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PORTABLE ALPHA-SURVEY INSTRUMENT

BERKELEY, CALIFORNIA

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Lawrence Radiation Laboratory
Berkeley, California

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William J. Roach and Robert J. Walker

April 17, 1961

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Abstract

A transistorized, portable alpha-survey instrument has been developed. Features included are: time-proved air proportional probe (18 in.^{2} area); D-cell powered, built-in speaker and audio amplifier; circuit board modules; and sufficient sensitivity and high-voltage power to operate almost any similar type of detector without modification.

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Introduction

Control of radiation and protection of workers from radiation exposure requires the use of portable survey instruments by experienced personnel. When dealing with alpha emitters one must be especially wary and have trustworthy instruments. This report tells of the development of a portable alpha-survey instrument which, we feel, meets the needs of alpha surveying.

Discussion

The instrument basically consists of three circuit boards, a meter readout, a speaker, and a probe. Figure 1 shows: (a) preamplified, (b) count-rate and audio amplifier, (c) high-voltage supply. Figure 2 shows: (a) instrument top with microammeter and speaker installed, (b) instrument bottom half with battery holders and probe holder installed. Figure 3 shows the complete instrument.

Separate circuit boards were chosen for two reasons: (a) on a common circuit board high-voltage leakage is always troublesome, and (b) in the event of irrevocable damage to one circuit an entire common circuit board must be discarded, but in module design only the faulty unit is lost.

Present placement of the boards offers the maximum natural shielding provided by the instrument case, and no further shielding is necessary. The high-voltage oscillator is placed at a point as far from the preamplifier as possible, in order to eliminate radiation coupling.

The preamplifier is a three-stage stabilized unit (Fig. 4). It features heavy current feedback and high attenuation of lower frequencies, which eliminates harmonic ripple introduced by the high-voltage power supply.

Preamplifier output is fed to a discriminator circuit which determines the firing level of the count-rate monostable. The audio section is coupled to the first half of the monostable and produces an audible click when a pulse is counted. The audio unit is designed to attenuate circuit noise yet give maximum volume for a pulse; it is biased in such a manner that current is used only when a pulse is produced. Range and discriminator potentiometers are full-size for reliability and ease of adjustment.

*This work was performed under the auspices of the U. S. Atomic Energy Commission.

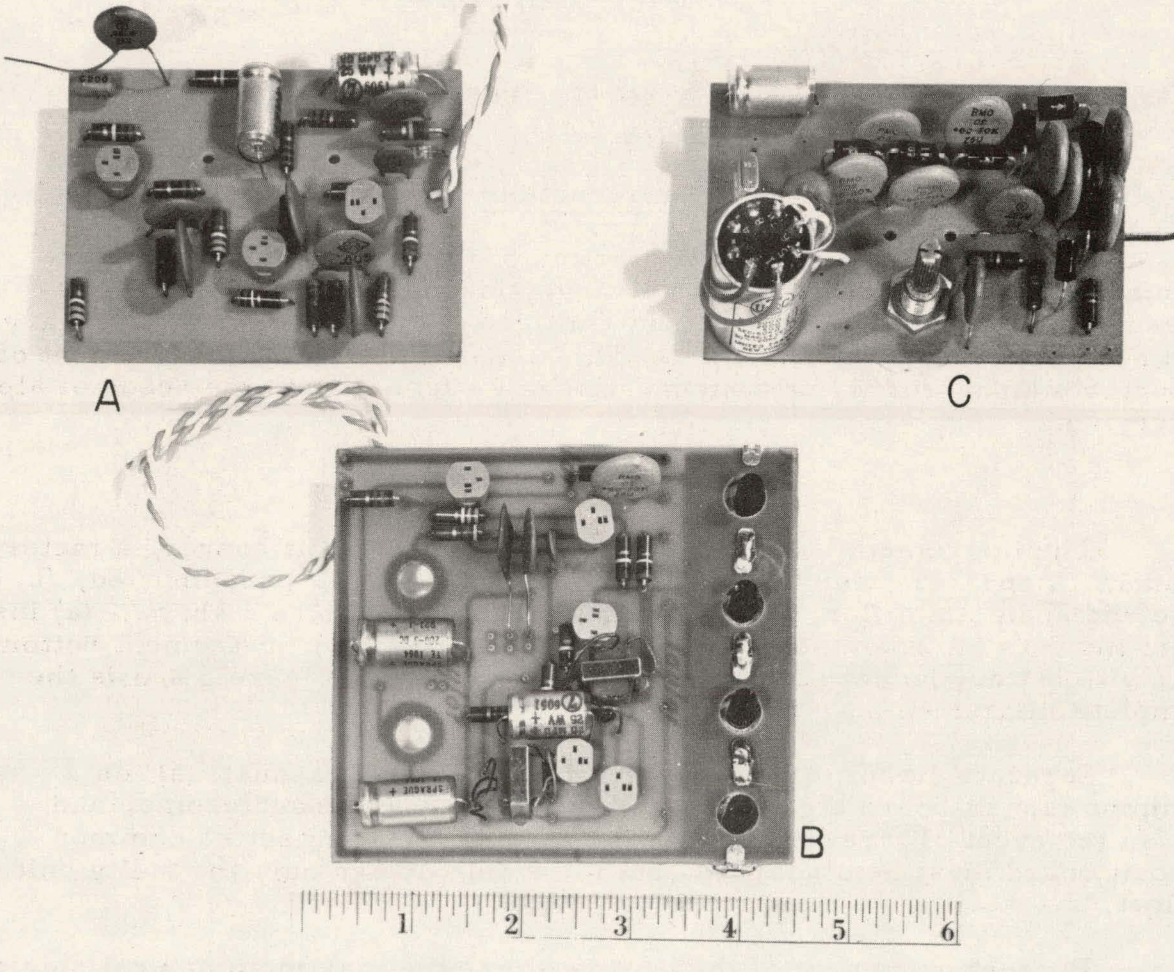

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Fig. 1

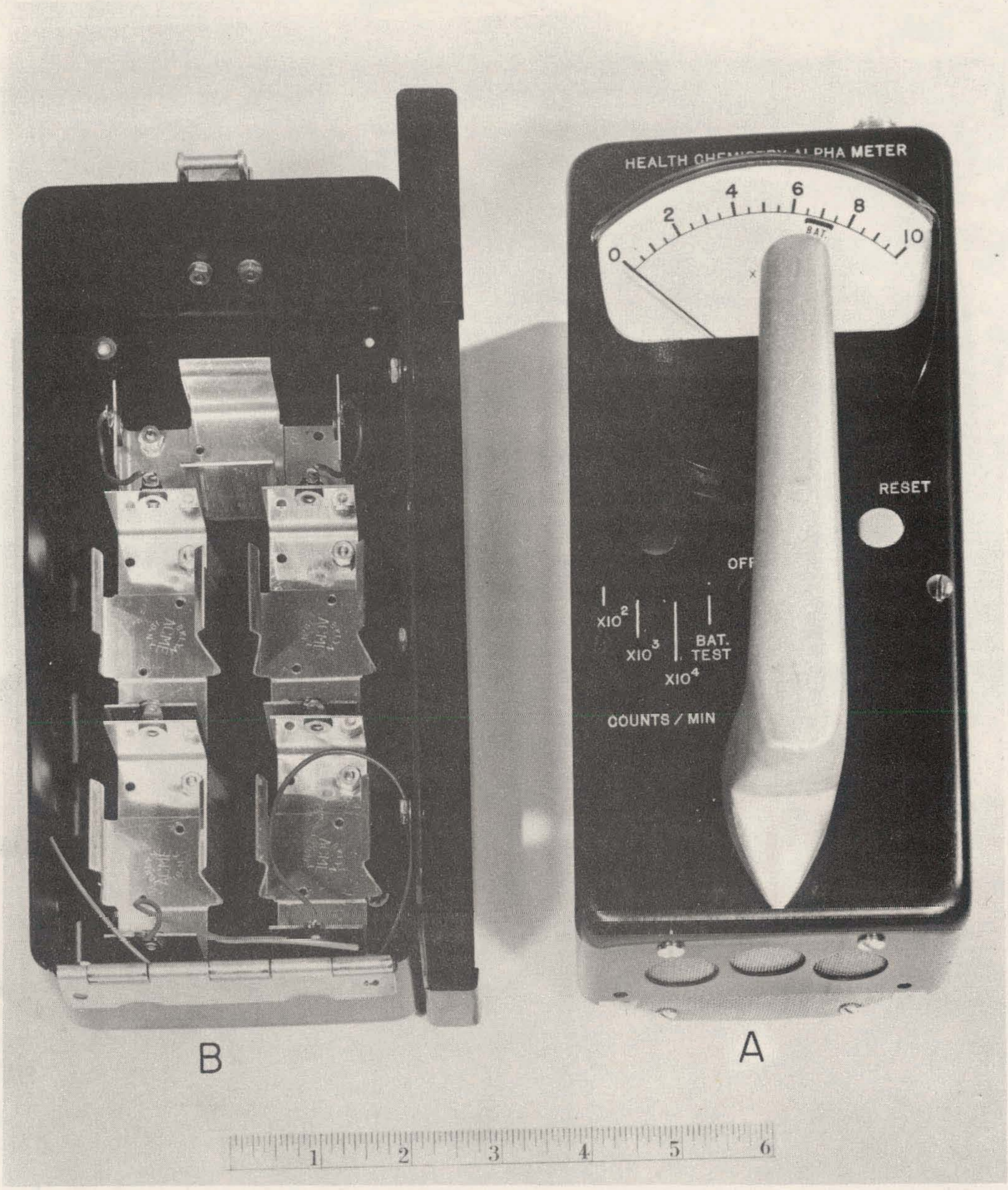
HEALTH CHEMISTRY ALPHA METER
0
2
4
6
8
10
BAT.
RESET
OFF
XIO2
XIO3
XIO4
BAT.
TEST
COUNTS / MIN
B
A
1
2
3
4
5
6

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Fig. 2

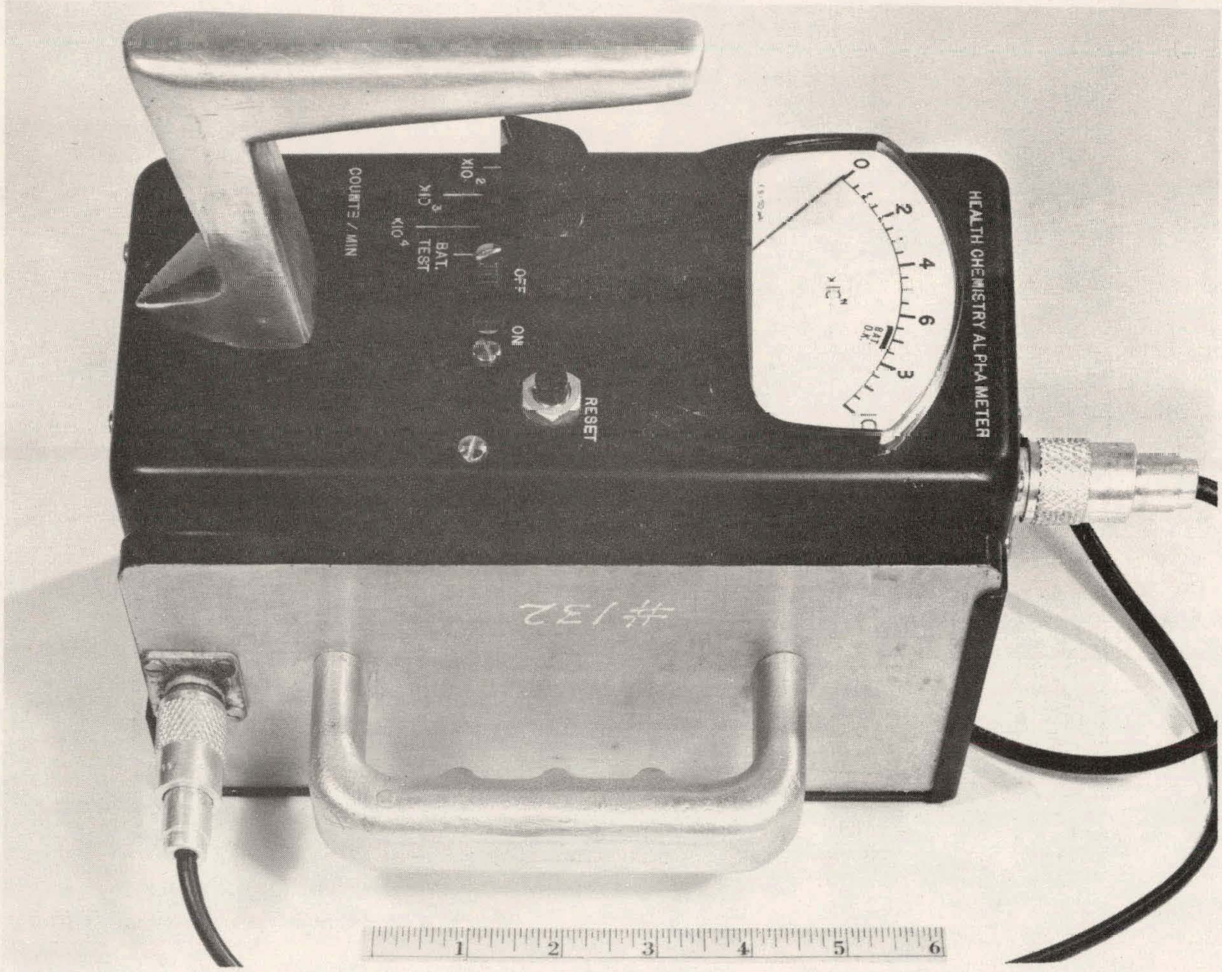
HEALTH CHEMISTRY ALPHA METER
RESET
OFF
ON
BAT. TEST
COUNTS / MIN
#132

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Fig. 3

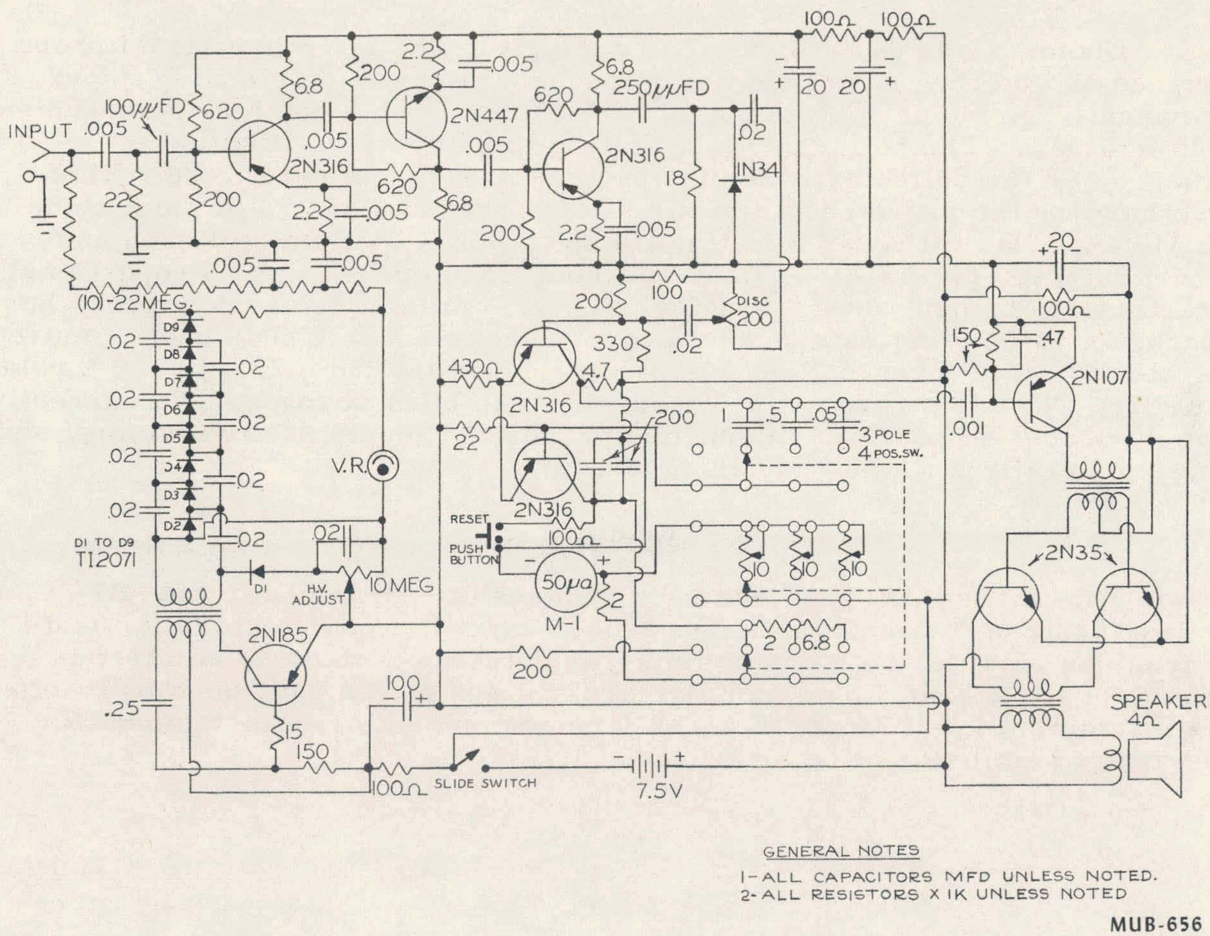

Fig. 4. Circuit diagram.

The high-voltage circuit features a relaxation oscillator and eight stages of doubling; output is regulated and adjustable. Diodes are a low-cost type selected for low leakage. The oscillator frequency is made as low as possible to enable the attenuation circuit in the preamplifier to be effective. The supply voltage to the high-voltage section and to the audio sections features decoupling and filtering to eliminate noise. Current drain is 5 to 6 ma, allowing 200 to 350 hours' use—depending on the duty cycle.

Choice of the detector was very simple. The air proportional probe designed and built at Lawrence Radiation Laboratory is outstanding in performance (Fig. 5); it operates at 1740 to 1760 v with a point source efficiency of 25% to 30%. The Mylar cover may need to be replaced if sufficiently damaged, or the collector wire may become broken and need to be replaced, but otherwise the probe has an infinite life. The area of this probe may be greatly expanded without affecting its operation. William J. Roach and Robert J. Walker, An Alpha Hand and Foot Counter Using Air Proportional Detectors, to be published as a UCRL report. An average survey probe has a background counting rate of 1 to 2 counts per minute. These probes must operate from sea level to 1000 ft above sea level and from 20% to 100% relative humidity. No effects are noticed from these ambient changes. We currently have 40 probes in service. About five probes per month need servicing, and this is generally for a new Mylar cover.

Results

This instrument has been used successfully with moderated BF^3 tubes for fast-neutron dosimetry; Geiger tubes; scintillation detectors for fast-neutron, thermal-neutron, or gamma-ray detection; and also solid-state alpha detectors. Sufficient gain and high-voltage power have been built into this instrument to eliminate the need for development of an instrument for each type of emission to be measured.

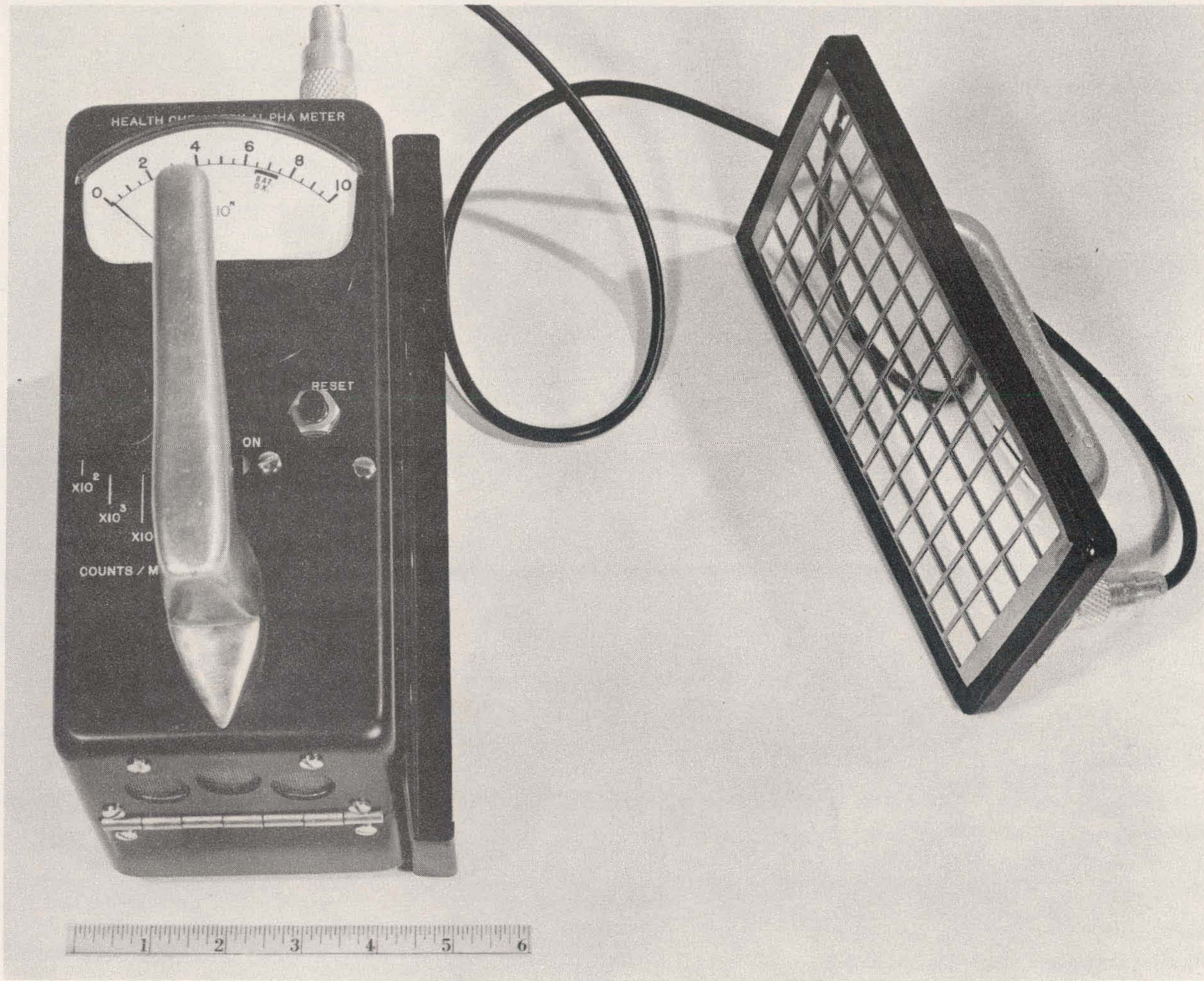

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Fig. 5