For high-pressure systems, the practical application of equation (4) is limited by the accuracy with which pressure can be measured. For these conditions, pitot-static tubes can be used with both piezometers and pitot tubes, so velocity heads can be measured directly using U-tube manometers.

Pitot-tube principles are used in some commercially available flow meters. These meters use special water-air manometers to measure mean velocity directly. The conventional pitot tube only measures point velocities, thus requiring several readings to obtain the mean.

In each of the pitot-tube applications, the cross-sectional area of the flow must be obtained to calculate the flow rate in the pipe or channel. For a pipe, the area may be easily obtained by measuring the inside diameter. Some pitot-tube gauges are constructed for a specific pipe diameter and are thus calibrated directly in terms of flow rates.

## Flow-Rate Methods Employing Constriction in the Flow Channel

Flow rates may be measured by constricting the flow in a channel and forcing it over or through a cross section of known geometry. Several devices of this type exist. Weirs, orifices, and flumes are commonly used for agricultural flow measurements and will be discussed here.

### Weirs

A weir may be defined as a restriction in a plane through which water passes (Figures 4 through 8, pp. 10–11). The restriction is normally created by constructing a plate with a notch in it. Weir notches have been constructed in various shapes. Weirs are classified by the shapes of the notches, the types of crests, and whether they are contracted or suppressed. Some examples are the 90 degree V-notch weir (Figure 4), the Cippolletti weir (Figure 5), the rectangular contracted weir (Figure 6), and the rectangular suppressed weir (Figure 7). Suppressed weirs have crest lengths approximately equal to the width of a channel, and contracted weirs have crest lengths much shorter than the width of the upstream channel so that the stream must converge as water approaches and flows through the weir notch.

Weirs can be either broad-crested (Figure 7) or sharp-crested (Figure 8). The sharp-crested weir has a sharp upstream edge that causes the water to cross only a line as it passes over the edge of the weir. The broad-crested weir has either a curved or rounded upstream edge or a crest, so that the water passes over a surface rather than a line. Because water passes over only a thin edge, much greater accuracy is obtained with sharp-crested weirs, which are used almost exclusively for measuring flow rates in irrigation canals or ditches.