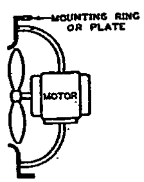
2. *Total pressure* of a fan is the rise of pressure from fan inlet to fan outlet.
3. *Velocity pressure* of a fan is the pressure corresponding to the average velocity determination from the volume of air flow at the fan outlet area.
4. *Static pressure* of a fan is the total pressure diminished by the fan velocity pressure.
5. *Power output* of a fan is expressed in horsepower and is based on fan volume and the fan total pressure.
6. *Power input* to a fan is expressed in horsepower and is measured horsepower delivered to the fan shaft.
7. *Mechanical efficiency* of a fan is the ratio of power output to power input.
8. *Static efficiency* of a fan is the mechanical efficiency multiplied by the ratio of static pressure to the total pressure.
9. *Fan outlet area* is the inside area of the fan outlet.
10. *Fan inlet area* is the inside area of the inlet collar.

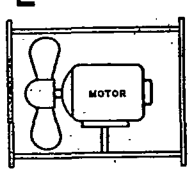
While the total pressure truly represents the actual pressure developed by the fan, the static pressure may best represent the useful pressure for overcoming resistance. In many installations, since the outlet velocity of the fan is greater than the duct velocity, some of the velocity pressure may be utilized by conversion to static pressure within the system. However, due to the uncertainty of the flow at the points of velocity change, the amount of conversion is seldom known and therefore, most fan tables list only the static pressure as available to overcome the system resistance.

Fig. 1. Names and Definitions of Types of Fans



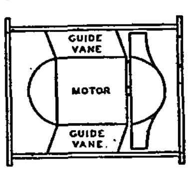
Propeller Fan

A propeller fan consists of a propeller or disc wheel within a mounting ring or plate.



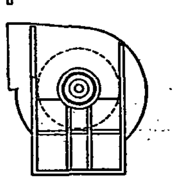
Tubeaxial Fan

A tubeaxial fan consists of an axial flow wheel within a cylinder.



Vaneaxial Fan

A vaneaxial fan consists of an axial flow wheel within a cylinder, combined with a set of air guide vanes located either before or after the wheel.



Centrifugal Fan

A centrifugal fan consists of a fan rotor or wheel within a scroll type of housing.

According to the Standard Test Code[3] the efficiencies may be determined by the formulas:

$$\text{Mechanical (total) Efficiency} = \frac{0.0001573 \times (\text{cfm}) \times \text{total pressure (inches water)}}{\text{horsepower input}}$$

$$\text{Static Efficiency} = \frac{0.0001573 \times (\text{cfm}) \times \text{static pressure (inches water)}}{\text{horsepower input}}$$

As the static pressure is often more useful than total pressure, static efficiency is likewise many times more useful than mechanical efficiency. However, where a high outlet velocity can be effectively utilized, the static efficiency fails to be a satisfactory measurement of performance; also when a fan operates against no resistance, the static efficiency becomes zero and is meaningless. Under such circumstances, many engineers prefer to use mechanical efficiency.

Sound developed by a fan is a characteristic which is becoming increasingly important. Unfortunately, no method has yet been devised for accurately measuring the sound actually discharged into a duct system. The A.S.H.V.E. Research Laboratory, in cooperation with the U. S. Navy, has a program underway seeking to find a method. Many manufacturers list the average sound (for various fan operating conditions) measured at seven stations near the fan. These stations, as specified in the *N.A.F.M.* Test Code,[4] are located in a horizontal plane passing through the fan shaft, and are at a distance of one wheel diameter (but not less than 5 ft) from the fan. Such values are useful in comparing the relative sound generated by various types and sizes of fans under comparable operating conditions.

FAN LAWS[5]

The performances of fans of all types follow certain laws which are useful in predicting the effect upon performance of changes in the conditions of operation, the duty required of the installation, or the size of the equipment due to the space, power, or speed limitations. In the following laws, groups 1 to 6, Q = air volume and P = static, velocity or total pressure. The laws pertaining to fan size apply only to fans geometrically similar, *i.e.*, those in which all dimensions are proportional to some lineal dimension denoted as *size*. If the size number is also lineally proportional, it may be used; otherwise, wheel diameter is commonly used as a size criterion.

1. Variation in Fan Speed:
   Constant Air Density—Constant System
   (a) Q: Varies as fan speed.
   (b) P: Varies as square of fan speed.
   (c) Power: Varies as cube of fan speed.

2. Variation in Fan Size:
   Constant Tip Speed—Constant Air Density
   Constant Fan Proportions—Fixed Point of Rating
   (a) Q: Varies as square of wheel diameter.
   (b) P: Remains constant.
   (c) RPM: Varies inversely as wheel diameter.
   (d) Power: Varies as square of wheel diameter.