IN THE LABORATORY

A Device for Obtaining a Continuous Record of Body Temperature From the External Auditory Canal

ROGER J. WILLIAMS and ROY C. THOMPSON
University of Texas, Austin

We were interested in devising a method whereby continuous records of body temperature might be obtained from a human subject without interfering with his normal activities and comfort. It occurred to us that the external auditory canal might constitute an opening from which reliable measurements of the body temperature could be obtained, and it is obvious that the encumbrance of one ear canal with a temperature-sensitive apparatus need not interfere with an individual's normal activities.

The temperature-sensitive element used was a Western Electric V611 thermistor of the type originally devised for use in measuring skin temperatures. This thermistor is disk-shaped, about 6 mm in diameter and 1 mm thick. It has a resistance at 38° C of 450 ohms and a temperature coefficient of −4.0%/°C. This resistance element was embedded in the surface of a specially fitted plastic ear mold of the type used with electronic hearing aids.

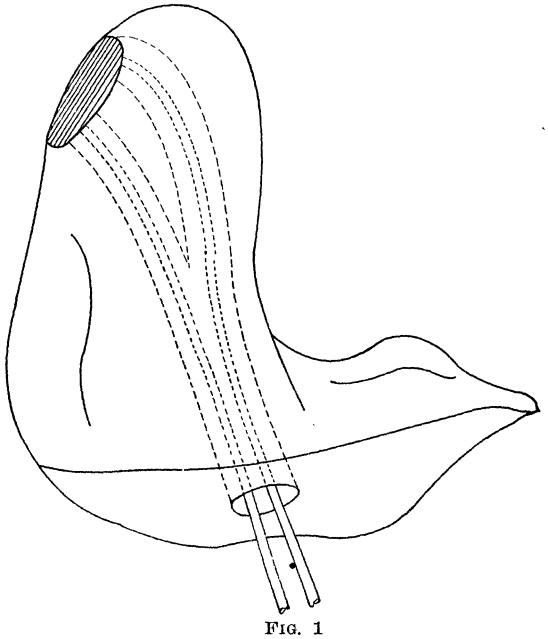

FIG. 1

Details of the arrangement are shown in Fig. 1. The flat surface of the thermistor provides a relatively large area for contact with the auditory canal, and the plastic plug, molded to the contour of the external ear, insulates the thermistor from environmental temperature fluctuations.

The thermistor and a recording microammeter were included in a Wheatstone bridge circuit as shown in Fig. 2, current being supplied by one or two 1.5-v dry

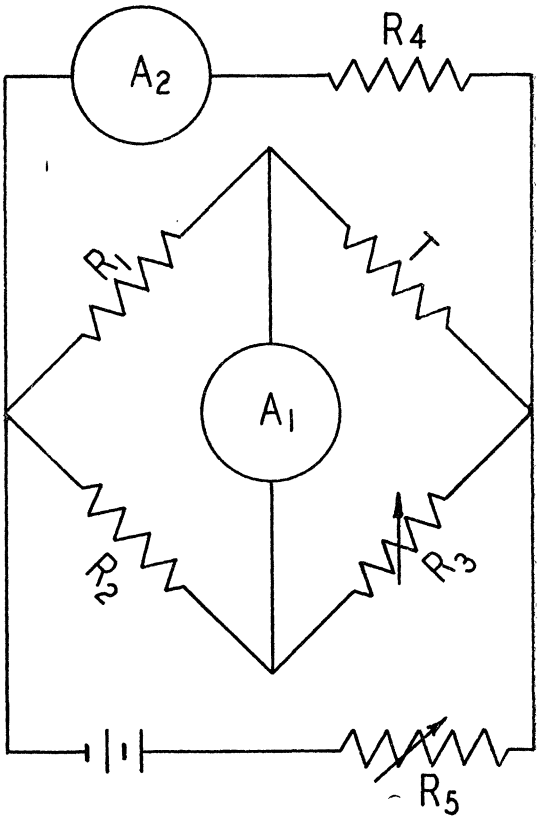

FIG. 2. A_1, recording microammeter; A_2, milliammeter; T, thermistor, 450Ω at 38° C; R_1, R_2, R_4, 1,000Ω; R_3, 0–1,500Ω; R_5, 0–500Ω.

cells. The recording instrument was a General Electric high-speed photoelectric recorder equipped with a microammeter having a full-scale sensitivity of 28 microamperes and a period of 1.2 sec. Temperature records are obtained on a tape about 4″ wide. The rheostat (R_5, Fig. 2) controls the current passing through the thermistor, and by adjustment of R_3 the desired range of temperatures can be centered on the tape.

The maximum sensitivity obtainable with the circuit shown in Fig. 2 corresponds to nearly 2″ on the tape/°C. The sensitivity is limited by the recording microammeter and by the amount of current which can be passed through the thermistor without causing appreciable heating of the element. We have usually operated the instrument with a current of 4.8 microamperes through

A_2. This results in a slight resistance heating of the thermistor. When in position in the ear, the increase in temperature from this source amounts to only about 0.05° C and is constant.

Our use of the instrument has thus far been limited to one individual, and extensive data have not been obtained. The auditory canal temperature was found in this case to be about 0.25° C lower than the sublingual temperature, which it parallels quite closely. The records

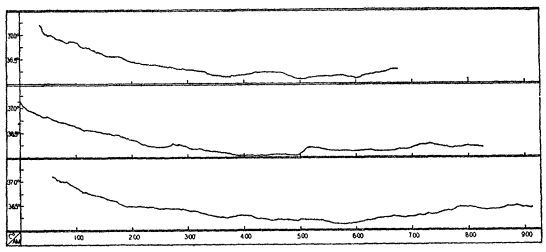

FIG. 3

reproduced in Fig. 3 will serve to illustrate the potentialities of the instrument. Three overnight temperature records are shown. For these measurements it was necessary to place adhesive tape over the ear and ear mold in order to prevent accidental removal during the night. This is unnecessary when the subject is awake. These records were obtained without discomfiture to the subject and without disturbing his sleep.

Use of X-Ray and Electron Diffraction as Methods of Analysis in Biochemical Chromatography

C. L. CHRIST, C. J. BURTON, and M. C. BOTTY[1]

Stamford Research Laboratories,
American Cyanamid Company,
Stamford, Connecticut

The resolution and purification of biological materials by partition chromatographic techniques has become well established as a method of biochemical analysis. In particular, the development by Consden, Gordon, and Martin (*1*) of a chromatographic technique which employs strips of wet filter paper as the adsorbent has made possible a very effective method for separation of amino acids. These workers were able to show the presence of 22 amino acids in a single experiment, using a total of only 200–400 μg of sample.

This technique has been employed by several groups in this Laboratory for the separation and identification of amino acids in various biochemical studies. As a result, the problem of independent qualitative identification of the separated constituents of a mixture has become a problem of considerable importance. Various microchemical methods have been used, but the availability of only a few hundred micrograms of purified material makes such analytical techniques difficult.

Physical methods of analysis have also been considered. Among these, electron diffraction appeared to offer many advantages (*2*), the most attractive being its ability to yield diffraction patterns from minute quantities of material. Offsetting this advantage are the well-known difficulties of studying organic materials which are subjected to the bombardment of high-energy electrons. That this difficulty should not be underestimated is perhaps obvious from a casual study of the literature, which reveals a remarkable dearth of publications describing electron diffraction studies of solid organic substances. Nevertheless, it was decided to investigate the technique as a method for qualitative analysis of amino acids separated chromatographically.

A simple method of extraction of small quantities (ca. 200 μg) of an amino acid fraction from the chromatogram was devised. The care customarily exercised in the preparation of specimens for electron diffraction study was observed throughout. The portion of the filter paper containing the desired component of the mixture is cut out and placed in the fold of platinum foil, 1″ square, folded in half. Sufficient distilled water (ca. $\frac{1}{3}$ cc) is dropped on the filter paper to provide a slight excess over the amount absorbed by the paper. After leaching for several minutes, the water solution is dropped on a clean microscope slide or a piece of platinum foil which is immediately placed in a vacuum chamber. Under a moderate vacuum the water freezes rapidly and is removed by sublimation. A residue of minute crystals remains, and this specimen is suitable for study by electron diffraction techniques. This simple method apparently minimizes possible salt formation and contamination of the sample.

Specimens prepared in this way were examined in an electron diffraction camera, using 60-kv electrons and a specimen-plate distance of 65 cm. Considerable difficulty was frequently encountered in obtaining diffraction patterns, despite much effort to standardize very carefully the method of specimen preparation and manipulation. Patterns would appear momentarily and then disappear, a phenomenon which led us to believe that sublimation and/or decomposition of the specimen was occurring. Certain amino acids yielded excellent diffraction patterns with a minimum of effort; others required preparation of many specimens before any pattern could be obtained. The extreme inconsistency of the method was most discouraging, although results, when obtained, were fairly uniform.

While evaluating this situation, the possibility of employing X-ray rather than electron diffraction was discussed. Preliminary experiments were encouraging, and ultimately a very simple technique was developed. The vacuum recrystallized material is scraped from the glass slide and packed in a $\frac{1}{2}$-mm aperture centered in a brass disk 0.4 mm thick. This disk is centered in a recess at

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