Quarterly Report on Project 15G-B2299
Contract: NSR-39-005-018
Period: 1 April - 30 June 1967

I. BRAIN PROBES

A system to enable monitoring of deep brain temperatures over the range of ca. 18° to 43° C is under design and fabrication.

The overall system is illustrated in Fig. 1. It will be designed so that the subject, while ambulatory, will be monitored continuously as he will when at a fixed location. The probes will be fabricated in three lengths: 1.5, 2.5, and 3.5 cm. They will consist of .013 inch thermistors sealed within Teflon tubing, which itself is filled with Sylgard silastic. The Teflon tubing is used to protect the thermistor and its leads. The leads are brought to a terminating plug especially designed for easy disconnect to avoid strain on the probe and possible damage to the subject. See Fig. 2 for probe.

All materials selected for the probe can withstand autoclaving and are generally non-oxidizing. The probe is held in place at the skull with three suture loops made of stainless steel, surgical alloy. The epoxy casting used as the skull anchor and suture loop retainer is covered with a thin layer of medical silastic. While the probe is not expected to be in place a sufficient time to expect serious tissue reaction to the epoxy casting (rests in bone), it seems wise to cover the epoxy surfaces with physiologically acceptable silastic.

The variation of probe-thermistor resistance will modify the time constant of a special circuit added to the miniature fm transmitter

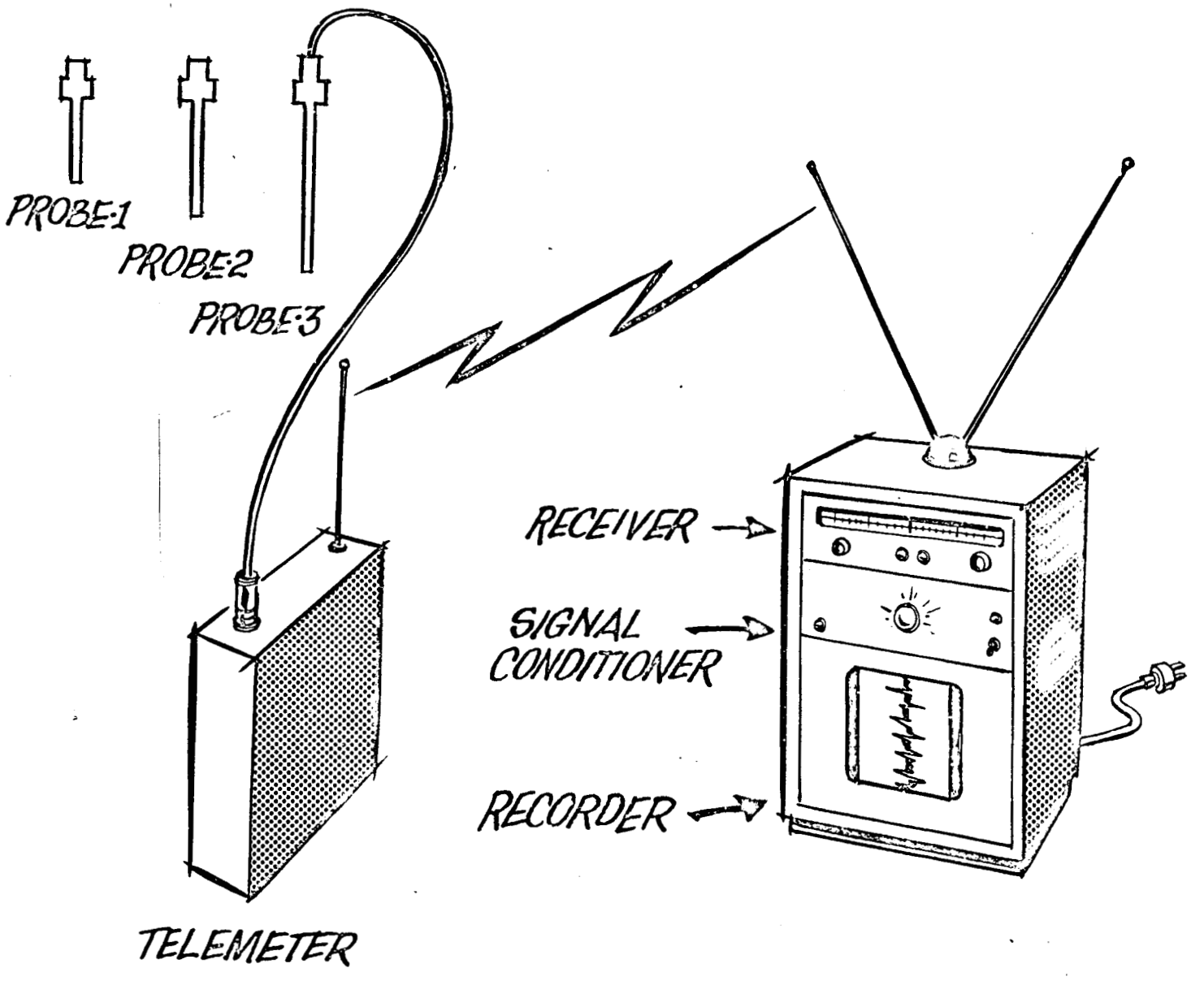

Fig. 1. Probe, FM - Telemeter and Receiving - Recording System

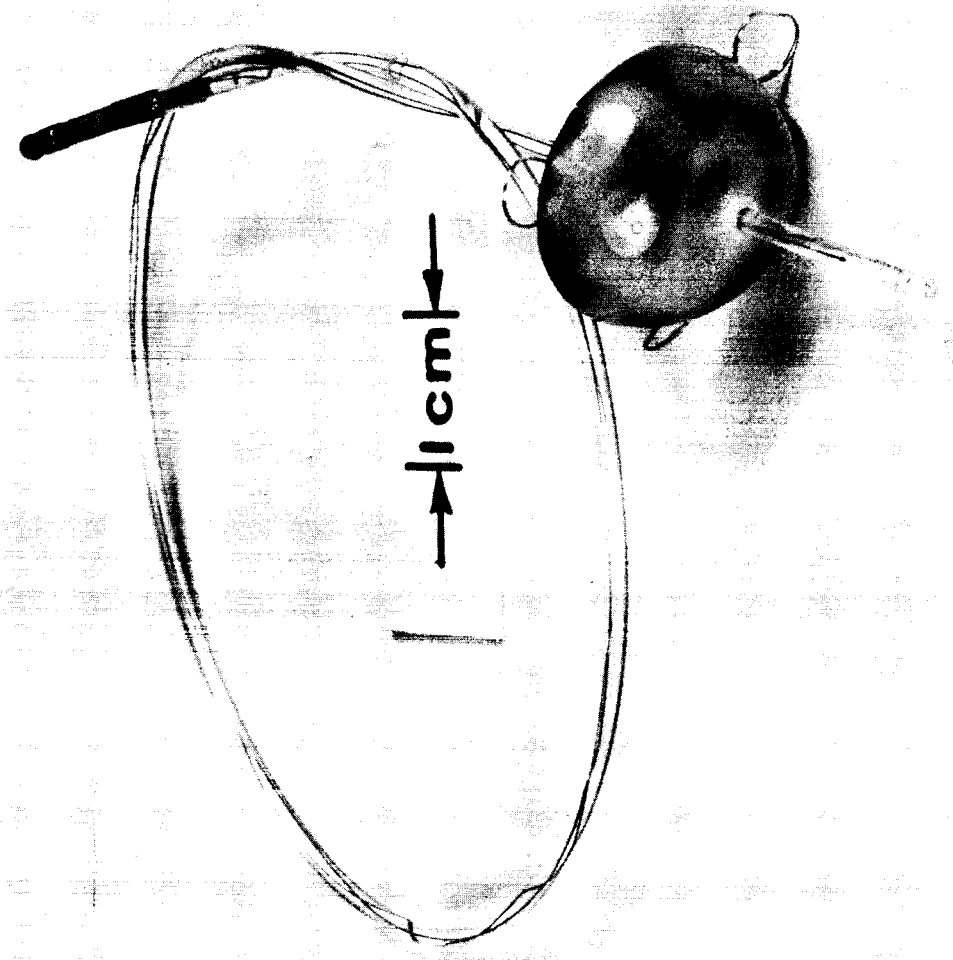

Figure 2 - Probe

indicated in the figure cited above. In effect, we will pulse-rate modulate the frequency modulation transmitter. The repetition frequency of transmitted signal will be proportional to sensed temperature.

The signal will be received by a commercially available fm unit, properly conditioned and linearized, and then recorded on the continuous ink writer as illustrated.

To date, the biggest problems relate to the mechanical fabrication of the probe itself. While Teflon has highly desirable characteristics of inertness and resistance to autoclave temperatures, it has proved extremely difficult to work with. We believe the basic problems have finally been worked out by anchoring the Teflon tubing within the epoxy casting with shrink-tubing. The epoxy itself has been selected to withstand temperatures up to 400°F.

The first probe will be sent to NIH for inspection shortly. If it proves suitable as discussed, we will immediately fabricate the last two units and proceed to complete design and fabrication of the rest of the system.

II. MULTI-CHANNEL TELEMETRY

During this period three major problems have been under attack:

a. Evaluation of various transistors in the oscillator circuit to minimize current requirements.

b. Selection of transistor types leading to simplified assembly procedures and more assured procurement.

c. Evolution of an fm modulator of less current drain and more versatility for a variety of biological transducer inputs.

Efforts to date are discussed.

The following transistors were tested in our oscillator circuit and current drains are indicated:

Transistor Type	Current Drain for Assured Oscillation
FSP-411/1	30 + μa
D26G-1	30 μa
LDA/406	30 μa
T1XM101	40 μa

It will be noted that the transistor type LDA/406 performed quite well on a relative basis. We have therefore selected this type unit for use. Its selection permits the use of LDA transistors throughout and therefore simplifies both procurement and wiring procedures.

In the process of evaluating these various transistors we made measurements at collector voltages of 1.354, 2.70 and 3.00 volts. This was done to assess effect of collector voltage on the h_{fe} characteristic of the transistor at 100 Mc/S. It was our hope that higher collector voltages would improve the h_{fe} situation and result in a net gain in efficiency. Unfortunately, over the voltage and size range available to us from standard mercury cells, no improvement was obtained.

We found that the LDA transistor package is convenient for use in these telemeters since they are extremely uniform in shape and size, and their solderable connection points permit easy circuit application. Both PNP and NPN units are available, and prices are modest even in small quantity procurement.

Work with the fm modulator has not been simple or greatly successful to date. Based on past work, it was planned to use the basic circuit, NPN-PNP complementary multivibrator, as an all-purpose modulator. However, it has become clear that while this circuit was beautifully applicable for temperature application and was successfully compensated as reported in our Annual Report B2299, March 1966-March 1967, it lacked the modulation sensitivity required for the variety of physiological inputs of interest. It also became clear that conditioning of ECG signals, dc potentials, pH, etc. required additional complex circuitry of some magnitude.

Because of these findings we have decided to investigate a new pulse circuit modulator for application to the problem. It is now under study and will be reported more fully in our next report.

III. TELEMETRIC BRAIN TEMPERATURE SENSORS

Two Mark IV-PLL(S) special units (low repetition frequency) were given to Dr. Maitland Baldwin of the Clinical Center (Neurosurgery) NIH. These devices were paraffin encapsulated and are used with a transistor radio and stopwatch—or can be used with a cardiotachometer for readout. It was interesting to note that the paraffin was sterilizable in 70% alcohol. Total immersion time was eighteen hours in multiple alcohol baths; the paraffin was unharmed. However, this does not sterilize the paraffin depth, and it was found that viable spores are

easily uncovered by possible abrasion of the sterilized surface. This problem was eliminated by using a thin coating of medical silastic. The bacteriological studies were carried out by Dr. Baldwin.

R. M. Goodman, Manager
Bio-Instrumentation Laboratory