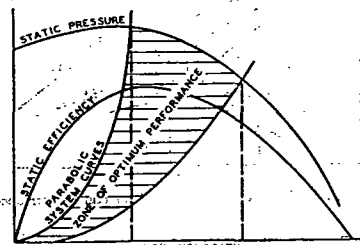


Table 1 Outlet Velocities for Optimum Performance of Typical Ventilating Fans



Static Pressure Inches of Water	Centrifugal Fans		Tubaxial and Vaneaxial Fans
	Outlet Velocity ft/min	Outlet Velocity of wheel dia. ft/min	
1/4	400-1100	950-1500	
1/2	550-1450	1350-1900	
1	700-1750	1850-2350	
1 1/2	800-2000	1900-2700	
2	1000-2500	2350-3300	
2 1/2	1150-2800	2700-3800	
3	1250-3200	3000-4300	
4	1400-3500	3300-4700	
6	1600-4050		
8	2000-4950		
10	2300-5700		
	2500-6400		

The selection of size of fan usually involves balancing cost and space against sound and efficiency. Unless the pressure involved is so high that a smaller fan running at greater speed requires a higher class of construction, the smallest fan is the cheapest in first cost of the fan only. However, as the cost of the driving equipment is also involved in the total installation cost, fan efficiency must be considered for that reason as well as its bearing on the cost of operation. In some cases where large fans operate long hours per year, selection at absolute maximum efficiency is indicated. Generally, however, the power saved by selecting for optimum efficiency does not justify the extra cost, and a slightly smaller fan gives the best balance of cost and efficiency. Reference to Figs. 2 to 4 shows that all types tend to have a minimum sound near maximum efficiency. When noise is a consideration, therefore, selection approaching maximum efficiency is indicated. Too large a fan may not only cause an unnecessary investment and an increased power consumption and sound, but may also give faulty performance if it is of a type having an unstable pressure characteristic at low capacity.

Table 1 shows outlet velocities for the range of optimum performance of typical ventilation fans. The optimum performance range is at or near peak efficiency and is also the range of lowest noise. Fans for churches, schools, residences, and other buildings having a low noise requirement should be selected for low outlet velocities. Fans may be selected for higher outlet velocities than shown in the table if more noise and lower efficiency are acceptable.

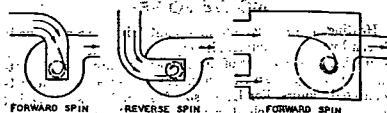


Fig. 13 Examples of Spin at Fan Inlet

FAN INSTALLATION

In designing heating, ventilating, and air-conditioning systems, the characteristics of the fans available for use there-with should not be ignored. Inlet and outlet connections to fans should be designed without restrictions and with minimum disturbance of air flow, because either or both defects will adversely affect fan performance. If double inlet fans or multiple fans in parallel are used, care must be taken that both inlets have the same free area and general approach conditions.

The approach to, and discharge from, the fan are very important to the proper operation of the system. Since a fan transfers energy to the air by creating a vortex or whirling flow, any interference with this action will result in a change in performance. The air should enter the fan inlet axially, without spin in either direction. A spin in the same direction as the fan rotation will reduce both the pressure output and power. A reverse spin at the inlet causes high horsepower, with practically no increase in pressure.

Fig. 13 indicates some inlet arrangements which tend to cause spin. It is well to avoid these conditions in the design stages, since it is often difficult to correct an inlet spin after installation.

The discharge duct should preferably be a straight section, several duct diameters in length, to allow full conversion of the fan energy. Fig. 14 illustrates both poor and good practice in fan discharge design.

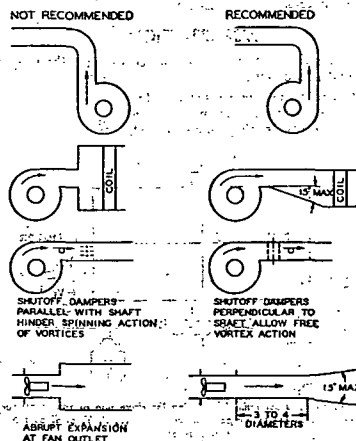


Fig. 14 Fan Discharge Design

The dimensions of the ductwork and the size of the various devices whose individual resistances determine the static pressure, dictate the fan selection. Often a minor modification of the system may permit use of a smaller motor, and even a lower class of fan, with considerable saving of cost. Invariably, the sound generated is affected, as fans operating at high pressure produce more noise than at lower pressure (see Chapter 14). However, the lowest overall cost may result from selecting the minimum size of system equipment, and installing adequate acoustical and vibration treatment.

All ducts should be connected to fan outlets and inlets by means of unpainted canvas or other flexible material. Access should be provided in the connections for periodic removal of any accumulations tending to unbalance the rotor. When operating against high resistance, or when ambient noise levels are low, it is preferable to locate the fan in a room removed from occupied areas or in one acoustically treated to prevent sound transmission. The lighter building constructions, which are common today, make it desirable to mount fans and driving motors on resilient bases designed to prevent transmission of vibrations through floors to the building structure. Conduits, pipes, and other rigid members should not be attached to fans. Noises due to high velocities, abrupt turns, grilles, and other items not connected with the fan, may be present. Treatment of such problems, as well as the design of sound and vibration absorbents, are discussed in Chapter 14.

FAN APPLICATIONS

Many fan applications and the corresponding types of fan commonly used are listed in the following paragraphs. Reference is also made to the chapters in which the applications are discussed.

Central-system supply fans are usually of the centrifugal type, since this application requires a wide range of satisfactory and quiet operation against high pressures. They can readily be connected to apparatus of large cross-section on the inlet side, and to relatively small ducts on the outlet side.

Comparative sizes have been standardized among manufacturers, and most rating tables cover a range of 700 to 500,000 cfm, and static pressures from 1/4 to 15 in. of water.

Central-system exhaust fans are predominantly centrifugal, but the space conservation of the axial is being increasingly utilized. Tubaxial and vaneaxial fan sizes are not yet standardized, but several manufacturers list capacities from 2000 to 125,000 cfm, and static pressures up to 3 in. of water.

Exhaust fans are found in all types. **Wall fans** are predominantly of the propeller type, since they operate against little or no resistance. They are listed in capacities from 1000 to 75,000 cfm. They are sometimes incorporated in factory-built penthouses or roof caps, or are provided with matching automatic louvers. **Hood-exhaust fans**, involving ductwork, are predominantly centrifugal, especially if handling hot, corrosive, or erosive fumes, where it is best to keep the bearings and drive remote from the air stream. Otherwise, axial fans are applicable, and where little or no ductwork is involved, propeller fans are suitable. **Spraybooth-exhaust fans** are frequently centrifugal, especially if built into self-contained booths. Tubaxial fans lend themselves particularly well to this application, where ease of cleaning and of suspension in a section of ductwork are advantageous. For such application, built-in cleanout doors are desirable. **Material handling fans** are usually straight radial (or modified) blade centrifugal type. They are of heavier construction, and have fewer blades and greater clearances than ventilating fans. Many characteristics are compromised to provide wear re-

sistance and ease of maintenance. They are commonly listed in capacities from 600 to 125,000 cfm, and static pressures up to 18 in. water.

Mine-fan applications vary greatly and require fans ranging from small portable units for local ventilation, to large centrifugal fans, for general or emergency ventilation. Vaneaxial fans are well suited to mine ventilation. For underground location, their compactness saves on cost of excavations, and above ground, their ready reversibility is valuable in emergencies, even if reversal causes a reduction in capacity.

Marine fans are available in both centrifugal and vaneaxial types. The latter are particularly well adapted to combatant ships and to noncombatant ships, where compactness and light weight are invaluable.

Unitary systems, i.e., unit heaters, unit ventilators, unit humidifiers, unit air conditioners, unit air coolers, and unit evaporative condensers are equipped with centrifugal or propeller fans, the latter usually being limited to the relatively small suspended type where no ductwork is involved. Fans for units having considerable internal, or possible external resistance, are mostly of the forward-curved blade, or the so-called *mixed-flow centrifugal* type. The latter is really a centrifugal type with axial inlets, having a pressure curve resembling a backward-curved-blade centrifugal fan. Both of these types have the high capacities (in relation to displacement) requisite for a compact unit. Ratings are frequently given for these units as separate fans, as well as in conjunction with the various internal resistances. In multiple units on a common shaft, they are listed up to 40,000 cfm capacities.

Cooling tower fans are predominantly of the propeller type, but axial types are also used for packed towers, and occasionally a centrifugal fan is used to supply forced draft.

Circulating fans are invariably of propeller or disk type, and are made in a vast variety of blade shapes and arrangements. They are designed for pleasing appearance, as well as utility.

General purpose fans are centrifugal fans of conventional design, built for service in the lower capacity ranges. They are built with the fan wheel mounted on the motor shaft, or connected to a self-contained belt-driven arrangement. They are listed in capacities from 100 to 20,000 cfm, and static pressures up to 1 1/4 in. water.

Kitchen fans for domestic use are small propeller fans arranged for window or wall mounting, with various useful fixtures. Their capacities range from 300 to 1200 cfm.

Attic fans are used during the warm seasons to draw large volumes of outdoor air through a house or other building whenever the indoor temperature exceeds the outdoor, and thereby utilize the cooling effect of the relatively cool evening or night air. Research by the ASHRAE indicates that a two- to three-minute air change is desirable in the North while in the South, a one-minute change is recommended to provide the additional cooling effect of air motion.

Fans may be centrally located in an attic or other unused space, or in a hallway, and arranged to draw proportionately from several rooms; or local window units may be installed in a single room. Central units may draw from the living quarters and discharge into the attic, whence the air escapes through windows or grilles, or the air may be drawn through grilles into the attic with the fan discharging directly outdoors. Discharge openings on the lee side are preferred.

Attic fans are usually of propeller type, and should be selected to operate at low velocities to minimize noise. Noise is more of a problem on local units, but care should be taken to prevent transmission of noise or vibration on