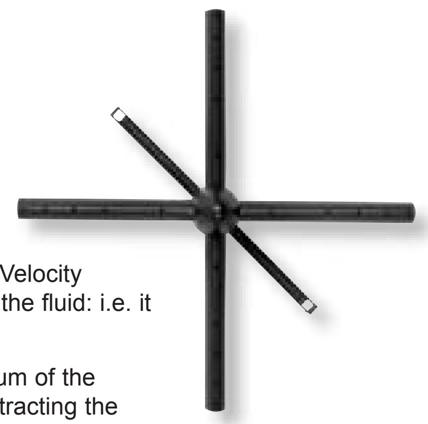
Anemostat Velocity Wing™ Airflow Sensor

Patent No. US 6,487,918 B1

Anemostat's new air terminal designs incorporate a patented airflow measuring device called the Velocity Wing™. This bulletin describes the purpose of airflow sensors and how the Velocity Wing™ offers superior measurement under quiet operation and low pressure loss.



Background

As air flows through a duct system from the source to the outlet(s), the duct is pressurized in the form of static pressure. Static pressure(s) can be either positive or negative in reference to atmospheric pressure, depending on the location in the duct system. A second pressure found in an air moving system is velocity pressure. Velocity pressure is defined as "the pressure that is created due to the velocity and density of the fluid: i.e. it is a measure of the kinetic energy that exists in a moving airstream." [1]

A third system component is total pressure. Total pressure is defined simply as the sum of the velocity and static pressures. Conversely, velocity pressure can be calculated by subtracting the static pressure from the total pressure. Since velocity (V), in feet per minute (FPM), at standard air conditions can be derived from velocity pressure (Pv) using the formula $V = 4005\sqrt{Pv}$, the airflow rate in cubic feet per minute (CFM) can be calculated where the duct area is known.

Airflow Sensors

When an airflow measuring device is inserted or mounted into an air stream, a differential pressure is developed across the device. Differential pressure is defined as "the difference in static or total pressure across a device mounted in an air stream", and "is a measure of the device's resistance to airflow."[1] The differential pressure serves as the measurement for connection to an inclined manometer or field transducer or controller.

Many fixed and unfixed airflow sensors of various types have been employed over the years with varying degrees of success in order to accurately measure the airflow rate.

Devices such as static pressure taps are single point, and require an orifice plate between the taps in order to develop a differential pressure signal for measurement. The resulting pressure drop across the orifice plate increases fan energy and sound power levels at the measuring station, and therefore the terminal unit.

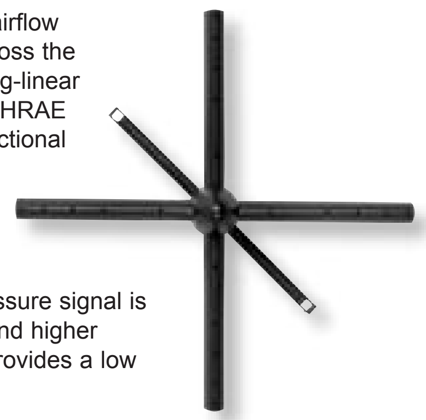
Pitot and traverse tubes provide little or no amplification between the total and static pressure ports, thereby developing very small differential pressure signals for measurement and control purposes. This lack of amplification of the differential pressure signal affects accuracy and control, especially at low airflows, and results in lower turndown ratios and higher energy costs in VAV systems. The addition of orifice plates or air dams in order to amplify the differential pressure signal has the negative affects described previously.

Additional airflow sensors have been developed to average multiple measurements over a cross section of the duct. These are typically designed with the upstream pressure ports arranged in equal concentric cross sectional areas. This type of spacing pattern fails to account for the frictional losses encountered at the duct wall that influence the measurement average.

[1] ANSI/ASHRAE Standard 111

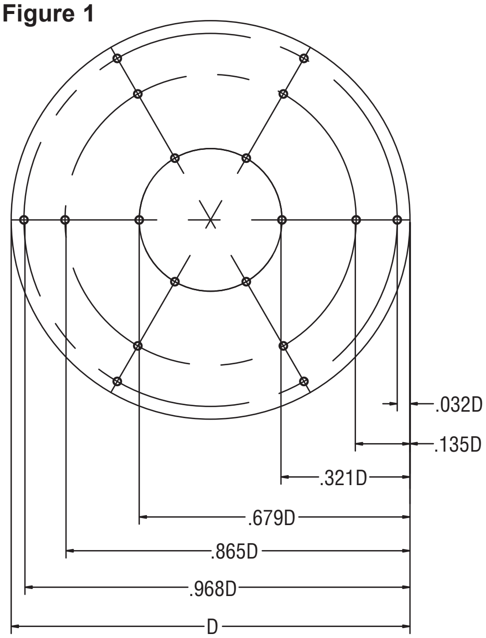
Velocity Wing™

The patented Velocity Wing™ airflow sensor is designed to accurately measure the airflow regardless of the upstream velocity profile. It does so by taking a sampling of air across the cross section of the air stream at points determined by the log-Tchebycheff rule, or log-linear rule for circular ducts (figure 1), as defined in ISO Standard 3966 and adopted by ASHRAE (Standard 111)and ANSI/AMCA (Standard 210). This feature compensates for the frictional drag along the duct walls to obtain a more accurate airflow measurement.



The Velocity Wing™ uses 20 measurement points on all 9 sizes of velocity sensors. Each of the 4 wings contains an internal passage to direct the total pressure to the center averaging chamber. The Velocity Wing™ also contains two enhanced amplifying static pressure pick-up tubes. The resulting differential pressure signal is amplified up to 3 times the actual velocity pressure, providing more control stability and higher resolution, especially during low airflow conditions. The sleek aerodynamic design provides a low pressure loss, quiet operation and accurate airflow control signals.

Figure 1



Log Linear rule for traverse points on 3 diameters in a circular duct.

Number of Measuring Points Per Diameter (D)	Position Relative to Inner Duct Wall
6	0.032, 0.135, 0.321, 0.679, 0.865, 0.968
8	0.021, 0.117, 0.184, 0.345, 0.655, 0.816, 0.883, 0.979
10	0.019, 0.077, 0.153, 0.217, 0.361, 0.639, 0.783, 0.847, 0.923, 0.981