system *A*, shown in Fig. 4 as one limit; and system *B* as the other limit. The fan performance will then fall between points *X* and *Y* on the fan curve at a point determined by the system characteristics at that particular time. If curves *A* and *B* are the limiting systems, the fan performance will never be outside the points *X* or *Y*.

## SELECTION OF FANS

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

1. Cubic feet of air per minute to be moved.
2. Static pressure required to move the air through the system.
3. Type of motive power available.
4. Whether fans are to operate singly or in parallel on any one duct.
5. What degree of noise is permissible.
6. Nature of the load, such as variable air quantities or pressures.

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 per cent 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 of the fan is usually shown by either bold-face or italicized figures in the capacity tables.

Other important factors to be considered in selecting fans are: (1) efficiency, (2) space occupied, (3) sound emission, (4) first cost, and (5) speed (both peripheral and revolutions per minute). These factors are not necessarily shown in the order of importance. In some installations space occupied may be of first importance. In others lowest power consumption is desirable. In many cases quietness of operation of the entire system is essential. Practically all fans operate at their lowest sound level when selected at or near the peak of the static efficiency so that in selecting a fan for highest static efficiency the quietest operating range of the fan will also be obtained. Table 1 shows desirable outlet

TABLE 1. GOOD OPERATING VELOCITIES AND TIP SPEEDS FOR MULTIBLADE VENTILATING FANS

| Static Pressure Inches of Water | Forward Curved Blade Fans | | Backward Tipped and Double Curved Blade Fans | |
|---|---|---|---|---|
| | Outlet Velocity Feet per Minute | Tip Speed Feet per Minute | Outlet Velocity Feet per Minute | Tip Speed Feet per Minute |
| ¼ | 1000–1100 | 1520–1700 | 800–1100 | 2600–3100 |
| ⅜ | 1000–1100 | 1760–1900 | 800–1150 | 3000–3500 |
| ½ | 1000–1200 | 1970–2150 | 900–1300 | 3400–4000 |
| ⅝ | 1200–1400 | 2225–2450 | 1000–1500 | 3800–4500 |
| ¾ | 1300–1500 | 2480–2700 | 1100–1650 | 4200–5000 |
| ⅞ | 1400–1700 | 2660–2910 | 1200–1750 | 4500–5300 |
| 1 | 1500–1800 | 2820–3120 | 1200–1900 | 4800–5750 |
| 1¼ | 1600–1900 | 3162–3450 | 1300–2100 | 5300–6350 |
| 1½ | 1800–2100 | 3480–3810 | 1400–2300 | 5750–6950 |
| 1¾ | 1900–2200 | 3760–4205 | 1500–2500 | 6200–7550 |
| 2 | 2000–2400 | 4000–4500 | 1600–2700 | 6650–8050 |
| 2¼ | 2200–2600 | 4250–4740 | 1700–2800 | 7050–8550 |
| 2½ | 2300–2600 | 4475–4970 | 1800–2950 | 7450–9000 |
| 3 | 2500–2800 | 4900–5365 | 2000–3200 | 8200–9850 |



velocities and tip speeds, or peripheral velocities, for various static pressures. Fans selected accordingly will operate at or near the peak of the static efficiency with resulting low power consumption and noise levels. Smaller fans with higher outlet velocities may be used if the installation requirements are such as to warrant the additional power and increased sound level. When space for duct expansion from a fan outlet is not available there may be advantages in selecting a larger fan for reducing duct noises, although lower outlet velocities generally result in lower fan efficiencies which cannot always be justified on the basis of increased cost and space requirements. Fans for schools, churches, residences, and all public buildings should be selected for lower outlet velocities and tip speeds than would be required for other types of installations.

Having selected a fan for its quietest operating point consistent with the requirements of the installation, it must be recognized that ventilating fans, even so selected, emit noise and precautions must be taken in the installation of the fans to prevent this noise from being transmitted to occupied portions of the building. Fans operating against high static pressures produce more noise than fans operating against low static pressures. Consequently, from a noise standpoint, the system should be designed to operate against the lowest static pressure possible. In many modern air conditioning systems it is necessary to introduce devices into the air stream for conditioning the air in various ways, the result of which is to set up a rather high static pressure against which the fan must operate. In such cases the sound level at the fan may be too high to be neglected and special sound treatment of the installation must be considered. When a fan is operating against higher pressures it should be located in a room either removed from the occupied areas, or in a room which has been acoustically treated to prevent sound being carried through the walls to adjoining spaces. The fan should be mounted on a resilient base along with its driving motor to absorb any noise or vibration which might be transmitted to the floor and thence to the building structure. All ducts should be connected to fans with unpainted canvas, or other flexible material, to prevent any vibrations being transmitted to the duct work. Ducts leading into the fan room or from the fan, should be acoustically treated on the interior and in special cases, should be provided with sound traps or filters. Many ventilating systems encounter noises which are connected with the fan in no way. Noises due to high duct velocities, abrupt turns, grilles, etc., may be present. Treatment of such problems is covered in Chapter 32.

If double width, double inlet fans are selected, care must be taken that both inlets have the same free area. If one inlet of a fan is obstructed more than the other, the fan will not operate properly, as one half of the wheel will deliver more air than the other half. Proper installation and location of fans is as important as the selection of the size of fan for that particular installation. All fans will work according to their characteristic curves if they are properly selected and properly installed and operated.

## FAN DESIGNATIONS

In order to prevent misunderstandings, which may cause delays and losses, the arrangements of fan drives adopted by the *National Association of Fan Manufacturers* and indicated in Fig. 5 are suggested.