also be used to adjust the fan volume. All of these methods will give control. From a power consumption consideration, a reduction of fan speed is most efficient when accomplished by direct mechanical method. Inlet vanes save some power, while dampers save the least. From consideration of first cost, dampers usually are the lowest in cost. In some installations, adjustments of volume are desirable at various times during the day, or continuously. In others, an increased supply of air in summer, over that needed in winter, is demanded. The demands in each case will dictate which type of control is most desirable. Where noise is a factor, a lowering of fan speed, if possible, is preferred as a control means, because of the resulting reduction in sound level.

When speed control is used, the revised fan performance can be calculated by means of the fan laws. The fan performance is changed, but the system curve remains the same.

System dampers change the system resistance but leave the fan performance unchanged. Fig. 5 shows 3 different system curves, A, B, and C, such as would be obtained by changing the damper setting.

Fig. 12 illustrates the change in fan performance when inlet vane control is used.

In addition to the above types of control, *tubeaxial* and *vaneaxial* fans are sometimes made with adjustable blades to permit balancing of the fan against the system, or making seasonal adjustment.

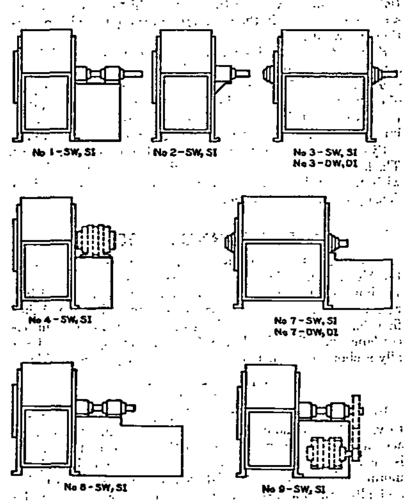


Fig. 9 .... Arrangement of Fan Drives

Arr. 1, SW, SI. For belt drive or direct connection. Wheel overhung. Two bearings on base.

Arr. 2, SW, SI. For belt drive or direct connection. Wheel overhung. Bearings in bracket supported by fan housing.

Arr. 3, SW, SI. For belt drive or direct connection. One bearing on each side and supported by fan housing. Not recommended in sizes 27 in. diameter wheel and smaller.

Arr. 3, DW, DI. For belt drive or direct connection. One bearing on each side and supported by fan housing.

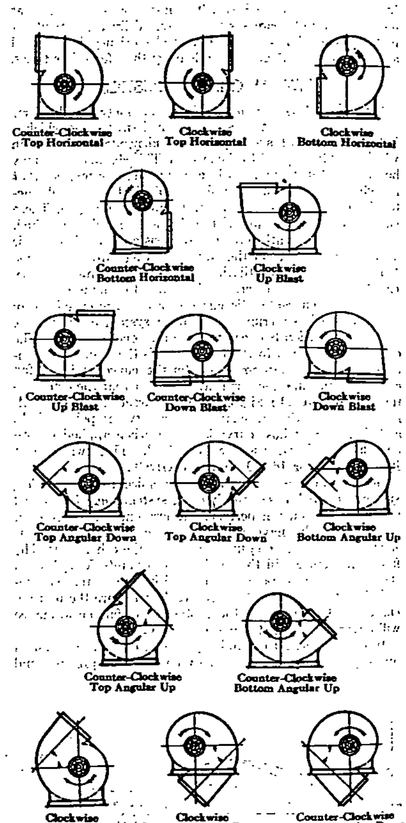
Arr. 4, SW, SI. For direct drive. Wheel overhung on prime mover shaft. No bearings on fan. Base or equivalent for prime mover.

Arr. 7, SW, SI. For belt drive or direct connection. Arrangement No. 3 plus base for prime mover. Not recommended in sizes 27 in. diameter and smaller.

Arr. 7, DW, DI. For belt drive or direct connection. Arrangement No. 3 plus base for prime mover.

Arr. 8, SW, SI. For belt drive or direct connection. Arrangement No. 1 plus base for prime mover.

Arr. 9, SW, SI. For belt drive. Arrangement No. 1 designed for mounting prime mover on side of base.



Note: Direction of Rotation is determined from the drive side for either single or double width or single or double inlet fans. (The driving side of a single inlet fan is considered to be the side opposite the inlet regardless of the actual location of the drive.) For fan inverted for ceiling suspension, direction of rotation and discharge is determined when fan is resting on floor.

Fig. 10 .... Designation of Direction of Rotation and Discharge

MOTIVE POWER

Heating, ventilating, and air-conditioning fans are usually driven by electric motors, although other prime movers may be used. The small sizes of fans, and especially those operating in the higher speed range, are equipped with direct-connected motors. For larger size fans, and those operating at lower speed, V-belt drives are generally used.

In selecting the size of motor for operating a fan, it is advisable to select at least the standard size next larger than the fan requirements. Direct-connected motors do not require so great a safety factor as belted units. Justification for liberal power provision exists only in systems where it is possible that larger volumes of air may be required at intervals and made available by use of bypass dampers, thus greatly reducing the system resistance. If such a system includes a fan with forward-curved blades, it would be necessary that the motor be sized for the maximum volume and duty. If such a system includes fans with backward-curved blades, the volume peak would not make it necessary to provide additional motor power. In selecting fans for such a system, sound ratings should be given careful consideration.

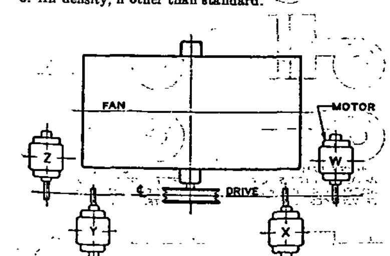
Where a system is constant and has no provision for volume change that would materially reduce the resistance, and when the resistance calculations are reasonably precise, there is no necessity for too liberal a motor allowance (even where fans with forward-curved blades are used), if the fan has been properly selected. Fig. 5 shows that the system resistance varies as the square of the volume, and that the fan static pressure varies approximately inversely as the volume, thus greatly offsetting the trend toward both increase in air delivery and motor load. Reference to Fig. 5 indicates that there is no justification for allowing large spare motor capacity. It is generally more economical to operate motors well loaded.

Since the power consumption of fans varies as the cube of the speed, very little starting torque is required of the motor. Refer to Chapter 57 for characteristics of various types of motors.

FAN SELECTION

The following information is required to select the proper type and size of fan:

1. Capacity in cubic feet per minute.
2. State pressure or system resistance.
3. Air density, if other than standard.



Location of motor is determined by facing the drive side of fan or blower and designating the motor position by letters W, X, Y, or Z as the case may be.

Fig. 11 .... Motor Position, Belt or Chain Drive

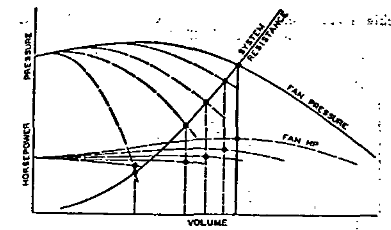


Fig. 12 .... Effect of Vane Control on Fan Performance

4. Type of application or service.
5. Arrangement of system.
6. Prevailing sound level or use of space served.
7. Nature of load.
8. Type of motive power available.

In order to facilitate the choice of apparatus, the various fan manufacturers supply fan tables or curves which usually show the following factors for each size of fan operating against a wide range of static pressures: (1) volume of air in cubic feet per minute (at a density of 0.075 lb per cubic foot), (2) outlet velocity, (3) revolutions per minute, (4) brake horsepower, (5) tip or peripheral speed, and (6) static pressure. The most efficient operating point is usually shown by either boldface or italicized figures in the capacity tables.

Often the service determines the type of fan. When operation occurs with little or no resistance, and particularly without a duct system, the propeller fan is indicated for convenience and low cost. When resistance is low, the power required is low, and efficiency becomes of secondary importance. When a duct system is involved, the choice is usually made between a centrifugal fan and a tubeaxial or vaneaxial fan. At times, the capacity-pressure-speed relationship (specific speed)[9] dictates a choice. Usually, space, efficiency, sound, cost, and serviceability must all be considered.[10] In general, centrifugal and axial fans are comparable in efficiency and sound, but the latter are lighter and require considerably less space, especially if arranged for straight-through operation. The comparison cannot be made on the cost of fans only, but the difference in cost of ductwork, mounting, and servicing must be included. A vaneaxial is more efficient and quieter than a tubeaxial, but is more expensive and frequently requires more space. While requiring less space than the centrifugal, the axial flow fan is inherently less accessible for service. When high-temperature air or air containing corrosive elements is being conveyed, motors and bearings should be located outside of the air stream. This requirement may determine the type of fan to be used. Where the system resistance is indefinite or variable, the pressure, horsepower, and noise characteristics of centrifugal fans usually indicate their selection. Under such conditions, a steep and constantly rising pressure curve permits less variation in air delivery when the resistance varies. Likewise, a flat sound curve minimizes the change of moving into a region of increased noise. A fan having a high efficiency over a wide range is more desirable than one which reaches an even higher maximum efficiency, but decreases more rapidly on either side of a narrow range. A self-limiting horsepower curve may permit more accurate selection of motor size.