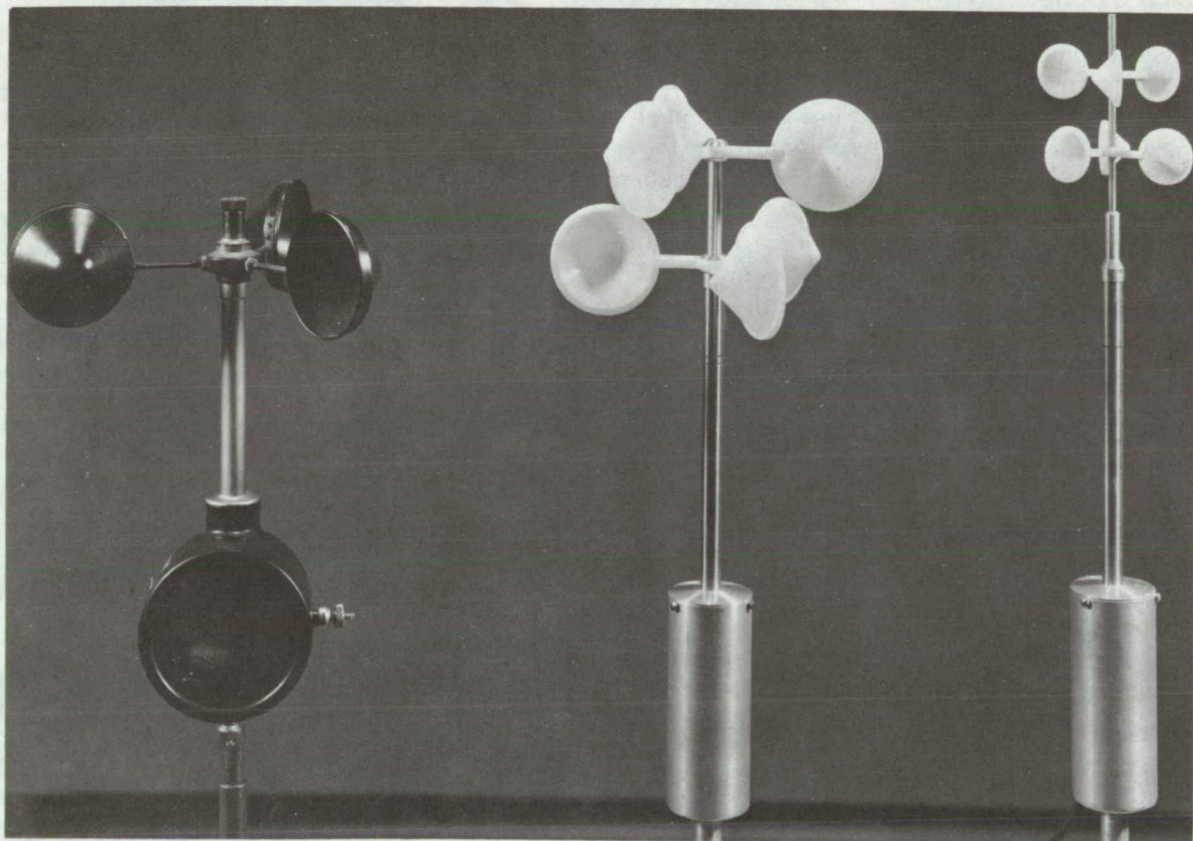


AEC-NASA TECH BRIEF



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Fast-Response Cup Anemometer Features Cosine Response



The problem:

To develop relatively simple equipment for the measurement of the true horizontal components of winds fluctuating rapidly in three dimensions. This information on the characteristics of natural turbulence is important to studies of the atmosphere's ability to disperse artificial pollutants and to exchange energy with the underlying surface. Resolution of winds into directed components ordinarily requires

such devices as hot-wire anemometers or bidirectionally oriented propellers.

Prior to the development of the present design, anemometers based upon the familiar cup principle have not been suited to the task. These simple instruments cannot distinguish between horizontal and vertical flows with the precision required. Moreover, in fluctuating winds, standard cup anemometers commonly overestimate average speeds by 10 percent or more.

(continued overleaf)

The solution:

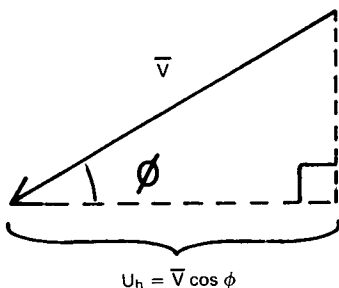
A six-cup, low-inertia anemometer that combines high resolution and fast response with a unique ability to sense only the horizontal component of the wind.

Cup rotors inherently accelerate more rapidly than they decelerate; consequently, cup instruments characteristically turn too fast in winds of fluctuating velocity. In the new design, this defect has been largely eliminated by: (a) maximizing the ratio between driving torque and rotor inertia; and (b) decreasing the difference between torques available to the rotor for acceleration and deceleration by increasing the drag coefficient of the reverse sides of the cups.

How it's done:

A 60-slot photochopper readout used in conjunction with cup rotors of unusually small wheel diameter that rotate proportionately faster in a given wind gives the new instrument sufficient resolution (only 1.4 cm per pulse) to record turbulent wind speed fluctuations as frequently as 10 times each second.

Six-cup construction smoothes the ripple introduced into the signal as each cup moves in succession through an orientation for maximum drag, the new instrument's reduced rotor inertia no longer being a sufficient flywheel to conceal this cup-pulse effect. The cups are assembled in two decks, one above the other and 60° out of phase, a so-called "staggered-six" array. Most importantly, adjustment of the vertical spacing between the decks has been found to afford a means whereby an instrument can be tuned for optimum cosine response ($u_h = \bar{V} \cos \phi$) over a useful range of wind elevation angles between $\pm 25^\circ$. When the decks are properly spaced in this fashion (the exact distance depending upon cup diameter and cup arm length), the wind-shading exerted by each cup upon the others in its own deck, and similar effects exerted by each deck upon the other, interact in such a way that the average rotation rate of the rotor essentially corresponds to the average speed of the horizontal component of the wind.



Notes:

1. Cup assemblies are fabricated of expanded polystyrene plastic. Cup arms are unusually short, the inner edge of each cup being located only one cup radius from the shaft.
2. A false shaft extension above the upper deck improves the symmetry of the instrument's response to flows on either side of horizontal.
3. An instrument of this design using cups 5.1 cm in diameter has a response length for acceleration of only 0.35 cm, corresponding to a response time of 0.1 sec in an average wind of 3.5 mps.
4. These instruments are being used to record horizontal wind fluctuation data from which turbulent energy spectra extending to frequencies as high as 2 or 3 Hz are routinely obtained.
5. The complete description of the instrument appears in *Modifications of Cup Anemometer Design to Improve the Measurement of Mean Horizontal Wind Speeds in Turbulence* by Paul Frenzen, which is included in ANL-7360, Radiological Physics Division Annual Report, July 1966 to June 1967. The report is available from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Va. 22151; price: \$3.00 (microfiche copies, \$0.65).
7. Inquiries concerning this innovation may be directed to:

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Argonne National Laboratory
9700 South Cass Avenue
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Reference: B68-10202

Source: Paul Frenzen
Radiological Physics Division
(ARG-90193)

Patent status:

Inquiries about obtaining rights for commercial use of this innovation may be made to:

Mr. George H. Lee, Chief
Chicago Patent Group
U.S. Atomic Energy Commission
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