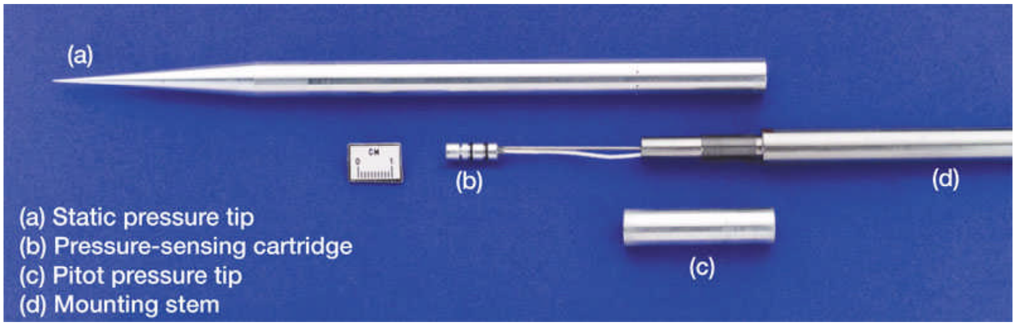
View metadata, citation and similar papers at core.ac.uk
brought to you by CORE
provided by NASA Technical Reports Server

Dynamic Pressure Probes Developed for Supersonic Flow-Field Measurements

Current trends in supersonic propulsion research tend to focus more on analyzing transient fluid flow phenomena. Steady-state data, although valuable and informative, may not give a true characterization of the flow field in question. What may appear to be a benign steady-state flow may have some undesirable transient characteristics that do not come to light because of the time-averaged nature of steady-state data acquisition. In the case of supersonic propulsion systems, recent analyses show that the instantaneous dynamic flow distortion at the inlet/engine interface plane is a more reliable predictor of impending engine compressor surge and stall than the steady-state flow distortion is. Also, fast-acting transients, such as an inlet unstart and subsequent engine compressor stall, occur on a millisecond time scale and cannot be adequately characterized with steady-state instrumentation.



Flow-field pressure probe components.

A series of dynamic flow-field pressure probes were developed for use in large-scale supersonic wind tunnels at the NASA Glenn Research Center. These flow-field probes include pitot and static pressure probes that can capture fast-acting flow-field pressure transients occurring on a millisecond timescale. The pitot and static probes can be used to determine local Mach number time histories during a transient event. The flow-field pressure probe contains four major components (see the photograph):

1. Static pressure aerodynamic tip
2. Pressure-sensing cartridge assembly
3. Pitot pressure aerodynamic tip
4. Mounting stem

This modular design allows for a variety of probe tips to be used for a specific application. Here, the focus is on flow-field pressure measurements in supersonic flows, so we developed a cone-cylinder static pressure tip and a pitot pressure tip. Alternatively, probe tips optimized for subsonic and transonic flows could be used with this design. The pressure-sensing cartridge assembly allows the simultaneous measurement of steady-state and transient pressure which allows continuous calibration of the dynamic pressure transducer. The transient frequency response is nominally 800 Hz when the static pressure probe tip is used and 1900 Hz when the pitot pressure probe tip is used.

These probes were designed, developed, and tested at NASA Glenn. They were also used in a NASA Glenn Research Center 10- by 10-Foot Supersonic Wind Tunnel test program, where they successfully acquired flow-field pressure data in the vicinity of a propulsion system during an engine compressor stall and inlet unstart transient event (ref. 1).

Reference

1. Porro, A.R.: Inlet Unstart Propulsion Integration Wind Tunnel Test Program Completed for High-Speed Civil Transport. Research & Technology 1999, NASA/TM--2000-209639, 2000, p. 87. http://www.grc.nasa.gov/WWW/RT1999/5000/5850porro.html

Glenn contact: A. Robert Porro, 216-433-5921, Alvin.R.Porro@grc.nasa.gov
Author: A. Robert Porro

Headquarters program office: OAT
Programs/Projects: HSSO