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R. FOX
GAMMA PROPORTIONAL COUNTER CONTAINING
HIGH Z GAS AND LOW Z MODERATOR
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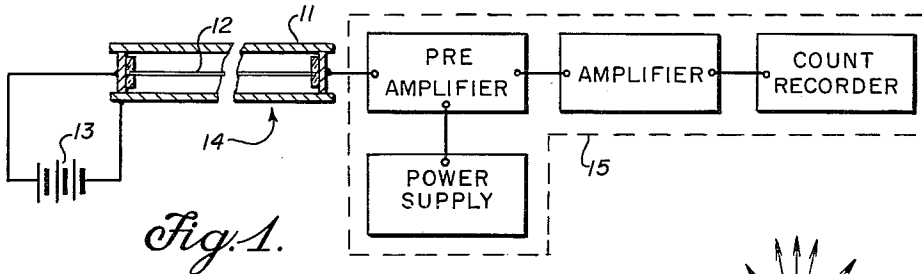


Fig. 2.

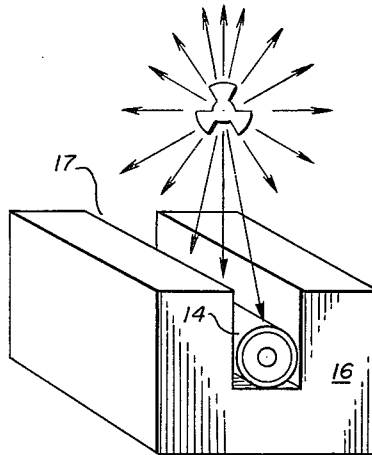


Fig. 3.

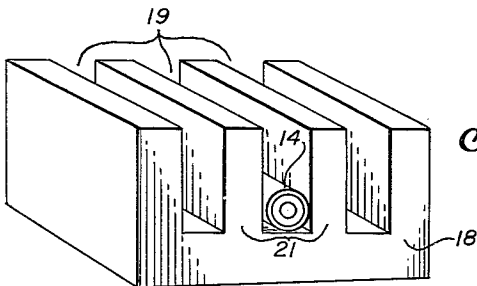
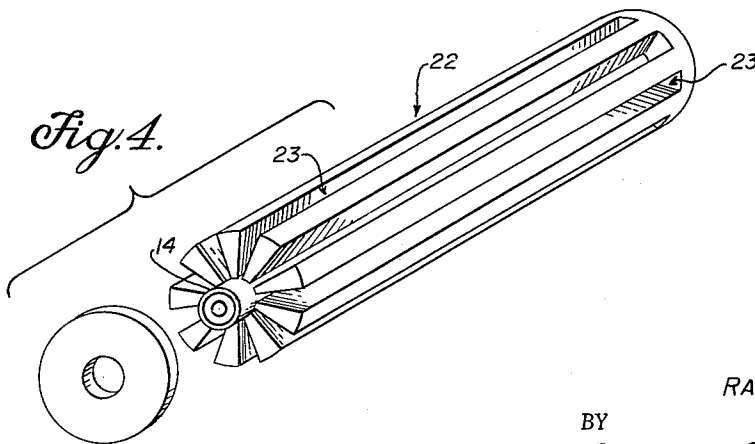


Fig. 4.



INVENTOR.
RAYMOND FOX

BY
Roland A. Anderson
ATTORNEY

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GAMMA PROPORTIONAL COUNTER CONTAINING HIGH Z GAS AND LOW Z MODERATOR

Raymond Fox, Oakland, Calif., assignor to the United States of America as represented by the United States Atomic Energy Commission

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3 Claims. (Cl. 313-93)

The present invention relates to radiation counters and more particularly to gamma radiation counters.

The art of detecting and counting radiation is largely concerned with providing suitable media to interact with the radiation of interest. Radiation interacts primarily with matter in one of three ways: (1) photoelectric absorption, (2) Compton scattering, or (3) pair production. Photoelectric absorption is the most predominant reaction of low energy radiation. This reaction is characterized by an electron absorbing radiation and becoming free from its parent atom. Materials having high atomic number (high Z) provide the most efficient media for photoelectric absorption of low energy radiation.

Radiation of energy greater than approximately 0.5 mev. but less than 5 mev. reacts predominantly by Compton scattering. The Compton scattering reaction is characterized by an electron absorbing a portion of the energy of an incident ray and scattering the ray at a lower energy. This reaction is proportional to the density of electrons in the interacting material and is thus approximately proportional to the density of the reacting material itself. Radiation above 5 mev. reacts appreciably by pair production in high Z material which is of little interest to this invention.

Most gammas of interest have energies of about 1 mev. or higher. Since gammas in the 1 mev. energy region react with matter predominantly by Compton scattering, it is not surprising to find prior art devices employing high density interaction media for detection of gammas. Due to its high density, sodium iodide crystal has become the most widely accepted media for receiving gamma radiation for the purpose of detecting and counting it.

Gamma counters employing sodium iodide crystals as a detection media observe the presence of radiation by light flashes produced in the crystals when a gamma ray and electron interact via Compton scattering. To measure the amount of radiation received a photomultiplier system is employed to indicate the amount of radiation by the number of light pulses from the crystal. While these prior art devices afford a means for detecting and counting gamma radiation, they are both inefficient and costly. They lack efficiency due to the practical limitation on the obtainable size of sodium iodide crystals and are costly due to the electronic equipment needed and the large crystals necessary for operation.

Another device known to the art of radiation detection and counting, but not normally employed in gamma counting is a gas proportional counter. This device is most actively employed in the counting of beta rays, where it provides a gaseous interaction media where beta rays strip off electrons from the gas atoms. The device is designed and used for very low energy radiation counting and is not useful for counting 1 mev. gamma rays. The device has, however, the desirable feature of being inexpensive to build, even for large detection areas.

The present invention provides a radiation counter utilizing a gas proportional counter in combination with a novel moderation means to detect and measure gamma radiation between 0.5 and 5 mev. The efficiency of this counter is greater than prior art counters and can be made substantially independent of gamma energy up to 5 mev.

Accordingly it is an object of this invention to provide

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an efficient, accurate and inexpensive means for detecting and counting gamma radiation.

It is another object of this invention to provide a gamma radiation counter the efficiency of which is energy independent up to 5 mev.

It is still another object of this invention to provide a means for employing a gas proportional counter to measure gamma radiation.

Other objects and advantages of the present invention will be made clear by the following detailed description and accompanying drawings of which:

FIGURE 1 is a sectional view of a gas proportional counter;

FIGURE 2 is an isometric view of the counter of FIGURE 1 in combination with a moderator;

FIGURE 3 represents an alternate embodiment of FIGURE 2; and

FIGURE 4 shows still another configuration of FIGURE 2.

Reference is now made to FIGURE 1 wherein an airtight electrically conducting cylinder 11, e.g., aluminum, has disposed therein a metal wire 12 which is suspended along its central axis. Since wire 12 is electrically insulated from cylinder 11, when a voltage potential is placed between the wire and cylinder as by voltage source 13, such wire acts as an anode while the cylinder acts as a cathode due to the fact that the wire is at the higher potential. Cylinder 11 is filled with a high Z gas, e.g., xenon, which provides the radiation reaction medium. In the arrangement described approximately every gamma reacting with the gas of the proportional counter will be detected. The gas and gamma reaction exhibits itself in the form of electric pulses between the anode 12 and the cathode 11 and a count of these pulses is a measure of the radiation. For a more detailed description of this phenomenon and the theory of gas proportional counters, reference is made to "Nuclear Radiation Detectors" by J. Sharpe, pp. 145-158.

In the modification shown in FIGURE 2 a gas proportional counter 14 as described above is surrounded by a moderator 16 of low Z material. As previously explained the gas proportional counter first described is not capable of counting gammas since they are mainly too high in energy to be absorbed. By surrounding the counter 14 with a material of low Z, e.g., carbon, the high energy gammas are provided with a medium in which they can decrease their energy by Compton scattering yet not be absorbed by the photoelectric absorption process. The gammas will scatter throughout the moderator 16 and many will find their way into the counter 14. When the gammas enter the counter 14 after having been scattered in the moderator 16, they will have low enough energies to be absorbed in the counter and thus be counted.

Two unique properties of gamma rays which experience Compton scattering are that they are not necessarily scattered in the forward direction, but may be scattered at any angle between 0° and 180° and that their percentage energy loss per collision varies with their energy. This means that a high energy gamma ray in the moderator 16 will lose on the average 50% of its energy per collision while a low energy gamma in the moderator 16 will lose approximately 10% of its energy per collision. Also the angular distribution of the scattered gammas become more isotropic with decreasing gamma energy. These two properties of gamma radiation coact to make the probability that a gamma ray in the moderator 16 will enter counter 14 very great. By providing the moderator with a slit 17 the radiation will enter the moderator in the most favorable manner for eventually entering the counter 14. It also will allow the small

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percentage of very low energy gammas to be absorbed and counted directly.

In FIGURE 3 a moderator 18 having a plurality of slits 19 provides more efficient energy means for gamma rays coming from a distance. When the incident radiation is essentially parallel the added number of slits 19 provide more area close to the counter 14 for the radiation to impinge upon. It is necessary to retain walls 21 near the counter, however, so that any scattered radiation entering the counter but still too high in energy to be counted can be further reduced in energy.

In the modification shown in FIGURE 4 a multi-slitted cylindrical moderator 22 provides a means for measuring radiation in an area where the source is not discretely determinable but rather random directioned gamma radiation exists. By arranging the slits 23 so that they are not diametrically opposed, a gamma ray of high energy passing through counter 14 will enter the moderator rather than pass on through a slit on the other side.

A preferred embodiment of the present invention may be constructed as follows: A taut 1 mil stainless steel wire is sealed concentrically in a 2-inch diameter, 28½ inches long, cylindrical glass tube. The inner wall of the tube is coated with an opaque layer of silver for a length of 24 inches. The end portions of the tube are not to be coated but are to be provided adequate insulation between the anode and cathode. External electrical leads and the unshielded end portions of the cathode should be shielded with aluminum foil in regions near the counter and shielded by coaxial cable thereafter.

The sealed tube preferably contains 1½ atmosphere of a mixture of 95% xenon and 5% CO₂. This mixture provides a high photoelectric reaction cross section for low energy gammas. Necessary electronic components include the use of a low noise preamplifier, a high voltage supply, a linear amplifier and a decade scaler. Preferred operating voltage is 2200. The geometry of the selected moderator is that shown in FIGURE 2. Typical dimensions are 3 x 3 x 3 feet. The results of such an embodiment compared to that of a sodium crystal counter favor the present invention by a count-to-cost ratio of six.

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The present invention has been described with reference to but a few preferred embodiments and numerous changes within the spirit and scope of the invention will be apparent to those skilled in the art. It is, therefore, not intended that the invention be limited by other than the following claims.

What is claimed is:

1. In a detector of gamma radiation, the combination comprising a cylindrical gas proportional counter, a high Z gas contained in said counter, and a low Z gamma radiation moderator having a flat base and a plurality of parallel rectangular walls extending from one face of said base, said gas proportional counter being positioned between two of said walls.

2. In a detector of gamma radiation, the combination comprising a cylindrical gas proportional counter, a high Z gas contained in said counter, and a plurality of uniformly spaced cylindrical segments of low Z gamma radiation moderator disposed radially about and extending the length of said cylindrical counter, said segments forming slits, each slit being diametrically opposed to one of said segments.

3. In a detector of gamma radiation, the combination comprising a cylindrical gas proportional counter, a high Z gas contained in said counter, a low Z gamma radiation moderator axially enclosing said cylindrical counter, said moderator having at least one slit therein providing unobstructed passage for radiation to said counter, said slit axially extending the length of said counter.

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