The backward curve types would include the full backward curve blade and the double curve blade having a forward curve heel and a backward curve tip. These types have steep pressure curves and non-overloading power characteristics and relatively high speed. (See Fig. 5.) These fans operate at a peripheral speed approximately 175 per cent of the forward curve multiblade types for like results. Pressure curves begin to drop at very low capacity and continue to fall consistently to full outlet opening. The steep pressure curves tend to produce nearly constant capacity under changing pressures. Where wide fluctuations in demand occur, this type of fan is desirable to prevent overloading of motors. The maximum power requirement occurs at about the maximum efficiency. Consequently a motor selected to carry the load at this point will be of sufficient capacity to drive the fan over its full range of capacities at a given speed. The high speed of this type makes it adaptable for direct connected electric motor drives. The dimensional bulk of this type of fan is usually greater than that of the forward curve multiblade type. The newer designs of these backward curve types have proven to be extremely quiet.

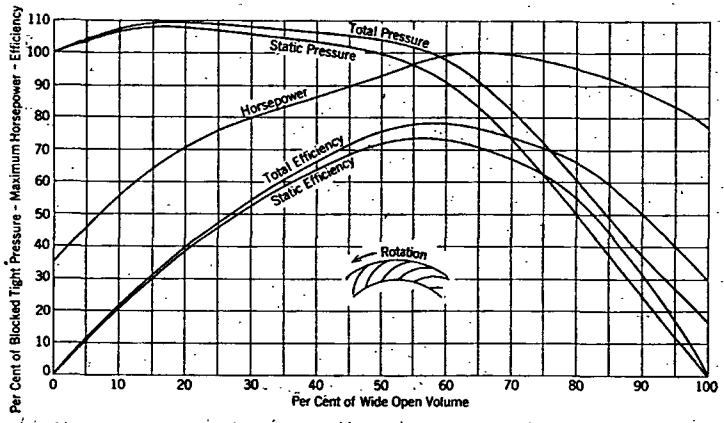


FIG. 5. OPERATING CHARACTERISTICS OF A FAN WITH BLADES CURVED BACKWARD

Between the extremes of the forward and backward curve blade type centrifugal fans, a number of modified designs exists, differing in angularity and in the shape of the blades. Characteristic curves of these types show varying degrees of resemblance to the curves of Figs. 4 and 5.

## SYSTEM CHARACTERISTICS

Any ventilating system consisting of duct work, heaters, air washers, filters, etc., has a system characteristic which is individual to that system and is independent of any fan which may be applied to the system. This characteristic may be expressed in curve form in exactly the same manner that fan characteristics may be shown. Typical system characteristic





curves are shown as *A*, *B* and *C* in Fig. 6. These curves are drawn to follow the simple parabolic law in which the static pressure or resistance to flow of air varies as the square of the volume flowing through the system. Heating and ventilating systems follow this law very closely and no serious error is introduced by its use.

When a constant speed fan curve for a given size fan is super-imposed upon a system characteristic curve, the relation between the two is at once apparent. The only point common to the two curves is the point at the intersection of the system characteristic curve and the fan characteristic curve, and it is at this point that the combination will operate. In Fig. 6, curves *A*, *B* and *C* cross the fan characteristic curve at points *X*, *Y* and *Z*. This means that when the fan whose curve is shown is applied

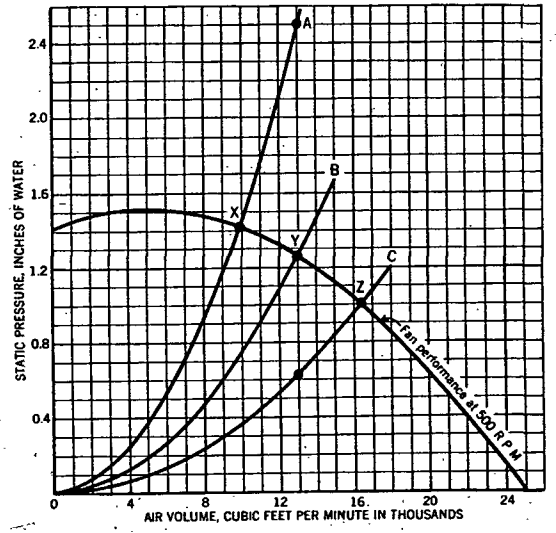


FIG. 6. PARABOLIC SYSTEM CHARACTERISTIC CURVES

to system *A*, 10,000 cfm will flow through the system. If it is applied to system *B*, 13,000 cfm will flow, and applied to system *C*, 16,400 cfm will flow through that system.

The curves in Fig. 6 also illustrate the effect of errors which may be determined by calculating the resistance of a ventilating system. For instance, a given system requires 13,000 cfm and the resistance to flow of the system has been computed as 1.25 in. static pressure. Such a system may be represented by curve *B* in Fig. 6. Assume that 100 per cent error has been made and the resistance calculated should have been 2.5 in. instead of 1.25 in. Then the system would be as shown in curve *A*. This new system curve crosses the fan curve at 10,000 cfm. Such an error would result in the flow of air being decreased from a design volume of 13,000 cfm to 10,000 cfm. In case the resistance to flow had been over estimated and instead of 1.25 in. being required, actually the resistance