EUR 429.e

EUROPEAN ATOMIC ENERGY COMMUNITY - EURATOM

ALPHA RATEMETER WITH SOLID STATE DETECTOR

by

V. MANDL and L. OLIVEIRA

1963

Joint Nuclear Research Center
Ispra Establishment - Italy

Nuclear Chemistry Service

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giving the reference : "EUR 429.e - Alpha ratemeter with solid state detector".

Printed by E. Guyot, s. a.
Brussels, October 1963.

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Brussels, October 1963 - pages 11 - figures 3.

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ALPHA RATEMETER WITH SOLID STATE DETECTOR

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V. MANDL and L. OLIVEIRA *

SUMMARY

A portable alpha monitor with solid state detectors is described. The full scale range is of 1000 p.p.s. and an auditive indication is also provided. The battery life is about 70 hours. The instrument operates correctly in a gamma field up to 8 r/h.

1 — INTRODUCTION

A portable alpha monitor with surface barrier solid state detectors (1) developed in our laboratory, has been built.

The main advantages of these detectors are their small size, light weight, and the possibility to operate them with the same voltage supply used for the electronic circuit. The absence of a high voltage makes the instrument much simpler and more reliable.

The instrument normally uses a single solid state detector of 2 cm^2 sensitive area. These small dimensions are particularly useful to determine located alpha contaminations. If required more detectors can be connected in parallel to increase the sensitive area.

The detector is placed in a probe connected to the monitor by a coaxial cable. This allows the remote operation.

2 — THE DESCRIPTION OF THE CIRCUIT

The circuit diagram of the monitor is shown in Fig. 1. The instrument consists of : a charge sensitive preamplifier, a main amplifier, an audio circuit and the diode pump.

The detector signals are amplified by the charge sensitive preamplifier (T_1, T_2 and T_3) placed inside the probe and supplied through the coaxial connecting cable. This charge sensitive configuration has a dynamic input capacitance of 2 500 pF approximately; it makes possible the interchanging of the detectors and the use of a mosaic type head.

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(1) F. Cappellani, G. Restelli. Construction and Performances of Silicon Surface Barrier Detectors. To be published in Nucl. Instr. and Meth.

The main amplifier has two shaping constants of 2 μsec. The differentiation is placed in the input circuit of the transistor T_4 and the integration network between transistors T_5 and T_6. The signal-to-noise ratio with an equivalent alpha particle of 1 Mev. an external input capacitance of 800 pF, and a reverse current of 1 μA is about 5. Such a low energy has been considered because of the attenuation which the particles undergo through the air and the sheet of aluminium which keeps the detector light protected.

The pulse shaper (transistors T_7, T_8, T_9) drives the audio and measuring circuit (T_{10}, T_{11}). The diode pump supplies a 50 μA meter. The full scale ranges are : 10, 100 and 1000 p.p.s. with the time constant of 5, 2 and 1 sec. respectively.

The overall resolving time is of 50 μsec. The detector and the charge sensitive preamplifier are placed inside a stainless steel probe in order to be easily decontaminated, if required. The detector is shock protected with a metallic mesh. A simple disconnecting system is foreseen providing an easy change of detectors. The complete instrument is shown in Fig. 2.

3 — PERFORMANCES

The instrument operates correctly up to 40° C.

The power is normally supplied from two series connected mercury-cell batteries assuring a rather constant voltage for about 70 hours service. In fixed operation an external power supply may be also used. (Fig. 3)

The solid state detectors are, as well known, almost insensible to gammas. Our monitor has been checked in a gamma field up to 8 r/h of Co^{60} and only a higher noise has been observed in the output of the charge sensitive preamplifier but no pulses were counted. At higher field levels however the noise is of the same order of magnitude as 5,8 Mev alphas.

4 — ACKNOWLEDGMENTS

We wish to thank Dr Bertolini for many useful discussions, Messrs. Cappellani and Restelli for supplying us with the solid state detectors, Messrs. Blocteur and Frippiat for gamma test sources.

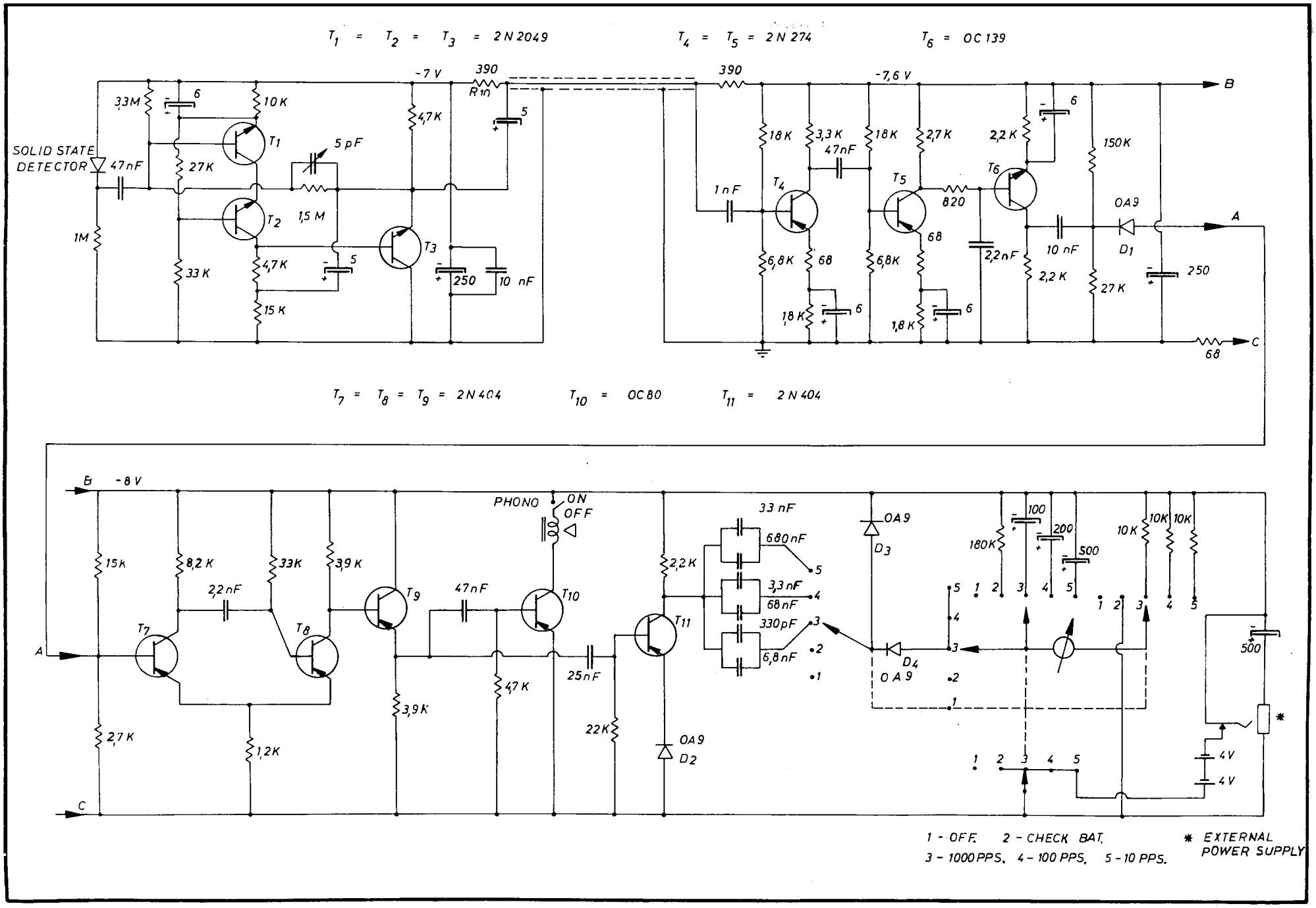

Fig. 1 — The schematic of the monitor. All resistances are in ohms, ¼ W, ± 10 %
and all capacitors in microfarad unless otherwise specified

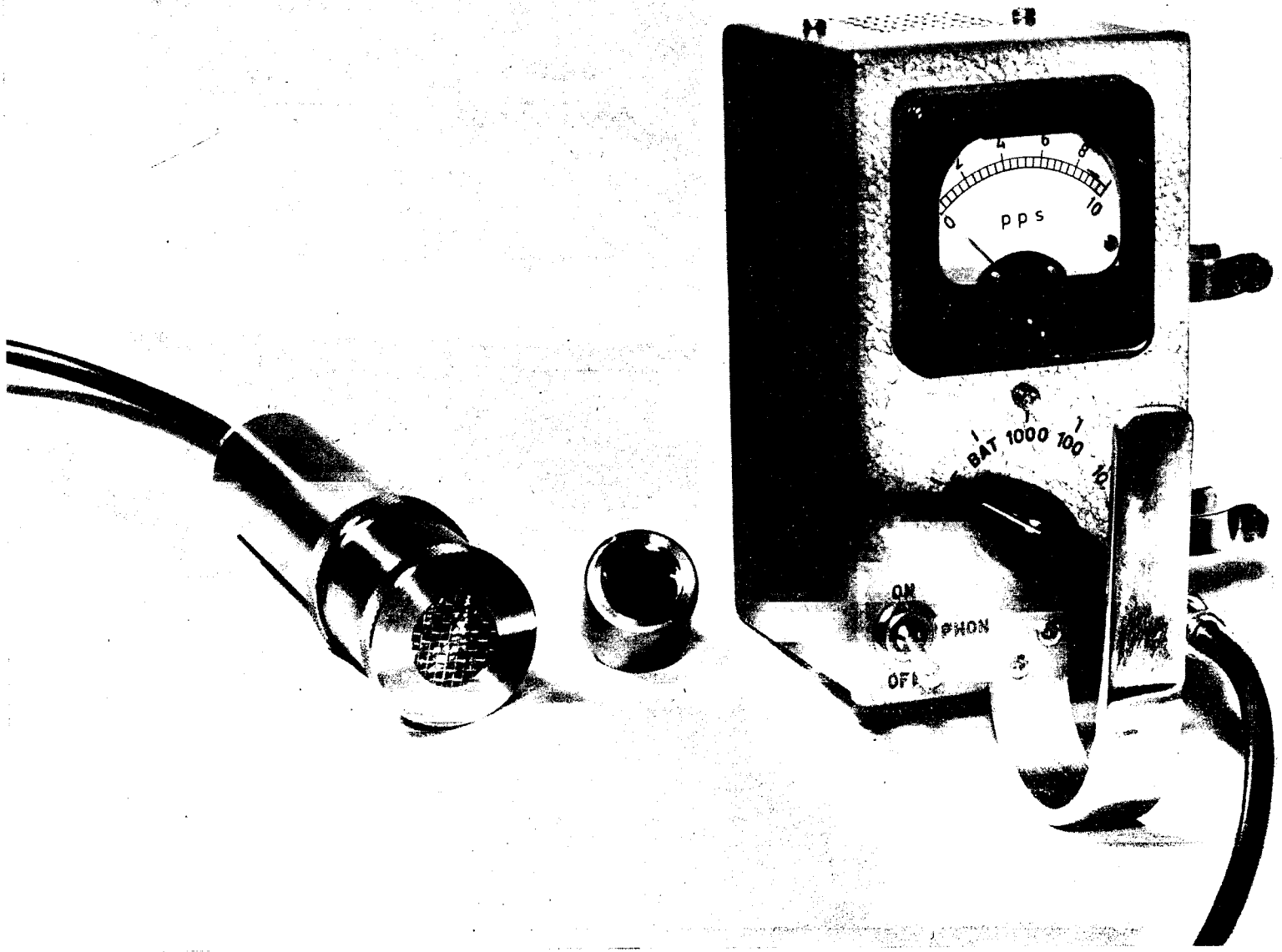

Fig. 2 — The solid state detector alpha ratemeter.

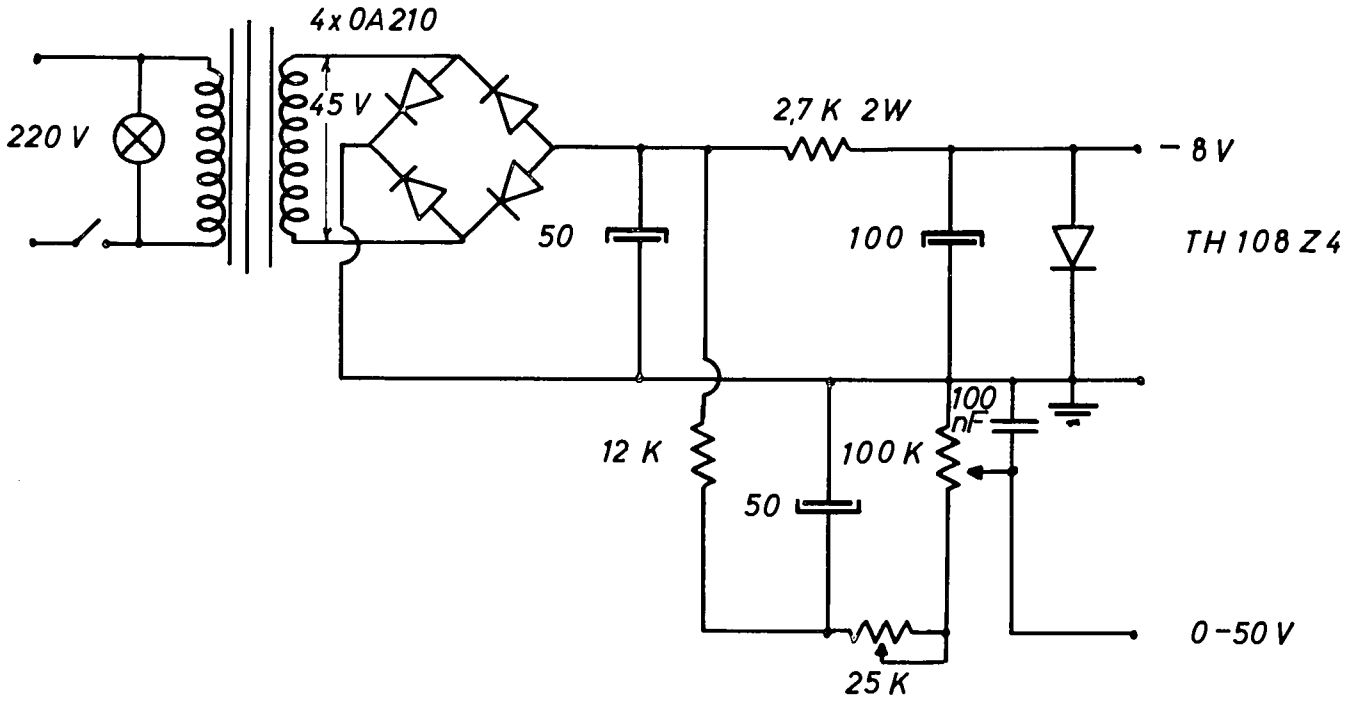

Fig. 3 — The schematic of the external power supply. All resistances are in ohms, ¼ W, ± 10 % and all capacitors in microfarad unless otherwise specified.