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.

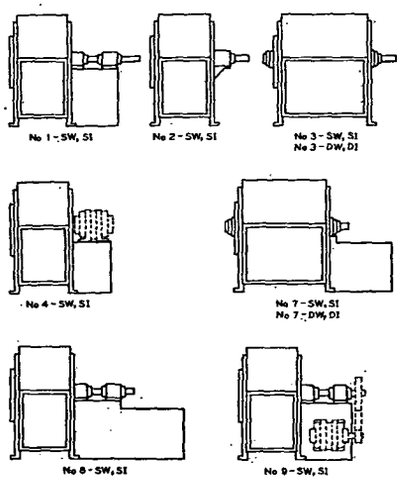


Fig. 6 .... Arrangement of Fan Drives

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.

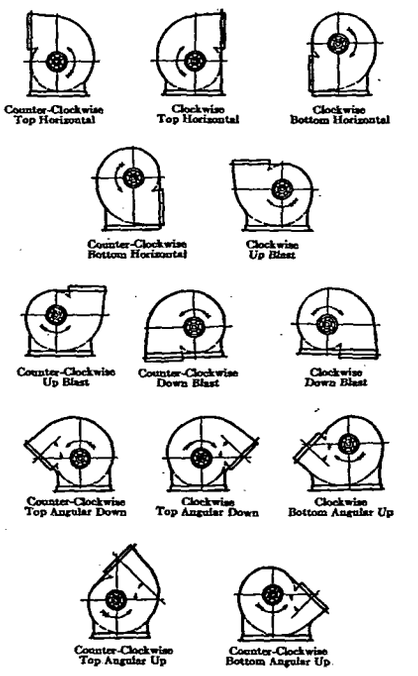
Arr. 4, SW, SI. For direct drive. Wheel overhung on prime mover shaft. No bearings on fan. Base or equivalent for prime mover.

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. 7 .... Designation of Direction of Rotation and Discharge

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 45 for characteristics of various types of motors.

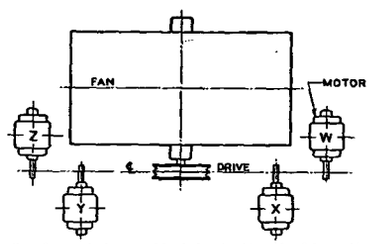
FAN SELECTION

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

1. Capacity in cubic feet per minute.
2. Static pressure or system resistance.
3. Air density if other than standard.
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 (68 F, 50 percent relative humidity, 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. At times the capacity-pressure-speed relationship (specific speed)[39] dictates a choice. Usually, space, efficiency, sound, cost, and serviceability must all be considered.[39] 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 effi-



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. 8 .... Motor Position, Belt or Chain Drive

Table 1 .... Good Operating Velocities and Tip Speeds for Ventilating Fans

Static Pressure Inches of Water	Forward Curved Blade Fans		Backward Tipped and Double Curved Blade Fans		Tubeaxial and Vaneaxial Fans
	Outlet Velocity Fpm	Tip Speed Fpm	Outlet Velocity Fpm	Tip Speed Fpm	Wheel Velocity* Fpm
¼	800–1100	1300–1500	800–1100	2500–3100	1100–1500
⅜	800–1250	1600–1850	800–1250	3000–3750	1250–1700
½	900–1450	1850–2150	900–1450	3400–4250	1400–1900
⅝	1000–1600	2050–2350	1000–1600	3800–4750	1500–2100
¾	1100–1750	2250–2600	1100–1750	4150–5200	1650–2350
⅞	1200–1900	2450–2850	1200–1900	4500–5600	1800–2500
1	1250–2000	2600–3000	1250–2000	4800–6000	1900–2700
1¼	1400–2300	2900–3350	1400–2300	5350–6700	2150–3000
1½	1550–2500	3200–3700	1550–2500	5900–7400	2350–3300
1¾	1700–2700	3400–3950	1700–2700	6350–7950	2500–3550
2	1800–2900	3700–4300	1800–2900	6800–8500	2700–3800
2¼	1900–3050	3900–4500	1900–3050	7200–9000	2900–4050
2½	2000–3200	4100–4750	2000–3200	7600–9500	3100–4300
3	2200–3500	4500–5200	2200–3500	8300–10500	3300–4600
3½	2400–3800	4900–5650	2400–3800	9000–11500	
4	2550–4050	5200–6000	2550–4050	9600–12000	
4½	2700–4300	5500–6350	2700–4300	10000–12500	
5	2850–4550	5800–6700	2850–4550	10500–13000	
5½	2950–4750	6100–7050	2950–4750	11000–13750	
6	3100–5000	6400–7400	3100–5000	12000–15000	
7	3350–5400	6900–7950	3350–5400	12700–16000	
8	3600–5750	7350–8500	3600–5750	13500–17000	
9	3800–6100	7800–9000	3800–6100	14500–18000	
10	4000–6400	8200–9450	4000–6400	15000–18500	