DP -142

Instrumentation

A SURVEY METER WITH AN EXTENDED PROBE

by

C. E. Flanagan, Jr. and R. T. Nowak

Instrument Development Division

December 1955

E. I. du Pont de Nemours & Co.
Explosives Department - Atomic Energy Division
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ABSTRACT

A survey meter with an extended probe was designed to measure radiation intensities of from 1 mr/hr to 30 r/hr. Because hot-filament tubes are not required, the battery life approaches shelf life.

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A SURVEY METER WITH AN EXTENDED PROBE

INTRODUCTION

A survey meter with an extended probe was needed to measure radiation intensities of 1 mr/hr to 30 r/hr. The sensing element was to be small and located at the end of a twelve-foot pole. Because there were no commercial instruments with these specifications, the development of a suitable instrument was undertaken.

SUMMARY

A portable survey instrument with a sensing element on the end of a twelve-foot pole was designed and built. The sensing element is a Geiger-Mueller tube of volume 0.9 in^3. The instrument measures radiation intensities from 1 mr/hr to 30 r/hr by means of the Geiger tube, a cold cathode count rate circuit, and a pulse integration circuit. The meter scales are quasi-logarithmic. Because hot-filament tubes are not required, the battery life approaches shelf life.

DISCUSSION

The long-probe survey meter, called the "Apple Picker," measures gamma radiation by means of a Victoreen VG-18 subminiature Geiger tube. The small geometry of this Geiger tube allows fairly accurate measurements of local radiation intensities in an extended radiation field. The VG-18 tube operates with 510 volts applied and gives pulses of 70-volt magnitude. It is a halogen-quenched tube.

To accommodate the required wide range of radiation intensities, two types of circuits are used. The first is a cold cathode count rate circuit with quasi-logarithmic response. A circuit of this type, with a linear response, was first mentioned by Peirson[1]. It was further developed by Hardwick[2] who gave it a logarithmic response by using a condenser-resistor network. The circuit used here eliminates the resistor network and depends on the characteristics of the 5823 tube for the quasi-logarithmic response. This circuit is used for ranges of 1 to 40 mr/hr and 1 to 1000 mr/hr. The second type circuit is used to measure intensities from 0.1 to 30 r/hr. In it the count rate circuit is switched out of the system and the meter integrates the Geiger tube pulses by using the d.c. characteristics of the Geiger tube directly.

The "Apple Picker" Schematic Diagram is shown in Figure 1. A type VG-18 halogen-quenched GM tube is used to detect the gamma radiation. At low count rates in low radiation fields the individual pulses trigger the type 5823 cold cathode trigger tube. As the tube fires, the charge on condenser C_2 is discharged. The charging current of the condenser then flows into the integrating circuit in the cathode of the tube. Resistor R_4 limits the current through the tube to a safe value. R_3 limits the anode current and R_2 limits the trigger current below the value at which continuous discharge occurs in the 5823. R_5 and R_6 control the integrating time

constant along with C_3. In higher fields, the current range is changed by shunting R_8 across the meter. As the radiation fields are increased, the pulses from the GM tube get closer and closer together until the pulse height begins to decrease because of pile-ups. As this happens the 5823 tube goes out of operation and the current through the GM tube is integrated and measured directly by R_6, C_3 and M. Resistor R_7 is used in a voltmeter circuit which measures the battery potential.

The Geiger tube and the cold cathode count rate circuit are encased in a brass cap located at one end of a 12-foot aluminum tube. An aluminum box at the other end of the pole contains the batteries, the indicating meter, and a range switch. Details of the meter box and of the probe are shown in Figures 2 and 3.

The calibration curves of the instrument are given in Figure 4.

Particularly long life is expected from the cold cathode tube as compared to thermionic types. Battery life will be extended because the instrument only uses battery power at a rate proportional to the count rate. Even if the instrument is left ON, battery power is dissipated only in the presence of a radiation field since there are no hot filaments.

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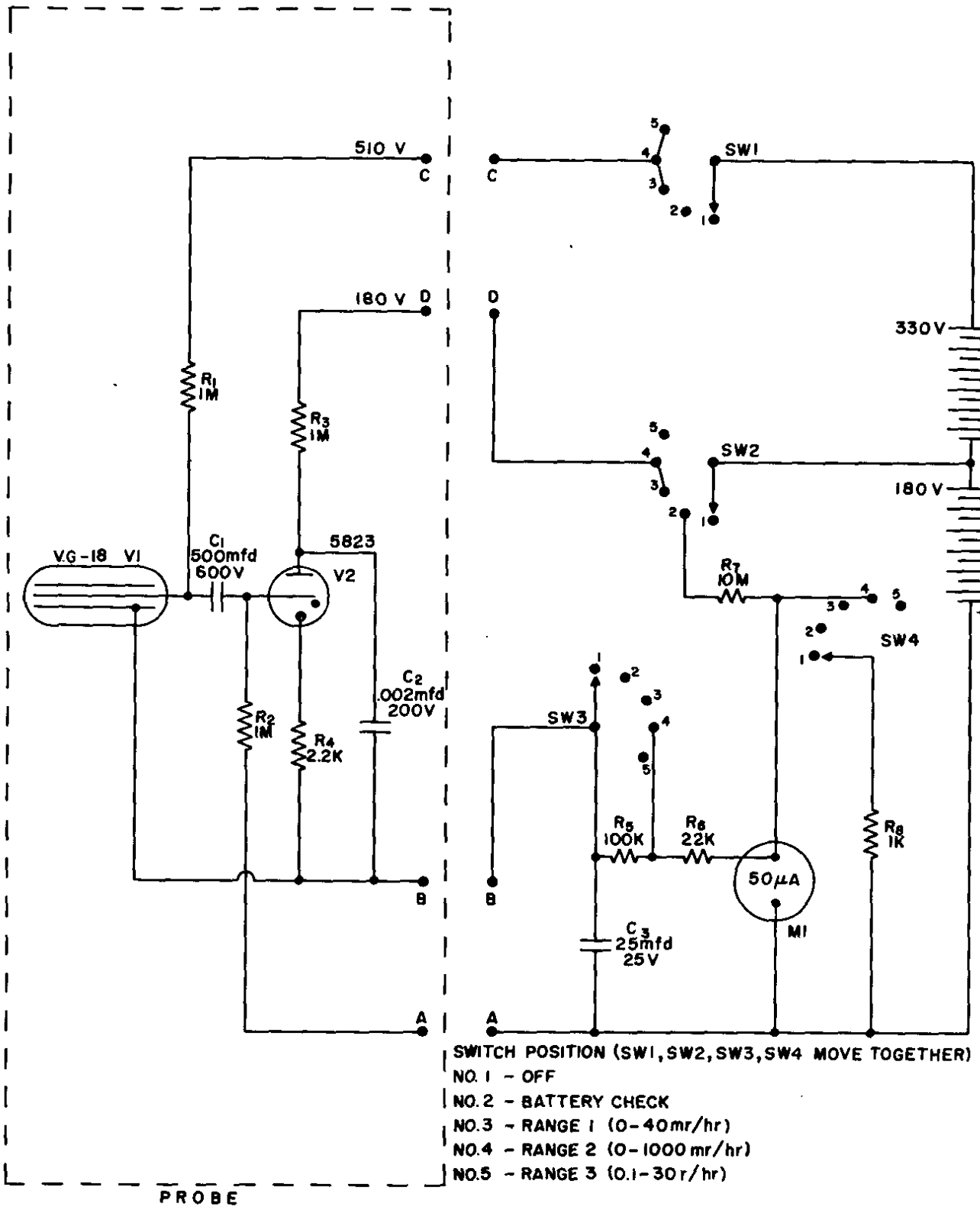
1. Peirson, D. H. Some Cold Cathode Valve Circuits used in the Measurement of Radioactivity. Atomic Energy Research Establishment, Harwell, Berks (England) AERE-E1/R-1204. March 1953.

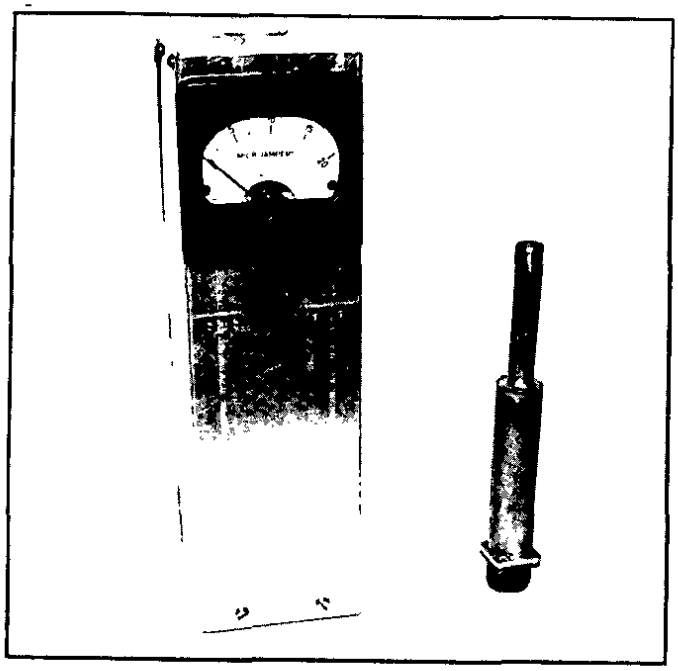
2. Hardwick, J. Chalk River, Personal Communication through L. Cathey. February 1955.

FIGURE 1



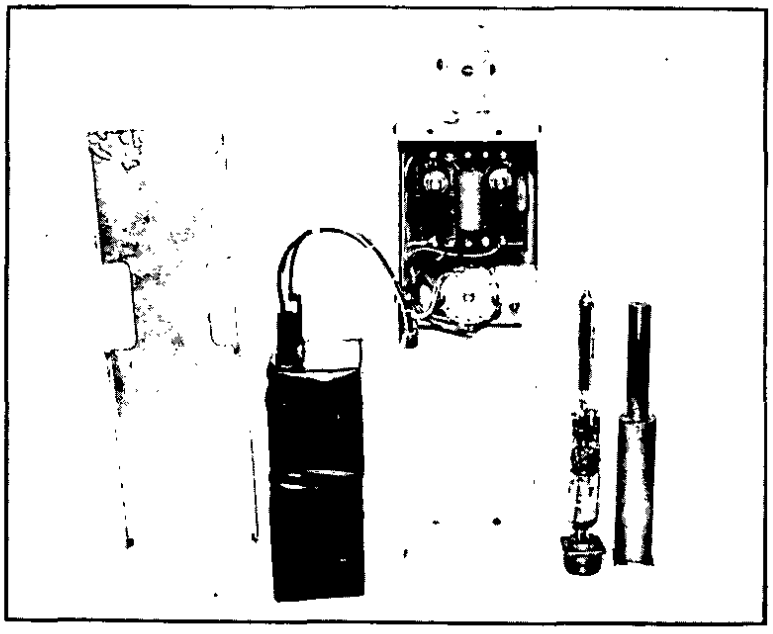
SCHEMATIC DIAGRAM OF THE INSTRUMENT

FIGURE 2



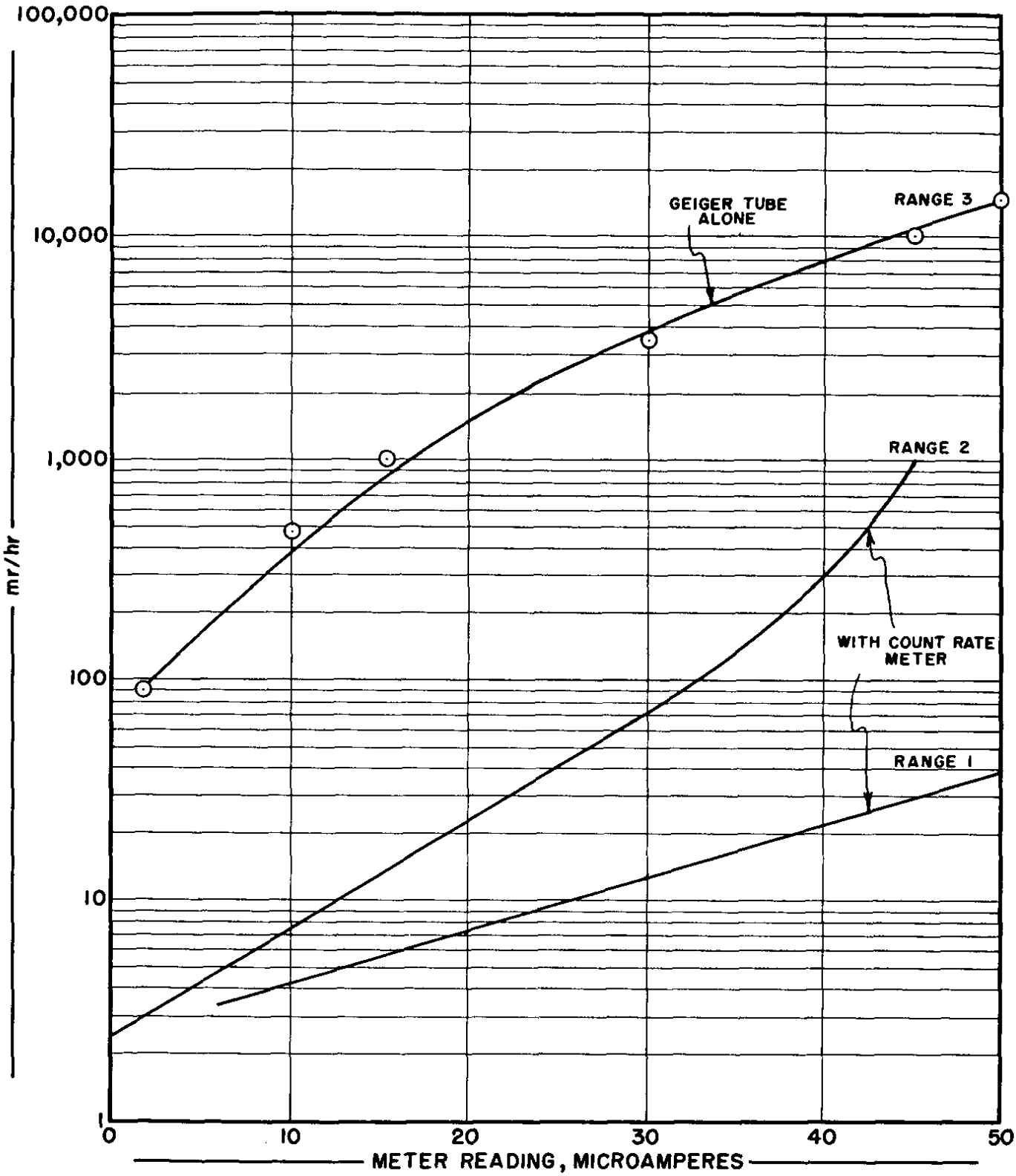
METER BOX AND PROBE HEAD

FIGURE 3



INTERNAL VIEWS OF METER BOX AND PROBE HEAD

FIGURE 4



CALIBRATION CURVES OF THE INSTRUMENT