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NASA TECH BRIEF



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Ion Mass Spectrometer for Special Uses

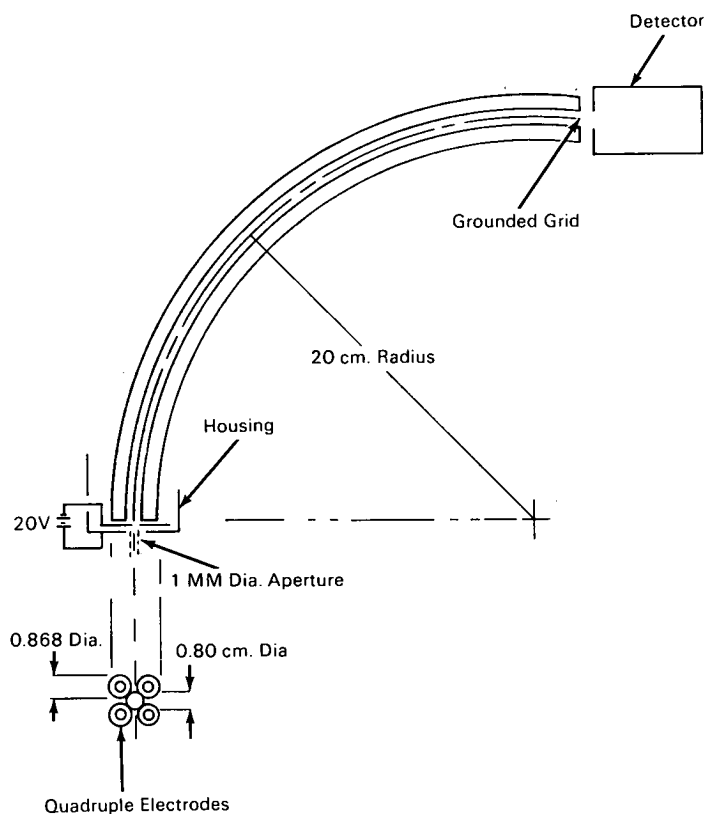


FIGURE 1. Curved-Electrode Geometry for Quadrupole Spectrometer

The problem:

To develop a highly sensitive ion mass spectrometer for direct measurement of very low ion densities.

The solution:

An engineering prototype of a curved-electrode, Paul-type, quadrupole, electrodynamic mass filter has been built. This instrument has the mass-resolution and transmission-factor properties expected from

both theoretical considerations and results of experiments using linear quadrupole features. Tests with ultraviolet light show that, if the interior of the quadrupole is blackened, its photoelectric response is negligible. The problem of a far-ultraviolet photoemission, in measurement of low count rates by the particle-detector, has been solved by bending of an electrodynamic quadrupole mass filter to a quarter-circle (fig. 1); thus several reflections of the

(continued overleaf)

photons entering the entrance aperture are forced before the photons strike the surface of the particle-detector.

How it's done:

The prototype operates satisfactorily at high incident-ion currents, when a simple Faraday-cup current-detector and a standard laboratory micromicroammeter provide adequate measurements. Use of a secondary electron-multiplier was studied at lower current densities, where either a current-amplification or a pulse-counting mode of detection is necessary.

The special oil-free vacuum system, the radio-frequency power supply, and peripheral electronics were specially constructed. Two quadrupole mass-filter structures were used in the development: a previously built aluminum unit weighing 3.5 lb without electronics and measuring 500 inch³; and a unit specially built of magnesium alloy, of the same volume and weighing about 1.5 lb without electronics. A special power supply was built in such a breadboard form that a flight-type power supply can be evolved from it.

The prime purpose of this development was an instrument for direct measurement of the ionized component of the lunar atmosphere. All aspects of the spectrometer are discussed. Extensive tests and reexamination of the project lead to the following conclusions: The principle of the curved-rail ion-mass filter is valid. An instrument yielding moderate resolution, with a reasonable transmission factor, is feasible; its sensitivity will depend on successful

design of a low-noise, low-count-rate particle-detector—the major requirement in development of an adequate flight instrument; present knowledge can cope with the problems in electronics. An instrument is feasible measuring about 10 by 10 by 6 inches, weighing 5 to 6 lb, and consuming less than 5 W of power.

The present instrument is significantly limited in long-range stability; further refinement is required. Limitations in resolution and sample-handling ability disqualify it from normal chemical analyses. The instrument's portability and sensitivity render it useful for measurement in vacuum, detection of leaks, and, with minor modification, determination of certain atmospheric contaminants of low molecular weight.

Notes:

1. Radiologists, designers of instruments, and air-pollution controllers may be interested in this spectrometer.
2. Requests for further information may be directed to:
Technology Utilization Officer
Headquarters
National Aeronautics and Space Admin.
Washington, D.C. 20546
Reference: TSP69-10510

Patent status:

No patent action is contemplated by NASA.

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