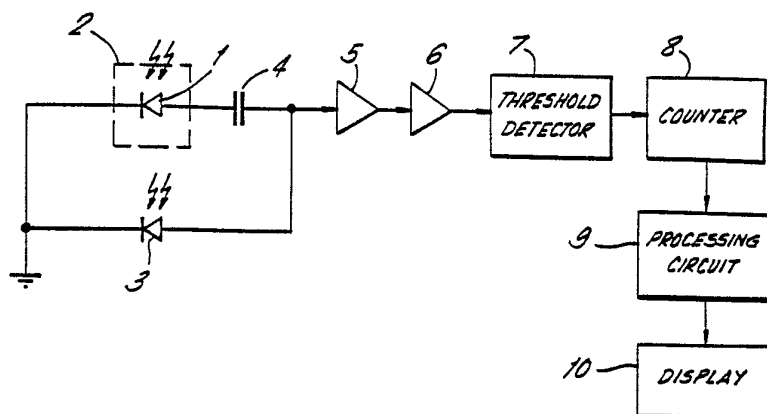




INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(54) Title: RADIATION DETECTOR**(57) Abstract**

A radiation meter comprises two p-i-n photodiodes (1, 3) each disposed to operate in a self-biasing mode. The larger diode has an attenuating shield (2) and the outputs of the diodes are combined. The invention is intended for active personal dose meters for the same general purpose as Geiger-Muller tubes.

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"RADIATION DETECTOR"BACKGROUND OF THE INVENTION

5 The present invention relates to a radiation detector which is particularly though not exclusively intended for use in doseimeters, for example small, active personal doseimeters for the same general purposes as Geiger Muller tubes.

10 The object of the present invention is to provide novel, and at least in some respects, improved detection of radiation.

SUMMARY OF THE INVENTION

15 The present invention is based on the use, in a radiation meter comprising a detector for generating pulses in response to incident radiation and means for indicating the rate of pulses which exceed a threshold, of a detector comprising at least one PIN photodiode structure disposed to operate in a self biasing mode.

20 According to a further aspect of the invention, a detector for generating pulses in response to incident radiation comprises two PIN photodiodes each disposed to operate in a self biasing mode, one of the diodes having an effective sensitive area substantially larger than that of the other and being provided with means for attenuating radiation incident thereon. Preferably the diodes are selected such that the variation of output with incident radiation is compensated by the output from the other. There may be provided means for reducing the amplitude of pulses produced by the larger diode; this means may comprise a capacitor in series with that diode.

35 The aforementioned means for attenuating may comprise a metallic screen, preferably in the form of a brass cap or shield.

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BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates schematically a radiation meter incorporating a detector according to the invention; and

5 Figure 2 illustrates one possible physical configuration of the components in the meter according to Figure 1.

DETAILED DESCRIPTION

10 Figure 1 illustrates by way of example a circuit comprising a detector, constituted in this embodiment by two silicon PIN photodiodes 1 and 3, together with other circuit elements forming a complete meter. In this particular embodiment of the invention the other elements comprise a capacitor 15 4 in series with the diode 1, a preamplifier 5 which is arranged to receive the combined output of the diodes 1 and 3, an amplifier 6, a threshold detector 7, and a counter and timer 8, the elements 5 to 8 constituting, in this embodiment, a means for 20 indicating the rate of pulses which exceed a threshold. The counter may be coupled to a processing circuit 9, which in known manner may produce denoting the dose rate and the total dose and provide an alarm signal if either the dose rate or 25 the dose exceeds a threshold. These signals may control respective sections of a display device 10 (such as a liquid crystal display).

 Considering first the diode 1, which is preferably a silicon photodiode having an intrinsic 30 layer between appropriately doped P and N regions, it will be understood that photon radiation incident on the diode can generate energetic electrons from photoelectric and Compton interactions with the silicon crystal lattice. Such electrons then lose 35 energy by interaction with the crystal lattice and can generate electron-hole pairs within the intrinsic

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layer. The electrons thus generated are separated by the inherent field within the device to form a charge pulse which can be amplified by the preamplifier 5 and the amplifier 6. In this embodiment of the invention, if the charge pulse is in excess of said threshold as determined by the threshold detector 7, the pulse may be counted.

Although a device employing only a single PIN diode in a self-biasing mode has some utility, it exhibits a response which is substantially non-uniform with variation in radiation energy and it is preferable to provide compensation by means of at least one further diode in order to obtain a combined output which is substantially uniform with variation of radiation energy. For this purpose the diode 1, which may be a BPX61 PIN diode, is provided with means for attenuating incident radiation, preferably constituted by a brass cap, typically of the order of 2.5 millimeters thick. The cap is schematically illustrated in Figure 1 by the dashed line 2. The provision of such a cap would normally result in a large underestimate for radiations of energy less than, for example, 150 keV. To compensate for this the output from a smaller diode 3 is added to that from the larger diode 1. The diode 3, which may be a BPX65 PIN diode of which the glass lens is removed to improve the low energy response, may have, for example, approximately 14% of the effectively sensitive area of the diode 1. In addition, a capacitor 4 may be disposed electrically in series with the diode 1 so as to reduce the signal amplitude from the diode 1. In this manner the falling output, from the larger diode, combined with the rising output, from the smaller diode, produces a response which is substantially uniform with respect to radiation energy. For the particular examples of

diode as stated above, the capacitor may be a 180pF capacitor.

Figure 2 illustrates by way of example the physical arrangement of a meter 11 which is electrically arranged according to Figure 1. The diodes 1 and 3 may be incorporated into an integrated circuit 12, which contains all the detection, amplifying and processing stages of the device.

The larger of the two diodes is covered by the brass shield 2. The two diodes should be mounted at least 6mm apart to reduce shadowing by the brass shield 2 of the unshielded diode 3 from low energy radiation. The surface of the integrated circuit in which the diodes are incorporated faces away from the body of the wearer. The shield may comprise a disc which is mounted centrally over the diode 1 and is of significantly larger area than the active area of the diode 1. This configuration has in essence the same properties as the shield described with reference to Figure 1. The display 10, is preferably mounted in the top face of the meter for the sake of good visibility. If desired an audible alarm device 13 (driven by the circuit 9 which is incorporated in the integrated circuit 12) may be disposed adjacent the display 10 and may be triggered by the alarm signal. A battery 14, preferably of sufficient capacity to last at least one year, may be disposed in a recess at the bottom of the meter.

A detector as described may readily be arranged to provide a pulse output which at a suitable threshold is substantially independent of photon energy and angle of incidence for photons of energy greater than approximately 40 keV. Such a device has a sensitivity suitable for employment of the device in an active personal dosimeter.

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A detector as described is capable of providing improved energy response and polar response with respect to known energy compensated Geiger Muller tubes and offer further the advantages of robustness, consistency, cheapness of ease of manufacture and a more accurate background response, in addition to avoiding any need for high voltage electrical supplies.

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CLAIMS:

1. A radiation meter comprising a detector
(1) for generating pulses in response to incident
5 radiation and means (7,8) for indicating the rate of
pulses which exceed a threshold, characterised in
that the detector (1) comprises at least one PIN
photodiode disposed to operate in a self biasing mode.

10 2. A radiation detector for generating
pulses in response to incident radiation
characterised by two PIN photodiodes (1,3) each
disposed to operate in a self biasing mode, one of
the diodes having an effective sensitive area
15 substantially larger than that of the other and the
larger area diode being provided with means (2) for
attenuating radiation incident thereon, and means (5)
for combining the output of each diode.

20 3. A radiation detector according to claim
2 in which the means (2) for attenuating comprises a
thin metallic member.

4. A radiation detector according to claim
25 2 or claim 3, further comprising means (4) for
reducing the amplitude of pulses produced by the
larger diode.

5. A detector according to claim 4 in
30 which the said means (4) for reducing comprises a
capacitor electrically in series with a larger diode.

6. A detector according to any of claims 2
to 5, further comprising means (7,8) for counting
35 pulses which exceed a threshold in the said output.

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FIG. 1.

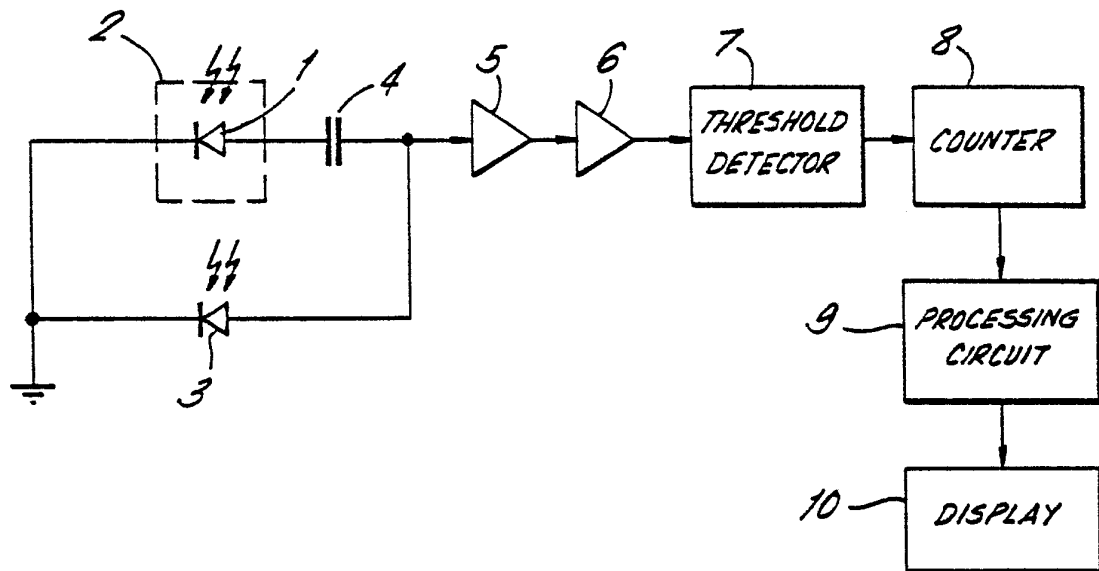
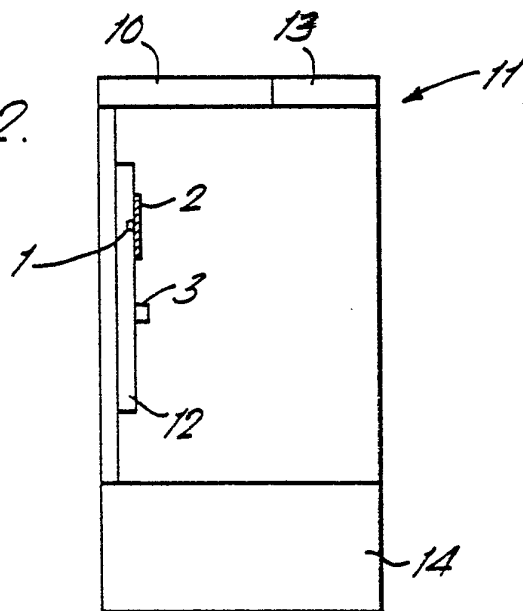
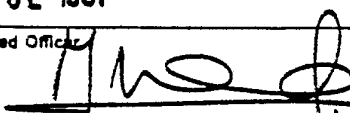


FIG. 2.



INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 87/00148

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) ⁶		
According to International Patent Classification (IPC) or to both National Classification and IPC		
IPC ⁴ : G 01 T 1/00; G 01 T 1/24		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁷		
Classification System	Classification Symbols	
IPC ⁴	G 01 T; H 01 L	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁸		
III. DOCUMENTS CONSIDERED TO BE RELEVANT ⁹		
Category ⁹	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
Y	Int. J. Applied Radiation and Isotopes, vol. 33, 1982 (Oxford, GB), Dixon et al., "Silicon diode dosimetry", pages 1171-1176, see page 1171, introduction, theoretical considerations; page 1173, energy dependance; page 1175, column 1, line 23 - column 2, line 10; page 1176, column 1, lines 32-37; figure 3 --	1-3,6
Y	GB, A, 1014682 (ASSOCIATED ELECTRICAL INDUSTRIES LTD) 31 December 1965, see page 1, lines 15-53; page 2, lines 96-114; figures --	1-3,6
A	Health Physics, vol. 44, February 1983, (Vermont, USA), Nowotny, "A silicon-diode pocket radiation chirpes", pages 158-160, see the whole document -----	1,6
¹⁰ Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. "&" document member of the same patent family		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
11th June 1987	16 JUL 1987	
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ANNEX TO THE INTERNATIONAL SEARCH REPORT ON

INTERNATIONAL APPLICATION NO. PCT/GB 87/00148 (SA 16363)

This Annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 29/06/87

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB-A- 1014682		None	

For more details about this annex :
see Official Journal of the European Patent Office, No. 12/82