Pressure Gages

The Bourdon type gage is a widely used device for measuring pressures. The Bourdon tube is elliptical in cross-section and circular in form, and is connected by suitable linkage to a pointer which moves over a dial. An increase in pressure tends to straighten the tube and a decrease has the opposite effect. When used with high temperature steam, the tube must be protected by a water seal. When used with ammonia it must be made of steel or other material not attacked by this substance. When used for sub-atmospheric pressure, the gage is known as a vacuum gage, and is usually graduated in inches of mercury. For pressures above atmospheric, it is termed a pressure gage and is graduated in pounds per square inch. Some are made to read in both directions and are termed compound gages. Calibration is usually made by means of a dead weight tester, consisting of a platform and weights resting on a piston floating on oil. The pressure at all points in the fluid is determined from the area of the piston and the total weight resting on the oil. Adjustments

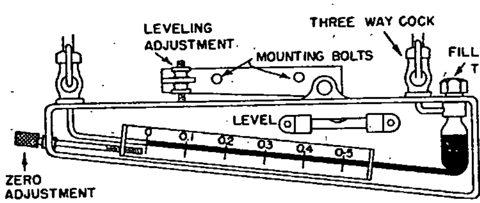

Fig. 4. Inclined Draft Gage

are provided in the gage linkage to make necessary corrections. A correction chart may be used for accurate work.

Manometers

For comparatively low gage pressures or differences in pressure between two points in a duct system, the vertical *U* tube is a simple and accurate gage and is often used for test work with various fluids such as mercury, water, kerosene, or alcohol. Readings may be in inches of any of these fluids.

For measuring pressure differences of a few inches of water, or less, *U* gages are often set at an angle for scale amplification. In commercial gages of this type, commonly termed *draft gages*, only one tube of small bore is used and the other leg is replaced by a reservoir. Although the scale is calibrated to read in inches of water, a fluid having the density and characteristics of kerosene is often used. It is necessary, in such a gage, to use a fluid having the same gravity as that for which the gage was originally calibrated, or to apply a correction if another fluid is used. Such gages may be checked one against another to detect errors in gravity of fluid. For more accurate calibration the gage may be checked against a micromanometer or a calibrating device known as a hook gage [7]. The accuracy of a draft gage is dependent on the slope of the tubes and consequently the base of the gage must be leveled carefully. It is not desirable to use a slope of less than 1 in 10.

The better grades of inclined draft gages are equipped as shown in Fig. 4. This includes a built-in level and leveling adjustment, a means of adjusting the scale to zero, and three-way vent cock connectors for checking purposes.

For measuring low pressure differences to within 0.001 in. of water very sensitive *micromanometers* are available, such as the Illinois or Wahlen, the Askania, and the Emswiler [8, 9]. Calibration of these is impossible, and readings are converted to pressure units by fundamental calculations involving the specific gravity of the fluids used and the design principles involved.

Static Holes and Tubes

In the case of low pressure air flow, the type of pressure opening used and its location are quite as important as the accuracy of the gage to

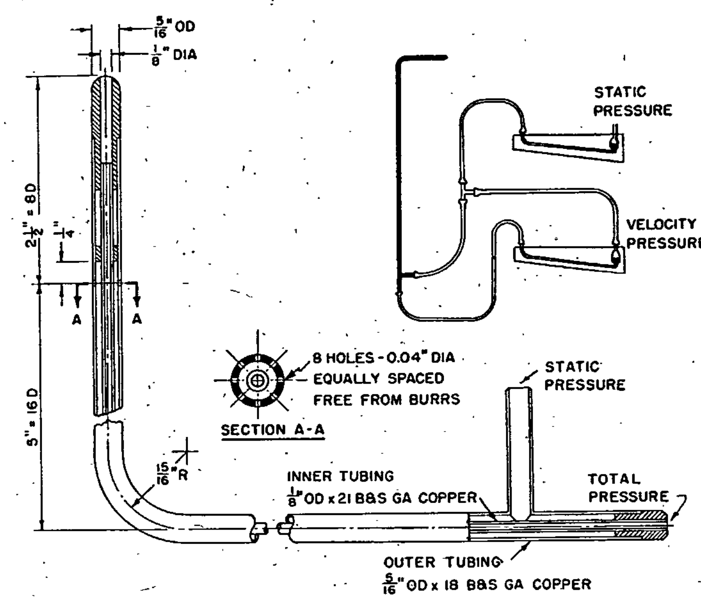

Fig. 5. Standard Pitot Tube

which it is connected. Where velocities are low, as in certain plenum chambers, or where flow is free of large eddies and parallel to the walls of the conduit, a carefully drilled opening cleared of burrs and at right angles to the stream will give accurate readings [10]. The drilled depth of this hole through the wall should be at least two diameters. A second method less likely to involve error is the use of the static pressure element of a Pitot tube shown in Fig. 5. A static tube of the same general design as the Pitot may also be used, omitting the center tube. In using this instrument it should be pointed upstream, avoiding impact or eddies.

MEASUREMENT OF AIR MOVEMENT

The problem of measuring air movement may be divided into three main parts: air confined in ducts, air circulating in free spaces, and air entering or leaving such space through openings such as grilles. Other