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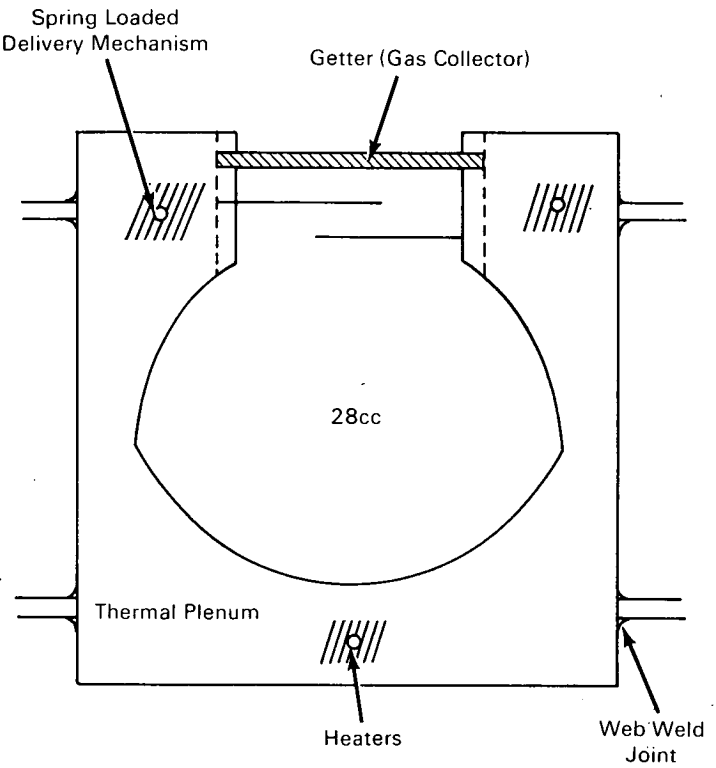
NASA TECH BRIEF

Life Detection



Typical Culture Chamber Cylinder

The problem:

Design apparatus for the detection of microbial life on the surface of Mars and other planets.

The solution:

A compact automated laboratory unit was designed with 60 independently treatable culture chamber assemblies for metabolic studies of cultured microorganisms. Three simple culture type specific life detectors were selected for the baseline design based on criteria of breadth of response to different organisms, high detection sensitivity, fast response time, and wide dynamic range. These life detectors consist of two of the Gulliver type which include four *in situ* probes, and one of the Wolf Trap type which senses turbidity and pH changes. The basic detection scheme is modeled after that of G. V. Levin and N. H. Horowitz, i.e., $LiOH\text{-}H_2O$ collection of evolved $C^{14}O_2$ and/or H_2S^{35} and subsequent quantization by adja-

(continued overleaf)

cent Geiger-Muller counters. Elements are incorporated which allow graduated heating of selected cultures to the point of combustion with added oxygen.

How it's done:

The culture chamber assemblies are circularly arranged in two like decks, one above the other. A rotating assembly carrying service elements for the chamber cylinder decks operates on a center with the stationary canisters and just above it. Service elements carried by the rotating assembly include six β detectors, the soil sample distribution equipment, and the initiator mechanism for sample, nutrient, and reagent dispensing.

A sectional view of a typical culture chamber cylinder and its supporting elements is shown in the drawing. An aliquot of soil sample is delivered from the rotating assembly to a spring loaded delivery tube, which is open at its top and located in the chamber cylinder wall. Nutrient media and antimetabolite in glass ampules are also contained in the chamber cylinder. Delivery is by means of a spring loaded plunger, which like the sample delivery plunger, is tripped at the proper time by wiping its attached spoke into a milled slot in the chamber cylinder. A mechanism located in the rotating assembly provides the mechanical motivation for these functions.

One Gulliver detector probes for life by attempting to elicit metabolism of prepared substrates. Several variations of nutrient media containing labeled organic substrates of C^{14} and/or S^{35} in aqueous solution are offered one at a time to equal portions of processed soil sample. Viable cells assimilating one or more of the labeled substrates are likely to evolve radioactive gases, $C^{14}O_2$ and/or H_2S^{35} which are collected on LiOH monolayers above each culture chamber. Disintegrations from the collected gas(es) leading to β emission are sensed by Geiger tubes. The disintegration rate is a measure of the net amount of gas collected and, thus, a measure of the net amount of substrate metabolized or degraded. Data obtained permit a decision of either no detectable metabolic involvement of carbon and sulfur or detectable involvement with or without growth (reproduction).

Another Gulliver detector employs labeled substrates of molecular $C^{14}O_2$ and/or H_2S^{35} with the nutrient media then being that of the organism's own natural environment. Sample treatment includes separation of light from dark induced fixation of the labeled gas(es). Strict phototrophs, for example, would be expected to fix $C^{14}O_2$ in the light and then when placed in the dark consume the energy compounds recently photosynthesized, thereby expiring $C^{14}O_2$ for collection. Light/dark modulation of the chambers of the first Gulliver detector is provided with graduated heating to combustion with oxygen in four chambers of the second Gulliver detector, which allows differentiation of biological from nonbiological gas fixing processes.

The Wolf Trap detector probes for life by sensing light scatter produced by a suspension of microorganism-sized particles and a change in pH of aqueous bacterial culture media. Each culture cell in this detector functions both as a thermally controlled incubation chamber and nephelometer cuvette. The conical interior of the culture cell is polished for good reflectivity.

Notes:

1. The compact laboratory unit designed is automated and programmable and may be useful as a monitoring system for chemical and microbiological studies in clinical pathology, drug, fermentation, and medical laboratories. For example, short term drug resistance (sensitivity) of cultured pathogens might be tested.
2. A valuable annotated bibliography is furnished in NASA SP-7015, "Extraterrestrial Life: A Bibliography Part I: Report Literature, September, 1964, Part II: Published Literature, December, 1965," for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402; Price Part I: $0.45, Part II: $2.00.
3. Documentation is available from:
   Clearinghouse for Federal Scientific
   and Technical Information
   Springfield, Virginia 22151
   Price $3.00
   Reference: TSP69-10475

Patent status:

No patent action is contemplated by NASA.

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