power input are not equally noisy. The example illustrated in Fig. 5 demonstrates this fact since the minimum value of PWL_s for this particular