May 1974

B74-10050

NASA TECH BRIEF

Ames Research Center

High-Directivity Acoustic Antenna

The problem:

To identify and define aerodynamic noise sources in a free field, particularly in a wind tunnel which is quite reverberant.

The solution:

A high-directivity acoustic antenna with a unique electronic steering control.

How it's done:

A theory of acoustic characteristics and reverberation modes of wind tunnels which has been developed shows that a wind tunnel is quasi-reverberant, having a characteristic length, L, of the order of magnitude of a wavelength. For a point source on the axis of the tunnel, approximately plane waves propagate beyond L, and higher-order modes attenuate rapidly within the volume specified by L; extended or nonaxial sources result in high-order modes propagating down the tunnel. In all cases, however, there is a quasi-reverberant field within the volume characterized by the length L; estimation of the true strength of a sound source radiating in the reverberant environment of wind tunnels requires that measurement be made very close to the source with highly-directional devices.

An acoustic antenna has been developed which has high directivity (10° half-angular resolution at 6 dB) and high frequency selectivity. It utilizes two linear arrays of 5 microphones each, which are placed along straight arms in such a way that the two arms form, preferably, a right-angle cross. Each array can be steered independently from 0° to 180° and, more importantly, the steering is independent of the acoustic frequency. The output of the model is the product of the two arrays.

By means of two simple dials on the electronic steering control, any position in the plane of the acoustic antenna may be selected without mechanically disturbing the transducers (microphones) in any way; for example, the plane of the transducers can be made to rotate clockwise or counterclockwise around a vertical axis, to rotate out of (or into) its own plane around a horizontal axis, or to tilt in any direction by the combined rotation around two axes. Thus, linear, two-dimensional, or helical scanning is possible. Dials control the phase-shifting of transducers to induce the equivalence of mechanical rotation; the phase-shifting is independent of the frequency of the detected radiation. Provision is made for high directivity as well as improved discrimination against unwanted background noise such as reverberation or echoes.

Notes:

1. The following documentation may be obtained from:

   National Technical Information Service
   Springfield, Virginia 22151
   Single copy price $3.00
   (or microfiche $0.95)
   Reference: NASA CR-114636 (N73-30669), Aerodynamic Noise in Free Field and Reverberant Environment of Wind Tunnels.
2. No additional documentation is available. Specific questions, however, may be directed to:

   Technology Utilization Officer
   Ames Research Center
   Moffett Field, California 94035
   Reference: B74-10050

Patent status:

NASA has decided not to apply for a patent.

(continued overleaf)

Source: Hussein M. A. El-Sum of
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under contract to
Ames Research Center
(ARC-10789)