but all from the change in velocity in passing through the impeller, and its conversion into static pressure. They are thus inherently high velocity fans, and are very dependent on blade conformation for good characteristics. For that reason, an air foil section, such as developed in wind tunnels for aircraft work[8] is frequently used. Since any shape of blade can only be correct for a narrow range of capacity at constant speed, the performance curves for any blade show definite characteristics. To absorb energy, the air must be given a tangential motion in passing the impeller,[7] and when operating against higher pressures, must have guide vanes (see vaneaxial fans) to obtain best efficiencies.

While *axial flow* fans are inherently a higher capacity type than centrifugal fans, they, too, may be designed with widely varying characteristics. As with a centrifugal fan, the pressure rises generally from free delivery to no delivery, but tubeaxial and vaneaxial fans may have a drop in pressure

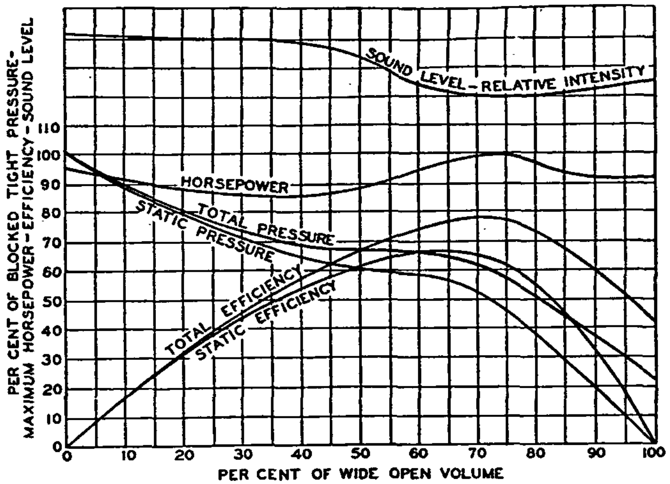

FIG. 4. PERCENTAGE PERFORMANCE CURVES OF AN AXIAL FLOW FAN

when the capacity decreases below a certain volume, a condition also found in the case of the centrifugal fan having forward-curved blades. The pressure drop is caused by the same condition for both fans, *i.e.*, the static pressure is largely dependent on conversion of velocity pressure, and velocity pressure is small at low capacity. Tubeaxial and vaneaxial fans may also have performance curves resembling somewhat those of a centrifugal fan with backward-curved blades. Fig. 4 shows the performance curves for a typical design.

The horsepower curve may be flat with a self-limiting characteristic as in a backward-curved blade centrifugal fan, or it may have a generally downward trend from no delivery to free delivery with the maximum at no delivery, contrary to that of a centrifugal fan. The type of guide vanes in a vaneaxial fan has a distinct bearing on the shape of the horsepower curve. The maximum efficiency tends to occur at a percentage of free delivery capacity higher than for a centrifugal fan.

The sound curve, which may have a minimum value comparable to centrifugal fans, is again lowest near maximum efficiency, but has a characteristic rise when the fan is operating at low capacities and the *stall* point of the blade section is reached.

Since *propeller fans* are designed for operation near free delivery, less attention is given the regaining of velocity to static pressure, and the pressure curve rises constantly from free delivery to no delivery. The horsepower is highest at no delivery, and decreases toward free delivery, in contrast to a centrifugal fan. Maximum total efficiency is obtained at a higher percentage of free delivery than for other types.

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

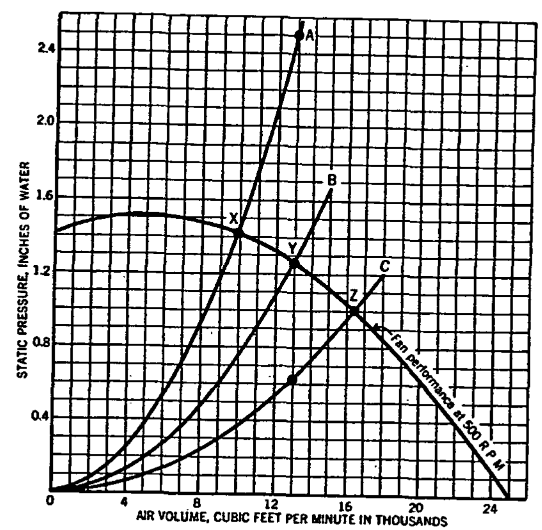

FIG. 5. PARABOLIC SYSTEM CHARACTERISTIC CURVES

that fan characteristics may be shown. Typical system characteristic curves are shown as A, B and C in Fig. 5. 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. 5, system characteristic curves A, B and C cross the fan characteristic curve at points X, Y and Z. The fan whose curve is shown, when applied to systems having characteristic curves A, B and C, will deliver 10,000, 13,000 or 16,400 cfm, respectively.