C to be subtracted from the observed barometer's height is obtained by means of Equation 2.

$$C = \frac{h(t - 28.630)}{(1.1123t - 10978)} \tag{2}$$

where

C = correction to be subtracted, inches of mercury.

h = observed height, inches of mercury.
t = observed temperature of the barometer, Fahrenheit degrees.

Standard atmospheric pressure at sea level is 29.921 in. Hg, and since normal atmospheric pressure decreases about 0.01 in. Hg for each 10 ft increase in elevation, it is important to make a correction if the elevation of the barometer is not that of the test apparatus. In many cases the barometric reading may be obtained from a nearby Weather Bureau Station, in which case inquiry should be made as to whether the value is for *station* or *sea level* pressure.

Atmospheric pressure may also be measured by an aneroid barometer which is easily portable. In this type, variations in atmospheric pressure deflect the thin surface of a sealed diaphragm capsule. Most commercially available aneroid barometers are not as accurate as the mercurial type, and the best require occasional recalibration. Open-scale aneroid barometers are more expensive than common mercurial barometers. Most of the pressure gages used in engineering work indicate gage pressures, that is, the difference between the pressure being measured and the atmospheric pressure. Such pressures are called gage pressures. Absolute pressure may be obtained by adding barometric pressure and gage pressure algebraically.

AIR FLOW MEASUREMENT

The theory of various means for measuring the flow of fluids is discussed in Chapter 4, Fluid Flow. Heating and air conditioning engineers are called upon to measure the flow of air more often than that of other gases, and usually the air is measured at or near atmospheric pressure. Under this condition, the air can be treated substantially as an incompressible fluid which implies that simplified formulas can be used with sufficient accuracy for the solution of many problems.[20]

The Pitot Tube

The construction of the Standard Pitot Tube[13] is shown in Fig. 3. The formula for velocity used in conjunction with it, is as follows:

$$V_m = 1096.5 \sqrt{\frac{h_{aw}}{\rho}} \tag{3}$$

where

V_m = velocity, feet per minute.
h_{aw} = velocity pressure (Pitot tube manometer reading), inches of water.
ρ = density of air, pounds per cubic foot.

Since the velocity in a duct is seldom uniform across any section, and since a Pitot tube reading indicates a velocity at only one location, a *traverse* is usually made to determine the average velocity so that the flow can be computed. Suggested Pitot tube locations for traversing round and rectangular ducts are shown in Fig. 4. In general, the velocity is lowest near the edges or corners, and greatest at or near the center. For this reason a large number of readings should be taken (in the case of round ducts not less than 20) along two diameters at centers of equal annular areas. In rectangular ducts the readings should be taken in the center of equal areas over the cross-section of the duct. The number of spaces should not be less than 16, and need not be more than 64. When less than 64 are taken, the number of equal spaces should be such that the centers of the areas are not more than 6 in. apart. In determining the average velocity in the duct from the readings given, the calculated individual velocities or the square roots of the velocity heads must be averaged. It is incorrect to use the average

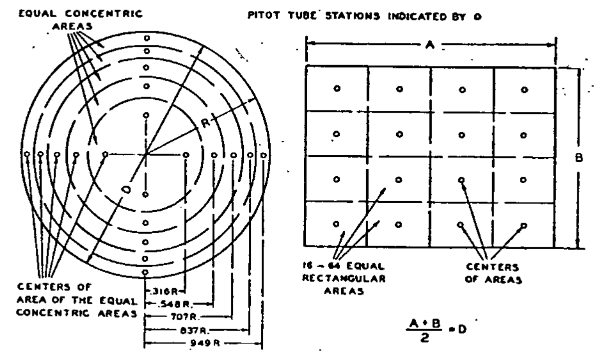

Fig. 4. Pitot Tube Traverse for Round and Rectangular Ducts

velocity head for this purpose. Pulsating or disturbed flow will give erroneous results and therefore, if possible, the Pitot tube should be located at least 7½ diameters down-stream from a disturbance such as that caused by a turn; or a criss-cross type of flow straightener should be installed in the duct 1½ diameters ahead of the Pitot tube.[13] Flow straighteners do not equalize flow velocity across a duct. They merely serve to improve the precision of measurements. Equalization can be effected, if desirable, for measuring purposes by the use of wire netting, perforated plates or cloth screens across the duct.

Many forms of Pitot tubes, other than the one described, have been used and calibrated.[21] A double-ended tube,[22] one end pointing down-stream, and one up-stream, is sometimes used for low velocities, but it should be carefully calibrated for accurate results. A special form of this tube design consists of two straight ⅛ in. tubes soldered together, closed at the end, and with a 0.04 in. hole in each tube opposite the line of contact. This tube is useful in exploring velocities in exhaust inlets, such as hoods placed around grinding wheels. To meet special conditions, different sized Pitot tubes which are geometrically similar to the standard tube can be used.

Plate Orifices

Application of the Pitot tube is often inconvenient when velocities are low, because the resultant velocity pressures become so small that extraordinary means are necessary for measuring them. In addition, velocity